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ALASKA MARINE SCIENCE SYMPOSIUM

JANUARY 27 – 31, 2020

PLENARY SESSIONS - HOTEL CAPTAIN COOK
POSTER PRESENTATIONS - EGAN CENTER
ANCHORAGE, ALASKA

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

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2020 Alaska Marine Science Symposium
Abstracts & Poster Presentations

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The 2020 AMSS Keynote and Plenary speaker abstracts are presented in chronological order

Poster presentations are grouped by day per Wave category

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MONDAY, JANUARY 27, 2020

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Keynote Schedule & Abstracts

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MAIJA KATAK LUKIN, SUPERINTENDENT, NATIONAL PARK SERVICE'S WESTERN ARCTIC NATIONAL PARKLANDS

Local implications of our Changing Weather

Maija Katak Lukin, Iñupiaq, was born in Kotzebue and raised on the shores of Cape Krusenstern National Monument at Sisualik. Her upbringing and traditional lifestyle lead her to advocate for the rights of the people of Northwest Alaska in her professional career, including; Regional Communications Director for NANA Regional Corporation, Environmental Program Manager for the 12 consolidated tribes of Maniilaq Association, and former Mayor of the City of Kotzebue.

Currently, Lukin is the superintendent at the National Park Service's Western Arctic National Parklands. The parks encompass over 9.2 million acres of federal public land in three parks in Northwest Alaska: Cape Krusenstern National Monument, Kobuk Valley National Park, and Noatak National Preserve. Lukin is responsible for protecting and preserving the natural and cultural resources within the parks, as well as community relationship building, subsistence management, and preparing for changes in the Arctic climate.

Katak and her husband reside in Kotzebue and have four children, one granddaughter, two dogs, and several chickens.

CISCO WERNER, PH.D., CHIEF SCIENCE ADVISOR, NOAA FISHERIES

Rapidly changing oceanic conditions: responses and next steps

Francisco "Cisco" Werner is Chief Science Advisor and Director of Scientific Programs of U.S. NOAA's National Marine Fisheries Service (NMFS). He leads NMFS' efforts to provide the science needed to support sustainable fisheries and ecosystems, ending overfishing, rebuilding fish populations, saving critical species, and preserving vital habitats. Cisco supervises the planning, development, and management of a multidisciplinary scientific enterprise of basic and applied research, and he oversees NMFS' Science Centers and Office of Science and Technology. His research has included the development of numerical models of ocean circulation, the effects of physical forcing on lower trophic levels, and the subsequent effect on the structure, function, and abundance of commercially and ecologically important species. He has a Ph.D. in Oceanography from the University of Washington.

SEBASTIEN DE HALLEUX,
CHIEF OPERATING OFFICER, SAILDRONE

THE EVOLUTION OF AUTONOMOUS OBSERVATIONS IN THE ARCTIC USING SAILDRONE'S USVS

Saildrone has conducted five years of Arctic missions in partnership with NOAA and NASA scientists, collecting large amounts of *in-situ* ocean data using autonomous unmanned surface vehicles. This talk will present the results of this successful public-private partnership, and highlight some of the key learnings along the way. Opening new cost-effective ways of studying the Arctic, the Saildrone Arctic fleet has enabled scientists to quantify heat and carbon fluxes, study fish biomass distribution, monitor right whales, perform focal follow of individual tagged seals, and collect hundreds of days of oceanographic data from the remote Bering and Chukchi Seas to the marginal ice zone, often in difficult and dangerous conditions, shedding new insights into the fast changing arctic environment with a minimal environmental footprint.

Sebastien de Halleux is currently chief operating officer at Saildrone, a company that designs, manufactures, and operates a global fleet of wind- and solar-powered ocean drones monitoring the state of the planet in real time. Saildrone's mission is to quantify planetary systems that affect humanity like extreme weather, global fisheries, and carbon fluxes.

Before Saildrone, de Halleux co-founded a video games company called Playfish, which disrupted the industry by turning solitary game play into social experiences. Playfish attracted hundreds of million of users before being acquired by Electronics Arts. He also helped launch one of the very first mobile game companies back when mobiles had black and white screens and actual keypads, which IPOed on NASDAQ.

An internationally recognized leader, recipient of the Tech 100 and Tech Fellow Awards, member of the Aspen Global Leadership Network, de Halleux holds a master's in Civil and Environmental Engineering from Imperial College, London.

ANDREW T. PIETRUSZKA, PH.D., UNDERWATER ARCHAEOLOGIST, SCRIPPS INSTITUTION OF OCEANOGRAPHY

Kiska: Alaska's Underwater Battlefield

In July 2018, members of Scripps Institution of Oceanography and the University of Delaware spent two weeks conducting an exploratory remote-sensing survey to locate and document WWII-era submerged archaeological sites in the waters off Kiska Island, Alaska, one of the last and most remote islands in the Aleutian chain. The often-forgotten Aleutian campaign was the sole WWII campaign fought on North American soil, and Kiska Island is one of the few U.S. territories occupied by foreign forces in the last 200 years. This talk explores the historical context of the Aleutian Campaign, project methodology, and results with an emphasis on the use of autonomous underwater vehicles (AUV) and other marine technologies for archaeological survey. The project was funded by a National Oceanic and Atmospheric Administration Office of Ocean Exploration and Research Grant, and Project Recover.

Dr. Andrew Pietruszka is an underwater archaeologist at the Scripps Institution of Oceanography at the University of California, San Diego specializing in the search, documentation, and recovery of U.S. service members missing in action as a result of our nation's previous conflicts. He received an M.A. in Underwater Archaeology/Maritime Studies from East Carolina University and a Ph.D. in Anthropology from Syracuse University. He has over 17 years of experience conducting underwater archaeological research around the world.

In 2011, he joined the Defense POW/MIA Accounting Agency as a forensic archaeologist overseeing global underwater recovery operations. In 2015, he served as the interim director of DPAA's laboratory at Offutt Air Force Base, Omaha, Nebraska. While at DPAA, Dr. Pietruszka successfully completed 2nd Class Diver training at the U.S. Naval Diving and Salvage Training Center, Panama City, Florida. In 2016, he left public service for an academic research position at the University of Delaware where he continues to serve as the forensic/archaeological expert for Project Recover—a collaborative effort to enlist 21st century science and technology in a quest to find the final underwater resting places of Americans missing in action since World War II.

TUESDAY, JANUARY 28, 2020

GULF OF ALASKA
PLENARY SESSION

PLENARY SESSIONS: TUESDAY, JANUARY 28 — GULF OF ALASKA

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9:00 - 9:15	Zooplankton Abundance Trends and Patterns in the Shelikof Strait, Western Gulf of Alaska 1990-2017: Is a Phenological Shift Underway?	David Kimmel	Lower Trophic Levels
9:15 - 9:30	Effects of Bitter Crab Disease on the Gene Expression of Alaskan Tanner Crabs	Grace Crandall*	Lower Trophic Levels
9:30 - 10:00	COFFEE BREAK		
10:00 - 10:15	What Ever Happened to Alaskan Abalone? Insights and Historical Comparisons of Pinto Abalone Populations in Southeast Alaska	Taylor White**	Lower Trophic Levels
10:15 - 10:30	Exploring the Trophic Ecology of Alaskan Populations of the Giant Pacific Octopus (GPO, *Enteroctopus dofleini*) Through a Multi-Tissue Stable Isotope Analysis	Benjamin Jevons	Fishes and Fish Habitat
10:30 - 10:45	Potential Causes and Consequences of Declines in Chinook Salmon Body Size	Jan Ohlberger	Fishes and Fish Habitat
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*Graduate Student / Master's ** Graduate Student / Doctorate

Novel Expressions of PDO Variability Accompany Warming in the Gulf of Alaska

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As climate change accelerates, different climate properties are expected to change at different rates, raising the potential for novel combinations of climatic and biological state variables that challenge established ecological understanding. Of particular interest in this context are climate indices such as the Pacific Decadal Oscillation (PDO) index. Because the PDO is a statistical pattern driven by many climate processes, expressions of the PDO are prone to change as relationships among the generative processes change. In this study, novel expressions of the PDO are tested for during 2014-2019, a period when the duration and magnitude of Gulf of Alaska temperature anomalies exceeded preindustrial maxima. Commercial catches of pink, sockeye, and coho salmon, lagged to ocean entry, are used as measures of fisheries response to PDO variability. Maps of correlations between catches and basin-scale North Pacific temperature fields resemble the PDO-positive spatial pattern prior to the late 1980s, consistent with the 'canonical' positive PDO-productivity relationship for Gulf of Alaska salmon. From the late 1980s until 2013, correlation maps show a more neutral pattern, consistent with the historical decay in PDO-salmon and temperature-salmon relationships during a period of reduced Aleutian Low variability. During 2014-2019, catch-temperature correlation maps resemble the PDO-negative spatial pattern, suggesting a switch in the sign of the PDO-salmon relationship in the Gulf of Alaska. Possible explanations for this changing relationship are provided by apparently novel relationships between the PDO and a suite of climate variables. Basin-scale sea level pressure and regional sea surface temperature, sea surface height, and wind stress all show relationships to the PDO index during 2014-2019 that appear to be outside the envelope of historical relationships during the previous fifty years. These changes may signal evolving relationships among ecologically important climate variables that are consistent with the concept of novel climates as a consequence of anthropogenic radiative forcing. Accounting for these changing relationships will be important for understanding emerging climate change effects on Gulf of Alaska fisheries.

Multi-Decadal to Multi-Centennial Histories of Climate, Productivity, and Teleconnections in Alaskan Marine Ecosystems

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Over the past decade, dendrochronology (tree-ring) techniques have been increasingly applied to growth-increment widths in the calcified structures of fish and bivalves from the Gulf of Alaska, Bering Sea, and Chukchi Sea. This emerging network of continuous, well-replicated, exactly dated, annually-resolved (one value per year) chronologies yield climate and growth histories of unprecedented length in Alaskan marine ecosystems that can be readily integrated with one another as well as observational climate records. In the Gulf of Alaska, extended bivalve chronologies from Pacific geoduck (Panopea generosa) in combination with tree-ring data provide the first multiproxy history of North Pacific decadal variability. The record is characterized by pronounced regime shifts throughout the Little Ice Age, relative quiescence in the 19th century, and the resumption of regime shifts superimposed on unprecedented warming through the early 21st century. In the Chukchi Sea, a new centennial-length Astarte borealis bivalve chronology captures low-frequency variability that covaries with that in geoduck and demonstrates the unique potential of this proxy to reconstruct high-latitude climate. Finally, histories of Pacific Decadal variability covary with independent reconstructions of the El Nino Southern Oscillation as evidence of consistently strong teleconnections between the North Pacific and tropical climate variability.

Warm Anomalies at Depth in the Northern Gulf of Alaska in Summer 2019

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A marine heat wave (MHW) developed in the northeast Pacific Ocean in the summer of 2019. This event is receiving considerable attention from the climate and fisheries-oceanography communities. Our interest is in the northern Gulf of Alaska near the shelf break, and in particular, the very warm temperatures at depths ranging from roughly 100 to 300 meters. These temperatures actually appear to exceed those that occurred during the recent extreme MHW of 2014-16.T he present study uses a combination of station data from fishery trawl surveys (which include temperature observations on the outer shelf), and gridded data from Argo and NOAA's Global Ocean Data Assimilation System (GODAS), to diagnose the cause(s) of the anomalous warmth at depth, and how they relate to the atmospheric forcing. The results are considered in the context of the GODAS record extending back to 1980. The biological responses to physical oceanographic conditions in 2019 are considered, with a focus on zooplankton and larval fish abundances and distributions.

Impact of the Warm, Dry 2019 Summer on Nearshore Waters in Kachemak Bay Alaska – Rain Versus Glacial Melt?

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Southcentral Alaska, along with other parts of the state, experienced one of the driest and warmest summers on record in 2019, as a result of persistent high pressure patterns over the southern part of the state. Drought conditions fueled extensive wildfires on the Kenai Peninsula and dropping reservoir levels also caused drinking water shortages in several communities. Low precipitation and increased air temperatures can also affect freshwater inputs to Gulf of Alaska estuaries, including Kachemak Bay and Cook Inlet, with decreased flows from a lack of rain, but potentially increased flows from glacial meltwater. Plankton, fish, shellfish and toxic algal species may all be affected by changes in water temperatures, salinities and water column stratification and we are interested in how estuary conditions are affected by seasonal climate perturbations such as the record warm and dry summer of 2019. We used oceanographic and meteorological time series data in Kachemak Bay Alaska to investigate the timing and degree of the response of nearshore water conditions during this period, as well as how that response compared to variability in bay conditions over the past two decades. Continuous oceanographic data from Kachemak Bay National Estuarine Research Reserve water quality stations at the Homer and Seldovia harbors were used to characterize nearshore conditions and conductivity-temperature versus depth (CTD) profiler data from monthly shipboard surveys were used to assess water column conditions.Monthly anomalies were calculated from nearshore temperature and salinity station data against 2002-2019 means, and summer 2019 water temperatures were significantly warmer (1 degree C) and slightly saltier (0.1 PSU) than normal. However, the salinity increase was relatively low compared to anomalies seen in previous years, which may reflect additional freshwater inputs from glacial melting. Water column observations also reflected the warmer than average conditions from surface to depth, as compared to 2012-2019 means, with changes in freshwater inputs reflected in surface salinities, water column stratification and overall freshwater content.

Zooplankton Abundance Trends and Patterns in the Shelikof Strait, Western Gulf of Alaska 1990-2017: Is a Phenological Shift Underway?

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Long-term patterns in zooplankton populations are indicators of ecosystem change and understanding these changes can help predict future ecosystem dynamics. A multivariate approach was used to analyze spring zooplankton abundance in the Shelikof Strait, western Gulf of Alaska: 1) Dynamic Factor Analysis (DFA) was used to estimate if common, multivariate trends were present; 2) DFA and individual time-series were tested for trends; 3) non-linear, generalized additive models (GAM) were used to relate environmental factors to zooplankton abundance. A positive trend in *Calanus marshallae* copepodite stage 5 (C5) and *C. pacificus* C5 and a negative trend in the abundance of *Neocalanus cristatus* C4 and *Neocalanus spp*. (*N. plumchrus* and *N. flemingeri*) C4 abundance were detected. DFA of environmental data found one underlying trend linked to the Pacific Decadal Oscillation as well as local oceanography. DFA of zooplankton time-series also indicated one underlying trend where the positive phase was characterized by increases in the abundance of *C. marshallae* C5, *C. pacificus* C5, *E. bungii* C4, *Pseudocalanus spp.* C5, and *L. helicina* and declines in the abundance of *N. cristatus* C4 and *Neocalanus spp*. C4. GAM models varied by species; however, the most important variables correlating with zooplankton abundance were water temperature, strength of upwelling, and Julian day of sampling. The decline or increase in abundance of several species appeared to reflect a shift in phenology related to temperature effects on development rate. The result can be applied to ecosystem-based fisheries management as shifting phenology impacts the match-mismatch between zooplankton and their predators.

Effects of Bitter Crab Disease on the Gene Expression of Alaskan Tanner Crabs

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Alaskan Tanner crabs (*Chionoecetes bairdi*) are a coldwater crab species found in the Bering Sea, along the Gulf of Alaska, and southeastern Alaska. The southern stocks supported a $21 million fishery in 2014, but warming waters and disease have been threatening their numbers as well as the industry's profits. Bitter crab disease is caused by a parasitic dinoflagellate of the genus Hematodinium, and is considered to be the "principal threat" to crab stocks by the Alaska Department of Fish and Game. Aside from its causing the crabs to become lethargic, among other signs, it renders their meat bitter and chalky. Due to this, the crab industry has been suffering from the loss of marketable product. It is not known how the disease is transmitted, or if it is fatal. It would be useful to have a better grasp of how the parasite affects its host on a molecular level, which is what our study set out to do. We held infected and uninfected crabs in tanks over the course of 2.5 weeks at ambient (8˚C), cold (4˚C), and warm (10˚C) temperatures, sampling their hemolymph at three time points. From these samples, we identified crab genes involved in immune response and temperature response. We were also able to characterize the parasite's transcriptome.These data will provide important insight into the linkages between bitter crab disease, climate change, and pathogenicity.

What Ever Happened to Alaskan Abalone? Insights and Historical Comparisons of Pinto Abalone Populations in Southeast Alaska

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Pinto abalone (*Haliotis kamtschatkana*) in Southeast Alaska experienced continued population decline following the peak years of their commercial harvest, 1978 – 1981. This precipitous decline was shared across the pinto abalone range, Salisbury Sound, Alaska to Baja California, Mexico, and has been attributed to disease, loss of habitat, and overfishing. For these reasons and others, pinto abalone are considered a Species of Concern by National Marine Fisheries Service (NMFS). The growing populations of re-introduced sea otter have also been blamed for declines in Southeast Alaska. However, in select areas, recent surveys show abalone population growth in the presence of predators, including sea otters. These surveys also find that current abalone counts in areas with little to no recent harvest are generally lower than they were historically, during periods of higher harvest. Until 2015, questions on abalone densities and population viability largely remained unanswered. Since then, multiple agencies have worked to address these data deficiencies including: The Alaska Department of Fish and Game, NMFS, The Sitka Sound Science Center, and University of California Santa Cruz. Southeast Alaska is a very large region and abalone populations experience different predation pressures throughout the area, yet uniform limits for personal use harvest persist. The growing number of recent dive surveys have focused on gathering key management parameters including spatially-explicit estimations of critical density and nearest neighbor distances that allow for successful reproduction, recorded recruitment, and population growth. This talk will focus on recent findings from surveys done in Sitka, Prince of Wales Island, and near Ketchikan. We will compare differences across abalone populations with new findings on habitat associations and refuge seeking behavior. Additionally, we will discuss how sea star and sea otter presence correlate with abalone demographics. Data collected sporadically from 1975 - 1997 on abalone population size and structure will be compared to current metrics in these areas. These data will provide managers with a more spatially accurate depiction of pinto abalone populations across their northern-most range.

Exploring the Trophic Ecology of Alaskan Populations of the Giant Pacific Octopus (GPO, *Enteroctopus dofleini*) Through a Multi-Tissue Stable Isotope Analysis

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Due to its rapid growth coincidental with both pelagic and benthic life stages, the giant Pacific octopus (GPO, *Enteroctopus dofleini*), represents a predator and prey species to a variety of marine organisms, and is therefore an important organism in the marine trophic structure. Despite this, our understanding of the trophic ecology of GPOs is limited due to the methodological challenges associated with studying octopus diet in the wild. Stable isotope analyses (SIA) of carbon and nitrogen isotopes are becoming more widely utilized to investigate cephalopod ecology and have begun to yield essential information on their importance in the marine trophic structure. SIA is especially powerful in cephalopods due to the presence of nonmetabolic beaks that retain isotopes in rings laid down over the life of the individual. Measuring the isotopes across these archival tissues may provide insight into diet changes, trophic shifts, and migration occurring throughout ontogenetic development. Here we present the results of a multi-tissue stable isotope analysis of GPOs across Alaska. Arm muscle and beaks were analyzed in the Eastern Aleutians, Lower Cook Inlet, and Prince William Sound, Alaska. Tissues differed significantly in d13C but not d15N between study sites, suggesting similar trophic levels, but potential source variability, between locations. Within Lower Cook Inlet, octopuses possessed significantly different isotope ratios between the mouth of Kachemak Bay and Elizabeth Islands, suggesting persistent local diet differentiation. Beaks exhibited enrichment in d15N from the lower rostral tip progressively to the lateral wall and wings, indicating trophic enrichment throughout the life of the organism. Our results provide the first isotope investigation of GPOs in Alaska and establish SIA as an effective method to track the trophic dynamics of this important Alaskan cephalopod.

Potential Causes and Consequences of Declines in Chinook Salmon Body Size

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Widespread declines in the mean age and size of North American Chinook salmon over the past four decades have been recently quantified, yet the drivers of these demographic shifts and the biological and management implications remain poorly understood. In many Chinook salmon populations along the west coast, older fish are becoming smaller and are returning to spawn at younger ages. This observation is consistent with the potential impact of size-selective mortality and raises the question of whether predation by marine mammals may be generating these trends in Chinook salmon life history characteristics. Abundances of fish-eating resident killer whales have increased over the past 40-50 years in coastal waters of the northeast Pacific Ocean. These predators feed primarily on Chinook salmon, and preferably target the largest and oldest fish. We used a size- and age-based population model for Chinook salmon that incorporates size-selective predation and fishery removals and allows for the evolution of individual growth and maturation. Our simulations suggest that increased predation since the 1970s, but not fishery selection alone, can explain the changes in age- and size-structure observed for North American Chinook salmon populations. The decline in mean size results from the selective removal of large fish and an evolutionary shift toward faster growth and earlier maturation. Our conclusion that intensifying predation by fish-eating killer whales contributes to the continuing decline in Chinook salmon body size points to conflicting management and conservation objectives for these iconic species. Furthermore, continuing declines in mean size of spawners might need to be accounted for when estimating reference points for fishery management. Future work will evaluate the consequences of declining reproductive potential for estimating reference points, and use management strategy evaluation as a tool to guide future management of Chinook salmon.

Influence of Embryonic Crude Oil Exposure on Overwinter Fasting and Disease Susceptibility in Juvenile Pacific Herring (*Clupea pallasi*)

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After the 1989 Exxon Valdez oil spill (EVOS) and the subsequent Pacific herring collapse of Prince William Sound, research focused on early life stage susceptibility to oil-derived contaminants like polycyclic aromatic hydrocarbons (PAHs). While the role of the spill in the collapse is still debated, it is clear that herring experience long-term cardiovascular dysfunction after embryonic exposure that may lead to delayed mortality. Delayed mortality is hypothesized to occur through multiple mechanisms including compromised cardiorespiratory performance, lipid dysfunction, and sensitization to infectious diseases like viral hemorrhagic septicemia virus (VHSV) and ichthyophonus. Since first-year survival is a strong predictor for recruitment and population fecundity, delayed mortality after early oil exposure could have significant population impacts. In these experiments we addressed whether crude oil exposure during early development influenced the ability to survive challenges of overwinter fasting or sensitivity to infectious disease. We exposed herring to Alaskan North Slope crude oil until 10 days post fertilization via a dispersion generator that produced concentrations ranging from 0-3.5 ppb ∑PAHs. After hatching into clean seawater and growth to juvenile stages, experiments were conducted in a full factorial design (n=3) for oil dosage (0, 1.5 ppb ∑PAHs) and feeding regime (fed, unfed) for the overwinter challenge and infection type for the disease challenges. Overwinter fish were sampled for condition factor, lipid composition, and RNA sequencing. Mortality during overwinter fasting occurred at a similar rate, but at a time point 19% earlier than controls ($p<0.0001$) in juveniles that experienced embryonic oil exposure. This was not associated with differences in condition factor ($p=0.6$). Lipid composition and RNA sequencing data will provide additional details on the bioenergetics of fasting fish previously exposed to oil. During viral disease challenge, mortality did not differ between oil treatments and an ichthyophonus challenge is currently underway. Therefore, our data do not currently support the role of VHSV in delayed mortality of Pacific herring after embryonic oil exposure. This is the first report of higher mortality of previously oiled fish during overwinter fasting and supports the hypothesis that embryonic exposure may have bioenergetic consequences at later life stages.

A Bayesian Analysis of the Utility of Ecosystem Information in a Stock Assessment Model of Prince William Sound Herring

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The failed recovery of the Prince William Sound herring population following its collapse in the 1990s is not well understood. Many hypotheses explaining reductions in annual numbers of recruiting juvenile herring and adult survival have been suggested, but little consensus on predominant drivers has been reached. Furthermore, much of the preceding hypothesis testing work is outdated in light of rapid ecosystem changes as well as improved statistical analysis techniques. For example, population and linear models representing hypotheses in previous work are caveated by correlative rather than predictive relationships, or improper assumptions about uncertainty in the data, process, and model itself. Stock assessment models used by fisheries management provide a unique tool for hypothesis evaluation because they synthesize and statistically weight various sources of information to produce the best fit or explanation of the data. We evaluate previous and new hypotheses with a recently developed Bayesian age-structured stock assessment model (BASA) for Prince William Sound herring. Recent innovation in efficient Bayesian estimation algorithms and Bayesian model selection allow us to take a novel approach to hypothesis evaluation by directly incorporating various types of uncertainty to determine the model(s) that have the greatest improvement in predictive ability. Factors from the physical environment (e.g. air temperature, PDO, NPGO) and interspecific interactions (e.g. abundances of humpback whales, walleye pollock, Pacific cod) are individually incorporated as covariates or latent variables in BASA to produce a suite of models for comparison using values of the Deviance and Watanabe-Akaike Information Criteria, and Posterior Predictive Loss. NPGO, walleye pollock spawning biomass, and Pacific cod effects on adult survival resulted in the best values of all selection criteria and greatest improvement in model predictions. Since the values of these effects are representative of the entire Gulf of Alaska, our results suggest regional bottom-up and food web interactions likely have a key role in recent adult herring mortality and overall biomass dynamics. By directly using BASA to determine important ecological factors connected to variability in herring mortality, we also provide a robust framework for incorporating ecosystem information with uncertainty into biomass projections used by fisheries management.

Reconstructing Reproductive Life Histories Using Hormones Recovered from Incrementally Grown Structures in Fish

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Assessments of spawning stock biomass are crucial for setting catch limits for commercial fisheries. These measures rely on abundance estimates, size or age of maturity, and spawning frequency. Such key life history parameters are estimated through seasonal sampling surveys, but the timing of such surveys can influence the capture and detection of spawning individuals and only provides a snapshot of a population's reproductive capacity. Additionally, variability in the age an individual enters the spawning population and spawning frequency can be difficult to assess using traditional methods. To make accurate estimations of spawning stock biomass and reproductive potential, methods need to be developed that can recreate reproductive histories and assess spawning frequency. Chemical and elemental signatures present in biological structures that retain seasonal growth patterns (e.g. otoliths, scales, fins, and bones) have been used to reconstruct migration events and seasonal growth patterns. We hypothesized that such structures could also provide a record of an individual's reproductive history by retaining hormones. To test this hypothesis, we extracted reproductive hormones from annual growth increments in bones from yelloweye rockfish (*Sebastes ruberrimus*), blue tuna (*Thunnus orientalis*), and black rockfish (*Sebastes melanops*). Results indicated hormone concentrations varied temporally within each structure and the resulting profiles allowed us to make inferences regarding the age of sexual maturity, reproductive frequency, and senescence. Such reconstructions of individual reproductive histories can be used to test assumptions of age at maturity and spawning frequency and examine how environmental factors may influence reproductive potential. Work is currently being conducted to refine methods and validate assumptions regarding data interpretation by comparing maturity status (via gonad development) and blood hormone levels to those recovered from hard parts. This new method could help fishery managers assess current paradigms and assumptions associated with age-based management and stock assessment for a variety of long-lived species and do so within the context of environmental change.

Longitudinal Trends in Hormones and Development of Reproductive Parameters of a Long-Lived Teleost

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Yelloweye rockfish (*Sebastes ruberrimus*) are a long-lived (> 100 years) teleost that is targeted by commercial, recreational, and subsistence fisheries in Alaska. Little is known about their reproductive and stress physiology and stocks are managed based on the assumption that females spawn each year after 20 years of age. In this study, reproductive (estradiol and progesterone) and stress related (cortisol) hormones were extracted from annually deposited growth increments (GIs) in opercula bones of female yelloweye rockfish. These opercula have visible GIs similar to tree rings making aging and sampling of those increments relatively simple, but younger GIs in older fish (> 20 years) are not visible due to a yellow substrate (YS) in the opercula. To timestamp these GIs, a sampling paradigm was developed based on known widths of visible GIs to establish a standardized sampling protocol across opercula. These data provided lifetime progesterone, estradiol, and cortisol concentrations on an annual timescale. Initial linear regression analyses revealed hormone profiles were highly correlated with one another ($P < 0.001$ all comparisons, $R2= 0.92$ for cortisol and estradiol, $R2=0.89$ for progesterone and cortisol, and $R2 = 0.87$ for estradiol and progesterone, a 38 year-old female). These hormone profiles were used to estimate age of sexual maturity and spawning frequency. Preliminary analysis of Z-scores among hormones measured along opercula GLGs of a 38-year old female yelloweye rockfish revealed a peak in estradiol and progesterone above baseline concentrations (i.e., Z-score > 0) at approximately 20 years. A spawning event was identified after sexual maturity if estradiol and progesterone both had Z-scores > 0. Thus, spawning frequency was 52% (i.e., there was a 52% chance this sexually mature female would spawn in a given year). While preliminary, these data are similar to reported ages of sexual maturity for yelloweye rockfish in the Gulf of Alaska and elucidates skipped spawning events that are beginning to be documented in other rockfish species. These hormone trends provide a potential method for determining key reproductive parameters needed for conservation of this commercially targeted species and give insight into stress and reproductive physiology of a long-lived teleost.

Developing Genetic Markers to Describe Population Structure for Black and Yelloweye Rockfish in Alaska: A Critical Management Need

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Black rockfish (*Sebastes melanops*) and yelloweye rockfish (*Sebastes ruberrimus*) are the two most fished rockfish species in Alaska. In recent years, the sport fish harvest of these two species have rapidly increased, while commercial harvest have remained relatively stable. Sport and commercial fisheries are managed separately using different tools and different regulatory areas.Sport fisheries are managed based on bag limits while the commercial fisheries based on guideline harvest levels. Both of these management tools require stock-based management and assessment strategies to maintain sustainable rockfish fisheries throughout the state.The first step for implementing these strategies is to identify and delineate the “stocks” by investigating population structure.Genetic markers have been used to investigate population structure by examining restrictions to gene flow among populations. Allozyme, mitochondria DNA, and microsatellite markers have been used to study population structure of rockfish along the Pacific coast in the past. Single-nucleotide polymorphism (SNPs) markers can provide more statistical power for the same cost as markers used in the past. The first step to developing new SNP markers is to sequence multiple individuals from each species representing multiple potential populations.We used restriction-site associated DNA sequencing (RADseq) method, a newer and cost-effective method, to sequence black rockfish from six locations and yelloweye rockfish from five locations throughout Alaska. We compared the resulting sequencing with the published reference sequences to develop 96 useful SNPs for investigating population structure that work across both species. This set of SNPs will provide a cost-effective means to examine population structure for both species by using a single set of assays. Previous researchers have found that rockfish population structure is associated with the boundaries between oceanographic domains (e.g. inside protected, and outside open waters) or geographic distance. We will use the newly developed SNP markers to evaluate the population structure of black and yelloweye rockfish from inside and outside waters proximate to Prince William Sound, North Gulf of Alaska, and Southeast Alaska.

A Disaster in the Making: Heatwaves and Pacific Cod in the Gulf of Alaska

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In 2014–2016 an unprecedented warming event in the North Pacific Ocean triggered changes in ecosystem of the Gulf of Alaska (GOA) impacting fisheries management. The marine heatwave was noteworthy in its geographical extent, depth range, and persistence, with evidence of shifts in species distribution and reduced productivity. In 2017 groundfish surveys indicated that GOA Pacific cod (Gadus macrocephalus) had experienced a 71% decline in abundance from the previous 2015 survey. The GOA Pacific cod fishery had supported a $103 million (2007-2016 mean first wholesale value) fishery which was 29% of the groundfish harvest value in the GOA. The allowable biological catch for the 2018 fishery was reduced by 80% from 2017 and the resulting fishery landings value was reduced to $32 million. This 69% decrease from the 10-year average was a substantial economic loss for the region. On September 25, 2019 the Gulf of Alaska Pacific cod fishery was declared a fishery disaster by the Secretary of Commerce. We hypothesize that this disaster can be attributed to an increase in metabolic demand in Pacific cod and reduced prey supply during the extended marine heatwave leading to poor body condition and higher mortality. Although increased mortality likely led to the decline in the Pacific cod population, historically low recruitment concurrent with the heatwave portends a slow recovery for the stock and gives a preview of impacts facing this region due to climate change. This talk will explore the intersection of climate change with ecosystem-based fisheries management in the context of GOA Pacific cod with a description of the sensitivities of the ecosystem, how the changes in the ecosystem affected the Pacific cod stock, and a description of how the management system in the North Pacific handled this shock. We also take a look into the future of Gulf of Alaska Pacific cod in a warming world.

Removal of Introduced Mink Initiates the Recovery of an Important Pigeon Guillemot Sub-Population in Prince William Sound that was Damaged by the Exxon Valdez Oil Spill

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Removal of introduced predators can be an effective tool for restoration of island-nesting seabirds. Pigeon guillemots (*Cepphus columba*) are a formerly abundant breeding seabird at the Naked Island Group in central Prince William Sound (PWS), where the subpopulation declined by >95% from 1979 to 2014. This protracted decline was concurrent with (1) a regime shift in the Pacific Decadal Oscillation during the late 1970s that negatively affected key forage fish stocks throughout the Gulf of Alaska, (2) the Exxon Valdez oil spill in 1989, which directly killed about 1,500 guillemots in PWS and impacted their food supply, and (3) the introduction of American mink (Neovison vison) to the Naked Island Group. To elucidate the role of mink predation in limiting this sub-population of guillemots, we studied guillemots nesting at the Naked Island Group spanning mink removal efforts, which began in 2014. During 2008-2014, the numbers of guillemots nesting at the Naked Island Group were in decline, while at nearby mink-free islands guillemot numbers were increasing slowly. In 2015, the first year following the initiation of mink removal, we observed a 38% increase in the numbers of guillemots at the Naked Island Group, and a 268% increase by 2019 compared to 2014. During this 5-year period, numbers of guillemots at nearby mink-free islands continued to increase slowly. We also observed a dramatic increase in numbers of active guillemot nests at the Naked Island Group following mink removal, from 11 nests in 2014 to 52 nests in 2018. This increase in guillemots and guillemot nests at the Naked Island Group was likely in response to the observed reduction in predation rates on nestling and adult guillemots following mink removal. There was also an increase following mink removal in the proportion of active guillemot nests in sites that were accessibility to mink. These changes likely enhanced immigration rates of prospecting guillemots from nearby sub-populations, resulting in the rapid response in guillemot numbers. Results indicate that the removal of introduced mink from the Naked Island Group was effective in initiating the recovery of what was formerly the largest aggregation of nesting guillemots in PWS.

Harmful Algal Blooms and Alaskan Seabirds: An Emerging Issue in Northern Waters?

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Harmful algal blooms (HABs) produce biotoxins that can injure or kill shellfish, fish, wildlife, and humans. These blooms occur naturally but have been increasing in frequency and severity worldwide due to recent climatic changes, including warming ocean temperatures. Such changes are especially pronounced in northern regions, where the effects of HABs on Arctic and Subarctic wildlife are of growing concern. In Alaska, unusually large seabird mortality events have occurred annually since 2015 and have affected numerous species, including murres, fulmars, shearwaters, puffins, gulls, auklets, and terns. To investigate possible causes of these die-offs and to better understand the geographic extent, timing, and impacts of algal toxins in Alaska marine ecosystems, we tested seabird tissues and forage taxa for saxitoxin (STX) and domoic acid (DA). STX was detected commonly in both die-off and apparently healthy birds across multiple species, locations, seasons, and years as well as in a variety of forage fish and marine invertebrates. DA was commonly detected in forage fish but was much less prevalent in seabird samples. Concentrations of STX in tissues collected from Northern Fulmars (*Fulmarus glacialis*) in the Bering and Chukchi sea region in 2017 and from Arctic Terns (*Sterna paradisaea)* in southeastern Alaska in 2019 were of similar magnitude to those reported from other STX-induced die-off events, suggesting that HABs may have played a role in bird mortality in these cases. Our research has demonstrated widespread occurrence of algal toxins, particularly STX, in Alaskan marine environments across multiple trophic levels. Additionally, STX has been implicated as a likely contributing factor in two recent seabird die-offs in northwestern and southeastern Alaska. These findings suggest that HABs present a hazard to Alaskan seabirds and other marine consumers and therefore warrant additional research.

Aleutian Tern Abundance at Nest Colonies Based on Unmanned Aerial Systems (UAV) Photography

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The Aleutian Tern (*Onychoprion aleuticus*) is an uncommon seabird that nests in coastal areas of Alaska and Russia. Renner et al. (2015) estimated a population decline of 8.1% annually since 1960 at known Alaskan colonies. Ground-based counts of Aleutian Terns are problematic because tall vegetation may obscure nests and observers may disturb nesting birds. As part of an effort to develop a statewide monitoring program, we tested the use of low-altitude photography obtained from unmanned aerial vehicles (UAV) as a method to estimate abundance at individual nesting colonies. In early June 2018, we used UAVs to photograph terns at even colonies in Kodiak, Kenai, and Yakutat, Alaska at 15 m above ground, collecting nearly 11,000 photos. No adverse effects on tern behavior were apparent during flights at this elevation. We developed a semi-automated aerial image object detection as photo recognition system to count Aleutian and Arctic Terns (*Sterna paradisaea*), frequently nesting in mixed colonies, based on Deep Learning, using a convoluted neural network. We measured tern density after computing photo footprint size. Terns proved relatively easy to identify in UAV photographs, but differentiating Aleutian and Arctic terns was not reliable. The semiautomated counting method estimated densities ranging from 0-4 terns per hectare (both species combined) across all seven colonies. We estimated tern abundance to be approximately 266 at Black Sand Spit (Yakutat), 2 at Kenai, 0 at Homer, and for four sites on Kodiak Island, 0 at Burton Ranch, 62 at Kalsin Bay, 14 at Middle Bay, and 20 at Women's Bay. Our results suggest that drones can be an effective tool in monitoring sensitive terns at nesting colonies, even applied to colonies of various sizes and landcover types. More broadly, our method demonstrates the utility of UAVs in surveying wildlife in field conditions where human survey is unreliable or not feasible.

Calibrating and Adjusting Counts of Harbor Seals in a Tidewater Glacier Fjord in Glacier Bay National Park to Estimate Abundance and Trends from 1992 to 2017

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Long-term monitoring for understanding status and trend of species of conservation concern is undeniably valuable, yet monitoring methods often evolve over time due to the development of new technology, fluctuations in funding, logistical constraints, and innovations in sampling methods or analytical approaches. Consequently, valuable insights into annual or decadal-scale trends can be lost unless calibration between historical and current methods are developed. Glacier Bay National Park, in southeastern Alaska, hosts an important regional population of harbor seals, with the majority of seals pupping and molting on icebergs calved from a tidewater glacier in Johns Hopkins Inlet. Monitoring efforts to assess abundance and trends of harbor seals used counts of seals by shore-based observers from 1992-2002, but transitioned to aerial photographic surveys in 2007 through 2017. To produce a rigorous long-term evaluation of abundance and trends of harbor seals we (1)conducted concurrent shore-based counts and aerial photographic surveys in 2007 and 2008; (2) developed an analytical calibration between the two monitoring methods; (3) developed a haul-out model to estimate the number of harbor seals in the water at the time of counts; and (4) estimated abundance and trends of harbor seals from 1992-2017 from the adjusted counts. Our calibration analysis revealed that during the pupping season in June, counts of harbor seals by observers from shore were consistently lower than counts from aerial surveys. During the molting season, counts by shore-based observers were only slightly less than aerial photographic surveys, and there was an interaction between survey method and season. After calibrating methods we found important decadal-scale changes in trend. Over the 26-year period (1992-2017), the estimated trend was negative; however, trends computed for rolling 10-year time intervals showed steep and significant declines ending around 2011, with leveling off and possibly some subsequent recovery. The most recent shorter-term (2013-2017) trends are negative again, rivaling the steepest decreases over the 26-year period. Our calibration between two monitoring methods improved continuity for long-term monitoring for a species of conservation concern by taking advantage of new sampling methods and innovations in analytical approaches.

An Epigenetic Clock to Estimate the Age of Cook Inlet Beluga Whales

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Age is a critical biological parameter for conservation and ecology. In cetaceans, accurate age data can improve population models by more accurately measuring reproductive rates, age at sexual maturity, lifespan, and familial relationships. Despite the utility and importance of age determination, a method to easily and accurately age living cetaceans has been elusive. Epigenetic methods present the most promising new tool for developing molecular biomarkers for estimating age. Recent research has reported correlations between age and methylation levels of specific cytosine-guanine dinucleotides (CpG sites) in the genomes of several species. These correlations have been leveraged to design 'epigenetic clocks' in mammal species including humans, mice, canids, chimpanzees, humpback whales, and bats. We present the first epigenetic clock for the beluga whale, Delphinapterus leucas, focusing on the distinct population segment in Cook Inlet, Alaska. This population is listed as endangered under the U.S. Endangered Species Act and depleted under the U.S. Marine Mammal Protection Act. Previous methods for aging individual beluga whales depend on counts of growth layer groups from teeth collected from dead whales. Here, we measured methylation levels at 37,488 CpG sites using a custom Illumina methylation array and a calibration dataset of known-age beluga whales that had been hunted, beach cast, or stranded (n = 71). An elastic-net, machine-learning algorithm was used to develop predictive multiple linear regression models that uses approximately 30-60 methylation sites. The best performing clocks had an r-squared value of approximately 0.92 and a median age error under three years. As a first step in establishing an age structure for the Cook Inlet population, we applied the calibrated epigenetic clock to 40 living beluga whales of unknown age using skin samples collected with a biopsy dart between 2016 and 2018. This research demonstrates the power of epigenetics to generate tools that will improve conservation and management of beluga whales throughout Alaska and the Arctic. The methods described here are applicable to any species of cetaceans and will aid in the future development of other epigenetic clocks.

The Alaska Beluga Monitoring Partnership: A Collaborative Citizen Science Monitoring Effort Exploring Endangered Beluga Habitat Use at Multiple Sites in Alaska's Cook Inlet

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Five populations of beluga whales (*Delphinapterus leucus*) inhabit the waters off Alaska's coasts, including the Cook Inlet beluga, a small geographically isolated population that resides exclusively within Alaska's Cook Inlet. Following a 75% decline in abundance, the Cook Inlet beluga was listed as endangered in 2008 and has since exhibited no signs of recovery. Although extensive scientific research has sought to understand beluga ecology and conservation in Cook Inlet, baseline data on beluga habitat use and disturbance at key foraging sites is limited. Contrary to other beluga populations in the state, Cook Inlet belugas inhabit the waters surrounding Alaska's largest human population center and can be observed from a variety of public sites, including highway pullouts, boat launches, and city docks. These characteristics make the Cook Inlet beluga population particularly well-suited for citizen science monitoring, wherein trained members of the public record and submit their beluga sighting data to the individuals and agencies facilitating Cook Inlet beluga recovery. Launched in 2019, the Alaska Beluga Monitoring Partnership (AKBMP) is a citizen science monitoring program supported by federal agency, non-profit, and university partners. The AKBMP is based in Anchorage, Alaska and trains members of the public to monitor beluga activity at five known foraging sites in Cook Inlet, during which they collect data on beluga presence, age class, behavior, and disturbance. Since this program commenced on August 15, 2019, over 100 members of the public have completed the AKBMP citizen science monitoring training and now conduct regular beluga monitoring sessions in the region. This presentation provides an overview of this partnership and monitoring program and presents preliminary findings from the AKBMP's first collaborative field season. Although the AKBMP remains in the early stages of its development, this program has already facilitated valuable cross-boundary collaboration between scientists and the public and provides a compelling example of how citizens can collect important baseline ecological data that directly contributes to endangered species conservation and recovery efforts.

The First Ocean Guardian School Program in Alaska: Inspiring Marine Stewardship in Schools

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The Ocean Guardian School Program started in 2010 in California as a joint effort between the National Oceanic and Atmospheric Administration (NOAA), National Marine Sanctuaries (NMS) and NMS Foundation as a commitment to the protection and conservation of local watersheds, the world's ocean, and special ocean areas, like national marine sanctuaries. Schools commit to and implement a school- or community-based conservation project. Schools can take one of five project pathways, which include reducing marine debris, recycling, watershed restoration, creating schoolyard habitats, or reducing energy use. During the 2018-2019 school year, the National Marine Fisheries Service Alaska Region partnered with NMS and local schools to pilot this program in Juneau. Thunder Mountain High School and Sayiék Gastineau Community School achieved their objectives and in August 2019 became the first official Ocean Guardian schools in Alaska. During the school year, students learned about marine conservation, collected measurable data, and communicated their findings to their school and community. Both schools committed to reducing single-use plastics, conducting waste audits, cleaning up Juneau beaches, and educating students, teachers, and the community about the impacts of marine debris on watersheds and oceans, and on the wildlife that inhabit these areas. Thunder Mountain High School students sold bracelets made from marine debris, coordinated and improved their recycling program, and reduced single-use water bottle use. Sayiék Gastineau Community School reduced single-use plastic by replacing plastic sporks with reusable silverware donated by school families. The students estimate that they eliminated 28,000 sporks from entering the landfill during the 2018-2019 school year. These schools are continuing their commitment during the 2019-2020 school year; ultimately, the goal is to expand the Ocean Guardian School Program to other parts of the state. If children become marine stewards at a young age, there is a high likelihood they will continue to protect the ocean as they become adults. For more information visit: https://sanctuaries.noaa.gov/education/ocean_guardian/.

Sustaining an Alaska Coastal Community: Integrating Place Based Well-being Indicators and Fisheries Participation

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Integrated Ecosystem Assessments (IEAs) are an increasingly used process to evaluate ecosystem goals, objectives and the current socio-ecological status of the ecosystem, and to guide the examination of management alternatives across multiple social, economic, and environmental outcomes. This presentation focuses on the results of a project intended to inform the fisheries management process in the North Pacific with a set of quantitative indicators that are related to multiple dimensions of human well-being and community connections to fisheries activities. As part of the Gulf of Alaska IEA, a team of researchers conducted a targeted effort aimed at understanding the linkages between fisheries and community well-being for Sitka, the most active commercial fishing community in Southeast Alaska. This presentation examines the results of that effort, showcasing a methodology of applying the well-being framework to develop locally relevant indicators that can be used to track how fishery shocks may reverberate through social systems and affect fishing communities. Furthermore, it demonstrates information on local values and complex dynamics between community well-being and fisheries uses that have been heretofore difficult to conceptualize and integrate into management decisions.

Development of a Predation Index to Assess Trophic Stability in the Gulf of Alaska

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Predation can have substantial and long-term effects on the population dynamics of prey species. Diverse predator assemblages, however, may produce stabilizing (i.e., 'portfolio') effects on prey abundance when consumption varies asynchronously among species. We developed a predation index for Walleye Pollock (*Gadus chalcogrammus*) to quantify portfolio effects and better understand diversity-stability relationships in the Gulf of Alaska, a large marine ecosystem that has recently undergone considerable changes in community composition. We selected pollock as our focal species because they support some of the largest commercial fisheries and serve as essential prey for a number of economically and culturally important species. Spatially-explicit predation indices accounted for annual variation in predator biomass, bioenergetics-based rations, and age-specific proportions of pollock consumed by key groundfishes in the Gulf of Alaska (1990 to 2015). We found that Arrowtooth Flounder (*Atheresthes stomias*) was, by far, the dominant pollock predator. We also found synchronous trends in consumption among pollock predators, indicating a lack of portfolio effects in the region. The combination of a single dominant predator and synchronous predator dynamics suggests some degree of trophic instability and strong top-down control over pollock in the Gulf of Alaska. Trophic instability tended to increase through time at the basin scale. Decreased synchrony at finer spatial scales, however, emphasizes the importance of spatial heterogeneity in maintaining food web structure and function. Pollock consumption by all groundfish predators was highly variable and often exceeded assessment-based estimates of productivity. We assert that using our holistic, empirically-derived predation index as a modifier of constant natural mortality would provide a practical method for incorporating ecological information into single species stock assessments. Temporal variation in portfolio effects may also serve as a useful indicator of trophic stability for inclusion in upcoming ecosystem status reports.

Developing a Placed-Based Participatory IEA Framework for Coastal Communities in the Gulf of Alaska

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Integrated Ecosystem Assessment (IEA) is a framework that organizes science to aid in the transition from traditional single species management towards ecosystem-based management. The US NOAA IEA National Program currently has five active regional plans, including the Gulf of Alaska. Within this large marine ecosystem, we identified coastal fishing communities based on geographic location and relevance for Alaska's federally managed fisheries, to allow us to develop localized, smaller-scale IEA frameworks with active engagement of local stakeholders. We completed the first stage of the IEA loop for Sitka, a Southeast Alaska community, which included the following steps: (1) project scoping (definition of a spatiotemporal scale and focal species), (2) identification of local ecosystem components and threats, and (3) development of socio-ecological conceptual models. These conceptual models were co-produced between scientists and local stakeholders using data gathered from two participatory workshops and an extensive literature review of ecosystem attributes driving the abundance of four focal species: Pacific halibut (*Hippoglossus stenolepis*), Pacific herring (*Clupea pallasii*), Chinook salmon (*Oncorhynchus tshawytscha*), and sablefish (*Anoplopoma fimbria*). We also operationalized these models using qualitative network models, which are mathematical representations of conceptual models in which perturbations of individual variables can be assessed for their qualitative impact on the entire system. A series of simulations were conducted to test different environmental scenarios while evaluating tradeoffs across human well-being components. Several potential sustainable local management strategies have resulted from this integrated approach involving transdisciplinary knowledge, a participatory stakeholder process, and modeling.

Ecosystem Response to a Prolonged Marine Heatwave in the Gulf of Alaska: Perspectives from Gulf Watch Alaska

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The recent marine heatwave in the northeast Pacific Ocean that began during the winter of 2013-14 induced broad-scale ecosystem responses in subsequent years. Data from the Gulf Watch Alaska long-term monitoring program demonstrate far-reaching effects of the heatwave in the Gulf of Alaska from offshore pelagic to nearshore intertidal species. Looking back, it is now clear that the "Northeast Pacific Heatwave 2015" (year of peak expression) was the longest lasting heatwave globally over the past decade. By 2017, many physical metrics of the heatwave began to dissipate throughout the Gulf of Alaska, however, this hiatus was temporary and another heatwave re-intensified in late-2018 through 2019. Whereas some taxa began to show indications of returning to long-term mean values during the hiatus, others did not. Furthermore, there was not a clear pattern by trophic level in response to the hiatus and re-intensification of a heatwave. For example, while some taxa showed positive responses during the hiatus, many other taxa ranging from intertidal organisms to upper trophic level predators showed minimal or no response. Therefore, variation among biological responses cannot be fully explained by trophic level or life history alone. Our analyses of Gulf of Alaska biological community metrics show distinct patterns in recent years compared to before or during the early periods of the heatwave. Continued synthesis efforts by Gulf Watch Alaska and other research programs will provide a collective assessment of future states of Gulf of Alaska ecosystems and potential effects on resource recovery, fisheries, and local communities.

WEDNESDAY, JANUARY 29, 2020

BERING SEA
PLENARY SESSION

PLENARY SESSIONS: WEDNESDAY, JANUARY 29 — BERING SEA

TIME	TITLE	PRESENTER	SECTION
8:00 - 8:15	Projections of Ocean Acidification on the Bering Sea Shelf	Darren Pilcher	Climate and Oceanography
8:15 - 8:30	Modeling Wintertime Changes in the Salinity Distribution on the Bering Sea Shelf	Scott Durski	Climate and Oceanography
8:30 - 8:45	Seasonal Spatio-Temporal Models for Calanus Index Standardization and Phenology in the Eastern Bering Sea	James Thorson	Lower Trophic Levels
8:45 - 9:00	Have Alaska Blue King Crab Come Home to Roost? An Overfishing, Habitat, and Climate Induced Vise-Grip on Early Life History Stages of *Paralithodes platypus*	Jared Weems**	Lower Trophic Levels
9:00 - 9:15	Selecting Vitality Assessment Metrics to Predict Discard Survival for Red King Crab (*Paralithodes camtschaticus*) in the Bristol Bay Groundfish Trawl Fishery	Cory Lescher*	Fishes and Fish Habitat
9:15 - 9:30	Mating Dynamics of Eastern Bering Sea Snow Crab	Laura Slater**	Fishes and Fish Habitat
9:30 - 10:00	COFFEE BREAK		
10:00 - 10:15	Satellite Tagging of Pacific Cod in the Aleutian Islands	Susanne McDermott	Fishes and Fish Habitat
10:15 - 10:30	Oceanographic Impacts on Walleye Pollock Distributions in the Northern Bering Sea	Lisa Eisner	Fishes and Fish Habitat
10:30 - 10:45	Examining Heat Stress During the Freshwater Migration of Adult Pacific Salmon	Vanessa von Biela	Fishes and Fish Habitat
10:45 - 11:00	The Future of Yukon River Chinook Salmon in a Warming World	Kathrine Howard	Fishes and Fish Habitat
11:00 - 11:15	Unabated Mass Mortality of Marine Birds in the Northeast Pacific	Julia Parrish	Seabirds
11:15 - 11:30	Changes in Late Winter Distribution of Spectacled Eiders in Response to Sea Ice Retreat in the Bering Sea	Kate Martin	Seabirds
11:30 - 1:00	LUNCH ON YOUR OWN		
1:00 - 1:15	Measuring the Lethal and Sublethal Effects of Saxitoxin Ingestion Using Avian Model Species, Mallard (*Anas platyrhynchos*) and Zebra Finch (Taeniopygia guttata): Implications for Naturally Exposed Seabirds in Alaska	Barbara Bodenstein	Seabirds
1:15 - 1:30	Mystery Call in the Southeastern Bering Sea	Stephanie Grassia	Mammals
1:30 - 1:45	Adopting Semantic Segmentation and Classification Neural Network Models to Extract Steller Sea Lion Brands Form Remote Cameras	Alexey Altukhov	Mammals
1:45 - 2:00	Assessing Oxidative and Antioxidant Status of Steller Sea Lions (*Eumetopias jubatus*): Associations with Mercury and Selenium Concentrations	Marianne Lian**	Mammals
2:00 - 2:15	Observations During a Springtime Bering Sea Research Cruise in a Year of Record-Low Sea Ice Extent	Michael Cameron	Mammals
2:15 - 2:30	Determining Biomarkers for Reproduction and Nutritional Status in Gray Whales (*Eschrichtius robustus*) From the Eastern North Pacific Ocean	Valentina Melica**	Mammals
2:30 - 3:00	COFFEE BREAK		
3:00 - 3:15	Lessons Learned: Moving Forward Marine Wildlife Response, Health Investigations, and Research in Western and Northern Coastal Alaska During Unparalleled Ecosystem Transition	Gay Sheffield	Humans
3:15 - 3:30	Signs of Large-Scale Recent Patterns of Dynamic Change in Beringian Food-Webs Using Seabirds as Indicators	Alexzandrea DePue*	Ecosystem Perspectives
3:30 - 3:45	The Global Habitat Cost of Wild Seafood Production: Solutions to Overcome These Tradeoffs	T. Scott Smeltz**	Ecosystem Perspectives
3:45 - 4:00	Defining the Economic Scope for Ecosystem-Based Management	Matt Reimer	Ecosystem Perspectives
4:00 - 4:15	Reduction of Sea Ice in the Bering Sea in 2018 and 2019 and Some Implications for the Ecosystem	Phyllis Stabeno	Ecosystem Perspectives
4:15 - 4:30	Kelp Forest Deforestation Leads to Community-Wide Dietary Niche Contraction	Scott Gabara**	Ecosystem Perspectives
4:30 - 4:45	What Can Sea Urchin Ecology Tell Us About Coastal Habitats in a Changing Climate?	Benjamin Weitzman**	Ecosystem Perspectives
4:45 - 5:00	BEST STUDENT POSTER PRESENTATION WINNERS ANNOUNCED		

*Graduate Student / Master's ** Graduate Student / Doctorate

Projections of Ocean Acidification on the Bering Sea Shelf

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Ocean acidification (OA) poses a significant threat to the highly productive Bering Sea marine ecosystem, which supports critical commercial and subsistence fisheries. Carbonate chemistry and oxygen cycling were recently added to a regional ecosystem model of the Bering Sea. A decadal hindcast illustrated that local processes generate considerable spatial variability in the biogeochemistry of Bering Sea shelf water. These prior results highlight how vulnerability to future environmental changes can vary substantially within a coastal shelf system. However, coastal ecosystem projections are typically produced from global-scale Earth System Models (ESM), which generally do not contain the spatial resolution and coastal biogeochemical processes required to capture these shelf features. Thus, we use our regional model to produce dynamically downscaled projections of OA for the Bering Sea shelf, using multiple ESMs and emissions scenarios. The regional downscaled results provide a substantially different spatial pattern of projected OA compared to the ESM output, including a reversed shelf spatial gradient in the greatest rates of OA, resulting primarily from the inclusion of freshwater biogeochemistry in the regional model. Interannual variability is also substantially greater in the regional projections, illustrating how variability from the ESM is amplified when downscaled to the regional biogeochemical model. These features simulated by the regional projections are similar in spatial scale to key ecosystem habitats and services, therefore, resolving these features is critical to addressing emerging stakeholder needs.

Modeling Wintertime Changes in the Salinity Distribution on the Bering Sea Shelf

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Most of the sea ice on the Bering Sea shelf melts far from where it initially formed. Northern coastal and island polynya regions, where sea ice production is particularly high, end the season saltier than they started due to brine rejection. Farther offshore and to the south, where transported sea ice encounters warmer slope waters, melting exceeds production resulting in a positive freshwater flux. Other factors such as the amount of arctic sea ice that enters the shelf from the north or the amount of meltwater flushed into the Bering Sea basin will cause changes in the net shelf salt content. Considering these factors, one expects that the redistribution of salinity in high ice coverage years can differ significantly from those with little sea ice. A regional coupled ice-ocean model for winter circulation on the Bering Sea shelf has been developed with particular attention to accurate representation of the exchange of salt across the ice-ocean interface. Model horizontal resolution is 2 km. Model salinity fields are validated with observations and patterns of redistribution are examined and quantified for the relatively high sea ice extent winter of 2010. It is found that there is a net increase in shelf salinity inshore of the 125m isobath over the winter of 2010, in part due to ice transport to the outer shelf. The model also shows a contrast between the St. Lawrence polynya (and other Alaskan coastal polynya regions) with the Chukotka peninsula polynya which is affected by the presence of warmer surface waters, resulting from transport of heat in the subsurface Anadyr current from the outer shelf. The results for 2010 will be compared with simulations for recent low-ice years (2018,2019) to gain insight into interannual variability.

Seasonal Spatio-Temporal Models for Calanus Index Standardization and Phenology in the Eastern Bering Sea

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Fisheries managers worldwide regulate fishing by changing inputs (e.g., fishing gear) or outputs (total catch) to achieve a target status for fish stocks, where status is typically determined on an annual or multi-year basis. Given this annual or multi-year cycle, marine surveys and analyses are often designed to identify changes in total biomass from one year to the next, and there is less research regarding optimal ways to identify dynamics occurring within a single year. To address this, we present a spatio-temporal model that includes both annual and seasonal variation in spatial distribution. We then highlight two potential benefits to seasonal spatio-temporal models including: (1) standardizing data that are spatially unbalanced within one or more season; and (2) identifying inter-annual changes in seasonal timing ("phenology") of population processes. We then demonstrate these benefits using a case study involving copepodite stage 3+ copepod (Calanus glacialis/marshallae) densities occurring Feb-Oct in the Eastern Bering Sea. The example highlights how a seasonal spatio-temporal model can assimilate seasonally unbalanced sampling, and identifies a positive correlation between cold-pool extent and an estimated index of the seasonal timing of copepod abundance. It also standardizes a Calanus abundance index from 1993-2016 using data from the many different sampling programs occurring over this period. We conclude by discussing future potential uses of seasonal spatio-temporal data, and emphasize in particular their role in identifying climate-driven shifts in the seasonal timing of fish movement and secondary productivity.

Have Alaska Blue King Crab Come Home to Roost? An Overfishing, Habitat, and Climate Induced Vise-Grip on Early Life History Stages of *Paralithodes platypus*

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Blue king crab (*Paralithodes platypus*) stocks surrounding the Pribilof and St. Matthew Islands are overfished, federally managed commercial fishery stocks in the North Pacific. Remaining populations across Alaska appear to be isolated with limited connectivity. Recruitment limitation at early life history stages could be exacerbating current population declines. Potential bottlenecks include juvenile crab supply, benthic habitat availability, and predator interactions. We conducted field studies on blue king crab larval settlement and early juvenile phase recruitment in nearshore Saint Paul Island, 2017-2019, and the northeastern Bering Sea and Chukchi Sea, 2012-2013. We quantified larval supply and juvenile abundance with larval collectors located at new and historically sampled (1983-1984) sites at Saint Paul Island and found very low abundance of blue king crab settlers compared to historical data. Our assessment of benthic habitat suggests that habitat is similar (87% match) to that identified in historical surveys with continued availability of complex shell hash substrate. Diver surveys, diet analysis, and juvenile red king crab tethering experiments assessed predation potential. Demersal fish communities were dominated by kelp greenling, Irish Lord, crescent gunnel, northern rock sole, Pacific halibut, and Pacific cod in 2017-2018 and fish prey items included highly abundant hermit, pygmy cancer, and decorator crab species (19 ± 7% of diets by weight). Tethering experiments show kelp greenling and wolf eel are major predators of juvenile red king crab with encounter and attack rate increasing with adult fish density. Zooplankton samples confirm low abundances of blue king crab larvae in late summer in the Bering and Chukchi seas. In a climactic ‘cold’ year (2012), larval blue king crab occupied offshore regions with cold bottom water in the Chukchi Sea down-stream of known adult stocks. Conversely, during an ‘average / warm’ year (2013), no larvae were found due to either depressed abundance or potentially earlier settlement. Climate induced warming of upstream areas could limit recruitment in complex benthic habitat of the Pribilof Islands and central Bering Sea.

Selecting Vitality Assessment Metrics to Predict Discard Survival for Red King Crab (*Paralithodes camtschaticus*) in the Bristol Bay Groundfish Trawl Fishery

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Incidentally caught red king crab (RKC) in the Bristol Bay groundfish trawl fishery are regulated as a prohibited species catch (PSC) with annual limits based on an assumed post-discard mortality of 80%. This mortality rate has not been reassessed since 1987 despite changes in fishing practices to reduce impacts to seafloor habitat and non-target species. Vitality assessment metrics (i.e., quantifiable behavior and reflex responses) have successfully been used to predict delayed mortality for crustaceans following fishing stressors, and to determine which fishing, environmental, or biological parameters affect survival (e.g., air temperature, total catch, animal size). We evaluated if these metrics can be used to reliably predict post-discard survival outcomes for RKC given their slower responses to stimulation and larger body size when compared to crab species (Cancer and Chionoecetes) with which similar assessments have previously been successful. We selected candidate metrics based on those used for other crab species, consultation with crab fishermen and tests on unimpaired crab in a laboratory setting and on post-capture crab on a fishing vessel. We tested seven metrics (presence/absence) on incidentally caught RKC during commercial fishing and then held the animals for 72-hours in tanks to determine mortality, reassessing them seven times before release. Crab were collected at two locations on the vessel: on deck after removal from the catch and in the below-deck factory at the point of discard. Overall mortality rate of crab held was 11%. The initial vitality score and location of collection were the most significant predictors of mortality, indicating that vitality metrics can be used as reliable survival predictors. This relationship was robust to other variables, including injury, sex and air exposure. These results suggest the potential importance of research to better understand RKC discard mortality rates over a range of conditions and to evaluate differences in mortality related to whether the crab are discarded on deck or in the factory.

Mating Dynamics of Eastern Bering Sea Snow Crab

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The snow crab (*Chionoecetes opilio*) population supports a commercial fishery in the eastern Bering Sea that has contributed, by weight, a quarter of U.S. crab harvest over the past three decades. To improve understanding of mating dynamics of this economically important stock, we utilized genetic methods to determine parentage of hybrid crab and to estimate the number of males that contributed to sperm stored by female snow crab (referred to as mates) and to paternity of brooded embryos (referred to as sires). Snow crab have determinate growth, and we used shell condition to parse females that had opportunity to participate in only one mating season (new shell condition) vs multiple mating seasons (old shell condition). Hybrid crab are present throughout the eastern Bering Sea and result from interspecies mating between snow crab and closely related Tanner crab (C. bairdi). The maternal line of hybrid crab revealed equal contributions of snow or Tanner crabs, revealing both mating pair combinations (snow crab female with Tanner crab male or Tanner crab female with snow crab male) occurred. Preliminary results showed both new and old shell condition females had a record of 0-4 mates in her sperm reserves, with 1-2 mates occurring most frequently for both groups. Most clutches had a single sire, though a few had 2 or 3 sires contributing to embryo paternity. The male genotype present in the clutch was sometimes missing from the sperm reserves; preliminary results showed this occurred for 37% of the males contributing to single-sire clutches and 50% of the males contributing to mixed-sire clutches. Analysis of data is ongoing and additional results will be prepared for presentation.

Satellite Tagging of Pacific Cod in the Aleutian Islands

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Pacific cod (*Gadus macrocephalus*) are the second largest groundfish fishery in Alaska and a key component of the Aleutian Islands ecosystem. They undergo large seasonal migrations in the Bering Sea, but little is known about their movement in the Aleutian Islands, where current Pacific cod management assumes no seasonal or spatial movement. The winter fishery for Pacific cod spawning aggregations tends to catch much larger cod than the ones seen in the biennial summer bottom trawl survey. This has raised questions on net selectivity, seasonal movement, and changes in population distribution patterns of cod from summer (survey) to winter (fishery).This study is a cooperative project between fishing industry and the AFSC.Fishing industry contributed funds and expertise to develop the methodology for capturing and releasing pop-up satellite tagged Pacific cod from commercial fishing vessels in the Aleutian Islands. Data from these tags provide insight into seasonal cod movements and ultimately will lead to the design of a large scale tagging project. These data were supplemented with biological information collected from various fishing locations around Adak Island and Nazan Bay to provide age structure, length distribution, genetic origin, and spawning condition data of the cod population in the region. Thirty-six Pacific cod were outfitted with satellite tags and released in March 2019: 21 in Nazan Bay, and 15 near Adak. We experienced an early mortality of 36%, likely linked to fish size (80 % mortality for fish > 80 cm). However, most of the surviving fish had tags that popped up at the programmed intervals or got recovered by the fishery. 5 tagged fish are still at large and are programmed to release their tags in March.Preliminary results show that out of the 9 fish that were at large for at least 60 days, 6 migrated to Seguam pass, one migrated to Atka Island, one to Petrel bank and one remained in Sitkin sound where it was tagged.Additional data recovered from the tags will be analyzed to determine travel path, timing, and feeding behavior.

Oceanographic Impacts on Walleye Pollock Distributions in the Northern Bering Sea

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Walleye pollock (*Gadus chalcogrammus*) abundance in recent years (2017, 2018, and 2019) has increased in northern regions of the Bering Sea. Lower abundances, compared to historic means, were observed further south on the eastern Bering Sea shelf in 2017 and 2018 suggesting northward movement of these populations. Adult and juvenile (age -1) pollock were sampled in the northeastern Bering Sea by the NOAA Alaska Fisheries Science Center bottom trawl surveys in 2010, 2017, 2018 and 2019. We relate changes in pollock distribution in recent low ice years (2017-2019) to a prior above average ice year (2010) and describe how recent observations relate to our longer time series (30+ years) in the southeastern Bering Sea. Physical oceanography data from bottom trawl surveys, fisheries oceanography surveys and oceanographic moorings (e.g., Pacific Marine Environmental Lab mooring M8, south of St Lawrence I.), sea ice indices (retreat timing and extent) from satellite observations, and model-based estimates of currents and circulation will be compared to changes in pollock distribution (with separate analysis for juveniles and adults) to determine potential environmental factors driving the observed changes.

Examining Heat Stress During the Freshwater Migration of Adult Pacific Salmon

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Marine conditions are a primary driver of interannual and decadal variation in the returns of Pacific salmon (*Oncorhynchus spp.*) to spawning grounds, but differences in freshwater temperatures during spawning migrations can also result in variable mortality (essentially 0% to 100%) with population-level consequences. Freshwater temperatures across Alaska now routinely exceed thresholds associated with heat stress and mortality (> 18 °C) in migrating Pacific salmon. Indeed, mortality among migrating adult Pacific salmon was observed in rivers across western Alaska during the record-breaking warmth of 2019. We examined the prevalence of thermal stress and potential for freshwater mortality in two wild salmon populations, Pilgrim River sockeye salmon (*O. nerka*) near Nome (2014-2016) and Yukon River Chinook salmon (*O. tshawytscha*) across the watershed (2016-2017). Heat stress was identified using heat shock protein 70 (HSP70) from non-lethal sampling of muscle tissue following experimental validation for each species. Migrating Pilgrim River sockeye salmon generally experienced cool temperatures <18 °C and a heat stress response was only indicated in just 5% of individuals (n = 66). Across the larger Yukon River watershed, river temperatures and heat stress prevalence were higher with variability among locations and years. Overall, heat stress was indicated in 39% (n = 477) of Chinook salmon sampled based on HSP70. Moreover, a gene transcription panel of mRNA suggested a more moderate level of heat stress in an additional 26% of individuals. Together, HSP70 and the gene transcription panel indicated heat stress in 65% of migrating Yukon River Chinook salmon sampled. Heat stress was generally more prevalent in locations and years with warmer water temperatures (e.g., 2016 East Fork Andreafsky River, 2017 Gisasa River, and both years at Rampart Rapids Fish Wheel). Identifying the areas where heat stress is most prevalent in migrating adult Pacific salmon provides actionable science to decision makers.

The Future of Yukon River Chinook Salmon in a Warming World

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Yukon River Chinook salmon run size dramatically declined since the late 1990s, leading to unprecedented uncertainty for subsistence, commercial and recreational fisheries dependent on these stocks. Since 2003, juvenile Yukon River Chinook salmon have been monitored after their first summer at sea in the northeastern Bering Sea using pelagic trawl gear. Size, condition, diet and abundance data were collected annually through these surveys. Stock composition from genetic mixed stock analysis and juvenile catch per unit effort data were used to estimate stock-specific abundance of juvenile Yukon River Chinook salmon. A linear regression model of juvenile abundance to adult returns was used to predict the number of adult survivors returning from each juvenile cohort, and maturity schedules based on established brood tables were used to apportion those returns to run year. Juvenile Chinook salmon data coupled with adult spawner and return data, and inriver smolt data revealed important changes that have occurred for these stocks with warming river and ocean conditions. Particularly warm conditions in recent years were correlated with changes to life history characteristics: earlier outmigration timing, younger age at maturity, and larger size of juveniles. Rearing juvenile Yukon River Chinook salmon and other Bering Sea species were also distributed more northerly in warmer years, potentially affecting their early marine ecology and food web dynamics. Despite these changes, later marine survival (after the first summer at sea) appeared to be relatively stable. Cohort strength appeared to be defined by September of the first year in the ocean, highlighting the importance of survival during freshwater and/or early marine life stages in stock productivity patterns. Juvenile abundance-based forecasts predicting up to three years into the future, have provided managers and stakeholders with some perspective on longer term stock trends. Based on recent juvenile Yukon River Chinook salmon abundance, it is expected that adult run size will decline in upcoming years. Managers and fishermen are being cautioned that while Yukon River adult Chinook salmon run abundance will likely provide for spawning escapement needs, substantial fishery restrictions may be warranted through the near future.

Unabated Mass Mortality of Marine Birds in the Northeast Pacific

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The scale and frequency of animal mass mortality events have increased over the last half a century, a trend that is likely to continue commensurate with the direct and indirect effects of climate variability and other anthropogenic forcing factors. In marine environments, even relatively small but persistent shifts in ecosystem temperature have been associated with a cascade of impacts. This paper reports on upper-trophic mass mortality events, specifically the beaching of hundreds to hundreds of thousands of marine birds across four large marine ecosystems - California Current, Gulf of Alaska, Bering Sea, Chukchi Sea - in conjunction with measured and persistent increases in sea surface warming, including the Northeast Pacific marine heatwave, a weak El Niño, and thinning/loss of Arctic sea ice. Since 2014 seabird mass mortality events (MMEs) have occurred at least annually, with eight distinct events collectively reaching >2 million birds. A before-after comparison utilizing regular monthly monitoring data (COASST, BeachWatchers, BeachCOMBERs, BCBBS); event-specific data gathered by community members, tribal biologists and resource experts, and state and federal resource management agency personnel; and a comprehensive survey of the scientific and news media literature, indicates that the frequency, magnitude and duration of post-2014 events greatly exceeds the pre-2014 period back to at least 1990. Concurrently, taxonomic specificity has narrowed, focusing on Alcids (mainly murres) and Procellariids (mainly shearwaters). The die-offs appear to arise from a combination of underlying factors, including but not limited to: increased disease prevalence, predator-prey phenology mismatch, and wholesale shifts in the composition of the epipelagic ecosystem with deleterious results to seabird foraging effort. Unexplained is the tendency for species normally found at the shelf's edge or beyond to invade nearshore waters (inside 100km), making carcass beaching much more likely. Taken as a set, the scale of these events appears to exceed other recorded marine bird MMEs anywhere in the world. With unabated warming, the development of a fast-response, comprehensive monitoring system allowing shared access to information becomes crucial so that communities can find information quickly about what is happening, human health concerns can be addressed, and ecosystem health can be conclusively monitored.

Changes in Late Winter Distribution of Spectacled Eiders in Response to Sea Ice Retreat in the Bering Sea

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Everything known about the wintering ecology of Spectacled Eiders, a species of sea duck endemic to the Bering Sea and listed under the Endangered Species Act, was learned during years of relatively high sea ice cover. Historically, wintering Spectacled Eiders resided in polynyas and other areas of open water within the pack ice south of St. Lawrence Island, AK. Studies to date suggest that moderate sea ice conditions in this core wintering area are ideal for eiders. Years with extremely high sea ice cover are associated with low annual survival, likely due to reduced access to benthic foraging areas, which lower energy intake rates. Years with extremely low sea ice cover are also associated with low annual survival, likely due to reduced access to sea ice for roosting and consequent increases to eider energy expenditure. However, there is little information on the behavior or distribution of Spectacled Eiders during years of low sea ice cover. During the winters of 2017–2018 and 2018–2019, sea ice extent in the Bering Sea reached unprecedented lows and the core wintering area used by Spectacled Eiders was ice-free for much of these winters. In May 2018, we deployed 39 satellite transmitters in Spectacled Eiders from the Yukon Kuskokwim Delta breeding area. During mid- to late winter, approximately one-third of the active transmitters from this cohort showed atypical movements north of St. Lawrence Island, coincident with the retreat of sea ice, into areas that are not typically ice-free. Another one-third were located along the south coast of St. Lawrence Island, an area where Spectacled Eiders have not been historically observed during late winter. The remaining one-third stayed within the area historically occupied by Spectacled Eiders during late winter despite the absence of sea ice. These results question the current relevance of previously-collected Spectacled Eider winter distribution data in rapidly changing conditions in the Bering Sea.

Measuring the Lethal and Sublethal Effects of Saxitoxin Ingestion Using Avian Model Species, Mallard (*Anas platyrhynchos*) and Zebra Finch (*Taeniopygia guttata*): Implications for Naturally Exposed Seabirds in Alaska

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Widespread annual mortality events involving multiple species of seabirds have been documented and continue to occur in the Gulf of Alaska, and the Bering and Chukchi seas. Although emaciation was determined to be the principle cause of death, STX was detected in stomach contents, cloacal contents, or liver tissue in 34% (39/113) of individuals tested. Contribution of STX exposure to these large-scale mortality events is not well understood and few data exist regarding the lethal and sublethal effects to birds in general and particularly, seabirds. To elucidate these effects, we conducted experimental infection trials in mallard and zebra finch, both commonly used laboratory avian species. The LD50 (dose at which 50% of birds die) for these species will be used to establish a baseline and define suitable experimental techniques that can be transferred to other avian species. The calculated LD50 for mallard was 167 ug/kg and for zebra finches it was 237 ug/kg. In mallards that survived initial dosing we were able to monitor fecal output using an enzyme-linked immunosorbent assay (ELISA) test for STX. STX was detected for up to 48 hrs, and 2 birds had STX detected in fecal samples at the end of the sampling period (7 days). and in all mallards, at necropsy we also tested tissue samples for STX and examined them microscopically. Among mallard tissues, toxin was infrequently detected in heart, kidney, liver, lung, and breast muscle. In mallards that died or were euthanized <2 hrs after dosing, STX was detected throughout the gastro-intestinal tract. No gross or microscopic lesions were observed that could be attributable to STX exposure in mallards. An LD50 study was also recently completed for zebra finches and preliminary results will be discussed. Given its acute toxicity to birds and the unknown effects of sublethal exposure, the challenges associated with detection, and its frequent occurrence in the Alaska marine environment, additional research on STX in seabirds is warranted.

Mystery Call in the Southeastern Bering Sea

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During the 2019 spring mooring cruise on the NOAA ship Oscar Dyson (19 Apr - 2 May), a low-frequency, long-duration signal was detected in the area centered between the Pribilof, St. Matthew, and Nunivak Islands in the Bering Sea. An initial literature search found the closest match to be the “foghorn” call type from North Atlantic right whales. Because of the critically endangered status of North Pacific right whales (NPRW), a more thorough analysis was conducted on data from 80 long-term passive acoustic recorder deployments. Initial data exploration suggested this sound was only present south of the Bering Strait, so nine years of data from eight mooring sites located from the Aleutian chain up to the PMEL M8 (62.2° N 174.7° W) mooring in the northern Bering Sea were further analyzed. A semi-automated workflow was designed using our custom analysis software INSTINCT to automatically detect and manually verify these calls from the data. Results indicate a seasonal occurrence beginning in February, with the majority of detections located between the Pribilof Islands (169° W) and the NPRW Critical Habitat (164° W). Interestingly, in most years with presence, detections first occur in the northwest region of this area, shifting to the southeast as the spring progresses. This suggests a possible basin-to-shelf movement pattern. To confirm the hypothesis that this call type is attributable to NPRW, comparison of the spatio-temporal trends of this call type and those of other marine mammals in the Bering Sea will be provided, as will results from analyses of archival sonobuoy data collected concurrently with visual surveys. Inter-annual differences in persistence of this call type will be explored via comparisons with oceanographic data collected concurrently at two oceanographic stations in the study area. Data were collected and analyzed under funding from BOEM and NOAA S&T.

Adopting Semantic Segmentation and Classification Neural Network Models to Extract Steller Sea Lion Brands Form Remote Cameras

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Steller sea lion population declined dramatically throughout much of Alaska and the Russian Far East from the mid-1970's through the late 1990's. The populations in the Western Aleutian Islands and nearby Commander Islands (Russia) continue to decline for unknown reasons. Long term mark recapture studies of SSL demographics begun in Russia back in 1989, when the first cohort was branded. Until 2012, observers were present on most of rookeries during the summer month to collect resight data. However due to complicated logistics and high expenses since 2012, we began deploying customized autonomous cameras to collect data on SSL sites. To date, we have collected over 12 million images from most of the SSL rookeries in Russia but have only been able to review approximately 18%. To remedy this problem, we developed machine learning algorithms using R, KERAS and TensorFlow to automate and accelerate marked SSL ID extraction. We use a semantic segmentation models based on U-Net convolutional neural network to mask and extract a potentially branded animal. Multiclass classification models, based on the VGG16 neural network was used to assign id to each selected branded animals. In our pilot study the data extraction from 30,269 images took about 96 hours of machine time, while an observer needed 960 hours to manually review the same number of images. The Deep learning algorithms rarely missed animals (missing 5% of animal encounters seen by an observer) but they discovered more IDs than observers (40% more ID identifications). Using this automated approach, we significantly reduced the time needed to extract ID information, improved performance and unified analysis across all sites.

Assessing Oxidative and Antioxidant Status of Steller Sea Lions (*Eumetopias jubatus*): Associations with Mercury and Selenium Concentrations

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The piscivorous diets of pinnipeds helps to support relatively high levels of systemic selenium (Se) and other antioxidants as an adaptation to reperfusion injury subsequent to long dives (hypoxia). Selenium bioavailability is required for the synthesis and function of essential Se-dependent antioxidants, including the enzyme glutathione peroxidase (GPX). Strong interactions between monomethyl mercury and Se are known to impair the critical antioxidant role of Se. A large proportion of Steller sea lion (*Eumetopias jubatus*, SSL) pups sampled in the central and western Aleutian Islands, Alaska, have total Hg concentrations ([THg]) above thresholds of concern for adverse physiologic effects in pinnipeds. Importantly, low molar ratios of TSe:THg, in some cases < 1 in several tissues, are documented for SSL pups with high [THg]. These low molar ratios may potentially lead to antioxidant deficiency. Pinnipeds can experience similar oxidative-dependent physiologic challenges during capture and general anesthesia as occurs during diving, including oxidative stress. Our aim with study was to evaluate the relationship between circulating [THg], [MeHg+], [TSe] and TSe:THg molar ratio status relative to oxidative stress and antioxidants measured during general anesthesia in free-ranging SSL. We captured, anesthetized and sampled newborn SSL pups at four different rookeries; Agattu (Western Aleutian Islands), Ulak (Central Aleutian Islands), Ugamak (Eastern Aleutian Islands) and Chiswell (Gulf of Alaska) Islands. Biomarkers analyzed for oxidative stress included 4-hydroxynenonal and thiobarbituric acid reactive substances (4-HNE and TBARS, respectively, for lipid peroxidation), protein carbonyl content (PCC, protein oxidation), and GPX activity as a key indicator for Se-dependent antioxidant defense levels. We found a negative association (slope = -11.59, R^2 = 0.15, $F_{1,50}$ = 2.81, p = 0.017) between TBARS and [TSe], and SSL with low [TSe] had higher concentrations of 4-HNE than those with intermediate [TSe] (chi-squared = 6.75, df = 2, p = 0.034). These results suggest that SSL with lower [TSe] experience increased lipid peroxidation potentially associated with [THg] status.

Observations During a Springtime Bering Sea Research Cruise in a Year of Record-Low Sea Ice Extent

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A warming climate is predicted to reduce the volume, extent and duration of Arctic sea ice. Ribbon, bearded, ringed and spotted seals ('ice seals') use sea ice in the spring as a platform for giving birth and nursing young. Hauling out also helps seals to raise their skin temperature, facilitating the molting process. In April 2014, 2016 and 2018, we conducted research surveys at the Bering Sea ice edge to collect samples and measurements from ice seals and to deploy seal-borne satellite-tags to record the seals' movements. In April 2018, the southern ice edge was nearly 375 km farther north than in previous years, approximating conditions predicted by climate models after 2050. 2018 might therefore prove useful as a case-study for a future Bering Sea. In 2014 and 2016, most of our sightings in the marginal ice zone were of ribbon seals, so we were surprised to observe almost no ribbon seals hauled out on floes at the more northerly ice edge in 2018. There were no reports of ribbon seals hauling out on shore in numbers that would explain their very low abundance at the ice edge, so ribbon seals may have moved west to occupy remnant sea ice in Russian waters. April is the peak of pupping for ribbon seals and they are not known to give birth or nurse pups in the water. If they instead opted to remain in their typical breeding areas near the shelf break, they would likely have suffered a significant pup production failure due to lack of ice in that region. Despite low sample sizes, there is evidence for a decline in the body condition (mass/length; $n = 32$) and blubber thickness ($n = 30$) of spotted seal pups over the period 2014-2018 ($p<0.05$). The reasons for these declines are not yet known, but a more northerly ice edge would require nursing mothers to occupy areas farther from their usual foraging zones near the shelf-break. Reduced access to preferred prey could in turn, induce spotted seal mothers to produce less milk of sufficient quality, affecting the condition of their pups.

Determining Biomarkers for Reproduction and Nutritional Status in Gray Whales (*Eschrichtius robustus*) From the Eastern North Pacific Ocean

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Identification of biomarkers that reflect physiological status is fundamental for assessing population health, as well as to provide accurate estimates of life history parameters. Recovered from commercial whaling, the Eastern North Pacific gray whale population migrates between their breeding grounds off Mexico to their feeding areas in the Bering and Chukchi Seas. Gray whales can be considered important ecosystem sentinels: feeding on low trophic levels and seasonally occurring in the Arctic, they can be significantly affected by changes in oceanographic parameters and prey availability. Additionally, sub-lethal effects of human-whale interactions (e.g., vessel traffic and underwater noise) are of growing concern. In 2019 gray whales have been experiencing high mortality rates, to the point that NOAA declared an Unusual Mortality Event (UME), with multiple animals showing signs of malnutrition. Stress hormones such as cortisol and corticosterone can be used as indicators of ongoing nutritional stress. Here, reproductive and stress related hormones (e.g. progesterone, cortisol) were extracted and measured in blubber samples (n=177) of both live and stranded animals collected between 2004 and 2019, standardized to percentage lipid content and analyzed in relationship to life history parameters (e.g., estimated age, reproductive state), over time and area. Preliminary results indicate progesterone to be a valid biomarker for pregnancy, with high concentrations found in pregnant females, sighted with calf the year after sampling. Validation of stress-related steroids indicated that corticosterone, cortisol and aldosterone are detectable and measurable in both males and females. Most importantly, with our dataset comprising both samples collected pre-UME and from 2019 strandings, we can test for a possible temporal increase of nutritional stress leading up to the UME, potentially as a result of recent marine perturbations.

Lessons Learned: Moving Forward Marine Wildlife Response, Health Investigations, and Research in Western and Northern Coastal Alaska During Unparalleled Ecosystem Transition

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Isolated coastal communities throughout the northern Bering, Chukchi, and Beaufort seas are reliant on the non-commercial acquisition of marine wildlife resources for their nutritional, cultural, and economic well-being. Coastal regions of the northern and western Alaska are typically comprised of smaller communities that rely on a larger coastal community, typically a regional transportation hub, to serve the region's response and informational needs. Federally-authorized managers and/or other researchers of marine resources (and/or emergency response agencies) are typically located in urban-based centers of Alaska, far from the coast of the Bering, Chukchi, and/or Beaufort seas.Evolving environmental conditions are rapidly reorganizing the maritime ecosystem of western and northern Alaska. As a result, the diversity, frequency, and breadth of biological/ecological/industrial novel events that coastal communities are experiencing - and that urban-based federal managers and/or other responders must investigate - are increasing quickly. Since 2010, response events have included but are not limited to: novel disease outbreaks, federally-designated multi-species ice seal Unusual Mortality Events, oil-fouling, algal toxins, invasive species and/or range extensions, massive scale shifts in fish population movements/timing, and multi-species seabird die-offs, etc. We share lessons learned resulting from years of collaborative responses that include urban-based resource managers, researchers, responders, and other organizations and regional rural coastal communities that include transboundary areas of western and northern Alaska. These include: Active maritime subsistence communities most likely to discover anomalies and alert regional partner institutions. Urban-based agencies are most effective when integrated with regional communication networks, tribal governments, and traditional knowledge holders. Adaptable flexible leadership allows local-regional-urban communication flow. Project observations and summary results are of immediate need and use – by coastal communities as well as researchers. Lack of western science locally/regionally does not mean a lack of knowledge. It is ethically responsible to alert Chukotka and NWT Territories of shared public health and/or marine wildlife concerns. Management and research of marine wildlife are not solely conservation issues and must consider regional public health and food security concerns. The holistic ecosystem-wide perspective of indigenous residents is appropriate during massive ecological transitions.

Signs of Large-Scale Recent Patterns of Dynamic Change in Beringian Food-Webs Using Seabirds as Indicators

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The Arctic regions are experiencing rapid change in marine and terrestrial environments from many sources, primarily caused by climate change and anthropogenic impacts of increased development and pollution. Several endemic species, such as Red-faced Cormorants (*Phalacrocorax urile*) are currently undergoing dramatic population declines, likely related to climate-related change in food availability and trophic structure of the local marine environment. In this study, we are analyzing the constituent stable isotopes (eg. C, N, S) of muscle and feather samples collected from 16 avian species collected in the far Western Aleutian Islands (eg., Near, Rat, and Delarof Islands) since 2000, and northern Bering Sea (St. Matthew and Hall Islands) in 2018 & 2019. Our preliminary results indicate that the community-wide spatial and temporal dynamics of marine bird ecosystems are far greater in the last decade (2009 – present) than has been evident over recent decades. We also find that the magnitude of change is lesser here in the low Arctic (e.g., western Aleutian Islands 53°N) compared to High Arctic coastal marine ecosystems (e.g., 78°N). In particular, we show that the ecological patterns observed within such widespread arctic species as puffins *(Fratercula spp*.), Northern Fulmars (*Fulmarus glacialis*), and Black-legged Kittiwake (*Rissa tridactyla*) indicate diets are strongly perturbed on small geographic and temporal scales of 101 km and decades. Moreover, we find that the variance in environmental and ecological parameters is increasing rapidly over time. We hypothesize that these fine-scale changes are related to mid-scale oceanographic and trophic-level changes (eg., the “Warm Blob” in 2013, possibly now in 2019), in addition to larger-scale perturbations possibly related to a cascade of climate-related factors

The Global Habitat Cost of Wild Seafood Production: Solutions to Overcome These Tradeoffs

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Wild harvested seafood is an important component of the global food supply, satisfying 8% of animal-based protein demands. While challenges with overfishing remain, many of the world's fisheries have reached sustainable levels of harvest. Current global assessments suggest that many fish stocks are underfished, providing capacity to increase harvest to meet an ever growing global seafood demand. Yet the benefits of fishery food production come at a cost of impacts to marine ecosystems. Trawls and other bottom-tendered gears, in particular, can cause reductions in the abundance of epifauna and other benthic structural habitat features that support marine ecosystem integrity. Consequently, mitigating benthic impacts is a key ecosystem consideration for maintaining sustainable fisheries.Here we make the first estimate of global benthic habitat impacts from fishing and quantify tradeoffs between maximizing food production from the sea and the associated habitat impacts from increased fisheries effort. Globally, we estimate 9% of the world's continental shelves (2.9 million sq. km of seafloor) is currently impacted by trawls and other bottom-tendered fishing gear. If bottom-tendered fisheries were managed to achieve maximum sustainable yield, we estimate sustainable harvests could increase by 26% (10 million mt), but at a cost of an 11% (340,00 sq. km) increase in the area of seafloor impacted. These competing objectives necessitate an informed discussion about tradeoffs between seafood production and habitat impacts from fishing. Existing strategies to reduce habitat disturbance from fishing are dominated by approaches that either displace the problem elsewhere, as may be the case with marine reserves, or require directly reducing fishing effort, and thus seafood production.However, technological solutions that modify fishing gear or maintain high catch rates to reduce gear-seafloor interactions may provide an alternative means to overcome this impasse. Globally we estimate reducing gear-seafloor interactions by 30%—an amount within the range of existing examples of bottom contact adjustments achieved through gear modifications—could mitigate the increase in habitat impacts associated with fishing that maximizes sustainable harvests from bottom tendered fisheries.

Defining the Economic Scope for Ecosystem-Based Management

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The emergence of ecosystem-based fisheries management (EBFM) has broadened the policy scope of fisheries management by accounting for the biological and ecological connectivity of fisheries. Less attention, however, has been given to the economic connectivity of fisheries. If fishers consider multiple fisheries when deciding where, when, and how much to fish, then management changes in one fishery can generate spillover impacts in other fisheries. Catch share programs are a popular fisheries management framework that may be particularly prone to generating spillovers given that they typically change fishers' incentives and their subsequent actions. We use data from Alaska fisheries to examine spillovers from each of the main catch share programs in Alaska. We evaluate changes in participation---a traditional indicator in fisheries economics---in both the catch share and non-catch share fisheries. Using network analysis, we also investigate whether catch-share programs change the economic connectivity of fisheries, which can have implications for the socioeconomic resilience and robustness of the ecosystem, and empirically identify the set of fisheries impacted by each Alaska catch share program. We find that cross-fishery participation spillovers and changes in economic connectivity coincide with some, but not all, catch share programs. Our findings suggest that economic connectivity and the potential for cross-fishery spillovers deserves serious consideration, especially when designing and evaluating EBFM policies.

Reduction of Sea Ice in the Bering Sea in 2018 and 2019 and Some Implications for the Ecosystem

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In the Bering Sea, the lowest maximum areal sea-ice coverage on record (1980-2019) occurred in the winter of 2017/2018, and the second lowest occurred in the winter 2018/2019. In fall 2017, sea ice arrived late due to warm southerly winds in November, while in fall 2018 ice extent was more typical. Strong, warm southerlies occurred in February and March of both winters, forcing the ice to retreat. Prior to 2016, these extended (>31days) outbreaks of southerly winds in winter were rare (<1 every 4 years), but during the last three years at least one outbreak has been observed each year. Loss of sea ice has had profound impacts on the Bering Sea ecosystem, especially in the north. The cold pool (shelf region with bottom water < 2°C) was the smallest on record in 2018 and the second smallest in 2019. In fact, bottom temperatures at the northern mooring M8 (62.2°N, 174°W) in fall 2018 reached 4.5°C, over 2°C warmer than previously observed. In 2019, depth-averaged temperatures at the southern mooring M2 (56.9°N, 164.1°W) were ~8°C, slightly warmer than in 2016, the previous high temperature. Historically (2005-2017), the largest increases in fluorescence at M8 coincided with the retreat of sea ice. The chlorophyll fluorescence time series (depth of ~22 m) at M8 in 2018 and again in 2019 showed no evidence of elevated chlorophyll prior to a well-defined bloom in June. These open-water blooms are more characteristic of the ice-free blooms of the southern shelf. High abundances of lipid-poor, small zooplankton and low abundances of lipid-rich, large zooplankton were observed during spring/summer 2018, a pattern common in low ice years in the southern Bering Sea. During summers of 2018 and 2019, both pollock and Pacific cod were found in large numbers on the northern shelf. This change in distribution was likely related to the lack of a cold pool. These observations provide information on ecosystem restructuring likely to persist under continued warming.

Kelp Forest Deforestation Leads to Community-Wide Dietary Niche Contraction

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Foundation species provide primary habitat and energy to their ecosystems, and their losses often leads to decreases in species abundance and diversity. Less understood is how these losses lead to changes in species interactions, specifically the feeding networks that create food webs. The loss of sea otters across the Aleutian Islands has led to the ecological release of sea urchins, an increase in their grazing intensity, and ultimately to the formation of sea urchin barrens that are characterized by high urchin densities, low abundances of fleshy macroalgae, and high cover of crustose coralline algae. To estimate how this kelp loss impacted the ecosystem's food webs, we compared food web structure among nearshore kelp forests and urchin barrens, and offshore communities across 10 Aleutian Islands. We constructed food webs for each habitat using primary producer and consumer stable isotope values (carbon δ13C, a proxy for food source, and nitrogen δ15N, a proxy for trophic level). Our results indicate that the loss of kelp forests and their associated biodiversity leads to a loss of stable isotope variation for entire communities, suggesting community-wide dietary niche contractions and homogenization of energy flow pathways. These contractions were caused by reduced dietary niche breadth for primary and secondary consumers and decreased trophic levels for fishes and secondary consumers. Surprisingly, fishes appear to increase their dietary niche breadth within urchin barrens and offshore habitats.

What Can Sea Urchin Ecology Tell Us About Coastal Habitats in a Changing Climate?

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Sea urchins are the dominant herbivore within Alaska's kelp forests. When they become hyper abundant they overgraze kelp forests, turning them into barren grounds devoid of most foliose macrophytes. The occurrence of barren grounds has increased globally in recent years due to trophic downgrading and climate change. The formation of barren grounds results in habitat degradation and the loss of key ecosystem services. The Aleutian archipelago once supported expansive and biodiverse kelp forests when sea otters were abundant and sea urchins were scarce, but with the loss of sea otters in the early 2000s, Aleutian reefs have rapidly transitioned into the barren phase state. Here, we synthesize decades of research to explain how changes in sea urchin demography and abiotic forcing have reshaped Aleutian rocky reef habitats. Now that sea otters are functionally extinct, sea urchin recruitment, sea surface temperature, and bathymetry (i.e., bottom-up drivers) have the predominant influence on sea urchin demography. More, in the absence of sea otters, climate change and the rise of large sea urchins has amplified the top-down effects that sea urchins have on ecosystem structure. Our synthesis suggests that further seawater warming and acidification in the region will have detrimental impacts to this rocky reef ecosystem.

THURSDAY, JANUARY 30, 2020

ARCTIC
PLENARY SESSION

PLENARY SESSIONS: THURSDAY, JANUARY 30 — ARCTIC

TIME	TITLE	PRESENTER	SECTION
8:00 - 8:15	A Comprehensive, Process-Based Model for Arctic Coastal Erosion	Jifeng Peng	Climate and Oceanography
8:15 - 8:30	Dynamics of Arctic Barrier Islands and its Influence on Nearshore Wave Energy	Li Erikson	Climate and Oceanography
8:30 - 8:45	The Role of Ocean Waves and Sea Ice in the Arctic Coastal Erosion	Lucia Hosekova	Climate and Oceanography
8:45 - 9:00	Diel Vertical Migration: A Diagnostic for Variability of Wind Forcing Over the Beaufort and Chukchi Seas	Stephen Okkonen	Climate and Oceanography
9:00 - 9:15	The Genomic Capabilities of Microbial Communities Track Seasonal Variation in Arctic Lagoons	Kristina Baker	Lower Trophic Levels
9:15 - 9:30	Polar Cod Early Life Stages Under a Warming Scenario Exhibit Extreme Sensitivity to Low Levels of Crude Oil	Morgan Bender**	Fishes and Fish Habitat
9:30 - 10:00	COFFEE BREAK		
10:00 - 10:15	Movements and Habitat Use of Loons Along the Arctic Coastal Plain of Northern Alaska	Sharon Poessel	Seabirds
10:15 - 10:30	Use of Satellite Tagged Birds and At-Sea Surveys to Document Red Phalarope Distribution and Migration Routes in the Beaufort, Chukchi and Bering Seas	Richard Lanctot	Seabirds
10:30 - 10:45	Alaska's Most Northern Seabird is Going Extinct	Pierre-Loup Jan	Seabirds
10:45 - 11:00	Seabirds Signal Changes in the Pacific Arctic	Kathy Kuletz	Seabirds
11:00 - 11:15	Marine Mammals in the Northern Bering and Southern Chukchi Seas: What Eavesdropping Can Tell Us	Catherine Berchok	Mammals
11:15 - 11:30	Locating and Censusing Calling Marine Mammals Amongst Black Holes	John Spiesberger	Mammals
11:30 - 1:00	LUNCH PROVIDED		
1:00 - 1:15	Data Integration Approaches to Estimate Polar Bear Abundance, Survival, Movement, and Recruitment	Nathan Hostetter	Mammals
1:15 - 1:30	Distribution and Abundance of Polar Bears and Ice-Associated Seals from a U.S. - Russia Multispecies, Instrument-Based Aerial Survey in the Chukchi Sea	Irina Trukhanova	Mammals
1:30 - 1:45	Where to Place the Alaskan Polar Bear Border: Insights from Stable Isotope Analysis	Malia Smith*	Mammals
1:45 - 2:00	Indigenous Knowledge for Species Habitat and Movement Models: A Case Study on Ice-Seals in Alaska	Rowenna Gryba**	Humans
2:00 - 2:15	Research-Based Educational and Cultural Exchange Program for Alaska Native and Native American Youth Focused on the Arctic, Beluga Whales and Climate Change	Tracy Romano	Humans
2:15 - 2:30	But Did They Learn Anything?	Janet Warburton	Humans
2:30 - 3:00	COFFEE BREAK		
3:00 - 3:15	Biodiversity Patterns Recovered in the Chukchi Sea from Metabarcoding and Environmental DNA (eDNA) of Plankton Samples and Seawater	Matthew Galaska	Ecosystem Perspectives
3:15 - 3:30	Evidence for Massive and Expanding Harmful Algal Blooms in the Alaskan Arctic	Donald Anderson	Ecosystem Perspectives
3:30 - 3:45	Algal Toxins in Alaskan Arctic Food Webs: Krill, Clams, Benthic Worms, Fish, Ice Seals, Walruses and Whales!	Kathi Lefebvre	Ecosystem Perspectives
3:45 - 4:00	Organic Matter Dynamics in Arctic Lagoons: Linking Seasonal and Spatial Patterns to Terrestrial Inputs and Ocean Exchange	James McClelland	Ecosystem Perspectives
4:00 - 4:15	The Ecological Significance and Astonishing Resiliency of Arctic Lagoon Benthic Communities	Kenneth Dunton	Ecosystem Perspectives
4:15 - 4:45	The Arctic Integrated Ecosystem Research Program: Are we Experiencing the Future Arctic?	Edward Farley	Ecosystem Perspectives
4:45 - 5:00	BEST STUDENT ORAL PRESENTATIONS WINNERS ANNOUNCED & CLOSING REMARKS		

*Graduate Student / Master's ** Graduate Student / Doctorate

A Comprehensive, Process-Based Model for Arctic Coastal Erosion

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In Arctic Alaska, coastal erosion rates are accelerating due to climate warming. The erosion is causing large-scale land loss, and is a potential hazard for infrastructure in many coastal communities, military installations, oil and gas fields, etc. Therefore, it is imperative to understand the physical mechanisms of Arctic coastal erosion and to establish models to quantitatively assess the process. However, the Arctic coastal erosion process is unique compared with erosion in warm-climate regions. It is more complex as it includes many physical processes and their interactions, such as storm surges, wave impacts, permafrost thaw, block collapses, etc. Therefore it makes process-based models for arctic coastal erosion more challenging. In this study, a comprehensive, process-based model for Arctic coastal erosion is established. In the model, storms and waves are described by hydrodynamics, permafrost thaw is governed by heat transfer, erosion is represented by fluid-structure interactions, and block collapses are dictated by soil mechanics. In model implementation, these components of the model are coupled at run-time through a finite-element-based numerical scheme. As a case study, the model is applied to the erosion on a coastal bluff. The study is able to demonstrate permafrost thaw due to the higher sea water level and temperature; bluff base erosion due to impact of imping waves on thawed soil; and block collapses due to bluff base erosion. Erosion rates are quantified for various environmental conditions. Environmental parameters are evaluated for their impacts on erosion rates and dominant factors are identified. The model is demonstrated as a useful tool to understand and to assess Arctic coastal erosion.

Dynamics of Arctic Barrier Islands and its Influence on Nearshore Wave Energy

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Barrier islands and spits along Arctic coastlines account for >20% of the globe's total of such features. In the Arctic, these landforms provide shelter to shorebirds (including threatened species), denning habitat for polar bears, haulout areas for walruses, protect energy and defence-related infrastructure situated on the mainland coast, and underlie many "at risk" native villages that struggle with the potential need to relocate as the land they reside on erodes. While decade-long changes in barrier island footprints, erosion and migration rates have been documented, studies indicate that the patterns, rates of migration, and erosion are increasing. The underlying causes for the perceived change in migration rates and increasing rate in loss of barrier areal footprint is not fully understood. Assessing the underlying causes have been limited or impossible due to a lack of historical data on sea-ice prevalence and break-up, wave conditions (storm and non-storm related), and water level variations. Recently completed studies, as well as ongoing work to update these data hindcasts, now make it possible to test various hypotheses. Understanding the dominant factors that have caused the already observed decade-long deterioration of barriers and changing footprint patterns across Alaska's North Slope, is a critical need for projecting the future fate of these islands. In this study, we investigate trends and variability in changing oceanographic conditions, consequent changes in barrier island footprints, and potential impacts to planned construction of oil and gas infrastructure along Alaska's North Slope. The study site is located along the Beaufort Sea coast in Foggy Island Bay, approximately 30km east of Prudhoe Bay, Alaska, and is part of a study initiated and supported by the Bureau of Ocean Energy Management (see abstract by Kasper et al.). An artificial island about 5km offshore in 6m water depth is to be constructed. In its current state, the region is protected from the direct onslaught of waves by a system of barrier islands; in this work, we investigate the potential of these barriers to diminish and the changes in wave energy affecting planned construction and facilities.

The Role of Ocean Waves and Sea Ice in the Arctic Coastal Erosion

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Recent trends in seasonal sea ice cover in the Western Arctic are directly linked to an increase in surface ocean waves with implications for Alaskan coastlines. Lengthening of the open water season increases the likelihood of a major storm event with large available fetch for generation of shoreward propagating surface waves. At the same time, prolonged absence of shorefast ice limits its role in dissipating the wave energy incident to the coast. The increased wave activity is particularly relevant to barrier islands where wave events and associated water level changes are dominant factors controlling erosion and accretion. We present a modelling and observational framework to quantify the role of sea ice in coastal wave dynamics and erosion at three representative sites along the Arctic coast. The wave model SWAN is updated to account for wave-ice interactions and validated using field observations in the north slope of Alaska obtained in August 2014 and November 2019. The extent to which increasing wave energy forces erosion of barrier systems will be evaluated using an equilibrium shoreline framework and tested against published values of shoreline retreat. Funded by the National Science Foundation and the Office of Naval Research.

Diel Vertical Migration: A Diagnostic for Variability of Wind Forcing Over the Beaufort and Chukchi Seas

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Measurements of echo intensities were acquired in shelf waters of the western Beaufort Sea near Utqiaġvik (formerly Barrow), Alaska by upward-looking 307 kHz acoustic Doppler current profilers during a 2008-2015 series of late-summer mooring deployments.These echo signals were analyzed for characteristic patterns of krill diel vertical migration (DVM) from which daily and seasonally-averaged DVM indices (DVMI) were derived. Time varying relationships among DVMIs (inferred krill biomasses) and local and regional wind regimes were diagnosed using an iterative correlation analytical methodology. Years (2009, 2012) in which inferred krill biomasses were higher on the western Beaufort shelf occurred when average mid-summer winds over the Chukchi Sea were from the south and average late-summer winds over the Beaufort shelf were weak and variable. In contrast, years (2008, 2010-11, 2013-15) in which inferred krill biomasses were lower occurred when average mid-summer winds over the Chukchi Sea were weak and variable and average late-summer winds over the Beaufort shelf were generally easterly and strong. The analytical methodology is generally applicable to interannual records of environmental variables that encode integrated wind forcing.

The Genomic Capabilities of Microbial Communities Track Seasonal Variation in Arctic Lagoons

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The lagoons spanning Alaska's Beaufort Sea coast provide a unique habitat for arctic wildlife. These lagoons and the food webs they support face extreme seasonality with nine months of ice cover and a large pulse of freshwater terrestrial material, including nutrients from spring thaw, which influences nutrient availability. Bacteria link these nutrients to the rest of the food web. Studying how microbes change in functional composition throughout the seasons provides insight on the biogeochemical processes occurring. Replicate water column samples were taken from three sites (two lagoons and one coastal) near Kaktovik, AK. Samples were taken in April, June, and August to represent winter, spring, and summer respectively, and size fractionated to separate free-living and particle-attached communities. Multivariate analysis of metagenomes indicated that seasonal variability in metabolic gene abundances was greater than differences between size fractions and sites, and that June differed substantially from the other months. We used DeSeq2, a negative binomial generalized linear model, to find differentially expressed genes between months as well as indicator analysis to find indicator genes for each month. Broadly, we see seasonal changes in carbohydrate and energy metabolism as well as in environmental information processing. April has an increase of nucleotide and amino acid processing genes belonging to Archaea, as well as increased abundance of nitrification indicator genes. Both of these gene groups belong to Thaumarchaeota, suggesting this mixotrophic organism plays an important role in oxidizing ammonium in under-ice conditions. Despite previous work suggesting dentification rates in the Arctic shelf do not change seasonally, we find June to have an increased abundance of indicator genes for denitrification, possibly linked to organic carbon availability. This study shows that estuarine microbial communities shift their metabolic functions between the extreme seasons of the Arctic suggesting that these communities may be resilient to climate variability in a rapidly changing Arctic.

Polar Cod Early Life Stages Under a Warming Scenario Exhibit Extreme Sensitivity to Low Levels of Crude Oil

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Spawning areas of the key Arctic forage fish, Polar cod (*Boreogadus saida*), are hotspots of warming. Concurrently, reduced sea ice has facilitated increases in both human activity and the risk of petroleum pollution in these regions. In an ex-situ multifactorial experiment, we show that the physiological sensitivity of Polar cod early life stages to the water-soluble fraction of crude oil is more severe in conjunction with a 2.3ºC increase in water temperature. Higher incubation temperatures elicited responses in mRNA expression of biotransformation and stress-related genes in embryos, decreased the duration of embryogenesis, and increased growth rates in larvae. Embryogenic exposure to low levels of crude oil (equating to 5-240 ng/L total polycyclic aromatic hydrocarbons (tPAHs) in the water at the start of exposure) led to reductions in egg buoyancy and cardiac activity, higher mortality in larval stages, deformities of the eyes and face, lower incidence of feeding and swim bladder inflation, and slower growth. The interaction of increased temperature and crude oil exposure resulted in increased bioaccumulation of oil compounds (842 ng/g embryo tPAHs) in embryos and higher rates of malformation, slower growth, and lower survival of larvae. The warmer, busier future Arctic may threaten the sensitive early life stages of this key forage fish.

Movements and Habitat Use of Loons Along the Arctic Coastal Plain of Northern Alaska

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Oil and gas development may have adverse effects on ecological processes and wildlife species. Future expansion of development in remote offshore and onshore areas of the Arctic Coastal Plain (ACP) of northern Alaska may pose threats to breeding loons. Certain management guidelines within the National Petroleum Reserve-Alaska (NPR-A) dictate buffer zones for coastal wildlife habitat and breeding and foraging sites of yellow-billed loons (YBLOs). However, little empirical data are available to evaluate the utility of these buffer zones for YBLOs or for two other sympatrically breeding species, red-throated loons (RTLOs) and Pacific loons (PALOs). Using multiple years of satellite telemetry data, we evaluated movements of these loons on the ACP to understand: 1) their seasonal timing; 2) extent of marine habitat use; and 3) spatial characteristics of breeding home ranges. We then used these data to evaluate current management strategies in the context of loon biology. Loon species differed in their use of terrestrial and marine environments. YBLOs stayed on breeding lakes the longest, used large nesting lakes, had large home ranges, and rarely used the marine environment in summer. In contrast, RTLOs and PALOs nested on small breeding lakes and regularly used the marine environment. During the autumn season, YBLOs and PALOs occupied marine waters farther from the coast than during spring or summer, whereas RTLOs used the marine environment similarly during all three seasons. Management buffers established for YBLO nesting areas corresponded well with nest site space use of all three species, suggesting appropriate management guidelines are in place for protecting the lakes loons use as breeding habitat. However, the majority of loon locations on the ACP were outside of coastal buffer zones established within the NPR-A for the protection of fish and wildlife habitat. These findings can inform both onshore and offshore development activities and current and future management guidelines to mitigate anthropogenic influences on loons in Alaska.

Use of Satellite Tagged Birds and At-Sea Surveys to Document Red Phalarope Distribution and Migration Routes in the Beaufort, Chukchi and Bering Seas

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Red Phalaropes spend all but 1-2 months each year in the pelagic environment.They are among the most commonly encountered marine bird in at-sea surveys of the northern Bering and Arctic oceans during late summer and fall, with highest densities near the Bering Strait. However, the link between specific breeding locations and nearshore coastal and marine areas are unknown.Staging areas in the Arctic marine environment are thought to be important for Red Phalaropes to replenish fat supplies for their long-distance migration to the South Pacific where they spend the winter.To better understand the pelagic migration routes and habitats use by this species, 2-gram PTT Argos tags were deployed on 80 females and 12 male Red Phalaropes at four sites in Alaska, 2017 – 2019.Subsequent location data indicate Red Phalaropes breeding in Arctic Alaska generally migrated westward, occupying mainland estuaries as well as offshore waters of the Chukchi and Bering seas. However, individual phalaropes showed vary different migration patterns, occupying portions of both Pacific North America and Pacific Russia.To our surprise, many of the phalaropes did not rely on the Arctic ice edge to forage.Over 200,000 km of at-sea seabird surveys conducted since 2010 provide an alternative source of information of phalarope distribution and abundance in the northern Bering, Chukchi and Beaufort seas.We will illustrate the dominant southward migration pathways and movement density surfaces generated by these two approaches.Future efforts will focus on correlating these density surfaces with oceanographic conditions to evaluate plausible causal relationships.

Alaska's Most Northern Seabird is Going Extinct

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The loss of sea ice in the Alaskan Arctic is one of the most visible and dramatic results of the region's rapidly increasing atmospheric temperatures. Species dependent on the presence of sea ice could be expected to have experienced major changes as a consequence of this loss, but there is a paucity of long-term data sets allowing assessment of impacts. Mandt's Black Guillemot (*Cepphus grylle mandtii*), one of the few Arctic seabirds dependent on sea ice, has undergone a long-term decline since the early 1990s, coinciding with a shift in the Arctic Oscillation causing increased atmospheric temperatures and sea ice melt throughout the Arctic. The largest breeding colony of the species in the Beaufort Sea, at Cooper Island, 35 km southeast of Point Barrow, has been monitored annually since 1975. Breeding productivity has decreased as decreased summer sea ice reduced prey available to parents provisioning nestlings. Recent unprecedented loss of ice in the Bering Sea wintering area has decreased overwinter survival.

The colony supported 209 pairs in 1987, producing 192 young, while in 2019 80 pairs produced only 32 young, as 70 percent of the nestlings died from starvation. To examine the demographic response of the colony to the recent decades of environmental change in the region, we are analyzing a 45-year database with detailed information on the breeding and survival of 5456 individuals with known histories. Our initial model identified the contribution of annual survival, reproductive rate, breeding success and immigration to the colony's growth rate. We found a decrease in immigration to be the most important factor in the colony's decline, with a positive correlation between summer sea ice concentration at source colonies and subsequent immigration rate on Cooper Island. Inclusion of environmental covariates in the model is still at an early stage, but preliminary results suggest survival of black guillemots is highly dependent of winter climatic conditions. Our long-term monitoring and the modeling it allows provide one of the few biological metrics of the consequences of recent sea ice loss to Arctic biota. Our monitoring and analysis will continue as Arctic sea ice is reduced in coming years.

Seabirds Signal Changes in the Pacific Arctic

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The Northern Bering (NB)-Chukchi Sea (CS) ecosystem supports millions of seabirds, and is undergoing rapid and dramatic changes. We used data from at-sea surveys (~145,000 km of transects) and colony monitoring during 2007–2019 to examine trends in seabird abundance, distribution, and productivity with respect to changes in zooplankton and fish communities. Planktivorous auklets and shearwaters numerically dominate the offshore avifauna in the NB and CS, whereas primarily piscivorous seabirds dominate nesting colonies in the CS. In a subset of data from the CS, planktivorous seabird and zooplankton communities were spatially correlated, but piscivorous seabird and fish communities were not, perhaps because breeding piscivorous birds of the CS foraged near their colonies. In general, persistent habitat (site) features influenced spatial distribution more than interannual variation in environmental conditions. In summers of 2017-2019, however, offshore abundance of some locally breeding seabird species were below long-term means in the NB-CS. Planktivorous auklets increased in offshore waters of the NB and decreased in the CS, suggesting that unlike in previous years, auklets did not migrate north to the CS to forage after the breeding season. In 2019, the zooplankton community in the NB was half as abundant as it was in 2017 and dominated by small copepods, while large copepods were largely absent in the NB, indicating both lower abundance and lower quality prey for planktivores. In contrast, piscivorous murres and kittiwakes had fair to good reproductive success in the CS in 2018 and 2019, suggesting that forage fish were available there. Seabird mortality events, with birds dying of starvation, occurred in both the NB and CS in 2017–2019. Together, low abundance or shifts in distribution of seabirds, evidence of low reproductive success in NB planktivores, and widespread mortality events signal environmental stress. Detrimental effects may have been more prevalent in the NB, but effects on both planktivorous and piscivorous seabirds suggest impacts at multiple trophic levels throughout the NB-CS.

Marine Mammals in the Northern Bering and Southern Chukchi Seas: What Eavesdropping Can Tell Us

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Increasing attention has been focused on the northern Bering Sea, where recent changes in water temperature and sea-ice extent are affecting the distributions of zooplankton and fish.Because marine mammals are wide-ranging, they have the potential to be impacted by both the changes in the northern Bering Sea as well as by changes caused by the rapid loss of sea ice occurring further north.A clear picture of how the distribution and timing of marine mammals in the US Arctic has been changing over time is required before the factors influencing their occurrence can be investigated.The three primary sources of these data are visual surveys (aerial and vessel-based), satellite telemetry (animal tagging), and passive acoustic monitoring (moorings and sonobuoys).NOAA's Marine Mammal Lab at the Alaska Fisheries Science Center has been deploying and analyzing long-term passive acoustic recorders in the Bering, Chukchi, and Beaufort Seas for over a decade, with funding from a number of sources, including NOAA S&T, the US Navy, and BOEM. Here, we present data from those moorings located from the northern Bering Sea to the Central Channel in the southern Chukchi Sea.These records begin in either 2010 or 2012, depending on the mooring site, and extend through the present.Results from two Arctic species (e.g., bowhead whales and walrus) will be presented through fall of 2019. Preliminary analysis has shown the timing of bowheads at the southern Chukchi sites has shifted from distinct fall and spring presence to continuous winter (ice season) presence, while the northern Bering sites have seen a reduction in the period of winter presence that corresponds with the reduction of ice.Some investigation into possible factors influencing these trends (e.g., long-term oceanographic data collected concurrently at these mooring sites, and sea ice extent) will be included. Primarily, we hope that this presentation of our current understanding of marine mammal timing will foster discussion and collaboration among scientists from the various fields working on these rapidly changing ecosystems.

Locating and Censusing Calling Marine Mammals Amongst Black Holes

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We show how to obtain an extremely reliable lower bound for the number of calling marine mammals by species from measurements of their Time-Differences-Of-Arrival among a plurality of receivers using two-dimensional (2D) models for location. This may be the first time location and censusing has been done correctly with 2D models in light of a fundamental and large contribution of error unrecognised since 1886 (https://arxiv.org/abs/1811.05539 https://arxiv.org/abs/1811.05539). We explain where this heretofore unknown contribution arises as seen from the perspective of Flatland (Edwin Abbott Abbott, 1884, https://en.wikisource.org/wiki/Flatland https://en.wikisource.org/wiki/Flatland), and explain how Flatland scientists discover acoustic black holes, finally realizing they live in a 3D universe instead. Ramifications of the new insight are accounted for in software yielding extremely reliable confidence intervals for location (CIL), with the U.S. Navy providing an independent validation of the method and software. When 2D models are required to yield correct locations, the speed of sound must increase from zero with horizontal distance from each receiver: the locations of the acoustic black holes. The new algorithm is applied to ten receivers deployed at 40-m depth in the Chukchi Sea in 2011 as part of the CHAOZ experiment. Locations and censuses are shown for bearded seals and bowhead whales. Small CIL are only obtained when animals are near the receivers. Since detection range greatly exceeds the size of the receiving arrays, CIL are usually large because the probability is small a call occurs nearby. This fact implies the importance of distributing many autonomous receivers over much larger areas so small CIL are obtained and lower bounds of population counts are increased due to the ability to better distinguish where sounds originate.

Data Integration Approaches to Estimate Polar Bear Abundance, Survival, Movement, and Recruitment

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Wildlife research and monitoring programs frequently aim to quantify multiple population processes, such as abundance, spatiotemporal changes in abundance, and the demographic processes driving those changes (e.g., survival, recruitment). As such, monitoring protocols regularly call for the collection of multiple pieces of information, either by utilizing multiple survey platforms (e.g., counts from aerial surveys and movement data from telemetry) or by collecting multiple data streams during a single survey (e.g., mark-recapture surveys wherein auxiliary data such as age, sex, or group size are recorded). In marine and Arctic environments, where data are particularly challenging to collect, researchers frequently utilize multiple survey platforms and are highly motivated to make the most of all available data. Modeling approaches integrating multiple data sources have been shown to improve inferences from population monitoring programs, however, species- and study-specific constraints must be considered to maximize these benefits. Herein, we describe data integration approaches for marine mammal studies that include mark-recapture, telemetry, count, and age data. We demonstrate these approaches using case studies focused on polar bear abundance and demographic rates. Our first case study focuses on integrating telemetry and spatial capture-recapture data to simultaneously estimate local density, abundance, and population-level movement processes for polar bears in the eastern Chukchi Sea. Our second example integrates age-structure into open-population Jolly-Seber models to jointly estimate recruitment, abundance, age-structure, and age-specific survival. Finally, we combine these approaches to develop a spatial open-population model integrating multi-year spatial capture-recapture, telemetry, reproduction, and age data to investigate polar bear abundance and spatial demography. Overall, we show how data integration approaches provide multiple benefits, including improved parameter precision, the ability to address deficiencies in any single data set, improved power to detect changes in abundance, and the ability to extend inferences to broader spatial scales and ecological processes. More generally, these approaches provide researchers and managers with generalizable frameworks for integrating multiple data sources to improve the accuracy and efficiency of monitoring programs across the Arctic.

Distribution and Abundance of Polar Bears and Ice-Associated Seals from a U.S. - Russia Multispecies, Instrument-Based Aerial Survey in the Chukchi Sea

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Accurate estimates of abundance have not previously been available for the shared subpopulation of polar bears found in the American and Russian portions of the Chukchi Sea. The bears' primary prey species in the region, ringed and bearded seals, have not been adequately assessed either. In this study we used data from spatially comprehensive, multispecies aerial surveys in the Chukchi Sea to address critical information gaps for polar bears, ringed seals, and bearded seals. In spring 2016, international collaborators successfully completed the field stage of the Chukchi and East Siberian Survey (ChESS) project, which consisted of instrument-based aerial surveys of the sea ice throughout American and Russian portions of the Chukchi Sea. Using state-of-the-art developments in sensor technology and statistical modeling capabilities, the ChESS project provided data on the distribution and abundance of polar bears and ice-dependent seals simultaneously in time and space. Under the current study we estimate the distribution and abundance of polar bears, ringed seals, and bearded seals the Chukchi Sea and evaluate spatial and temporal relationships in species occurrence within a unified analytical framework. The data analysis has been performed with support from NPRB research award NA17NMF4720289.

Where to Place the Alaskan Polar Bear Border: Insights from Stable Isotope Analysis

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This study analyzed bulk δ13C and δ15N isotope values in bone collagen of two Alaska polar bear (*Ursus maritimus*) subpopulations over the past 65 years. The Southern Beaufort Sea polar bear subpopulation is declining in response to sea ice loss, while the Chukchi Sea subpopulation appears stable. We used 118 polar bear bones from 1954–2019 provided by archives of the University of Alaska Museum of the North, as well as samples collected by Alaska Native subsistence hunters. Our study shows a significant difference in δ13C ($p<0.001$), but not δ15N ($p=0.34$) between the Chukchi (-13.0‰±0.3‰ and 22.0‰±0.9‰, respectively) and the Southern Beaufort Sea bears (-14.7‰±1.3‰ and 22.2‰±1.0‰, respectively). The Alaska Nunnut Co-Management Council decided to change the polar bear subpopulation boundary from Utqiaġvik (previously Barrow) back to Icy Cape, Alaska. We performed a linear discriminant function analysis to predict the placement of polar bears into their subpopulations based on their stable isotopic signatures. By using the proposed new border at Icy Cape, the model was able to correctly place the polar bears 89% of the time. Using the current border at Utqiaġvik, the models' accuracy decreases to 85% overall. When excluding bears from the Wainwright and Icy Cape region, accuracy placement was 95%. This indicates that the area between Wainwright and Icy Cape is a polar bear mixing zone including bears from both subpopulations. This research is instrumental to informing management and co-management groups about sustainability of an important subsistence resource in Alaska.

Indigenous Knowledge for Species Habitat and Movement Models: A Case Study on Ice-Seals in Alaska

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Quantitatively combining Indigenous knowledge (IK) with western science has proven challenging due to a mismatch between the type and structure of the information and the difficulty in developing formal quantitative frameworks that can integrate both types of knowledge. IK contains a wealth of ecological information, which, if combined with western science in a meaningful way, would benefit conservation and management efforts by improving our understanding of wildlife and its habitat. Further, engaging Indigenous communities in the management of their natural resources is an important component of successful conservation and management efforts. While IK is often well documented, it is typically included in scientific studies as a parallel source of information. Fortunately, new quantitative methods to combine IK and western science into one framework are emerging, but examples are still few. Using ringed, bearded, and spotted seals as case studies, we are developing an analytical approach that allows for the formal quantitative integration of IK and satellite telemetry data into Bayesian animal habitat selection models. To do this, we are initially focusing on collecting IK on ringed, bearded, and spotted seal movement, activity, and behaviors associated with specific habitats, and methods to interpret the IK shared. Initial IK interviews have been conducted in Utqiaġvik, Point Hope, and Kotzebue, Alaska. This shared IK data contains valuable information that subsistence hunters have accrued over a lifetime (often generations) of experience observing seals. The IK data is broad, ranging from seal diving behavior to their associations with different currents in the region. Follow-up interviews ensure that we have adequately captured the information shared by the hunters prior to its model integration. We anticipate that this important data source has the potential to improve habitat selection models.

Research-Based Educational and Cultural Exchange Program for Alaska Native and Native American Youth Focused on the Arctic, Beluga Whales and Climate Change

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Abstract Mystic Aquarium (MA), Connecticut, (CT), and the North Slope Borough Department of Wildlife Management (NSB-DWM), Alaska (AK) are partners in an ongoing study to collect and analyze life history and health information from Chukchi Sea belugas to establish current baseline information and provide comparative data for Cook Inlet and other beluga stocks. Based on this research, an educational and cultural exchange program was established for Alaska Native youth and Native American youth. The main goal of the program is to stimulate interest and excitement about science, inspire high school students to pursue education and ultimately be a resource to their communities for the management and sustainability of marine resources. The youth from northern AK and CT also share their culture and traditions. The program begins in Point Lay, AK when MA and NSB-DWM scientists conduct fieldwork on wild belugas during the summer. The youth assist with live capture, tagging, sampling and release of belugas and collection of data and samples from subsistence harvested animals.Subsequently, the northern AK youth travel to Mystic, CT, to participate in hands-on beluga research at MA, analyze samples collected and learn what the samples reveal. Students also participate in learning activities focused on beluga biology, the local marine environment, other aspects of science, conservation, and husbandry and various career opportunities. Time is spent at the Mashantucket Pequot Museum and reservation learning about the history, culture and traditions of this local community. During their visit to the reservation, the students have an opportunity to interact with tribal members and participate in native crafts, dance and sports. Following the program, the students are encouraged to return to MA or work with the NSB as a research intern, participate in other science programs/camps and conferences, go on to college and share their learning experience with other youth and their communities. The desired outcome is engagement and education that leads towards local involvement in the management and sustainability of belugas for generations to come. Acknowledgements: the authors wish to thank the Mayor's office of the North Slope Borough for funding the program, the staff at Mystic Aquarium and the Mashantucket Museum and Research Center, the Mashantucket Pequot Tribal Council for funding travel support, Rodney Butler (Chairman), the Mashantucket Pequot Tribal Nation and the people of Point Lay, Alaska. Funding for a 2019 workshop was provided by the National Science Foundation award #1931117.

But Did They Learn Anything?

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Outreach activities targeting K-12 STEM education are increasingly identified as a priority for marine and coastal research grantors, particularly in the Arctic. Planning and implementing effective activities in Alaska's rural schools can be challenging. We have developed and evaluated outreach strategies and models designed to facilitate and support researcher participation in Alaska K-12 STEM education. Our hypotheses are that: 1) Professional development will increase the teachers' content knowledge and change their instructional practice, and 2) Interactions and collaborations among educators and researchers will produce lesson plans and other educational resources that will engage students in reaching STEM learning outcomes. We will present the results of evaluating three programs: 1) a series of scientist-educator professional development training workshops in the context of integrated research projects on each of Alaska's three Large Marine Ecosystems, 2) professional development provided by Alaska Sea Grant in 11 of Alaska's 56 school districts, and 3) the ARCUS PolarTREC and NOAA Teacher at Sea partnership that provides opportunities for K-12 educators to participate in oceanographic and coastal research. Finally, we will provide the highlights of a "best practices" working group convened in May, 2019, to develop guidance for Alaska researchers and grantors on "best practices" for culturally responsive K-12 STEM education for Alaska's Indigenous students. Evaluation methods included pre- and post- surveys of educators participating in professional development, peer and expert reviews of lesson plans and units developed collaboratively by educators and scientists, reflective self-assessments by educators about what worked and what didn't in the classroom following trainings and completion of instructional practica, and evaluations conducted by external evaluators at the programmatic level. Our conclusions reinforce those of other educational research - that the effectiveness of K-12 STEM education depends primarily on its relevance to students - to the place where they live, inclusive and respectful of the local and regional Indigenous culture, and to their community. We will provide some unique insights, however, on how grantors can best support and researchers can best design and implement place-based and culturally responsive K-12 STEM activities collaboratively with Alaska's rural schools, educators, and communities.

Biodiversity Patterns Recovered in the Chukchi Sea from Metabarcoding and Environmental DNA (eDNA) of Plankton Samples and Seawater

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Changing oceanic conditions, including warming, acidification, and hypoxia, have increased the importance of research to characterize biodiversity and assess overall ecosystem health. This work has traditionally relied on net capture and taxonomic experts to perform expensive, time intensive identifications. Metabarcoding assays and environmental (e)DNA sampling offer fast, cost efficient characterization of biodiversity, providing timely information for interpreting community responses to changing physical conditions. A region of high primary production and conservation concern, the Chukchi Sea region may be prone to large scale community composition and biodiversity shifts due to changing oceanic temperatures, conditions, and reduced annual sea ice coverage. The latter poses increased potential for international fishery exploitation. This region is designated essential habitat for Arctic and saffron cods, as well as snow crab, whose distributions may be changing. Our research employs high-throughput eDNA, plankton community sampling, and targeted metagenomic techniques involving multi-locus metabarcoding and bioinformatic processing, to characterize the invertebrate and fish community compositions of the Chukchi Sea using plankton and water samples collected during August 2017, 2018, and 2019 pilot investigations over a ~900 km range from just north of the Bering Strait, to Barrow Canyon. We compare these results with those from traditional sampling, diversity measures, and physical parameters. Annual sampling will provide opportunity to detect tractable changes within the community assemblages over time and a biodiversity baseline for comparison in future monitoring.

Evidence for Massive and Expanding Harmful Algal Blooms in the Alaskan Arctic

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The Pacific sector of the Arctic Ocean is experiencing rapid and dramatic changes due to climate-driven warming. Many organisms may spread into and flourish in Arctic waters as a result of rising temperatures and sea ice loss, but few present such significant threats to human and ecosystem health as harmful algal bloom (HAB) species.Here we present results from cruises in 2018 & 2019 that collected sediment and plankton samples from the Bering Strait to the Chukchi and Beaufort Seas, a large region with little history of toxic HABs.A massive, well-defined Alexandrium catenella cyst seedbed was documented north of Cape Lisburne in the Chukchi Sea both years.This persistent feature has cyst concentrations up to 17,000 cysts cm-3 that are the highest ever reported for this species.In both years, large-scale blooms of A. catenella cells at densities sufficient to cause shellfish toxicity elsewhere were observed over much of the cyst seedbed area. In 2019, high cell concentrations were also observed just north of Bering Strait and east of Barrow Canyon in the Beaufort Sea.Bottom and surface water temperatures both years were within ranges that support relatively rapid cyst germination and cell growth. Using historical shipboard hydrographic and velocity data, we demonstrate that the circulation slows considerably in the region of the cyst seedbed north of Cape Lisburne, consistent with the propagation of bottom temperature signals. This indicates that enhanced deposition occurs there, which can explain the seedbed. The recent warming in the region suggests that the associated A. catenella bloom was a local feature – implying that recurrent blooms will occur in the future. By contrast, the blooms to the south and north in 2019 were likely remotely sourced. In a parallel study, several domoic acid producing Pseudo-nitzschia species were documented in plankton samples from all cruises, including P. australis, a highly toxic species responsible for widespread blooms and toxicity in temperate waters along the US west coast. These and other results will be discussed in the context of the emerging threat of toxic HABs to ecosystems and food sources for local communities in the Alaskan Arctic.

Algal Toxins in Alaskan Arctic Food Webs: Krill, Clams, Benthic Worms, Fish, Ice Seals, Walruses and Whales!

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Changing ocean conditions threaten to increase harmful algal bloom (HAB) frequency, severity and geographic extent in northern seas raising concerns regarding the trophic transfer of algal toxins in marine food webs and potential exposure risks to marine wildlife and humans. Coastal Alaskan communities in Arctic and subarctic regions rely heavily on non-commercial harvest of marine wildlife for nutritional, economic, and cultural well-being. Thus, the health of marine wildlife is not solely a wildlife conservation issue, but includes public health and food security issues. Here we present data on the prevalence of the algal toxins domoic acid (DA) and saxitoxins (STXs) in multiple levels of Alaskan Arctic food webs. DA and STX are neurotoxic and are responsible for the shellfish poisoning syndromes known as Amnesic Shellfish Poisoning (ASP) and Paralytic Shellfish Poisoning (PSP), respectively. We will present algal toxin prevalence results from long-term data sets (up to 15 years) of subsistence-harvested marine mammals including bowhead whales, walruses, and four species of ice seals (bearded, ringed, spotted and ribbon) representing well over 1,000 animals. We will also present preliminary results on the presence of algal toxins quantified in krill, clams, benthic worms, and fish samples collected during 2019 research cruises in the Beaufort Sea, Chukchi Sea, Bering Strait Region, Bering Sea, and Gulf of Alaska. Both DA and STX were detected in all regions examined and the potential for increased algal toxin prevalence and food web transfer in Arctic waters will be discussed.

Organic Matter Dynamics in Arctic Lagoons: Linking Seasonal and Spatial Patterns to Terrestrial Inputs and Ocean Exchange

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Terrestrial, freshwater, and marine scientists have a shared interest in organic matter transport and cycling in the Arctic. This is, in part, driven by a need to understand how climate change is impacting stocks of carbon that are currently stored in permafrost. As this permafrost carbon thaws, it may be decomposed in the terrestrial environment and/or mobilized to freshwater and marine ecosystems. Data collected by the Beaufort Lagoon Ecosystems Long Term Ecological Research (BLE-LTER) program is being used to investigate sources and fates of organic matter in coastal waters of northern Alaska. This presentation will focus on seasonal and spatial patterns in dissolved and particulate organic matter characteristics (e.g. concentrations, stable isotope ratios, optical properties) in lagoons along the Alaska Beaufort Sea coast as a first step toward evaluating potential changes in inputs and organic matter processing. Previous work in lagoons along the eastern Alaska Beaufort Sea coast has documented strong seasonal variations in organic matter characteristics that are linked to interactions between terrestrial inputs and ocean exchange. This presentation will explore organic matter dynamics over a larger spatial domain that includes lagoons along central and western portions of Alaska's Beaufort Sea coastline. East-west gradients in the properties of freshwater and ocean inputs are expected to contribute to changes in lagoon organic matter characteristics across the larger domain. For example, concentrations of dissolved organic carbon increase between the ice covered and ice break-up periods in all three study regions (west, central, eastern), but absolute values and magnitudes of seasonal variation differ among regions. These regional differences may influence trajectories of change and the roles that different lagoons play in organic matter processing as the Arctic warms.

The Ecological Significance and Astonishing Resiliency of Arctic Lagoon Benthic Communities

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Arctic estuarine systems are characterized by profound seasonality of terrestrial and marine inputs. For example, over 50% of annual discharge from rivers on the North Slope of Alaska occurs during two weeks of high flow in spring. In contrast, water exchange between the lagoons and ocean waters is greatly reduced by sea-ice formation during winter. These strong temporal variations can play a central role in determining trophic linkages, population stability, and community resilience. The highly differential availability of seasonally distinct resources (e.g., marine vs. terrestrial carbon) across lagoon systems is a major focus of the Beaufort Lagoon Ecosystems Long Term Ecological Research (BLE-LTER). Recent data collected by the BLE LTER provide a more comprehensive understanding of how physical and biogeochemical processes shape the ecological character and productivity of lagoons across the Alaskan Beaufort Sea coast. Our data reveal a resilient biota that endures extraordinary physicochemical extremes of nearly complete darkness, bottom fast ice, freezing, ice scour, and periods of hypoxia and hypersalinity. Despite these conditions, which are exacerbated by restricted exchange with oceanic waters, the relatively shallow lagoons, bays and estuaries of the Beaufort Sea shelf support a rich and diverse benthic fauna. In addition to a strong temporal component, benthic species composition varies spatially across the Beaufort shelf, from west to east, presumably in response to hydrographic gradients in water mass properties. Our data suggest that many species are seasonally dependent on river-borne organic material in deltas and shallow lagoon waters, which become popular early spring feeding grounds for migratory waterfowl and a vibrant subsistence fishery.

The Arctic Integrated Ecosystem Research Program: Are We Experiencing the Future Arctic?

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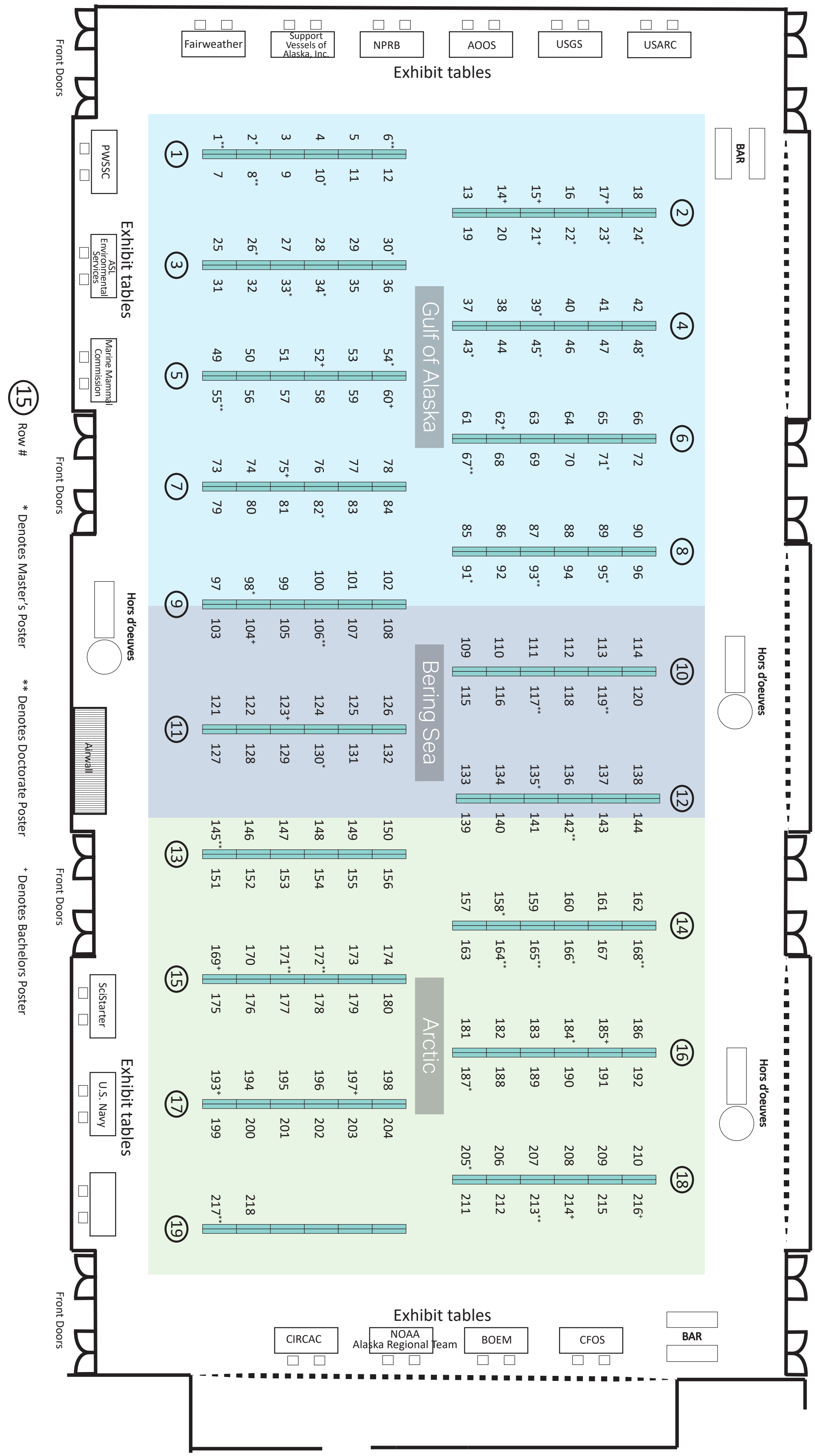
This presentation provides an overview of results from the Arctic Integrated Ecosystem Research Program (Arctic IERP). Our overarching goal is to understand how reductions in Arctic sea ice and the associated changes in the physical environment influence the flow of energy through the ecosystem in the Chukchi Sea. A summary of this research presented last year at AMSS illustrated how anomalous environmental conditions during 2017 to 2018, including a dramatic lack of sea ice during winter and spring, were a marked change even from recent unusually warm years. We update observations on key physical drivers and biological responses from the Arctic IERP research, including preliminary results from ship board and mooring observations collected during 2019, another anomalously warm year, and consider whether these changes are indicative of the future Arctic. For instance, our preliminary results suggest: spring and summer sea temperatures were anomalously warm during all Arctic IERP years; along with thermal changes within the ice-albedo feedback loop, mooring-based observations of ocean heat fluxed into the Arctic in mid-winter help explain the historically low sea ice concentrations observed in 2017, 2018 and 2019; during warm years, a very large fraction of the pelagic primary production falls to the sea floor; we note that there were fewer copepods during summer 2019 than previous years; abundance of larval and age 0 Arctic cod was highest during 2017, however the age 0 Arctic cod lipid content was lowest during that year; there appears to be a northward movement of age 0 walleye Pollock into the Chukchi Sea while age 0 Arctic cod are restricted to the northern most region of our survey area; dead seabirds were found during the 2019 summer survey; there is greater marine mammal diversity and humpback, fin, and killer whales are heard into early winter west of St Lawrence Island.

Poster Presentations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* Denotes Master's Poster
** Denotes Doctorate Poster
+ Denotes Bachelors Poster

MONDAY, JANUARY 27, 2020

WAVE 1
GULF OF ALASKA

(6:00 PM TO 7:30 PM)

POSTER PRESENTATIONS: MONDAY, WAVE 1 6:00PM - 7:30PM
GULF OF ALASKA

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
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Variation in Subtidal Community Structure Along a Glacial Gradient	Elizabeth Hasan, Brenda Konar, Mary K. McCabe	Climate and Oceanography	Row 1 | P3
A Synthesis of Marine CO_2 Observations Collected within Alaskan Coastal Waters	Wiley Evans, Jessica Cross, Darren Pilcher, Natalie Monacci, Amanda Kelley, Claudine Hauri, Burke Hales, Jeff Hetrick, Jacqueline Ramsay, Simone Alin , Michael DeGrandpre, Kristy Kroeker, Taro Takahashi	Climate and Oceanography	Row 1 | P5
EPSCoR Lagrangian Drifter Studies in Kachemak Bay	Mark Johnson, Brenda Konar, Kris Holderied	Climate and Oceanography	Row 1 | P7
Quantifying Phytoplankton Biomass and Productivity at Unprecedented Spatial Scales in the Northern Gulf of Alaska LTER Program Using Ship-Board Optical Measurements	William Burt, Russel Hopcroft, Seth Danielson, Suzanne Strom	Climate and Oceanography	Row 1 | P9
NPRB 1801 - Prevalence of Paralytic Shellfish Toxins in the Marine Food Web of Southcentral and Southwest Alaska: Year 1 Update	Steve Kibler, Bruce Wright, Xiuning Du, Rob Campbell, Kris Holderied, Dominic Hondolero, Rose Masui, Chris Guo, Coowe Walker	Lower Trophic Levels	Row 1 | P11
Kelp Forest and Seagrass Mapping in Kachemak Bay, Alaska Using a Drone	Dominic Hondolero, Tom Bell, Benjamin Weitzman, Kristine Holderied	Lower Trophic Levels	Row 2 | P13
Temporal and Spatial Expression of HSP 70 in Northern Spot Shrimp (*Pandalus platyceros*) Exposed to Thermal Stress	Mari Fester, Sherry Tamone, Jamie Musbach , Tom Levy, Rivka Mnor, Amir Sagi	Lower Trophic Levels	Row 2 | P15
Associating Clam Recruitment with Adult Standing Stock in the Northern Gulf of Alaska	Brian Zhang, Brenda Konar, Ben Weitzman, Heather Coletti, Dan Esler	Lower Trophic Levels	Row 2 | P17
The Annual Secondary Productivity Cycle in Prince William Sound Measured with the Prince William Sound Plankton Camera	Robert Campbell, Paul Roberts, Jules Jaffe	Lower Trophic Levels	Row 2 | P19
Variability in *Mytilus trossulus* Size Frequency Distributions in a High Latitude Estuary	Emily Williamson, Brenda Konar, Katrin Iken, Mary McCabe	Lower Trophic Levels	Row 2 | P21
The Importance of Seaweed Wrack as Habitat and Resource	Brian Ulaski, Brenda Konar, Ted Otis	Lower Trophic Levels	Row 2 | P23
Two Decades of the North Pacific Continuous Plankton Recorder Survey	Sonia Batten	Lower Trophic Levels	Row 3 | P25
NPRB Project 1616: Implementation of Community Based PSP Testing for Subsistence and Recreational Shellfish Harvesting in Southwestern Alaska—Year 3 Update	Steve Kibler, Julie Matweyou, R. Wayne Litaker, Bruce Wright, D. Ransom Hardison, Patricia Tester, Jennifer McCall	Lower Trophic Levels	Row 3 | P27
Shifting Phenology of Spawning and Early Life Stages of Fishes in the Gulf of Alaska	Lauren Rogers	Fishes and Fish Habitat	Row 3 | P29
Decadal Changes in Habitat Suitability for Pacific Cod Eggs and Larvae in Alaskan Waters	Benjamin Laurel, Mary Hunsicker, Lauren Rogers, Lorenzo Ciannelli, Janet Duffy-Anderson, Thomas Hurst, Robert O'Malley	Fishes and Fish Habitat	Row 3 | P31
Effects of Crude Oil on Juvenile Threespine Stickleback	Kelly Ireland, Kathryn Milligan-Myhre	Fishes and Fish Habitat	Row 3 | P33

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
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Into the Intertidal: Beach Seining and Quadrat Sampling in Alaska's Estuaries	Madison Bargas, Anne Beaudreau, Nina Lundstrom, Sydney King	Fishes and Fish Habitat	Row 4 | P37
Oxygen Consumption Rates of Two Juvenile Pacific Sleeper Sharks, Somniosus pacificus	Markus Horning, Jared Guthridge, Amanda Bishop, Richard Hocking, Christopher Lowe, Taylor Smith	Fishes and Fish Habitat	Row 4 | P39
Evaluating Thermal Effects on Spawn Timing and Early Growth of Gulf of Alaska Pacific Cod: Implications for Survival and Recruitment	Jessica Miller, Mike Litzow, Lauren Rogers, Hillary Thalmann, Ben Laurel	Fishes and Fish Habitat	Row 4 | P41
Thermal Effects on Juvenile Pacific Cod Condition and Foraging in Gulf of Alaska Nursery Habitats	Hillary Thalmann, Benjamin Laurel, Jessica Miller	Fishes and Fish Habitat	Row 4 | P43
Overwinter Energy Allocation in Juvenile Sablefish	Matt Callahan, Anne Beaudreau, Ron Heintz, Franz Mueter	Fishes and Fish Habitat	Row 4 | P45
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Oceanic Movement and Behavior of Steelhead, Elucidated with Pop-up Satellite Tags	Andrew Seitz, Michael Courtney, Andre Boustany, Emily Miller, Matt Catterson, Kyle Van Houtan	Fishes and Fish Habitat	Row 5 | P51
Feasibility of a Camera-Based Survey for Estimating Groundfish Abundance on Untrawlable Habitat in the Gulf of Alaska	David Bryan, Kresimir Williams, Chris Rooper	Fishes and Fish Habitat	Row 5 | P53
The Decline of Acoustic Backscatter Associated with Overwintering Pacific Herring (*Clupea pallasii*) in Lynn Canal, Alaska	Kevin Boswell, Ron Heintz, Johanna Vollenweider , John Moran, Savannah LaBua	Fishes and Fish Habitat	Row 5 | P55
Long-Term Shedding of Viral Hemorrhagic Septicemia Virus From Pacific Herring	Paul Hershberger, Ashley MacKenzie, Jacob Gregg, Rachel Powers, Maureen Purcell	Fishes and Fish Habitat	Row 5 | P57
Black Is the New Orange: Bringing the Poorly Understood Pacific Sleeper Shark into Temporary Captivity for Controlled Access Studies	Markus Horning, Amanda Bishop, Jared Guthridge, Richard Hocking, Christopher Lowe, Taylor Smith	Fishes and Fish Habitat	Row 5 | P59
Varying Population-Level Effects in Seabirds Following the Marine Heat Wave of 2014-2016	Sarah Schoen, Mayumi Arimitsu, John Piatt, Caitlin Marsteller	Seabirds	Row 6 | P61
Resolving the Annual Pelagic Distribution of Tufted Puffins in the Gulf of Alaska Using Geolocator Technology	Kristen Gorman, Mary Anne Bishop, Anne Schaefer	Seabirds	Row 6 | P63
Estimating Fecundity and Survival for the Endangered Cook Inlet Beluga Whales Using Multi-Event Capture-Resight Modeling of Photo-ID Data	Gina Himes Boor, Tamara McGuire, Rebecca Taylor, John McClung, Amber Stephens	Mammals	Row 6 | P65
Automated Pixel-Based Tool for Assessment of Body Condition in Large Whales	Kelly Cates, Bryn Kellar, Lars Bejder, Fredrik Christiansen	Mammals	Row 6 | P67
2019 Alaska Region Marine Mammal Stranding Summary	Kate Savage, Barbara Mahoney, Sadie Wright, Barb Lake	Mammals	Row 6 | P69
Evaluating Aerial Survey Methods for Estimating Abundance and Distribution of Cook Inlet Belugas	Stephanie Thurner, Charlotte Boyd, Sarah Converse, Eiren Jacobson, André Punt, Kim Shelden	Mammals	Row 6 | P71
Humpback Whale Numbers Have Not Recovered in Prince William Sound Following the 2014 – 2016 Marine Heatwave	John Moran, Jan Straley	Mammals	Row 7 | P73

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Investigating Habitat-Use of Cook Inlet Beluga Whales in the Kenai River	Teresa Becher, Kimberly Ovitz, Alison Gardell	Mammals	Row 7 | P75
Summary of Cook Inlet Beluga Whale Strandings from 2008 through 2019	Barbara Mahoney, Bonnie Easley-Appleyard, Jill Prewitt, Kate Savage, Sadie Wright	Mammals	Row 7 | P77
Changes in Humpback Whale Behavior and Prey Availability in Glacier Bay National Park and Icy Strait, Alaska	Caitlin Marsteller, Mayumi Arimitsu, Christine Gabriele, John Piatt, Janet Neilson, Louise Taylor-Thomas	Mammals	Row 7 | P79
Update on NMFS Cook Inlet & Kodiak Marine Mammal Disaster Response Guidelines	Sadie Wright, Jen Dushane-Garner, David Gann, Barbara Mahoney	Mammals	Row 7 | P81
2019 Gray Whale Unusual Mortality Event in Alaska	Kate Savage, Kathy Burek-Huntington, Deborah Fauquier, Sadie Wright, Jill Prewitt, Bonnie Easley-Appleyard	Mammals	Row 7 | P83
Reproductive Natural History of Endangered Cook Inlet Beluga Whales: Insights from a Long-Term Photo-Identification Study	Tamara McGuire, Amber Stephens, John McClung, Christopher Garner, Kim E.W. Shelden, Gina K. Himes Boor, Bruce Wright	Mammals	Row 8 | P85
Cetacean Distribution in the Northern Gulf of Alaska: Results from the 2019 IWC-POWER Cruise	Jessica Crance, Koji Matsuoka, James Gilpatrick	Mammals	Row 8 | P87
The First Successful Steller Sea Lion Satellite Flipper Tag Deployment: New Application Yields Promising Results	Kimberly Raum Suryan, Lauri Jemison, Kate Savage, Michael Rehberg, Seaberry Nachbar, Namoi Pollack	Mammals	Row 8 | P89
Marine Associated Bird and Mammal Habitat Use at the Five Finger Light	Lori Beraha	Mammals	Row 8 | P91
Examining Hypotheses for Limited Recovery of Cook Inlet Beluga Whales: Integrated Population Models Reduce Uncertainty in Population Viability Analyses	Amanda J. Warlick, Charlotte Boyd, Tamara L. McGuire, Kim E.W. Shelden, Eiren K. Jacobson, Andre E. Punt, Sarah J. Converse	Mammals	Row 8 | P93
Resident Killer Whale (*Orcinus orca*) Spatial Use in the Gulf of Alaska	Hannah Myers, Dan Olsen, Craig Matkin, Brenda Konar	Mammals	Row 8 | P95
The Tip of the Iceberg: Three Case Studies of Spill Risk Assessments Used in Environmental Impact Statements	Susan Lubetkin	Humans	Row 9 | P97
Connecting Alaskan Coastal Communities to Scientific Research through the Scientist in Residency Fellowship Program	Lisa Busch, Jan Straley , Ron Heintz, MaryLou Madden, Callie Simmons	Ecosystem Perspectives	Row 9 | P99
Sitka National Historical Park Intertidal Taxa Inventory	Brinnen Carter, Callie Simmons, Ron Heintz	Ecosystem Perspectives	Row 9 | P101
Changes in Marine Predator and Prey Populations in the Northern Gulf of Alaska: Gulf Watch Alaska Pelagic Update 2019	Mayumi Arimitsu, Mary Anne Bishop, Dan Cushing, Scott Hatch, Robert Kaler, Kathy Kuletz, Craig Matkin, John Moran, Dan Olsen, John Piatt, Anne Schaeffer, Jan Straley	Ecosystem Perspectives	Row 9 | P103

Particulate Carbon Flux, Flux Attenuation, and Export Efficiency in the Summer of 2019 Across the Northern Gulf of Alaska Shelf

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Through the efforts of thirty years of monitoring and the new Long Term Ecological Research project designated in 2018, the biological carbon pump in the northern Gulf of Alaska is thought to be important; however, it remains poorly characterized. We observed particulate organic and inorganic carbon fluxes, flux attenuation rates, as well as export efficiency at 9 stations on the 2019 summer cruise as a part of the Northern Gulf of Alaska Long Term Ecological Research project (NGA-LTER). Drifting sediment traps were deployed for 6-19 hours, collecting sinking material at multiple depths throughout the water column for bulk biogeochemical analysis and imaging of particles embedded in viscous polyacrylamide gels. Simultaneously, we performed 24-h, Carbon-13 based primary productivity measurements, which will allow for calculation of export efficiencies. Results shed light on the strength and efficiency of the biological carbon pump during the summer of 2019. We observed relatively low flux attenuation, indicating minimal degradation of sinking particles in the water column. The flux was characterized by very long (>3 cm) delicate chains of Rhizosolenia diatom frustules, other diatom chains, and numerous zooplankton swimmers and fecal pellets. In addition, we observed a large number of pteropods in the sediment traps at stations on the outer Kodiak Line. Our results indicate the important role of zooplankton grazers and a strong silica and carbon pump over the Northern Gulf of Alaska shelf during the summer months.

Variation in Subtidal Community Structure Along a Glacial Gradient

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Climate change has sparked a drive to study the impact of increased glacial melt on high-latitude ecosystems. Kachemak Bay, Alaska, serves as a model ecosystem for studying these changes as the glacial gradient (0–60% glaciated) present across five watersheds allows for studying the effect of glacial melt on the physio-chemical properties of downstream estuarine ecosystems. The present study addresses how subtidal community structure of algae and invertebrates vary across a glacial gradient. Data were collected during months of peak biological production, June-August 2019, by sampling 10 quadrats across two transects per site placed near environmental sensors. Similarities in algal and invertebrate communities were found in the least and most glaciated sites (0% and 60%, respectively). The second least glaciated site, at 8%, displayed unique trends in algal community structure. All five sites displayed greater differences between sites than within sites, but contained relevant levels of within-site variability. It is likely that site-specific variation is related to environmental factors not directly related to glacial coverage in a watershed or ones that do not vary predictably along our glacial gradient. These results suggest that these subtidal communities may be somewhat resilient to future glacial melt as it appears that algal and invertebrate community structure are not correlated to overall glacial cover in the watersheds.

A Synthesis of Marine CO2 Observations Collected within Alaskan Coastal Waters

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Marine CO2 observations have been collected from a number of platforms within Alaskan coastal waters; including research vessels, ships-of-opportunity, moorings, autonomous vehicles, shore-based instrumentation, and citizen science campaigns. Collectively these datasets reveal not only a broad range of variability in CO2 conditions in the surface layer and water column, but also spatial and temporal differences in data density and understanding related to the processes that drive the observed variability in the four unique coastal ocean domains surrounding Alaska: the Gulf of Alaska, Bering, Chukchi, and Beaufort Seas. We provide a synthesis of these data so as to help identify needs related to understanding ocean acidification (OA) in Alaskan coastal waters, which include: recommendations for expanded ocean observing that leverages existing capacity, information required to enhance experimental work assessing the biological effects of OA, and aspects required for better model forecasting of changing conditions in Alaska's vulnerable coastal waters.

EPSCoR Lagrangian Drifter Studies in Kachemak Bay

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The Alaska EPSCoR program "Fire and Ice: Navigating Variability in Boreal Wildfire Regimes and Subarctic Coastal Ecosystems" began a series of Lagrangian drifter deployments in Kachemak Bay and Lynn Canal, Alaska, to investigate whether the local circulation may be altered due to possible changes in the freshwater glacial input driven by potential climate warming. This research improves the basic knowledge of the local circulation patterns, and has particular relevance to larval transport and recruitment. To meet our goals, ten sets of four surface drifters each were deployed from May through September 2019 near where the Grewingk Glacier discharges into inner Kachemak Bay. Each time, the deployment location was approximately the same in order to evaluate temporal variations in the local surface circulation over the course of the summer field season. By deploying sets of four drifters at one time, we can estimate rates of dispersion which are proportional to changes in the triangular area defined from the drifter positions. Each deployment set resulted in unique trajectories consistent with a high degree of temporal variability in Kachemak Bay. Most drifters were equipped with TidbiT temperature loggers which were interpolated to the ten-minute drifter positions sent via Iridium phone. Current velocities were calculated using finite differences along each trajectory.

Quantifying Phytoplankton Biomass and Productivity at Unprecedented Spatial Scales in the Northern Gulf of Alaska LTER Program Using Ship-Board Optical Measurements

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We present details of an ocean optics monitoring program as part of the newly-funded Northern Gulf of Alaska Long Term Ecological Research (NGA-LTER) program. Building upon prior results from the southern Gulf of Alaska region, we outline plans for the inaugural expedition aboard the UNOLS ship R/V Sikuliaq in spring 2020. Namely, the building and installation of an underway optical platform for surface water absorption/attenuation (via AC-S) and back-scatter (via BB-3) measurements to estimate phytoplankton physiology (via carbon-to-chlorophyll ratios) and productivity (NPP via CbPM) at high-resolution. Coupling these measurements to high-resolution surface nitrate (via ISUS) and iron (via trace-metal clean surface sampler) measurements, we will explore the complex interplay of light and macro/micro-nutrient limitation on the phytoplankton community both regionally, and across small scale hydrographic features. Direct on-station measurements of chlorophyll, phytoplankton carbon, POC, and net primary productivity, already in-place as part of the NGA-LTER, will ground-truth the optical data and facilitate generation of regionally-tuned bio-optical models. We will also continue to investigate the use of high-frequency backscatter data to quantify zooplankton size and abundance. As part of the NGA-LTER, optical datasets will span multiple seasons for the next several years, providing an opportunity to establish seasonal and inter-annual variability in a region undergoing rapid change. For this reason, we also present potential future directions for this program, including expansion of the underway optical system (e.g. acidification modules and imaging capability) and collection of radiometric data for remote-sensing applications, with the goal of inciting collaborative discussions.

NPRB 1801 - Prevalence of Paralytic Shellfish Toxins in the Marine Food Web of Southcentral and Southwest Alaska: Year 1 Update

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Saxitoxins (STXs) produced by Alexandrium species are potent neurotoxins that accumulate in Alaskan shellfish and cause potentially fatal paralytic shellfish poisoning (PSP) in consumers. Recent data indicate STXs reach Alaskan marine mammals and seabirds via the food web, although the relevant trophic transfer pathways are poorly understood. Here we present data from two projects examining occurrence of PSP toxins in the marine food webs of southwest and southcentral Alaska. Study sites include Prince William Sound, Kachemak Bay/Lower Cook Inlet, and the Kodiak, Aleutian and Pribilof Islands—locations exhibiting a broad range of shellfish toxicity. The projects focus on PSP toxin levels (µg STX Eq. 100g-1) in phytoplankton, zooplankton, bivalves, forage fishes, predatory fishes, and other biota. Toxins were quantified via enzyme-linked immuno-sorbent assay (ELISA) and/or high performance liquid chromatography (HPLC). 2018 Data indicate toxin levels were generally low (<10µg g-1) in forage fishes during summer/autumn relative to the FDA/EPA safety level of 80µg g-1 STX in fish and shellfish. Toxicity was commensurate with low Alexandrium abundance and shellfish toxicity observed in much of south-central and southeast Alaska in 2018. However, there were sporadic incidences of moderate toxicity (10-50µg g-1) in some forage fish samples. STXs were also detected in predatory fishes during the same period, with the highest concentrations in digestive organs (≤31µg g-1) and lower levels in kidney (17µg g-1), liver (13.3µg g-1), muscle (10.8µg g-1), and roe (~0). Preliminary data from 2019 indicated more intense Alexandrium blooms in the Aleutians with higher toxin concentrations in bivalves (>10,000µg g-1), forage fishes (>200µg g-1), predatory fishes (to 80µg g-1) and other benthic invertebrates (to 122µg g-1). Prevalence of STXs in predatory fish viscera rather than muscle tissue indicates there is little risk to human health, but clear trophic transfer pathways to marine mammals, seabirds and other piscivorous predators.

Kelp Forest and Seagrass Mapping in Kachemak Bay, Alaska Using a Drone

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Kelp forests and seagrass beds provide sources of carbon from primary production and also important habitat structure for many marine organisms. Both of these habitats can serve as nurseries for juvenile fishes and invertebrates as well as foraging areas for seabirds and fishes. Recently, the state of Alaska has seen an increase in requests for kelp mariculture permits and kelp mariculture is also projected to increase nationwide. In Kachemak Bay, there have been a few aerial surveys of the canopy-forming kelps in the past, but, partially due to the cost of aircraft surveys, there is no routine monitoring of kelp beds and there have been no comprehensive kelp mapping efforts in the area for almost 20 years. To develop methods for a cost-effective, routine monitoring program, we used a DJI Phantom 4 Pro unmanned aerial vehicle (UAV or drone) to map several kelp forests and a seagrass bed in Kachemak Bay in summer 2019. The sites are part of the Gulf Watch Alaska long-term ecosystem monitoring program of the Exxon Valdez oil spill Trustee Council. All sites were surveyed during a single spring tide series in early August 2019. Using a consumer UAV with a color camera we were about to create georeferenced orthomosaics for each site as well as maps of kelp area using a simple spectral algorithm. We also were able to create a digital elevation model of one of our seagrass beds using structure for motion. We will be comparing our estimates of total area to previous estimates from aerial surveys and field site visits. In the future, we plan to refine methods to apply UAV mapping for routine annual monitoring, as well as investigating use of other methods of assessing kelp forests including remote sensing, diver surveys, and side scan/multibeam sonar.

Temporal and Spatial Expression of HSP 70 in Northern Spot Shrimp (*Pandalus platyceros*) Exposed to Thermal Stress

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Heat shock proteins (hsps) are highly conserved chaperone proteins which support cellular function and are ubiquitous across diverse organisms. Specific sub-groups of HSP's recognized by their size, may be significantly upregulated in a cell in response to stressors as a mechanism to stabilize proteins. Hsp70 is a well-studied hsp because of its role in protecting cells during temperature stress; a stressor commonly associated with climate change. The Northern spot shrimp (Pandalus platyceros) from Alaska is a good model for studying effects of increased ocean temperatures on cellular responses to climate change since within a particular latitude, it typically experiences a narrow range of temperatures.We exposed 27 juvenile shrimp to either ambient (7 °C) or warmer (12°C) temperatures for 0, 2, 8, and 24 hours.At each time point, tissue samples (gills, muscle, hepatopancreas) were dissected from three randomly selected control and three randomly selected experimental shrimp and stored in RNAlater. Total RNA was extracted and first strand cDNA was synthesized for PCR analysis. A recently sequenced transcriptomic library for *P. platyceros hepatopancreas* provided the hsp70 specific sequence with which gene specific primers were developed.Expression of hsp70 was demonstrated using PCR in all three tissues obtained and the levels of hsp70 gene expression differed temporally and spatially. The expression of hsp70 in the gills was evaluated in a semi-quantitative method and showed no significant increase between control and elevated temperature in the 2-hour samples. The levels of hsp70 in the elevated temperature treatment were upregulated by 50% and 38% in the 8 hour and 24-hour samples respectively. In muscles, the 2-hour samples showed no upregulation, but the 8-hour and 24-hour were upregulated by 10% and 18% respectively. Additionally, glycosyl-phosphatylinositol-linked carbonic anhydrase (CAg), a gene known to be upregulated in crustaceans during salinity and pH stress, was expressed in all three tissues. This project is part of a larger project being conducted to understand the physiological changes associated with both increased temperature and ocean acidification on the highly commercially important P. platyceros.

Associating Clam Recruitment with Adult Standing Stock in the Northern Gulf of Alaska

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Clams are an important food source for personal and subsistence use around the world. They perform several vital ecosystem functions by providing a nutrient-rich prey item for many apex predators and serving as filter feeders where they uptake phytoplankton and suspended particles (detritus), potentially changing water quality. Anthropogenic stressors such as climate change and pollution threaten clam populations. Concurrently, recovering sea otter populations across the Gulf of Alaska also impact current clam populations. Declines of large, hard shell clams has prompted a need to examine the factors that impact clam standing stock. We examined the potential role of clam recruitment in maintaining adult standing stocks for three of the most harvested hard shell clam species in the northern Gulf of Alaska, the Butter clam (*Saxidomus gigantea*), Litteneck clam (*Leukoma staminea*), and Heart Cockle (*Clinocardium nuttalli*). In cooperation with Gulf Watch Alaska, clam recruitment and standing stocks from four regions (Kachemak Bay, Prince William Sound, Kenai Fjords National Park, Katmai National Park and Preserve) were compared over three years. In addition to region wide comparisons of recruitment and adult standing stock, in Kachemak Bay we also examined the influence of oceanic vs. more estuarine sites. In Kachemak Bay, we classified sites as oceanic or estuarine and compared recruitment and standing stock between these sites. We hypothesized that increased recruitment would correlate with higher abundance of standing stocks unless other factors, such as adult mortality, have greater influence. We found that the presence of recruitment often coincided with the presence of standing stock. Within Kachemak Bay, standing stock variation between the estuarine and oceanic sites depended on the species of clam (e.g., higher standing stock at oceanic sites compared to estuarine sites for Clinocardium, in contrast to higher standing stock at estuarine sites for other two species). Our results will inform long-term monitoring efforts in the northern Gulf of Alaska to determine if annual clam recruitment patterns can be used as a good indicator of standing stock status.

The Annual Secondary Productivity Cycle in Prince William Sound Measured with the Prince William Sound Plankton Camera

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A novel plankton imager was developed and deployed aboard a profiling mooring in Prince William Sound in 2016 through 2019. The imager consisted of a 12 MP camera and a 0.137X telecentric lens, along with darkfield illumination produced by an in-line ring/condenser lens system. The camera imaged ~325 liters per profile (from ~60 m to surface), and almost 2.5 x 10^6 images were collected during the three years of deployments. A subset of almost 2 x 10^4 images was manually identified into 43 unique classes, and a hybrid convolutional neural network classifier was developed and trained to identify the images. Accuracy varied among the different classes, and applying thresholds to the output of the neural network (interpretable as probabilities) improved classification accuracy in non-ambiguous groups to between 80 and 100%. The system documented interannual differences in abundance that corresponded with concentrations estimated from plankton nets. The system also observed high frequency variability in the abundance of several taxa (small blooms lasting days to weeks); intraannual changes in depth distributions (to sub-meter resolution) over the course of the year; and diel migratory behavior in some taxa. Imagery-based estimates of abundance shows promise for rapid, relatively low cost observing of zooplankton biomass, and potentially the extraction of additional information on some individual plankters (e.g. gut fullness, lipid stores).

Variability in Mytilus trossulus Size Frequency Distributions in a High Latitude Estuary

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The Pacific blue mussel, *Mytilus trossulus*, is a common nearshore bivalve that is a food source for both animals and humans. Determining how mussel populations are structured across different hydrographic regimes may provide insight into what factors can influence mussel demographics. Here, mussel size frequency distributions are examined across different hydrographic regimes in Kachemak Bay, a model high latitude estuary. Mussels were collected from 11 sites as part of the Alaska EPSCoR Fire and Ice project and the Gulf Watch Alaska monitoring program in May and June 2019. At all sites, ten 25-cm2 quadrats were scraped along a 50-m transect laid parallel to the waterline in the high intertidal and later measured for valve length in the lab. The sites were categorized into three hydrographic regimes (oceanic, glacially influenced, and downstream of glacial influence). Oceanic sites and the most highly glaciated site tended to have small and medium-sized mussels. All other glaciated sites tended to have the largest mussels, while the downstream sites had the smallest mussels and an obvious lack of large mussels. It appears that size frequency distributions of M. trossulus do vary across the three hydrographic regimes of this model estuary. The differences may reflect variation in recruitment of M. trossulus caused by larval advection, substrate type, food availability, and/or presence of predators.

The Importance of Seaweed Wrack as Habitat and Resource

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Wrack, organic material washed up on the beach, is an important resource collected by people who use it for garden fertilizer. Wrack studies from other areas of the world have shown that its removal can have significant ecological consequences on a variety of species that use it as habitat or a place to forage. However, viable spores often persist within wrack and they may contribute to seaweed productivity if they become re-suspended during high tides and settle in suitable habitats. In Southcentral Alaska, collecting wrack is common but in most places, it is currently illegal. These precautionary restrictions are in place partly because so little is known about this resource. It is important that Alaska Department of Fish and Game (ADF&G) managers and the public (harvesters) understand the effects of removing wrack from Alaskan beaches and if there are preferred times to collect that minimize impacts on the wrack ecosystem and overall seaweed productivity. This study is based in Kachemak Bay, a model Alaska system where seaweed is carefully regulated by ADF&G. Reproductive viability and spatial and temporal variability in wrack biomass and composition were determined by monthly wrack collections in 2018 (March to September). The biomass and composition surveys will be repeated in 2020 and we will also document animals using wrack that may be impacted when wrack is removed. In 2020, we will also determine the succession in invertebrate communities as wrack ages. This research will help ADF&G develop appropriate management strategies for wrack collection as interest and human use of this resource increases. Our Alaska results will be compared to other areas around the world where wrack plays a crucial role in sandy beach ecosystems. This study will determine how wrack biomass and composition varies spatially, monthly, and between years, which organisms are impacted by the removal of wrack habitat, how deposition timing affects invertebrates, and how harvest timing might be used to mitigate impacts.

Two Decades of the North Pacific Continuous Plankton Recorder Survey

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At the 1998 annual meeting of the North Pacific Marine Science Organisation (PICES) it was recommended that the Continuous Plankton Recorder (CPR) be used to monitor the plankton populations of the North Pacific, to provide large scale seasonal coverage of the then poorly-sampled open ocean ecosystems. This recommendation was acted upon and 2019 marks the 20th year of regular plankton sampling in the eastern and western North Pacific, including the Southern Bering Sea, using CPRs. Over 30,000 plankton samples have now been collected and archived, with taxonomically-resolved abundance data for several hundred plankton taxa available for over 8,000 samples. This poster showcases some of the highlights and outputs from this program over the last 19 years. Contributions from the North Pacific Research Board and the Exxon Valdez Oil Spill Trustee Council have been invaluable in maintaining the sampling over this time period, and enable regular contributions to regional assessments, such as the NOAA Ecosystem Considerations report for the Gulf of Alaska and Canadian Dept Fisheries and Oceans State of the Pacific Ocean report. The program represents a significant contribution to biological ocean observation and also provides input to global initiatives such as the Global Alliance of CPR Surveys (GACS), the International Group for Marine Time Series (IGMETS) and the Global Ocean Observing System (GOOS) Biology and Ecosystems Essential Ocean Variables.

NPRB Project 1616: Implementation of Community Based PSP Testing for Subsistence and Recreational Shellfish Harvesting in Southwestern Alaska—Year 3 Update

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Despite high risks of paralytic shellfish poisoning (PSP) to subsistence harvesters in southwest Alaska, the State currently has no capacity for routine testing of non-commercially harvested shellfish. This project aims to provide tools to inform local shellfish harvesting decisions through community-based toxin monitoring and development of PSP testing methods. We leverage community networks from the 2012-2015 Alaska Department of Environmental Conservation (ADEC) Recreational Shellfish Beach Monitoring Pilot Program, the Aleutian Pribilof Islands Association, and NPRB-funded technologies (#118) to evaluate community-based monitoring on Kodiak Island (Old Harbor, Ouzinkie, Kodiak) and the Aleutians (Sand Point, King Cove). Toxin testing was performed by high performance liquid chromatography. Results through Year 3 of the study showed clam toxicity varied substantially among the sites, with the highest toxicities at Sand Point, and the lowest in the City of Kodiak. Interannual differences showed toxicity depended on regional water temperature, with higher toxicities during regional warming in 2015-2016 (the blob) and still higher toxicities during 2018-2019. Saxitoxin (STX) congener data revealed a seasonal toxicity increase during May-June associated with gonyautoxins (GTXs) produced during Alexandrium blooms. An improved enzyme-linked immunoassay (ELISA) was developed using a new antibody with sensitivity to both STX and neosaxitoxin (neoSTX), the most toxic of the STX congeners. This method allows a significant improvement in quantification of PSP toxins via ELISA-based screening. To address community interest, we also examined distribution of toxins in specific butter clam tissues and how their removal affected PSP risk. STX and neoSTX were often concentrated in the clam siphons during the winter, accounting for >80% of the toxicity in individual clams. But during summer Alexandrium blooms, GTXs in digestive tissues could account for up to 62% of the clam toxicity. Removal of digestive tissues, the siphon tip, and other tissues deemed inedible sometimes yielded a substantial decrease in clam toxicity, but variability was too high to provide a reliable margin of safety for consumers. Non-commercial butter clam harvesters are cautioned not to rely upon traditional preparation methods alone to reduce PSP risks.

Shifting Phenology of Spawning and Early Life Stages of Fishes in the Gulf of Alaska

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Shifts in phenology are a well-documented ecological response to changes in climate, which may or may not be adaptive for a species depending on the climate-sensitivity of other ecosystem processes. In recent years, the Gulf of Alaska has experienced a record-breaking heatwave, and warm conditions have returned in 2019. However, it is unknown what this warming, as well as future warming, means for the timing of ecological processes in springtime. We investigate how changes in temperature influence the timing of spawning and the occurrence of first feeding larval stages of fishes in the water column. First focusing on walleye pollock, we use 32 years of data from ichthyoplankton surveys to reconstruct timing of pollock reproduction in the Gulf of Alaska, and find that the mean date of spawning has varied by over 3 weeks throughout the last 3 decades. Climate clearly drives variation in spawn timing, with warmer temperatures leading to an earlier and more protracted spawning period, consistent with expectations of advanced spring phenology under warming. However, population demographics are equally as important as temperature: an older and more age-diverse spawning stock tends to spawn earlier and over a longer duration than a younger stock. Beyond pollock, we find widespread temperature-sensitivity among fishes sampled as larvae in spring, including Pacific cod, resulting in interannual variation in the timing of when first-feeding larvae are in the water column. Depending on the thermal sensitivity of zooplankton production, these phenological shifts could have significant implications for match-mismatch dynamics and fish recruitment. Finally, we demonstrate how a mechanistic understanding of spawning phenology in pollock can be used to derive pre-season forecasts of spawn timing, which can be used to optimize survey timing and improve management advice under changing climate conditions.

Decadal Changes in Habitat Suitability for Pacific Cod Eggs and Larvae in Alaskan Waters

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Recent warming events in the North Pacific have prompted questions of whether key fisheries are being negatively impacted by increased metabolic demand and shifting lower trophic productivity.Pacific cod (*Gadus macrocephalus*) are highly sensitive to temperature at the egg stage, and first-feeding larvae may be at increasing risk of starvation through shifting match-mismatch dynamics with prey. An understanding of the direct and synergistic effects of temperature and spring production (phytoplankton phenology) is therefore needed to anticipate the possible impacts of continued warming to recruitment potential of Pacific cod in Alaska waters. In two related studies, we develop habitat suitability indices for cod eggs and larvae by combining new experimental biological data with available temperature and satellite remote-sensing measures of chlorophyll a.Habitat suitability indices were developed for Pacific cod eggs in the Gulf of Alaska (GOA, 1994-2019) and first feeding Pacific cod larvae in the GOA and the southeast Bering Sea (EBS) from 1996-2016. Models indicate cod egg and larval habitat in the GOA was historically impacted by extreme warming events (e.g., 1998 and 2003 El Niños), but the recent heatwave (2014-16) and return to heatwave conditions in 2019 represented the most significant loss in habitat.These indices were independently and positively linked with observational data on pre-recruit abundance and estimates of age-3s in the GOA.In contrast, the EBS remains relatively cooler, and larval habitat appears more sensitive to interannual fluctuations of phytoplankton bloom phenology.However, larval habitat suitability is not correlated with year class strength in the EBS, indicating that unaccounted sources of mortality during the egg, larval or juvenile phase influence Pacific cod recruitment variability in that region. These results provide new mechanisms and hypotheses on how climate variability may be differentially impacting population dynamics of Pacific cod in the GOA and EBS.

Effects of Crude Oil on Juvenile Threespine Stickleback

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Crude oil has many harmful organismal effects. In fish species, PAHs, a component of crude oil, are known to have immunotoxic effects which can increase susceptibility to many pathogens. Many of the studies on the effects of PAHs on fish focus on the immunotoxic effects of individual PAHs and not complex mixtures of PAHs, such as crude oil. Given the number of oil spills that occur around the world a better understanding of the effects crude oil has on organisms as a mixture of PAHs is needed. There also have not been any studies of the effects of crude oil on threespine stickleback (*Gasterosteus aculeatus*), a model organism that is a ubiquitous sentinel species in the northern hemisphere. This study aimed to elucidate the effects of crude oil on juvenile threespine stickleback at 14 and 28 days post fertilization (dpf) following an exposure to crude oil between 7-14 dpf. Effects on somatic development and the expression of several innate immune gene transcripts associated with inflammation, interleukin 1 beta (IL-1β) and tumor necrosis factor (TNF), were assessed. Crude oil was shown to decrease growth at 14 dpf, but after 2 weeks of depuration fish exposed to crude oil had no difference in somatic measurements compared to control fish. There were no effects of crude oil on the immune genes of interest in this study.

Age at Maturation Predicted from Scale Measurements in Pacific Herring (*Clupea pallasii*)

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Age at maturation is linked to population productivity and directly impacts forecasts of population biomass and resultant harvest limits set by management agencies. Based on the original concept of scale growth from Johan Hjort and his collaborators, the current study examined a new way of estimating maturity empirically using scales for Pacific herring *Clupea pallasii*, following methods applied successfully to Norwegian spring-spawning Atlantic herring, *Clupea harengus*. The overarching objective of this study was to assess whether herring maturity at age can be determined with scale growth. Specifically, we hypothesized that maturing herring (herring that will spawn in the upcoming spring) grow less than immature herring during the summer before spawning based on scale measurements (e.g. mature herring are hypothesized to have smaller mean outer-ring scale growth than immature herring, as more energy is geared towards reproduction). If so, scales of fully mature herring can be examined to identify the year in which they first matured. Pacific herring were collected in the field during fall 2017, maturity was determined through histology, fish were aged and annuli measured from scales, and generalized linear models with binomial maturity data were fit to the data of age-3 fish. Based on the results of the model, there was no difference in the outer ring measurement of immature and mature age-3 herring; maturing age-3 herring do not grow less than immature age-3 herring during the summer before spawning based on scale measurements. Based on these results, we conclude that Pacific herring growth the summer before spawning is not the only determinant as to whether a fish will spawn the following spring. Other hypotheses, such as cumulative growth may play a larger role in determine at what age a fish reaches maturity and spawns.

Into the Intertidal: Beach Seining and Quadrat Sampling in Alaska's Estuaries

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Alaska's nearshore marine habitats are vital for many important marine fish and invertebrate species. Nearshore habitats are influenced by surrounding watersheds that are experiencing climate-driven changes in freshwater runoff. Warming summer temperatures and glacier mass loss will result in an increase in annual freshwater discharge that will carry organic matter and nutrients from terrestrial to marine habitats. The Alaska EPSCoR Coastal Margins estuary field team studied ecological attributes of estuaries along a gradient of glacial to non-glacial watersheds in Lynn Canal (Southeast Alaska) and Kachemak Bay (Southcentral Alaska). This poster presents an overview of the fieldwork done at five estuary sites in Lynn Canal during our first year of data collection. From April through September 2019, we conducted beach seines, intertidal quadrat sampling, and water quality collection during the lowest tide series of each month. A total of 9,278 fish were caught, identified, measured, and released. We retained 59 juvenile Coho Salmon (*Oncorhynchus kisutch*) to analyze their stomach contents. Copepods, cumaceans, and gammarid amphipods were the most abundant prey items in Coho stomachs. Quadrat transects were performed to characterize high intertidal invertebrate and algal communities, including biomass and recruitment. Water quality data were collected to measure temperature, salinity, dissolved oxygen, light, and turbidity near- and off-shore. These data will be incorporated into a large interdisciplinary study examining freshwater drivers of estuary communities along the Gulf of Alaska. Fieldwork will occur in the same sites during the summers of 2020-2022.

Oxygen Consumption Rates of Two Juvenile Pacific Sleeper Sharks, *Somniosus pacificus*

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Little is known about the biology and life history of the Pacific sleeper shark (*Somniosus pacificus*); however, the closely-related Greenland shark was recently found to live to several hundred years of age and reach sexual maturity at ~150 years. As the Pacific sleeper shark is genetically similar to the Greenland shark, they likely have similar longevity and could need protection due to high levels of bycatch in the North Pacific. Two juvenile Pacific sleeper sharks (199 cm, 84.5 kg; 162 cm, 40 kg) were caught and temporarily housed at the Alaska SeaLife Center in Seward, Alaska via methods described at AMSS2020 by Horning et al. While at the Center, respirometry measurement sessions were performed utilizing an annular flow, intermittent-closed system respirometer to measure oxygen consumption. The average routine metabolic rate for both individuals at 7.3°C ± 0.5 was calculated at 16.2 ± 3.4 mgO2/kg/hr, while standard metabolic rate for the second individual at 7.5°C ± 0.5 was calculated at 15.3 ± 5.65 mgO2/kg/hr. Both the routine and standard metabolic rates of Pacific sleeper sharks appear similar to the measured routine metabolic rate of a zebra shark (*Stegostoma fasciatum*), a temperate elasmobranch, of comparable size utilizing a high Q10 or thermal sensitivity – when extrapolated to lower temperatures – calculated at 16.8 mgO2/kg/hr. Few published studies have measured the oxygen consumption rates of species larger than 1.5 m, and none on elasmobranchs measured at temperatures below 10°C. These initial measurements of the metabolic rate of Pacific sleeper sharks enhance deep-sea and polar physiology knowledge by filling gaps in respirometry research for large, arctic elasmobranchs. The metabolic Q10 for these two sleeper shark individuals was estimated at ~3.3 utilizing the difference in routine metabolic rate between a 1 – 2°C temperature chance. This comparably high value could make this potentially long-lived species vulnerable to climate change-related ocean temperature rises.

Evaluating Thermal Effects on Spawn Timing and Early Growth of Gulf of Alaska Pacific Cod: Implications for Survival and Recruitment

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Understanding the effects of environmental variability and climate change on recruitment in marine populations is critical for sound conservation and management. Variation in the abundance of Pacific Cod in the Gulf of Alaska (GOA) has been related to water temperature with greater production during cooler periods; however, the mechanisms underlying this pattern remain unclear. Furthermore, a recent and dramatic reduction in GOA Pacific Cod abundance was observed after a prolonged 2013-2016 marine heatwave. Thus, a better understanding of the potential consequences of thermal variation on Pacific Cod, including spawning phenology, early growth, and patterns of mortality, is a critical research priority. For example, Pacific Cod are benthic spawners and the spawning output and hatch success are likely dependent on the timing and availability of bottom water within a temperature range that is conducive to hatch success. Subsequent larval survival is dependent on availability of adequate prey resources for successful first feeding and subsequent growth, which could affect the size and timing of settlement in nursery grounds. The characteristics of settlers can influence predation rate and interannual variation in nursery habitat quality can impact competition and foraging success. Thus, an approach that integrates across life stages can provide a more comprehensive understanding of the mechanisms regulating recruitment in GOA Pacific Cod. Our research approach builds upon extensive field collections of Pacific Cod larvae (32 years) and juveniles (13 years) within the GOA. We are combining structural analysis of archived otoliths with field and laboratory data to estimate spawn timing, size and timing of hatch, and reconstruct growth during the pelagic stage as well as in coastal nursery habitats. We will incorporate age and size information in temperature-dependent models of developmental and growth rates and environmental data to address key hypotheses regarding how early life history processes influence subsequent recruitment. Understanding how this commercially important, stenothermic species responds to thermal variation is integral for disentangling processes regulating growth and survival to recruitment and predicting population-level responses to climate variation.

Thermal Effects on Juvenile Pacific Cod Condition and Foraging in Gulf of Alaska Nursery Habitats

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The Gulf of Alaska (GOA) ecosystem is influenced by thermal variation including climatic phenomena (e.g. El Niño Southern Oscillation and Pacific Decadal Oscillation) and anomalous warming events such as the 2013-2016 and the developing 2019 marine heatwaves, both of which produced temperature anomalies > 2.5°C. Thermal variation, particularly heatwaves, impact age-0 Pacific Cod (*Gadus macrocephalus*) during periods of rapid summer growth in central GOA nurseries and can influence juvenile body condition, foraging, growth, and selective mortality during the nursery residence. In addition, thermal variability can correlate with shifts in zooplankton community composition and condition in nearshore nursery habitats, contributing to interannual shifts in juvenile Pacific Cod diet composition and energy budget. Understanding the consequences of thermal variability on juvenile Pacific Cod condition and foraging is especially relevant given the large declines in estimated adult abundance (~75% reductions in Acceptable Biological Catch) following the 2013-2016 marine heatwave. To evaluate the potential consequences of extreme thermal variability, we assessed the size, growth, and condition of juvenile Pacific Cod during their Kodiak Island nursery residence and described shifts in prey composition for a subset of 8 years between 2006 and 2019 using stomach contents analysis and stable isotope analysis. Initial results indicate that juvenile Pacific Cod size and condition increases markedly during the nursery residence in warm ocean years. We hypothesize that this variability may, in part, be explained by diet shifts in warmer years. Here, juvenile Pacific Cod condition, diet composition, and stable isotope data from years that represent thermal extremes between 2006 and 2019 will be contrasted to examine correlative effects of temperature on the nursery residence. Understanding thermal effects on age-0 Pacific Cod can inform mechanistic models of recruitment and overwinter survival in the face of climate change and contribute to the management of nursery habitats in future warming scenarios.

Overwinter Energy Allocation in Juvenile Sablefish

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The first winter is a period of nutritional stress and high mortality for many fish species and may dictate year class strength. Fish that grow large and store energy before their first winter are more likely to survive to adulthood. We studied overwinter energy allocation in sablefish (*Anoplopoma fimbria*), a fast-growing piscivore with highly variable recruitment and a target of valuable commercial fisheries in Alaska. We captured juvenile sablefish of the 2018 year class during October before their first winter, during late winter/early spring in March, and in July during their second summer. We compared metrics of growth, body condition, and diet between seasons, including length frequencies, energy density, total energy, and carbon and nitrogen stable isotopes. Sablefish grew throughout the year, including over the winter: mean length was 239 mm in October, 281 mm in March, and 310 mm in July. Energy densities (kJ/g) were lowest in March but total energies (kJ per individual) increased significantly between October and March. Slopes of energy density and total energy versus length regressions were steepest in March, indicating that large fish maintain energy stores better than small fish during winter. March δC13 and δN15 were each positively correlated with length, which suggests a size based diet difference overwinter. Our results show advantages for sablefish achieving large size prior to winter and broadly support the hypothesis that first winter is a life history bottleneck for juvenile sablefish. This work informs our conceptual model of sablefish energy allocation during early life history and our understanding of possible recruitment drivers.

High Ocean Temperatures are Linked to Low Juvenile Pacific Cod Abundance in the Western Gulf of Alaska

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In 2018-19, a Cooperative Research project between the Alaska Fisheries Science Center (AFSC) and University of Alaska Fairbanks (UAF) was undertaken to expand current surveys and address factors regulating survival and condition for age-0 and age-1 juvenile Pacific cod (*Gadus macrocephalus*) across the western Gulf of Alaska. Beach seine locations (n=72) were established in 2018 in 13 bays along the eastern side of Kodiak Island, the Alaska Peninsula, and in the Shumagin Islands.These same sites were again surveyed in July and August of 2019. For each haul, all fish were counted and measured in the field, and sub-samples of tissue and whole fish were returned to the lab for supporting investigations on diet, condition, age, and population genetics. Habitat information, temperature, and salinity data were also collected at each site in both years. Findings to date indicate abundance of age-0 Pacific cod was approximately two orders of magnitude lower in 2019 (mean CPUE = 3 cod/haul) than in 2018 (mean CPUE = 143 cod/haul). Reduced abundance during the heatwave in 2019, coupled with poor nursery settlement during the 2014-2016 marine heatwave, lends support to the theory that cod recruitment is poor when ocean temperatures are high. Abundances of walleye pollock and pink salmon were also notably less in 2019, with Pacific sandlance and Pacific herring being the dominant nearshore species. Laboratory analysis of juvenile cod condition and diets is currently under way. With continued sampling in coming years, this joint research project will both monitor changes and further our understanding of processes regulating demographic variability of age-0 Pacific cod in the GOA.

Effects of Elevated CO2 on Lipid Composition of Walleye Pollock (*Theragra chalcogramma*) Larvae

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Ocean acidification is predicted to severely impact high-latitude seas, which support several important commercial fisheries. Walleye pollock (*Theragra chalcogramma*), one of the fish species dependent on this habitat, represents the United States' largest single-species fishery. Previous studies have suggested a general resilience of growth and survival in juvenile and larval walleye pollock to CO2 levels predicted for the Gulf of Alaska and Bering Sea. However, examination of lipid dynamics may provide insight to other aspects of CO2 sensitivity. To examine the direct impacts of elevated CO2 on newly hatched walleye pollock, we reared larvae at ambient (~500 µatm) and elevated (~1500 µatm) levels of CO2, examining growth and lipid composition at 2 weeks and 4 weeks after hatch. While CO2 treatment did not affect fish size or total lipid density, larvae exposed to higher CO2 levels possessed more storage lipids (i.e., greater TAG:ST) at 2 weeks post-hatch. At 4 weeks, this effect was reversed. In addition to lower storage lipids, later-stage larvae exposed to high CO2 exhibited lower fatty acid density and differences in fatty acid composition. These trends indicate that the impacts of CO2 exposure on walleye pollock lipid composition are stage-specific, as previously reported for other high-latitude species. The observed trends also appear species-specific, differing in directionality from those observed among Pacific and Atlantic cod larvae. Though the mechanisms driving these trends are not fully understood, our findings suggest that this ecologically and commercially crucial species may be more sensitive to ocean acidification than initially indicated.

Oceanic Movement and Behavior of Steelhead, Elucidated with Pop-up Satellite Tags

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To examine the oceanic ecology of steelhead (*Oncorhynchus mykiss*), about which little is known, we are conducting a study in which large, post-spawn steelhead kelts are tagged with pop-up satellite archival tags at a weir in the Situk River, near Yakutat, Alaska. While externally attached to the fish, the tags measure and record ambient light (for daily geoposition estimates), depth and temperature data. On a pre-programmed date, 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.After two field seasons in 2018 and 2019, tags have remained attached to steelhead for 3 to 88 days, providing a total of 467 days of data from 19 individual steelhead. Most (n = 18) pop-up locations of tagged steelhead were in the GOA where they occupied depths to 91 m and water temperatures from 6.3 to 15.6°C during summer. In contrast, one tagged steelhead left the Gulf of Alaska, and its tag popped up near the Aleutian Islands. Based on temperature and light records, predation/consumption of steelhead (n = 2) by ectothermic fishes occurred in the Gulf of Alaska. This project will continue in 2020 when up to 30 additional steelhead will be satellite tagged. The information from this project provides valuable initial insights into the oceanic ecology of steelhead, which may be used for a variety of applications, such as understanding bioenergetics and population dynamics.

Feasibility of a Camera-Based Survey for Estimating Groundfish Abundance on Untrawlable Habitat in the Gulf of Alaska

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To explore the feasibility of camera-based survey of groundfish abundance on untrawlable habitat in the Gulf of Alaska (GOA), we created a 1x1 km grid that combined a variety of information on trawlability from 6 data sources including empirical data, multi-frequency acoustic surveys, and predictive models. Within this new trawlable/untrawlable map, 64% of the grid cells were classified as trawlable by a majority of data sources, 19% were untrawlable, and 17% had conflicting designations and were classified as uncertain. Three years of towed stereo camera data (2013 (n=63,) 2015 (n=89), and 2017 (n=77) were used to predict sample size requirements for an untrawlable habitat survey and to compare design- and model-based estimates of abundance. Our focus was on four rockfish species: Dusky rockfish (*Sebastes sp. cf. ciliates*), harlequin rockfish (*Sebastes variegatus*), northern rockfish (*Sebastes polyspinis*) and Pacific ocean perch (*Sebastes alutus*) all of which had significantly higher densities in camera tows occurring in untrawlable habitat. Coefficient of variation (CV) for abundance estimates from the image data were generally high, between 33-52%, but post-stratification analysis suggested that a depth stratification could reduce the number of samples required to reach a target CV of 20% by 40% for dusky rockfish and Pacific ocean perch and around 15% for harlequin and northern rockfish. The predicted number of samples for a CV of 20% for the stratified random design ranged from 182-366 individual tows depending on the species of interest. In addition to design-based estimates, we also explore the use of a spatio-temporal model (VAST) to generate abundance estimates from camera data. Preliminary results suggest some annual differences in abundance estimates and a reduction in CV for some species using model-based approach. In 2019, an additional 136 stereo camera tows were made in the GOA. These data targeted areas of high conflict in different mapping products and can be used to help determine classification of uncertain grid cells. They will also be used to update our design-based post-stratification analysis and further refine the VAST model.

The Decline of Acoustic Backscatter Associated with Overwintering Pacific Herring (*Clupea pallasii*) in Lynn Canal, Alaska

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Pacific herring (*Clupea pallasii*) are a conspicuous forage fish in Southeast Alaska, serving an ecologically important species role by occupying a key trophic link. Herring are a critical resource for marine mammals, seabirds, and many commercially important fish species, such as Chinook salmon (*Oncorhynchus tshawytscha*). Declines in herring across multiple locations in southeastern Alaska have been demonstrated by decreases in commercial harvests, closed fisheries and reduced spatial extent of herring spawns and overwintering aggregations. Several hypotheses have been proposed for these declines including overfishing, disease, increasing numbers of marine predators (humpback whales (*Megaptera novaeangliae*)), or climate-driven changes within habitats. In response to this, we examined historical acoustic data collected from consistently sampled sites within Lynn Canal to derive a fishery independent assessment of herring abundance using calibrated acoustic backscatter at 38 and 120 kHz. Here we examine patterns in acoustically derived fish density (fish m-3) in three historic overwintering habitats in Lynn Canal from 2008-2019, quantify the decline in acoustic backscatter intensity and characterize changes in aggregation density and morphology over time. Additionally, we examine these trends in relation to environmental fluctuations and predator sightings using generalized additive models (GAMs). The goals of this study are to identify the overall degree of decline in herring density, describe changes in spatial extent of overwinter aggregations, and examine the effects of changing environmental parameters and predators on depressed stocks. Preliminary analyses indicate during our study period, herring densities have declined by orders of magnitude and schooling morphology has shifted from trends of large, densely packed aggregations to more sparse, patchy clusters. Given that Alaskan ecosystems are vulnerable to a rapidly changing climate, it is essential to distinguish the driving processes behind declines and changes in distribution of mid-level trophic species.

Long-Term Shedding of Viral Hemorrhagic Septicemia Virus From Pacific Herring

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Processes that allow viral hemorrhagic septicemia (VHS) virus to persist in the marine environment remain enigmatic, owing largely to the occurrence of extremely low host infection prevalence during typical sub-epizootic periods. Traditionally, the involvement of Pacific herring as an effective long term reservoir has been dismissed as unlikely because naïve individuals are considered super-susceptible to the disease, and survivors of the resulting epizootic apparently clear the infection within several weeks. Here we demonstrate that Pacific herring continue to shed VHS virus at extremely low levels for extended periods after surviving a VHS epizootic. Further, these low waterborne VHS virus levels are capable of establishing new infections in naïve Pacific herring for at least 6 months after cessation of the epizootic. This transmission mechanism was not necessarily dependent on the intensity of the initial epizootic, as prolonged transmission was demonstrated from two groups of donor herring that experienced cumulative mortalities of 4% and 30%. These studies provide support for a new VHS virus perpetuation paradigm in the marine environment, whereby herring that survive an epizootic represent effective host reservoirs and are capable of cycling the virus to sympatric cohorts.

Black Is the New Orange: Bringing the Poorly Understood Pacific Sleeper Shark into Temporary Captivity for Controlled Access Studies

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We locally caught, transported and maintained immature Pacific sleeper sharks (*Somniosus pacificus*) for controlled access studies at the Alaska SeaLife Center (ASLC) in Seward, Alaska. We deployed 4 sets of capture gear for 4-hour daytime soaks. Hooks were baited with salmon, halibut, sablefish or skate carcass parts, and placed between 150 and 300 m depth in Resurrection Bay, near Seward. 23 sharks were brought to the surface in 19 effort days in 2018 (9 sharks) and 32 days in 2019 (14 sharks). Average total length of 22 sharks was 2.8 m (range 1.6 to 3.5). Two sharks small enough to lift in a water-holding stretcher (1.6m and 2.0m) were transferred into a 1,750 liter fiberglass Transport and Experimental Container (TEC) partially filled with seawater placed on the deck of a vessel, driven to the Seward harbor and trailered to the ASLC where the sharks were lifted by stretcher into the largest outdoor saltwater holding tank (282,588 liters). A floating pool cover provided a shaded area and reduced solar heating. During captivity, multiple closed-circuit, intermittent-flow measurements of oxygen consumption were performed on sharks placed in the closed TEC as reported at AMSS2020 by Taylor Smith et al. The two sharks were individually maintained for 14 and 12 days, respectively, before being transferred via TEC back into Resurrection Bay. Blood samples were collected via caudal venipuncture from 12 of 23 sharks, and epaxial muscle samples from ten sharks. 21 sharks were marked with numbered spaghetti tags, and ten with a Vemco acoustic transmitter and a Wildlife Computers mini-PAT satellite transmitter. Two Mini-PATs were programmed to detach and report 90 after days, eight after 180 days. The absence of early detachment and reporting potentially triggered by a mortality-detecting algorithm confirms the survival of the two sharks released after temporary captivity for at least the duration of the monitoring period. This demonstrates the viability of this experimental design of working with temporarily captive sharks in controlled conditions. Future work could be enabled by extended captivity periods, including studies of feeding behavior, temperature tolerance, and studies supporting environmental DNA-based survey methods.

Varying Population-Level Effects in Seabirds Following the Marine Heat Wave of 2014-2016

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A prolonged and extreme marine heat wave in the North Pacific Ocean during 2014-2016 precipitated the largest die-off of Common Murres (*Uria aalge*) ever recorded in the North Pacific in 2015-2016. The apparent cause of mortality was starvation, coincident with a large-scale decrease in forage fish availability and quality. To detect population level effects following the die-off, we censused whole colony populations and estimated productivity (# chicks fledged/ eggs laid) of Common Murres at breeding colonies in Cook Inlet (Chisik Island) and Kachemak Bay (Gull Island) during summers 2016-2019 and compared our findings with earlier (1995-1999) demographic studies. We collected similar data on Black-legged Kittiwakes (Rissa tridactyla), a species that did not experience massive die-offs during the marine heat wave. Recent census counts for murres at Gull steadily declined from a high of 7636 birds in 2016, when they were slightly lower than historic levels (mean 8937 SD 1852), to the lowest ever count of 3147 birds in 2018. Counts from 2019 are in progress. At Chisik, counts for both species were below historic estimates in all years. For the first time on record, murres at both colonies completely failed to fledge chicks in 2016, 2017, and 2018. Murres at Chisik also failed in 2019, but low numbers of murre chicks fledged from Gull Island in 2019. A subset of murres attending colonies in 2018 and 2019 were emaciated, which is unprecedented in our experience. In contrast to murres, kittiwake counts at Gull across recent years (mean 6392 SD 834) were in general similar to historic levels (mean 6988 SD 1179), although the lowest count across all years was immediately following the heatwave in 2016 (5141). Kittiwake productivity was at or near zero at Chisik in all years and at Gull in 2016 and 2018. In 2017 and 2019, however, kittiwakes at Gull produced above average numbers of chicks. The heat wave produced population-level effects on seabirds, suggesting a chronic scarcity of quality forage, but populations are starting to show signs of recovery. Effects of the heatwave on population estimates and productivity were more pronounced in murres than in kittiwakes in Cook Inlet.

Resolving the Annual Pelagic Distribution of Tufted Puffins in the Gulf of Alaska Using Geolocator Technology

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We initiated a two-year, integrative field and laboratory study in 2018 that is examining the at-sea distribution and marine habitat use by Tufted Puffins (*Fratercula cirrhata*) in the Gulf of Alaska (GOA) during the non-breeding season. Populations of Tufted Puffins throughout the GOA have historically been considered at least stable or increasing. However, new analysis suggests these populations are now declining and are predicted to do so in the future. While much is known about Tufted Puffin breeding ecology, the species' migratory routes and wintering areas are currently not specifically known but have been noted as important to determine for management purposes. Our work relies on geolocator tracking technology – small archival tags mounted on plastic leg bands that measure light levels, which can be used to discern the latitude and longitude positions of animals. Geolocators weigh only a tiny fraction of a puffin's body weight and can therefore be deployed on these birds for extended periods of time. In June 2019, we recovered a first set of geolocators that were deployed on Tufted Puffins breeding at Middleton Island during July 2018. We recovered 16 of 30 geolocators representing a 53% recovery rate. Here, we present a preliminary analysis of migration and wintering areas used by Tufted Puffins of the GOA between 2018 and 2019 based on geolocator data. We examine differences between males and females in over-winter marine distributions. The GOA has experienced rapid ocean-climate changes in recent years (since 2014) due to an anomalous marine heatwave, which may be currently redeveloping. Resolving little known aspects of Tufted Puffin ecology is important for better understanding the species vulnerability to rapid changes in the marine environment.

Estimating Fecundity and Survival for the Endangered Cook Inlet Beluga Whales Using Multi-Event Capture-Resight Modeling of Photo-ID Data

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Alaska's Cook Inlet beluga whale (CIBW) population has declined dramatically from historic estimates, but our ability to facilitate recovery for this isolated population is hampered by lack of understanding about current and historic demographic rates. Despite cessation of hunting and the addition of protections afforded by the Endangered Species Act when CIBW were listed as endangered in 2008, the population remains well below historic estimates. Difficult field conditions (including high water turbidity, exceptionally large tidal range, and the large sampling area of Cook Inlet) have hindered data collection for this population. However, one particularly valuable, yet relatively untapped data source is a photo-identification (photo-ID) dataset collected between 2005 and the present that contains longitudinal records of individual whales identified by unique patterns of permanent marks and scars. We used records of these whales identified and resighted between 2005 and 2017, along with any associated calves, and applied a series of Bayesian multi-event models to estimate survival and fecundity. Our models address some of the challenges inherent in the photo-ID data, including unknown sex for most individuals, uneven sampling, and most challengingly, state-classification uncertainty. State-classification uncertainty refers to uncertainty in an individual's reproductive status on any given resight occasion because mothers are not always seen or photographed with their calves. In addition, a whale observed with a calf did not necessarily reproduce that year since calves stay with their mothers for up to 5 years. Finally, with the exception of some neonates, definitive calf ages can rarely be determined in the field. Our simplest model used the relatively small number of confirmed neonate observations to identify reproductively active females, and our most complex model included all calf observations and incorporated calf-age uncertainty to address uncertainty in the mother's reproductive status. Here we compare results among models to show tradeoffs in parameter identifiability, precision, and realism of assumptions. We also discuss potential biases arising from each model. Our fecundity and survival estimates can readily be incorporated into future demographic models to help elucidate the lack of recovery for the CIBW population and to identify appropriate future management actions.

Automated Pixel-Based Tool for Assessment of Body Condition in Large Whales

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Marine ecosystems around the planet are undergoing unprecedented change and its species are facing increasingly variable and potentially inhospitable habitats, as evidenced by large-scale die-offs of numerous marine species. In order to keep abreast of change, researchers need tools that can quickly gauge the health of marine species. With recent advances in Unmanned Aerial Vehicle (UAV) technology, the ability to collect such data has never been greater. However, the ability to analyze this data accurately and efficiently is lacking and often creates a daunting backlog. With data analysis limitations in mind, we developed a Machine Learning Algorithm (MLA) that can automate morphometric measurements of large whales. The MLA can be taught to recognize a specific object from a background and then provide information on that object. A base network trained in object detection via ImageNet was modified to recognize southern right whales (Eubalaena australis) and provide morphometric information on the body shape of an individual whale. The MLA, named 'CetaCon' is able to measure a whale along its central axis from rostrum to fluke notch and width at every pixel along the body axis. With morphometric data on a multitude of individual whales, CetaCon is able to output a population distribution of body shape, with the added ability to compare individual whales to this distribution to determine by what percentage they vary from the mean. Distributions from disparate populations can also be compared in order to monitor whale health across temporal and spatial lenses.CetaCon will provide a standard tool with which researchers can easily analyze large amounts of morphometric data in a relatively fast and easy manner. It will not only facilitate the development and validation of methods for rapid assessment of condition, health and demography for southern right whales, but has the potential for modification for cetacean species around the globe.

2019 Alaska Region Marine Mammal Stranding Summary

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The Alaska Region Marine Mammal Stranding Network was created to provide a consistent framework in which to collect and compile data about marine mammal strandings that occur throughout the state and are reported to the National Marine Fisheries Service (NMFS). The network is a partnership composed of state and federal wildlife and fisheries agencies, veterinary clinics, Alaska Native organizations, non-profit organizations, and academic institutions who respond to or provide professional advice on stranded animals. The extent to which reported stranded animals are examined is variable, from no examination to a full necropsy and analysis of pathology. Stranded animals may provide information on species geographical distribution, feeding habits, reproduction, age distribution, diseases, parasites, contaminant levels, and other possible stressors. The network also may facilitate the rapid identification of mass mortalities or strandings caused by disease, toxicity/pollution, etc. By conducting necropsies on dead stranded animals, it is also possible to learn more about the basic physiology and biology of animals not easily accessible in the wild. Necropsies provide data on the incidence of human interactions including ship strikes, shootings, entanglements, and marine debris ingestion. These data inform NOAA Fisheries management about populations of marine mammals in Alaska. With more than 400 stranded animals and two declared Unusual Mortality Events (gray whale and ice seals), 2019 has been an unprecedented year for stranding reports and response in Alaska. Preliminary findings from the 2019 stranding season will be presented regarding the number and species of reported animals and available necropsy results.

Evaluating Aerial Survey Methods for Estimating Abundance and Distribution of Cook Inlet Belugas

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Cook Inlet belugas (*Delphinapterus leucas*, CIB) are a small, geographically isolated population resident in Cook Inlet, Alaska. In the 1990s, CIB underwent severe declines due to unsustainable levels of subsistence harvest. Even with extremely reduced harvest since 1999 and no documented harvest since 2005, there is limited evidence of recovery to date. Consequently, CIB are listed as endangered under the U.S Endangered Species Act. We conducted a Research Strategy Analysis to evaluate the potential contribution of research actions designed to monitor CIB population status, as required by the CIB Recovery Plan. Aerial surveys of marine wildlife species that aggregate in groups are generally susceptible to four major sources of bias that could lead to underestimation of population abundance: (1) group availability bias, (2) group perception bias, (3) individual availability bias, and (4) individual perception bias. We evaluated the potential for accurate and precise estimation of CIB abundance and trends using aerial surveys involving a new aerial survey design that is standardized to ensure consistent coverage across years and provides spatially and temporally replicated counts. We simulated CIB population dynamics and distribution patterns, and resulting survey data over a 10-year period. Based on these simulated data, we estimated trends and abundance using (a) linear regression, (b) a Kalman filter, and (c) a Bayesian N-mixture-type model. Linear regression and the Kalman filter were able to distinguish stable (0% annual growth), increasing (~2% annual growth), and decreasing (~2% annual decrease) trends, despite various types of availability and detection bias as long as there were no long-term trends in bias. The Bayesian N-mixture-type model was able to estimate annual abundance under various types of availability and detection bias acting in isolation; but performance deteriorated when multiple sources of bias occurred simultaneously. Nevertheless, we submit that the standardized survey designs represent an improvement over strategic approaches because they provide a more consistent basis for trend estimation.

Humpback Whale Numbers Have Not Recovered in Prince William Sound Following the 2014 – 2016 Marine Heatwave

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Humpback whale (*Megaptera novaeangliae*) numbers have failed to rebound in the waters of Prince William Sound following a decline associated with the 2014-2016 warm water event in the Gulf of Alaska. Encounter rates for humpback whales during fall surveys were 6.7 times higher in the years preceding the heatwave (2008, 2011-2014), than during the years following (2017-2019). It is likely that the reduction of humpback whales is related to prey and linked to a decline in the spawning and overwintering biomass of Pacific herring (*Clupea pallasii*) within the Sound. Humpback whale calf production continues to remain low, supporting the hypothesis that the reduction in whale numbers is nutritionally based. In September of 2019, the majority of whales observed appeared to be feeding on euphausiids with a few targeting schools of juvenile rather than adult herring. If environmental conditions are conducive for growth and survival, lower whale numbers combined with a switch to alternate prey should benefit struggling herring populations by reducing top-down pressure. The fate of the missing whales remains unknown. A collaborative research effort across the North Pacific Basin will help address this issue. Ecological conditions in Prince William Sound remain dynamic as another warm water mass forms in the Gulf of Alaska.

Investigating Habitat-Use of Cook Inlet Beluga Whales in the Kenai River

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Alaska is home to five distinct populations of beluga whales (*Delphinapterus leucas*), including the endangered Cook Inlet beluga whale, which contains an estimated 328 individuals. Beluga whales are unique among cetaceans in that they routinely forage in estuarine and freshwater environments and have been known to travel a considerable distance up large rivers. In particular, Cook Inlet belugas are known to forage seasonally in the various rivers and streams that flow into the inlet, including in the lower reaches of the Kenai River. One of the largest and most heavily-fished rivers in Alaska, the Kenai River supports active sport, personal-use, and commercial salmon fisheries, among a number of other human activities. The objective of this study was to acquire baseline data on beluga habitat use, behavior, and disturbance in the Kenai River during the fall of 2019. From August - November, faculty and undergraduate students at the Kenai Peninsula College collaborated with the Alaska Beluga Monitoring Partnership to monitor beluga activity from shore-based sites in the lower Kenai River. This poster presents the preliminary findings generated during this beluga monitoring effort, which provide insight into beluga habitat-use trends (e.g., frequency, group size, and age class composition) and disturbance at this important foraging site. These preliminary findings enhance our understanding of when and how Cook Inlet belugas use the Kenai River and can help inform the management and conservation of this endangered population.

Summary of Cook Inlet Beluga Whale Strandings from 2008 through 2019

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Beluga whales (*Delphinapterus leucas*) reside year-round in the waters of Cook Inlet, Alaska. The Cook Inlet population declined an estimated 50% between 1994 and 1998, and has remained between 300 and 400 animals since 1999. Due to a rapid population decline and the failure of this population to recover, the Cook Inlet beluga whales (CIBWs) were listed as endangered under the Endangered Species Act (ESA) in 2008. Cook Inlet beluga whales are known to strand along mudflats in upper Cook Inlet, both individually and in groups. Strandings include beached and floating carcasses, as well as live belugas found in waters too shallow to permit them to swim. The cause for strandings may be due to the extreme tidal fluctuations, predator or threat avoidance, or pursuit of prey, or other possible causes (73 FR 62928). From 2008-2018, there were 71 dead CIBWs reported, and 10 live stranding events involving at least 72 CIBWs. Through September 2019, there were 7 dead CIBWs reported, and 1 live stranding event involving at least 6 whales. The number of reported CIBW strandings may fluctuate annually or month to month for a variety of reasons including 1) the number of dead whales, 2) the stranding locations, and 3) public awareness of Cook Inlet beluga whales. Responding to each stranded Cook Inlet beluga whale provides an opportunity to obtain individual health, natural history data, evidence of human interactions, and long term monitoring of the population health.

Changes in Humpback Whale Behavior and Prey Availability in Glacier Bay National Park and Icy Strait, Alaska

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Glacier Bay National Park and Preserve is a vital foraging ground and long-term monitoring site for migratory humpback whales (*Megaptera novaeangliae*), who feed on small forage fish and krill. In recent years, humpback whale abundances have decreased more than 50% since reaching a record high in 2013. Declining abundances have also been associated with low occurrences of mother/calf pairs and increased frequency of abnormally thin individuals. This trend in humpback populations has been observed in other areas in the North Pacific and is concurrent with the 2014-2016 North Pacific marine heatwave, which has had widespread ecosystem effects. We hypothesize that changes in prey characteristics, such as species composition, density, depth distribution, or fish condition (weight at length) may be limiting whale foraging success and thereby driving the recent downward trend of whales in this region. To assess changes in whale foraging behavior and prey availability over time, we conducted humpback whale focal follows and hydroacoustic-trawl prey surveys in Glacier Bay and Icy Strait, Alaska in 2001, 2002 and 2018. While the behavior and spatial distribution of whales in this region was similar among years, whale densities were lower and more variable in 2018 than 2001-2002, particularly at Point Adolphus, a historically important foraging area. Whales in Icy Strait were tightly associated with herring aggregations, which fluctuated with tidal state, while those in Glacier Bay were associated with a greater diversity of prey, including Pacific sand lance (*Ammodytes personatus*), Pacific herring (*Clupea pallasii*), and capelin (*Mallotus villosus*). This work will aid in understanding how prey characteristics influence humpback whale distribution, abundance and trends, thereby informing resource management decisions in Glacier Bay National Park and the greater Gulf of Alaska.

Update on NMFS Cook Inlet & Kodiak Marine Mammal Disaster Response Guidelines

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The National Marine Fisheries Service Alaska Region is nearing completion of a regional marine mammal disaster response plan for Cook Inlet and Kodiak. While the primary disaster considered in the plan is oil spills, the plan will also aid in marine mammal response for other hazardous materials spills, natural disasters, and unusual mortality events. Interest in expanded oil and gas exploration and marine shipping in Alaska have highlighted the need for disaster response preparedness for affected wildlife. In addition, changing ocean conditions have led to increased harmful algal blooms and fluctuations in prey availability and distribution in Alaska's waters that could have consequences for marine mammals, such as mass stranding events. Concentrated oil and gas development and shipping in Cook Inlet, multiple vessel groundings, and recent large whale unusual mortality events around Kodiak, led NMFS to select these important areas for the next regional marine mammal disaster response guidelines. Following community visits in the Anchorage municipality, the Kenai Peninsula, and Kodiak Island in Spring 2017, NMFS drafted a guidance document and requested review by stakeholders who had provided input. In addition, NMFS published a request soliciting public comments (84 FR 24102: May 24, 2019). The comments that NMFS received will be addressed and integrated into the final guidance document. The Cook Inlet & Kodiak Marine Mammal Disaster Response Guidelines build upon existing communication pathways, identify potential response infrastructure, outline response processes, and incorporate protocols for marine mammal de-oiling, tissue sampling, carcass collection, and necropsies. The associated Appendices provide the contacts, facilities, protocols, and decision-making tools that will be used by personnel responding to oiled wildlife under NMFS's jurisdiction. The most recent version of the Guidelines are available at this website: https://www.fisheries.noaa.gov/alaska/marine-life-distress/alaska-marine-mammal-stranding-network https://www.fisheries.noaa.gov/alaska/marine-life-distress/alaska-marine-mammal-stranding-network

2019 Gray Whale Unusual Mortality Event in Alaska

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Since January of 2019, a significant increase in gray whale (*Eschrichtius robustus*) mortality has been observed along the west coast of North America from Mexico through Alaska. In May of 2019, the National Oceanic and Atmospheric Administration (NOAA) declared these strandings an Unusual Mortality Event (UME), defined under the Marine Mammal Protection Act as “a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response.” In late winter and spring, gray whales from the eastern distinct population segment typically migrate northward along the West Coast, from mating and calving grounds in Mexico to feeding grounds in northern Alaska. In 2019, gray whale strandings started in Mexico and followed the migration up the coast with the first documented Alaska gray whale stranding on May 9 in Cook Inlet. Since then, over 45 gray whales have stranded in the Alaska Region, representing a four fold increase over 2001-2018 strandings. The cause of this UME is currently under investigation, with differentials including: nutritional stress, biotoxins, disease and parasites, human interactions, and contaminants. Full or partial necropsy examinations were conducted on a subset of these whales. Preliminary findings in several of the whales have shown evidence of poor nutrition, but this was not a consistent finding and all data will require analysis before the cause of death can be determined. Because of correlations between environmental change and shifts in the distribution and behavior of gray whales, the eastern North Pacific gray whale is considered an “ecosystem sentinel” for North Pacific and western arctic ecosystems (Moore 2008). Considering the rapidly changing conditions in northern Alaskan waters, this UME may consequently be of special significance.

Reproductive Natural History of Endangered Cook Inlet Beluga Whales: Insights from a Long-Term Photo-Identification Study

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We examine the results of a long-term photo-identification study of Alaska's Cook Inlet beluga whales (CIBW; *Delphinapterus leucas*) for insight into the reproductive natural history of this endangered and distinct subpolar population. Information on CIBW-specific reproductive parameters is currently sparse, preventing comparisons pre- and post-population decline. Data are from over 400 photo-id surveys conducted 2005-2017 and over 400 identified individuals, augmented with biological data from strandings, biopsies, and tagging. During an April-October field season, neonates were seen July through October, but never April through June. Three possible births were photographed, all occurring between July and September. Neonates were observed in 30% of all groups encountered and comprised 2% of all belugas encountered. Neonate folds were not seen after one to three weeks of age for most newborns, although they were seen on some individuals for up to two months. Individual mothers were observed with 1-5 calves each over the 13 years of records, averaging a calf every 2.6-13 years, and an observed birth interval of 2-13 years. This corresponds to rates of 0.08-0.38 calves per year per mother. The youngest mother of known age photographed with a calf was 13 years old, and the oldest mother with a calf was 31 years old (ages estimated from teeth). Most calves were photographed alongside their mothers between 1 and 4 years, although one was recorded with its mother for 8 years. Some mothers were photographed simultaneously with a newborn and an older calf. While these data are summaries of observations and are not statistically modeled estimates, they provide critical insight into CIBW reproductive natural history that will be essential to informing future modeling endeavors and management decisions.

Cetacean Distribution in the Northern Gulf of Alaska: Results from the 2019 IWC-POWER Cruise

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The IWC-POWER (Pacific Ocean Whale and Ecosystem Research) cruises in the North Pacific are a collaborative effort between the International Whaling Commission and the Government of Japan, with the main objective of obtaining information on abundance, distribution, and stock structure of large whales to inform conservation and management. Though primarily a visual line-transect survey, passive acoustics (via sonobuoys) was included to acoustically monitor for marine mammals, especially eastern North Pacific right whales (*Eubalaena japonica*, hereafter NPRW). The 2019 POWER cruise occurred between 17 July and 14 September in the northern Gulf of Alaska. During the middle and end of the survey, the vessel surveyed throughout the NPRW Critical Habitat. Sonobuoys were deployed approximately every 2-2.5 hours, or approximately every 20-25 nm to obtain an evenly-sampled census of marine mammal vocalizations. When in/near the NPRW critical habitat, buoys were deployed continuously during daylight hours to maximize the potential for detecting a NPRW. NPRW were identified by their two main call types, the gunshot and upcall. Results presented here focus on the passive acoustic component. A total of 229 sonobuoys were deployed, of which 212 were successful, for a total of over 820 monitoring hours. Species detected include fin whales, detected on 119 sonobuoys (56.1%), sperm whales (112, 52.8%), killer whales (76, 35.8%), blue whales (54, 25.5%), humpback whales (47, 22.2%), North Pacific right whales (10, 4.7%), and sei whales (4, 1.9%). Other species/sounds detected include Baird's beaked whales (3, 1.4%), Pacific white-sided dolphins (3, 1.4%), earthquakes (33, 15.6%), and unknown calls/signals (12, 5.7%).No minke or gray whales were acoustically detected, although they were visually sighted. Although NPRW gunshots were detected in their Critical Habitat at the end of the survey, the animal was never sighted due to inclement weather and infrequent calling. Sei whales were only detected in the western stratum; conversely, blue whales were detected throughout the research area. Generally, acoustic detections aligned nicely with visual sightings, with the exception of sperm whales, killer whales, gray whales, and minke whales.

The First Successful Steller Sea Lion Satellite Flipper Tag Deployment: New Application Yields Promising Results

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Advances in satellite technology have yielded valuable information on movements, dive behavior, and foraging range of pinnipeds. However, most satellite tags are secured to the hair of pinnipeds using epoxy, limiting deployment time because tags fall off during the late summer/early fall molting period. To combat this problem and possibly provide longer-term movement data, we (National Marine Fisheries Service and Alaska Department of Fish and Game) deployed "location only" Smart Position and Temperature (SPOT) 6 Model 371B inline satellite tags to the foreflippers of Steller sea lions (*Eumetopias jubatus*). These tags have been used on phocids in recent years but this was the first attachment to the flipper of an otariid. To prepare for deployment, we attached the SPOT tags to sea lion flipper carcasses to determine best tag placement and orientation, and best tools for attachment. We then tested (in collaboration with Wildlife Computers) the SPOT tags on a flipper carcass lying on the beach in various orientations and at varying distances from the water's edge. We found limited information about otariid flipper vasculature so we dissected a Steller sea lion carcass flipper to locate major and minor vessels to ensure tag placement would not interfere with major blood vessels or nerves. From 2018-2019 in Southeast Alaska, we successfully deployed six SPOT 6 371B tags to the flippers of Steller sea lions: five on sub-adult males during entanglement responses and one to an adult male stranded because of harassment. All six tags provided data on animal location with a maximum of 296 day transmission. Results to date demonstrate that SPOT tags can be used to track Steller sea lions during the summer-fall molt period. We are guardedly optimistic that these tags will be retained by sea lions and function for many months, perhaps >1 year, allowing for longer-term tracking than previously possible. Deploying SPOT tags on otariid flippers not only provides survival data for post-entanglement and stranding response, but allows an opportunity to answer future research questions.

Marine Associated Bird and Mammal Habitat Use at the Five Finger Light

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In summer 2017 I studied the abundance and distribution of marine associated birds and mammals at the Five Finger Lighthouse in Southeast Alaska. My objectives were (1) to identify the areas of highest habitat use by species of conservation concern, (2) to make recommendations for an ecosystem-based management plan for the island, and (3) to initiate a citizen science project supporting continued place-based research and conservation. This study documented seven species of marine mammals and 20 taxonomic groups of birds derived from 110 field surveys. My analysis found higher relative abundance and greater biodiversity of both birds and marine mammals on the south and west facing sectors of the island compared to the north and east facing sectors. I attribute this to the greater habitat complexity on the south and west facing sectors that comprise a near-shore reef, a mixed kelp forest, and a channel between the reef and rocky cliffs, areas used extensively for foraging, nesting, traveling, socializing, and resting by many of the documented species. These findings provided the basis for recommendations to avoid development and to minimize anthropogenic disturbance on the southern and western portions of the island including the adjacent reef and channel. In 2018, novel results from this study were used to prevent disturbance to harbor seals (*Phoca vitulina*) during pup rearing season, a species of high conservation concern in Alaska both due to declining numbers and importance to traditional subsistence harvest practices. As both the Five Finger Lighthouse ecosystem and management continue to evolve in response to changing environmental conditions and human interests, this study also established a baseline for future study that will inform future adaptive management, document changes over time, and engage community stakeholders in science and conservation.

Examining Hypotheses for Limited Recovery of Cook Inlet Beluga Whales: Integrated Population Models Reduce Uncertainty in Population Viability Analyses

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The Cook Inlet population of beluga whales (*Delphinapterus leucas*) is estimated to have declined by 75 percent over two decades and is listed under the U.S. Endangered Species Act. Substantial monitoring effort and resources have been invested to conduct aerial and mark-resight surveys, yet considerable uncertainty still exists about demographic rates, population abundance, and potential factors limiting recovery. Much of this uncertainty is attributable to the challenges of studying the population given its habitat and life history characteristics (e.g., variable group sizes and detection of animals in turbid waters). However, one way to improve our understanding of population dynamics and future viability is through integrated population modeling, where multiple sources of information are combined to reduce bias and improve precision in life-history parameter estimates. This study builds on a recent integrated population model to estimate time-varying adult survival, fecundity, and abundance using aerial and mark-resight survey data collected from 2004-2016. We conduct a population viability analysis (PVA) to quantify the magnitude of change in extinction probabilities across a range of demographic rates estimated in the integrated model. Additionally, we outline the next steps of this project, including an expert elicitation framework that will be used to refine existing hypotheses about the most pertinent anthropogenic, environmental, or intrinsic threats to population persistence and recovery. The PVA will be used in the future to examine the potential effects of anthropogenic mortality, decreased fecundity, or reduced carrying capacity due to the unquantified and unknown effects of stressors such as underwater noise, prey depletion, or habitat range contraction. This information will help identify whether intrinsic or extrinsic factors may be limiting recovery and what, if any, management actions could ameliorate the effects of the most impactful anthropogenic activities. Model results will be communicated broadly through a user-friendly RShiny data visualization tool that will improve the accessibility of information for decision makers. Our findings highlight the utility of integrated population modeling for capitalizing on all available information to account for and reduce uncertainty when estimating extinction risks for a depleted, geographically isolated population.

Resident Killer Whale (*Orcinus orca*) Spatial Use in the Gulf of Alaska

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Resident killer whales (*Orcinus orca*) are top predators in the Gulf of Alaska marine ecosystem. Understanding their spatiotemporal distribution is therefore important not only for managing this federally protected species, but also to provide insight into other species and changes within the ecosystem at large. Previous killer whale distribution research using vessel surveys and satellite transmitters (conducted primarily in the summer months) has found distinct preferences for certain areas by season and pod, though wintertime spatial use has not yet been described. Since fall 2016, the North Gulf Oceanic Society has been collecting year-round acoustic data every twenty minutes from an array of hydrophones placed in locations known to receive high use in summer months in Prince William Sound and Kenai Fjords. Autonomous recording hydrophones provide an advantage over surveys and telemetry because they are not limited by season or weather, can document more animals than can feasibly be tagged, and are non-invasive. Using this acoustic dataset, we will provide the first description of year-round resident killer whale distribution in the Gulf of Alaska. Preliminary results show disproportionate use of Montague Strait from October through February (present in 80 to 90 percent of days each month). We will also update the southern Alaska resident killer whale call catalogue by matching calls from field recordings to photographically identified individuals, then describe pod- and matriline-specific spatial use patterns. We also plan to estimate the number of animals present in autonomous acoustic recordings by matching identifiable calls with the number of animals per pod or matriline and by using measures of call diversity and call rates. Finally, due to the multi-year nature of these data, significant interannual distribution changes or patterns will be described.

The Tip of the Iceberg: Three Case Studies of Spill Risk Assessments Used in Environmental Impact Statements

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Environmental impact statements (EISs) are based on science produced about specific project proposals, which results in a large quantity of grey literature. Spill risk estimates are part of that body of work. This is a critique the spill risk models cited in EISs for proposed drilling on the Alaskan Coastal Plain, along the proposed Pebble Mine transportation corridor, and Arctic offshore drilling, prepared by the Bureau of Land Management, the US Army Corps of Engineers, and the Bureau of Ocean Energy Management, respectively. All three case studies are scored against published standards of best practices for ecological risk assessments and each had a unique set of major shortcomings. For the Coastal Plain, the solid and hazardous spill risks were given qualitatively or based on spill data nearly a decade old. For the proposed Pebble Mine, the transportation corridor spill risks considered only a small fraction of the potential spill sources or substances and only at volumes well above the threshold to be considered large spills. For drilling on the Arctic outer continental shelf, the spill risks were based on modeling that had poor data handling, inconsistent and unfounded assumptions, and incorrect use of prior models, among other concerns. To put these case studies in the larger context of other EIS process, the amount of peer reviewed science and the amount of grey literature cited in recent EISs are shown. Suggestions of how agencies, scientists, and peer reviewed journals can contribute to meaningful review of grey literature in regulatory science are offered.

Connecting Alaskan Coastal Communities to Scientific Research through the Scientist in Residency Fellowship Program

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Improving scientific literacy increases a community's capacity to make more informed policy and management decisions related natural resources. The Sitka Sound Science Center has demonstrably increased the scientific literacy in Alaska's Arctic and subarctic communities through the Scientist in Residency Fellowship (SIRF) Program. Statewide science testing shows Sitka scoring consistently in the top percentage of districts statewide. This trend is also true for sectors of our population that often have lower science test scores, including students who are female, Alaska native, and from economically disadvantaged backgrounds. The Sitka School district credits this consistency, in part, to the contributions the SIRF program has made to the Sitka community and the school district. The SIRF program is aimed at improving polar scientists' ability to convey the importance of their research to rural and Alaska Natives living in subarctic communities. In close collaboration with minority-serving institutions in Sitka, carefully coordinated community engagement outlets have been developed to assist polar scientists in communicating the significance of their research to the public. Science educators from SSSC work with each SIRF Fellow and K-12 teachers to develop pre-lessons in advance of the scientist's visit, to lay the groundwork for productive interactions. The scientists are also given other opportunities to interact with the community in more informal settings. Sitka residents then become familiar with scientists on a more personal level, which creates the possibility of new STEM connections community-wide. In total, we have hosted 36 month long residential fellowships for mid-career scientists since 2011. This program is critical in working towards changing the culture of science in communities across Alaska and working towards closing achievement gaps between groups of students.

Sitka National Historical Park Intertidal Taxa Inventory

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Detecting ecosystem structural and functional changes requires identifying ecosystem components. In Sitka, Alaska, the Sitka National Historic Park is seeking to catalog the species present in the Park's intertidal community as ecosystem components.The Park's intertidal is comprised of a single, 2-hectare low gradient beach, with cobble and mud substrates. We cataloged all the observed species on the beach through a series of BioBlitzes completed in conjunction with 20 local and regionally relevant scientists and 191 community members. Multiple BioBlitzes were conducted to account for seasonal variation in the abundance of species. Each unique species was identified and recorded. Selected voucher specimens were retained. A complete taxa list was retained in NPSpecies, the National Park Service's database. In addition, we created photo vouchers and identifications available through the iNaturalist application available for mobile devices. In all, we made 609 species observations encompassing 11 distinct phyla. Previous surveys in the same area identified 480 unique species. These discrepancies in observations are partially explained by seasonal shifts in species abundance and distribution. The most frequently observed phylum was Arthropoda. This could be attributed, in part, to Arthropoda being the most diverse animal phylum with the largest number of species. This group also includes many easily identifiable large mobile and sessile organisms. Previous surveys found the largest amount of species in the phylum Mollusca. Our multiple survey approach allowed us to intensively cover larger swaths of the intertidal, rather than focusing on single transects in a single snapshot in time. This approach better considers species life histories, locomotion adaptations, and spatial distributions of organisms. The Intertidal Taxa Inventory will provide Sitka National Historical Park and adjacent areas with important baseline information for monitoring species composition changes over time and for informing future management decisions within the Park's boundaries.

Changes in Marine Predator and Prey Populations in the Northern Gulf of Alaska: Gulf Watch Alaska Pelagic Update 2019

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The Gulf Watch Alaska (GWA) long-term monitoring program supports several coordinated efforts to understand population status, trends, and trophic interactions within the Northern Gulf of Alaska marine ecosystem. GWA's pelagic component includes monitoring of breeding and non-breeding marine birds, killer whales, humpback whales, and forage fish. During spring of 2019, offshore abundance of seabirds along the Seward Line was the lowest seen in 12 years, and during summer, abundance of shearwaters over the banks east of Kodiak Island was lower than in 2018. In summer and fall, there were unusual observations, including southern species of seabirds, cetaceans, and fish, and large whales in the inner shelf or in Prince William Sound (PWS). While some marine bird species wintering in PWS (e.g. murres) seem to be recovering from the 2014-2016 warm water event, we observed changes in densities and distributions of other species (e.g. shearwaters) potentially in response to the warm water mass currently developing in the Gulf of Alaska. The fish-eating resident killer whales are showing no growth or possibly negative growth in the closely monitored segment of the population. There has been decreased presence of many killer whale pods inshore, particularly in the fall months in Montague Strait where fall aggregations were a regular occurrence for decades prior to 2016. PWS 2019 humpback whale numbers were up from 2018 but still below pre-heatwave abundance. The majority of humpbacks appeared to be feeding on krill or juvenile herring rather than adult herring. Although humpbacks appeared healthier than in recent years, no calves were encountered on the survey. The frequency, size, and density of forage fish, including capelin, older age-classes of sand lance, and krill, were higher in PWS during 2019 compared to recent years. Sand lance occurrence in seabird diets at Middleton declined slightly in 2019 compared to 2018, the difference being countered by a modest increase in capelin and greenling. Continued monitoring of the pelagic ecosystem by the GWA program will provide data required to evaluate the response of key predators and their prey to changes in the marine environment.

MONDAY, JANUARY 27, 2020

WAVE 2
GULF OF ALASKA

(7:30 PM TO 9:00 PM)

POSTER PRESENTATIONS: MONDAY, WAVE 2, 7:30PM - 9:00PM
GULF OF ALASKA

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Potential Formation and Implications of Oil-Related Marine Snow in the Cook Inlet Region	Jesse Ross, Susan Saupe, Nancy Kinner, Kai Ziervogel	Climate and Oceanography	Row 1 | P2
The Yakutat Wave Energy Study	Jeremy Kasper, Michael Courtney, Manuele Castellote, Kate Stafford, Andy Seitz	Climate and Oceanography	Row 1 | P4
Investigating the Impact of Increased pCO2 and Temperature on the Bidarki (*K. tunicata*) in Alaska	Marina Washburn, Amanda Kelley	Climate and Oceanography	Row 1 | P6
Examining Concretion to Shell Development of Larval Pacific Razor Clams (*Siliqua patula*) under Elevated and Variable pCO2 Conditions	Marina Washburn, Amanda Kelley	Climate and Oceanography	Row 1 | P8
Abundance and Distributions of Gelatinous Zooplankton in the Northern Gulf of Alaska	Heidi Mendoza Islas, Russell Hopcroft	Lower Trophic Levels	Row 1 | P10
Warm-Water Zooplankton in the Northern Gulf of Alaska: Observations from the Seward Line	Caitlin Smoot, Kenneth Coyle, Russell Hopcroft	Lower Trophic Levels	Row 1 | P12
Associating Clam Recruitment with Adult Standing Stock in the Northern Gulf of Alaska	Brian Zhang, Brenda Konar, Ben Weitzman, Heather Coletti, Dan Esler	Lower Trophic Levels	Row 2 | P14
Past, Present and Future of Kelps in the Gulf of Alaska	Stewart Grant, Michael Stekoll	Lower Trophic Levels	Row 2 | P16
Unexpected Importance of the Smallest Phytoplankton in the Northern Gulf of Alaska Ecosystem	Kerri Fredrickson, Hana Busse, Delphina Walker-Phelan, Clay Mazur, Suzanne Strom	Lower Trophic Levels	Row 2 | P18
Managing Kelp Cultivation in Alaska: The Role and Research of ADF&G	William Templin, Cynthia Pring-Ham, Zac Grauvogel, Christopher Habicht, Erica Chenoweth	Lower Trophic Levels	Row 2 | P20
Northern Spot Shrimp (*Pandalus platyceros*) Early Life History Stages: Metabolic and Growth Physiology in a Warming Ocean	Jamie Musbach, Sherry Tamone, Mari Fester	Lower Trophic Levels	Row 2 | P22
Watershed Influence on Terrestrial Resource Use by Nearshore Consumers	James Schloemer, Katrin Iken	Lower Trophic Levels	Row 2 | P24
Variability in Pacific Blue Mussel (*Mytilus trossulus*) Demographics in a Glacially Influenced Estuary	Amy Dowling, Brenda Konar, Katrin Iken	Lower Trophic Levels	Row 3 | P26
Preliminary Findings From the Winter 2019 International Gulf of Alaska Expedition	Charles Waters, Dion Oxman, Todd Miller, Emily Fergusson, Edward Farley	Fishes and Fish Habitat	Row 3 | P28
The Influence of Water Flow, Water Conditions, and Seasonality on Nearshore Estuarine Fish Communities	Chris Guo, Brenda Konar, Coowe Walker	Fishes and Fish Habitat	Row 3 | P30
Identification of Physiological Growth Signatures in Skeletal Muscle of Pacific Halibut (*Hippoglossus stenolepis*) for Monitoring Population Growth Patterns	Josep Planas, Dana Rudy, Anna Simeon, Anita Kroska, Nathan Wolf, Bradley Harris, Thomas Hurst	Fishes and Fish Habitat	Row 3 | P32
Evaluating Nearshore Fish Community Composition along a Glacial Gradient in Southcentral and Southeast Alaska	Nina Lundstrom, Anne Beaudreau, Franz Mueter	Fishes and Fish Habitat	Row 3 | P34
Habitat Linked Growth and Survival of Juvenile Pollock in the Gulf of Alaska	speaker: Jodi Pirtle, Ben Laurel, Georgina Gibson, Louise Copeman	Fishes and Fish Habitat	Row 3 | P36
Stock Enhancements, Stock Rehabilitations, Sea Ranching and Mariculture in Alaska	Stewart Grant, Milo Adkison	Fishes and Fish Habitat	Row 4 | P38
Development of Molecular Assays to Measure the Expression Levels of Genes Encoding Growth Markers in Pacific Halibut (*Hippoglossus stenolepis*)	Anna Simeon, Dana Rudy, Josep V. Planas	Fishes and Fish Habitat	Row 4 | P40
Combined Effects of Temperature and Food Quality on Growth and Energy Allocation of Juvenile Pacific Cod (*Gadus macrocephalus*)	Ashwin Sreenivasan, Ron Heintz, Johanna Vollenweider, Katharine Miller	Fishes and Fish Habitat	Row 4 | P42

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Automated Electronic Monitoring to Validate Salmon Bycatch Reports from Kodiak Fish Processing Plants	Craig S Rose, Katy McGauley, Julie Bonney, Jenq-Neng Hwang, Jiarui Cai	Fishes and Fish Habitat	Row 4 | P44
Can We Reconstruct the Growth History of the Pacific Halibut (*Hippoglossus stenolepis*) Population by Otolith Increment Analysis?	Dana Rudy, Joan Forsberg, Tim Loher, Ian Stewart, Chris Johnston, Robert Tobin, Josep V. Planas	Fishes and Fish Habitat	Row 4 | P46
Good Eating: Crab Abundance and Size Distribution Along a Sea Otter Gradient in Southeast Alaska	Rebecca Cates, Lia Domke, Wendel Raymond, Ginny Eckert	Fishes and Fish Habitat	Row 4 | P48
Prince William Sound Herring Research and Monitoring Program	W. Scott Pegau, Trevor Branch, David McGowan, John Trochta, Andrew Whitehead, Paul Hershberger, Maya Groner, Pete Rand, kristen Gorman, Mary Anne Bishop, Stormy Haught	Fishes and Fish Habitat	Row 5 | P50
Visualizing and Communicating Spatiotemporal Trends in Kachemak Bay Fish Communities Using ArcGIS Story Maps	Andrew Scotti, Kris Holderied, Brenda Konar	Fishes and Fish Habitat	Row 5 | P52
Pacific Halibut (*Hippoglossus stenolepis*) Maturity Status Explored Via Histology and Macroscopic Maturity Staging Methods	Nathan Wolf, Bradley Harris, Josep Planas, Teresa Fish	Fishes and Fish Habitat	Row 5 | P54
Preliminary Assessment of the Spatial Distribution of Nearshore Fishes Near, Yakutat, AK	Michael Courtney, Andrew Seitz	Fishes and Fish Habitat	Row 5 | P56
Regional Differences in Walleye Pollock Size, Condition, and Prey Selectivity Suggest Density-Dependent Effects on the Western Gulf of Alaska 2013 Year Class	Jesse F Lamb, David G Kimmel	Fishes and Fish Habitat	Row 5 | P58
High Diversity and Richness at the Top of Giacomini and Quinn Seamounts in the Gulf of Alaska	Kate Ariola, Katrin Iken	Fishes and Fish Habitat	Row 5 | P60
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Potential Formation and Implications of Oil-Related Marine Snow in the Cook Inlet Region

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Marine snow is the phenomenon of organic particle aggregation and sinking throughout the world's oceans. It varies seasonally with primary productivity and is a food source for pelagic and benthic organisms. Spilled oil can become incorporated into the aggregates, forming oil-related marine snow, creating a pathway for oil to enter marine food webs. This route of exposure was first documented following the 2010 Deepwater Horizon in the Gulf of Mexico. Subsequent research suggests oil-related marine snow could play a significant role in the fate of spilled oil in other regions exhibiting similar drivers: seasonally high primary productivity, high suspended sediment loads, and the potential for oil to enter the environment. Characterization of particle fluxes in areas of petroleum exploration and extraction enhances response preparedness and decision-making. This research investigated the potential formation and fate of oil-related marine snow in the Cook Inlet region. A surface-tethered sediment trap was used to measure particle fluxes at four sites in southeastern Cook Inlet during the summer in 2018 and 2019, and across shallow banks in the western Gulf of Alaska (GOA) in July 2019. Fluxes were similar at three sites along the axis of Kachemak Bay (117 ± 54 g m-2 d-1), and significantly larger at Anchor Point (225 ± 138 g m-2 d-1). Fluxes in the western GOA, at a depth of 40 m, were 25 ± 15 g m-2 d-1. The organic flux (20-45% of total flux) in southeastern Cook Inlet indicates high primary productivity across the region that is being exported out of the mixed layer. In laboratory experiments, roller-bottles with surface water from Kachemak Bay were used to explore the interaction of surface oil and natural assemblages. The results corroborate studies in other regions; oil enhanced biological aggregation and there is potential for surface oil to become submerged in organic aggregates. Estimates from UV-microscopy indicate that 0.6-9.3% of the total oil added to surface water samples became incorporated in non-floating aggregates. The results suggest oil-related marine snow could form and sink in the Cook Inlet region and should be considered in oil spill preparedness and assessment of impacts.

The Yakutat Wave Energy Study

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Yakutat, Alaska, is a village on the outer coast of the Gulf of Alaska that currently relies on costly barged-in diesel for heat and electricity. The community has actively been exploring alternatives to this expensive fuel source. Simultaneously, the development and implementation of ocean wave energy technology is advancing rapidly and has the potential to provide long-term renewable energy to Alaska villages such as Yakutat that have access to the ocean, favorable wave conditions and high fuel costs. The Bureau of Ocean Energy Management sponsored the Yakutat Wave Energy Study to understand potential environmental impacts from the installation of wave energy converters in communities such as Yakutat. Fishery, hydrographic, beach elevation and photogrammetric surveys were conducted in the shallow waters of- and along- the beach face of the Gulf of Alaska adjacent to Yakutat. In addition, three oceanographic moorings were deployed offshore of the community to document presence of marine mammals, ambient noise baseline, and the physical forces responsible for driving sediment transport and coastal morphology in the region. A real-time met station was also recently established to measure local winds, barometric pressure, temperature and solar insolation and multiple low cost, real-time Spoondrift wave buoys have been deployed in the region over the past 1.5 years. Some initial findings are presented here including from the fisheries and topo-bathy surveys: mid-water trawling captured very few fishes while bottom trawling produced substantially more fishes, consisting mostly of flatfishes. Rod and reel fishing in the spring and summer captured relatively few fishes consisting mostly of small Pacific halibut and big skates, except for fall when catch of Coho salmon was relatively high. Only small changes were found in beach elevation between 2018 and the last time such elevation transects were measured, in 2014, with the exception of one transect adjacent to the nearby Situk River which was submerged between 2014 and 2018 due to changes induced by the river. Acoustic detections of humpback whales, killer whales and porpoises were common. In addition to marine mammals, boat signals were recorded from spring through fall which influenced background noise levels over short time periods.

Investigating the Impact of Increased pCO2 and Temperature on the Bidarki (*K. tunicata*) in Alaska

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The Bidarki (*Katharina tunicata*) is an organism of immense cultural and subsistence importance to Native communities throughout coastal Alaska, but whose population has shown recent declines. One of the theories behind this decline is that Bidarkis could be suffering from the negative consequences of ocean acidification (OA). OA is long-term process through which worldwide oceanic pH is decreasing. It is attributed to the dramatic increase in CO2 that has been ongoing since the start of the industrial revolution. This decrease in pH has been demonstrated to have detrimental impacts on calcifying organisms. This study aims to understand how an increase in pCO2/reduced pH and elevated temperature both individually, and in concert, will impact the physiology of the Bidarki. Metrics for this study include oxygen consumption, grazing as a proxy for behavioral changes, shell mineralization, shell composition and dissolution, as well as measuring mRNA levels for two genes associated with OA stress. Answering questions about this species will help lay the baseline of knowledge regarding OA and Alaskan organisms and possibly help answer questions regarding an animal vital to Alaskans.

Examining Concretion to Shell Development of Larval Pacific Razor Clams (*Siliqua patula*) under Elevated and Variable pCO2 Conditions

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Global climate change, facilitated by the increase of anthropogenic CO2, is driving oceanic chemical changes resulting in a long-term global decrease in ocean pH. This change is colloquially known as ocean acidification (OA). Previous studies have shown that OA can have negative physiological consequences for calcifying organisms, particularly bivalves. This study looks to examine the effects of ocean acidification- increased pCO2and lowered pH on larval Pacific razor clams (Siliqua patula). During preliminary analyses of experimental samples it was discovered that S. patula utilizes a relatively unique form of shell development, more often found in gastropods. This has led to new investigations regarding shell development during early life stages. The new analyses employed for this study include further compositional examination and mineral structure analysis. Understanding exactly how this unique process of shell development occurs in S. patula is critical not only to understanding how S. patula may be affected by elevated pCO2, but also to opening new avenues of research into possible “winners and losers” in an acidified ocean.

Abundance and Distributions of Gelatinous Zooplankton in the Northern Gulf of Alaska

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Small gelatinous predators have been relatively well-studied in Gulf of Alaska for decades, but the seasonal and spatial patterns of gelatinous zooplankton in the Gulf are poorly known, despite suggestion of increased jellyfish populations in Bering Sea and numerous ecosystems globally. We determined gelatinous zooplankton abundances and distributions during July and September of 2018 and 2019, as part of the Northern Gulf of Alaska Long-term Ecological Research (NGA LTER) cruises. We sampled 42 stations along four cross-shelf transects and within Prince William Sound using a 5 m2Methot Trawl. Although scyphomedusae ("true jellyfish") were our primary focus, hydromedusae and ctenophores were also captured, with a total of eight prominent species across these three taxonomic categories. The hydromedusae Aequorea was the most abundant genera and occurred at most stations during both years of sampling. Generally, biomass was greatest in offshore waters, driven by larger individuals. In contrast, near-shore biomass was lower but showed high abundance of smaller individuals. The biomass of these large predators was over an order of magnitude greater than estimates obtained from other sampling methods. These observations will help improve our understanding of the jellyfish composition, spatial and temporal patterns, as well as their ecological importance in the Gulf of Alaska ecosystem.

Warm-Water Zooplankton in the Northern Gulf of Alaska: Observations from the Seward Line

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The Northern Gulf of Alaska (NGA) is a rich and diverse ecosystem that sustains significant fisheries resources, birds, and marine mammals. Lipid-rich copepods such as Neocalanus spp., Calanus marshallae, and Pseudocalanus spp. support these important upper trophic levels. In recent years, anomalous water temperatures in the NGA region have coincided with the presence of warm-water taxa, such as *Calanus pacificus*, *Paracalanus spp*., *Mesocalanus tenuicornis*, and *Clausocalanus spp*. These taxa are comparatively smaller and lipid-poor; thus, these variations in the zooplankton community composition may have implications for energetic transfer to higher trophic levels. Here we examine recent spatio-temporal patterns of these warm-water taxa collected in the upper 100 m with a 150 µm CalVet net along the Seward Line, now part of the Northern Gulf of Alaska Long Term Ecological Research (NGA-LTER) site. The decades-long sampling history of the Seward Line provides a rich dataset to provide historical context to recent observations. Preliminary data from recent years suggest that *C. pacificus* and *Paracalanus spp*. are more numerous in the fall. *C. pacificus* is generally more successful in offshore waters, while *Paracalanus spp*. are encountered in highest numbers nearshore and within Prince William Sound. In contrast, *M. tenuicornis* and *Clausocalanus spp*. occur in lower numbers and do not exhibit a clear spatial pattern. Continued monitoring as part of the NGA-LTER will be critical as this ecosystem continues to undergo change.

Associating Clam Recruitment with Adult Standing Stock in the Northern Gulf of Alaska

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Clams are an important food source for personal and subsistence use around the world. They also perform several vital ecosystem functions including serving as prey for many apex predators and improving water quality as they filter-feed. Globally, there are a number of factors affecting clam populations, including overharvest, changing climate, and reduced water quality In some areas, natural predation (e.g., by sea otters in the north Pacific) reduces clam abundance. For these reasons, declines in abundance have been observed in many populations of large, hard shell clams, prompting a need to examine factors that affect clam standing stock. We examined the potential role of clam recruitment in maintaining adult standing stocks for three of the most harvested hard shell clam species in the northern Gulf of Alaska, the Butter clam (*Saxidomus gigantea*), Litteneck clam (*Leukoma staminea*), and Heart Cockle (*Clinocardium nuttalli*). In cooperation with Gulf Watch Alaska, clam recruitment and standing stocks from four regions (Kachemak Bay, Prince William Sound, Kenai Fjords National Park, Katmai National Park and Preserve) were compared over three years. In addition to region wide comparisons of recruitment and adult standing stock, in Kachemak Bay we also examined the influence of oceanic vs. more estuarine sites. We hypothesized that increased recruitment would correlate with higher abundance of standing stocks unless other factors, such as adult mortality, have greater influence. We found that the presence of recruitment often coincided with the presence of standing stock. Within Kachemak Bay, standing stock variation between the estuarine and oceanic sites depended on the species of clam (e.g., higher standing stock at oceanic sites compared to estuarine sites for Clinocardium, in contrast to higher standing stock at estuarine sites for other two species). Our results will inform long-term monitoring efforts in the northern Gulf of Alaska to determine if annual clam recruitment patterns can be used as a good indicator of standing stock status.

Past, Present and Future of Kelps in the Gulf of Alaska

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Kelp farming along the Alaskan coast holds the promise of economic development. The past, present, and future of kelp populations must be considered in the development of management strategies for this budding industry. Genetic data show that populations of sugar (*Saccharina latissima*), split (*Hedophyllum nigripes*) and winged (*Alaria sp*.) kelps survived ice-age coastal glaciations in the northern refugia around the Gulf of Alaska. Expansions from these refugia and isolation by colonization has led to a mosaic patchwork of genetic population structure in present-day populations with little dispersal between populations. Little is known about the distributions and ecologies of kelps along Alaska's long coastline. In the North Atlantic and NW Pacific populations can be ephemeral on decadal time scales. Even though the macroscopic sporophytic stage may disappear, microscopic gametophytes can remain dormant for several growing seasons and repopulate a shore with sporophytes when environmental conditions improve. It remains to be seen what effect large-scale kelp farming might affect natural kelp populations, or indeed, the ecology of the near shore communities. In addition to short-term climate cycles, global warming will also influence the abundances of kelp populations. Climate warming from the effects of greenhouse gases will have a large impact on high latitude populations of fishes and invertebrates in Alaskan waters through elevated temperatures, increased concentrations of CO2, and ocean acidification. Kelps, however, may benefit from greater concentrations of CO2 in sea water, which promotes photosynthesis, but warmer temperatures can prevent the development of spores and lead to local extinctions. Evolutionary legacy, ecology, including potential influences of farming on natural populations, and future environmental change must be considered in the management of kelp resources.

Unexpected Importance of the Smallest Phytoplankton in the Northern Gulf of Alaska Ecosystem

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While the importance of diatom blooms to northern coastal ecosystems is well known, recent study of the northern Gulf of Alaska (NGA) has highlighted the high abundance and multiple roles of the smallest phytoplankton - cyanobacteria and <10 µm flagellates – in the planktonic ecosystem. With the exception of production 'hot spots' such as fronts and eddies, these small autotrophs comprised most of the chlorophyll-a in the pre-bloom spring community as well as in the summer and fall stratified communities. Tiny (1 µm) Synechococcus spp. cyanobacteria were unexpectedly numerous, reaching bloom abundances of 1-2 x 105 cells/ml in offshore waters in spring 2019, and throughout the region in summers 2018 and 2019. Size-fractionated measurement of photosynthetic efficiency (Fv/Fm) across the shelf in summer 2019 showed that cells ≤5 µm had consistently higher Fv/Fm than larger cells, likely indicative of a lesser degree of micro- and/or macronutrient limitation. These small cell-dominated communities had high carbon:chlorophyll ratios, with median values of ~100 in spring, and ~200 in summer. Whole-community primary production measurements also showed the seasonally dynamic relationship between chlorophyll concentration and carbon cycling, with summer C fixation per unit chlorophyll almost 3x that in spring. These findings demonstrate that use of chlorophyll to predict biomass and production in the NGA will result in significant underestimates unless seasonally and spatially adjusted C:chl ratios are used. Taxon-specific rate measurements using the dilution technique showed these smallest phytoplankton were significant contributors to the NGA food web in summer 2019, growing at high rates (>1 doubling per day) even in low-nutrient stratified waters, and experiencing moderate rates of grazing loss. High growth rates of photosynthetic flagellates could have been supported, in part, by mixotrophy. These primary producers can ingest prey, as demonstrated by samples from the natural community as well as during prey (Synechococcus) addition experiments. Taken together, these data show that biochemical (high C:chl) and nutritional (mixotrophy) adaptations allow the smallest phytoplankton to thrive and likely dominate C fixation and lower trophic level C fluxes during large portions of the spring-summer season in the NGA.

Managing Kelp Cultivation in Alaska: The Role and Research of ADF&G

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Mariculture of kelp is an expanding industry worldwide. Alaska's over 40,000 miles of pristine tidal shoreline (much of it protected) and fisheries infrastructure is well suited for kelp mariculture. The Alaska Mariculture Development Plan projects a thriving mariculture industry worth $100 million by 2040 and permit applications have increased substantially since 2016 with the establishment of the Alaska Mariculture Initiative and Task Force. The Alaska Department of Fish and Game (ADF&G) is one of three state agencies who authorize and manage mariculture activities. In anticipation of this growing industry, ADF&G's Gene Conservation Laboratory (GCL) formulated guidelines to protect the natural productivity of wild kelp populations. One of these guidelines limits the distance of 50 km by water between broodstock acquisition and resulting progeny outplanting sites and is designed to protect local adaptations. To help evaluate whether the existing guideline is appropriate, GCL completed an initial survey of the population structure of wild stands of the two most commonly cultured kelp species in Alaska, *Saccharina latissima* (sugar kelp) and *Alaria spp*. (ribbon or winged kelp), using North Pacific Research Board grant funding. Our examination of mitochondrial, chloroplast, and microsatellite DNA revealed significant differences among populations on a range of spatial scales. The existence of highly variable allele frequencies over small geographic areas provides support for the current guideline for kelp species. Larger sampling efforts are needed to better understand finer-scale population structures of both kelps and to examine structure in other species of mariculture interest. ADF&G will continue to pursue research studies to understand how best to protect and maintain wild populations while supporting development of mariculture and cultivation of kelp in Alaska. Key words: Management, kelp, seaweed, macroalgae, mtDNA, cpDNA, microsatellite DNA, Alaska, policy

Northern Spot Shrimp (*Pandalus platyceros*) Early Life History Stages: Metabolic and Growth Physiology in a Warming Ocean

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Northern spot shrimp *Pandalus platyceros* support commercial, subsistence, and recreational fisheries in Southeast Alaska. They are the primary species targeted by the pot shrimp fishery, and while not the largest of the shellfish fisheries, are economically viable to Southeast Alaska. Recently, declining catches and greater restrictions on previously productive regions of Southeast motivate a deeper understanding of spot shrimp early life history stages and metabolic physiology. P. platyceros has a complicated life history that spans multiple ecosystems and is a relatively data poor shellfish species. Ocean acidification and increased ocean temperatures are environmental stressors associated with climate change that have been shown to alter calcification, development, and metabolic rates in other marine invertebrates. While increased carbon dioxide concentrations in the ocean impact calcification for some crustaceans, knowledge is lacking on how physiological processes including metabolism might be affected by ocean acidification. Indirect calorimetry, a measure of oxygen consumption, will be utilized to assess potential energetic costs to benthic juveniles in ambient, increased temperature, and increased CO2conditions. Oxygen consumption rates of juvenile P. platyceros will be measured using a spectrophototmetric respirometry system (Loligo® Systems) to obtain mass specific metabolic rates. Measuring the energetics of P. platyceros will provide data of the physiological costs associated with living in ocean conditions predicted to be warmer and more acidic. A change in energy demand could lead to impacts on growth rates, size at maturity, and recruitment success all of which could alter an economically and ecologically important species in Southeast Alaska. Understanding how these environmental changes might affect early life history stages of P. platyceros is imperative in managing a sustainable fishery.

Watershed Influence on Terrestrial Resource Use by Nearshore Consumers

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Nearshore estuarine habitats are among the most productive ecosystems on earth and are supported by organic matter from both terrestrial and marine origins. Terrestrial carbon uptake in nearshore marine consumers proximate to river outflows may vary based on differences in upstream vegetation and physical attributes of contributing watersheds. Climate-driven impacts such as retreating glaciers, increased river discharge, and shifting vegetative community composition will alter the quality and quantity of organic matter exported to nearshore environments. It is imperative that the effects of climate on coastal resources are fully understood to best promote effective management of resilient ecological communities and the important services they provide to the people depending on them. This project will address this issue by documenting terrestrial resource use by nearshore invertebrates and identify watershed characteristics that contribute most to the type of organic matter (phytoplankton, macroalgae, terrestrial matter) being utilized. This will be achieved through applying 1) bulk stable isotope mixing models to determine carbon sourcing in select nearshore invertebrates at watersheds of varying glacial influence, and 2) remote sensing of watershed characteristics to describe organic matter source and delivery to riverine systems. Preliminary data collected in 2019 as part of EPSCoR Fire & Ice Coastal Margins team project will be discussed to demonstrate the conceptual application of this approach

Variability in Pacific Blue Mussel (*Mytilus trossulus*) Demographics in a Glacially Influenced Estuary

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Variability in Pacific blue mussel (*Mytilus trossulus*) demographics in a glacially influenced estuary Pacific blue mussels (*Mytilus trossulus*) are an integral part of the nutrient cycle in near-shore and estuarine ecosystems. As abundant filter feeders, Pacific blue mussels act as connectors between the water column and the benthic zone and serve as a food source to many higher trophic level species. Estuaries and near-shore ecosystems at high latitudes receive freshwater runoff from both rivers and glaciers; study sites located closer to glaciers are more heavily influenced by glacial runoff than sites more exposed to rain-fed riverine or oceanic influence. These hydrographic conditions affect environmental variables such as water temperature, salinity, and nutrient availability, which in turn affect the demographics of local species such as Pacific blue mussels. As global warming trends influence these high-latitude systems, understanding how these near-shore estuarine ecosystems are being affected is becoming more urgent. We propose that Pacific blue mussels make an ideal model species to assess biological responses to environmental variability, as they play an important role in benthic nutrient production. This research will determine how and to what degree mussel demographics, specifically age, growth, and size frequency, vary along hydrographic conditions in Kachemak Bay, a model system for a glacially influenced estuary. In-situ growth and length measurements will be taken at all sites, while age will be determined using a combination of growth rates and acetate peels. Combined, this study will identify variability in Pacific blue mussel demographics, and how hydrographic conditions correlate to this variability.

Preliminary Findings From the Winter 2019 International Gulf of Alaska Expedition

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The International Year of the Salmon (IYS) is an initiative of the North Pacific Anadromous Fish Commission and its North Atlantic partner that aims to connect numerous organizations across various countries to address key challenges facing salmon and the communities that rely on them. The International Gulf of Alaska Expedition, a signature project of IYS organized by Dr. Richard "Dick" Beamish, was a comprehensive survey to study the winter ecology of Pacific salmon in the Gulf of Alaska. Spanning 30 days and nearly 700,000 km2, the expedition was conducted on a Russian research vessel with 21 scientists from Canada, Korea, Japan, Russia, and the United States. To better understand the critical winter period, which may regulate the productivity of salmon in the high seas environment, the team collected a range of ecosystem data including oceanographic measurements, zooplankton community composition and abundance, and the origins and abundance of salmon. Here, I will present the preliminary findings of the expedition. For example, chum salmon were the most abundant species while, surprisingly, pink salmon were the second least abundant (outnumbering only Chinook). These catches were used to generate winter abundance estimates of salmon the Gulf of Alaska (54.95 million fish), which have potential to inform fisheries management. Additionally, species distributions differed substantially within the survey area, with sockeye found in the cooler waters of the north while chum, coho, and pink salmon were observed largely in the warmer waters of the south. I will close by discussing the research questions that NOAA's Auke Bay Laboratories and the Alaska Department of Fish and Game aim to address, including intra- and inter-species competition and winter fitness of Pacific salmon. This expedition will hopefully be the first of many to better understand factors that affect salmon productivity in the face of a changing ocean environment.

The Influence of Water Flow, Water Conditions, and Seasonality on Nearshore Estuarine Fish Communities

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Estuaries provide important habitat for many nearshore fish. These fish benefit from the unique hydrologic conditions provided by estuaries (e.g., increased productivity from mixing waters, allochthonous input of nutrients, refugia from increased turbidity), with the variability in those conditions influencing fish community structure. In the Gulf of Alaska, current climate patterns appear to be shifting the force and seasonal timing of freshwater inputs. To examine this variability and the hydrological influences, water flow, fish communities (species composition and abundance), and water conditions (temperature, salinity, dissolved oxygen, and turbidity) were examined every two weeks during the summer and fall of 2018 at three sites with high flow conditions and three sites with low flow conditions in Kachemak Bay in lower Cook Inlet, AK. Multivariate analyses were used to determine the influence of water flow, the other water conditions, and seasonality on the variability in fish composition and abundance. Seasonal trends were apparent in both water conditions and fish community, which was driven mostly by the appearance of young-of-the-year age groups. After accounting for seasonal effects and other water conditions, water flow was found to have a significant effect on fish community. Forage species (e.g., Pacific sand lance, Pacific herring, smelts) associated more with high flow sites; whereas, benthic-dwelling species (e.g., crescent gunnels, snake pricklebacks) and multi-year rearing salmon (e.g., coho, sockeye, and chinook salmon) associated more with low flow sites. All of the factors studied here were significantly correlated to variability in fish species abundance with water flow, dissolved oxygen, and seasonality explaining a relatively larger proportion of the variance compared to temperature, salinity, and turbidity.

Identification of Physiological Growth Signatures in Skeletal Muscle of Pacific Halibut (*Hippoglossus stenolepis*) for Monitoring Population Growth Patterns

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The International Pacific Halibut Commission has reported changes in the size-at-age (SAA) of Pacific halibut (*Hippoglossus stenolepis*) for almost 100 years. However, our understanding of the potential causes for the long-term variability in SAA is limited. Although several factors could contribute to this variability, recent analyses have suggested that temperature variation may have been a contributing factor to the observed changes in SAA. Therefore, a better understanding of the physiological effects of temperature on growth in this species is needed. To address this issue, we investigated the effects of temperature-induced growth manipulations on white skeletal muscle in juvenile Pacific halibut. Two groups of juveniles were acclimated for 8 weeks at 2°C and 9°C, after which half of the individuals from the 2ºC group were gradually acclimated to 9ºC and held at that temperature for an additional 6 weeks. Initial acclimation at 2°C resulted in a significant reduction in the specific growth rate (SGR) of juvenile Pacific halibut when compared to fish acclimated only at 9°C. Following the first acclimation period, the group initially acclimated at 2ºC and subsequently acclimated to 9ºC displayed a significant increase in SGR when compared to fish that were constantly held at 9°C, demonstrating compensatory growth. We performed transcriptomic, proteomic and stable isotope analyses of white skeletal muscle collected from these experimental groups to identify growth-related processes that are regulated by temperature. The resulting physiological signatures of temperature-regulated growth should be useful to monitor growth patterns in the Pacific halibut population.

Evaluating Nearshore Fish Community Composition along a Glacial Gradient in Southcentral and Southeast Alaska

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Alaska's ecosystems are on the forefront of climate-driven ecological change. Some of the ecosystems that may be most impacted by current climate change and forecasted increases in temperature and precipitation are estuaries downstream of glaciers. By collecting data on fish communities in estuaries that fall along a gradient of glacial influence, we may be able to draw conclusions about the impacts of future glacial melt on nearshore fish community composition in the Gulf of Alaska (GOA). The objectives of this study were to: 1) Quantify and compare nearshore fish community composition in estuaries along a glacial gradient and in two regions of the GOA; and 2) Evaluate seasonal trends in nearshore fish community composition in the GOA. Fish community data were collected from 10 estuary sites along a gradient of watersheds with 0% glacial cover to 60% glacial cover in two regions, Southcentral (Kachemak Bay) and Southeast Alaska (Lynn Canal). We conducted beach seine sampling at each site monthly from April through September 2019. There were greater differences in species composition between regions than across the glacial gradient within regions. Species composition was relatively consistent across sites within Lynn Canal, whereas assemblages were more varied in Kachemak Bay. The two sites with the highest glacial cover (Mendenhall River estuary in Lynn Canal and Grewingk River estuary in Kachemak Bay) showed the greatest differences in species composition. For both regions, catches peaked in June and July, driven by pulses in recruitment of many species including pacific herring, starry flounder, and various osmerids. Further data collection in the coming years will paint a more holistic picture of climate change impacts on nearshore fish communities, but these preliminary data demonstrate the importance of quantifying estuarine fish community composition in a range of watershed and habitat types.

Habitat Linked Growth and Survival of Juvenile Pollock in the Gulf of Alaska

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Understanding mechanisms through which environmental conditions influence survival and growth of juvenile life stages can help inform stock productivity estimates for commercially and ecologically important species such as walleye pollock (*Gadus chalcogrammus*). The ability to link habitat information such as temperature to rate dependent functions of survival and growth can help better define essential fish habitat (EFH) for groundfish within the region. A habitat model was developed for juvenile pollock (40 - 120 mm) in the Gulf of Alaska. Laboratory experiments were conducted with juvenile pollock collected in the Gulf of Alaska to develop vital rate functions, including temperature and size dependent survival and growth rates during summer and winter conditions. These vital rates were integrated with available summer catch data and associated physical habitat covariates (e.g., depth, terrain, substrate, currents) to develop habitat maps for seasons and years with limited observations. EFH information is advanced through this work for juvenile pollock in the Gulf of Alaska Fishery Management Area. There is potential to extend this mechanistic approach to other species where vital rate functions linked to environmental covariates have been developed.

Stock Enhancements, Stock Rehabilitations, Sea Ranching and Mariculture in Alaska

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A broad spectrum of habitats in Alaska are ideally suited to the commercial production of fishes, invertebrates, and seaweeds. In addition to the harvests of natural populations, stock enhancements, sea ranching and mariculture are used to boost production, and stock rehabilitations attempt to help in the recovery of depressed populations. A fundamental concern underpinning these activities is the protection of the ecological and genetic integrities of wild populations. Ecological concerns include bio-pollution and competition between farmed and wild stocks. Genetic concerns center on brood stock origins and sizes, and hybridizations between farmed and wild individuals. The development of aquaculture in Alaska is playing out against a backdrop of climate warming and ocean acidification, which will lead to range shifts, local extinctions and altered levels of production. Attempts to boost the production of Alaska's bio-resources come with several trade offs between environmental protection and the development of economic opportunity. In other areas of the world these trade offs are influenced by societal demands for food and and the desire for economic growth.

Development of Molecular Assays to Measure the Expression Levels of Genes Encoding Growth Markers in Pacific Halibut (*Hippoglossus stenolepis*)

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Growth in fish is the result of a complex set of biochemical processes that result in synthesis of new body tissues. These processes are regulated by the expression of key genes that control aspects of energy acquisition, metabolic rates, digestive activities, energy transfer and protein synthesis. The molecular and biochemical fine-tuning of growth responses to habitat changes is particularly relevant during periods of environmental variability or habitat shifts. Importantly, environmental and ecological influences in the form of changes in ambient parameters (e.g. temperature) or in the competitive interaction with other species have been hypothesized to influence size-at-age in Pacific halibut (*Hippoglossus stenolepis*) by regulating somatic growth. However, we presently lack the species-specific analytical tools required to evaluate the spatial, temporal, and age-specific growth patterns to fully evaluate this hypothesis. For this reason, we set out to develop molecular assays to measure the expression levels of genes encoding growth markers in this species. Based on the results of an ongoing study evaluating the overall transcriptomic response of skeletal muscle to temperature-induced growth variations in juvenile Pacific halibut, we have identified a set of genes that could represent potential useful molecular markers of growth in this species. We will present initial results on the development of real time quantitative polymerase chain reaction (qPCR) assays for identified growth marker candidates as well as for house-keeping genes that are used to quantify relative gene expression levels of potential growth markers.

Combined Effects of Temperature and Food Quality on Growth and Energy Allocation of Juvenile Pacific Cod (*Gadus macrocephalus*)

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The recent heat wave in the Gulf of Alaska which lasted from late 2013 until late 2015 raised concerns about the impacts of elevated temperature on the growth and survival of juvenile Pacific cod (*Gadus macrocephalus*). Previous studies demonstrated that juvenile cod growth is maximized at 11.5 °C, but temperatures in their nearshore rearing habitats may have been substantially higher during the heat wave. For example, the Sitka and Kodiak tide stations reported temperatures in excess of 12.8 °C for the entire month of August in 2014.Moreover, zooplankton species compositions during the warm period included large numbers of small, low lipid species from more southerly latitudes suggesting juvenile cod prey quality was diminished. We conducted a laboratory experiment designed to understand the effect of prey quality on cod growth at different temperatures. Newly settled cod were collected from beaches in southeastern AK, brought back to Auke Bay Laboratories, and reared in temperature-controlled water for 56 days. Fish held at 6 °C, 8°C, 10°C, and 12 °C were offered either a low lipid (2% lipid, 22% protein, 12.7 kJ/g) or high lipid (4.8% lipid, 15% protein, 13.7 kJ/g) diet. Preliminary analysis indicates growth increased with temperature but diet quality had no detectable effect. Fish fed the low lipid diet averaged 1.7 ± 0.3 % increase in weight per day, compared with 2.0 ± 0.3 % for the high lipid diet. However, consumption rates increased with temperature and were 34% greater for fish on the high lipid diet than those on the low lipid diet. Increased assimilation efficiencies of fish on the low lipid diet may have compensated for their reduced consumption. Thus, the impacts of the recent heat wave on the growth of juvenile cod may have been limited to temperature effects. We are currently analyzing how the fish allocated their energy between lipid and protein to assess their relative preparedness for winter and future survival.

Automated Electronic Monitoring to Validate Salmon Bycatch Reports from Kodiak Fish Processing Plants

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Accurately and efficiently knowing how many salmon are caught by Alaska groundfish trawl fisheries (bycatch) is critical to managing those fisheries. Learning those numbers is difficult, particularly at sea, as tons of groundfish must be scanned to detect a few salmon. Bycatch counts can be improved by effectively prohibiting at-sea discards and monitoring on-shore deliveries. Alaska fish processing plants sort and measure catch and bycatch components of groundfish deliveries and report them on state fish tickets. While these reports provide detailed data from entire deliveries, an inability to independently verify plant sorting and accounting processes has limited their use for managing salmon bycatch. The Alaska Fisheries Science Center's Electronic Monitoring Innovation Program, working with Dr. J-N Hwang's Information Processing Laboratory at the University of Washington, the Alaska Groundfish Data Bank and FishNext Research, are developing and testing an automated electronic monitoring system to provide fisheries managers sufficient confidence in plant reports to use them for salmon bycatch management. In 2018, we monitored rockfish deliveries for salmon at four Kodiak plants with both trained samplers and video cameras. Analysis of imagery from those collections indicated strong feasibility of both automated detection of salmon entering sorting areas and species identification from closeup images. Additional video collections in 2019 improved camera imagery and greatly increased the number of salmon images for process training. Our monitoring system uses a trained deep learning detector to detect salmon entering the plant's sorting area. Tracking across video frames then identifies and eliminates false detections. Preliminary tests of automated salmon detectors indicate detection of most salmon entering the sorting area. As each salmon is sorted from the catch, sorting crews briefly put it in the view of a 'check-in' camera set to provide a detailed picture. Times of video detection will be compared with check-in times to assure that all detected salmon are found and sorted out. Species identifications from the check-in will also be compared with salmon counts from that delivery's catch report. All of these processes can be done automatically, with imagery saved for checking when any discrepancies occur.

Can We Reconstruct the Growth History of the Pacific Halibut (*Hippoglossus stenolepis*) Population by Otolith Increment Analysis?

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The average size at age for both male and female Pacific halibut has significantly decreased during the last 25 years, particularly in the Gulf of Alaska. This has led to a decrease in the exploitable biomass of halibut stocks. Several factors, including environmental, fisheries-related, and even anthropogenic, could be responsible for the observed decrease in the growth potential of this species. Since the International Pacific Halibut Commission maintains a long-term, coast-wide otolith collection, we aimed to determine if otolith growth corresponds with somatic growth in Pacific halibut. Specifically, we looked at otoliths from the 1977, 1987, 1992, and 2002 cohorts from three different regions of biological significance within the Pacific halibut's range. Despite the significant decline in Pacific halibut size at age in these cohorts, we did not find a similar decline in otolith growth during this time period. For example, in 15-year-old females sampled in the Gulf of Alaska from the 1977 and 1992 cohorts, there was a 2.45% increase in mean otolith radius during that time period, despite a 14.97% decrease in mean body length for those fish. Additionally, we found that otolith accretion in male and female Pacific halibut does not reflect their large dimorphic size differences. Although factors regulating otolith growth in Pacific halibut are not well understood, otolith growth appears to be decoupled from somatic growth.

Good Eating: Crab Abundance and Size Distribution Along a Sea Otter Gradient in Southeast Alaska

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Once locally extinct in Southeast Alaska, sea otters (*Enhydra lutris*) were reintroduced in the 1960s creating a natural experiment in which sea otters gradually recolonized, with resultant decreases in shellfish important for commercial and subsistence fisheries. Crabs are highly vulnerable to sea otter predation, and Dungeness crab (*Metacarcinus magister*) is an essential resource to fisheries and communities in Southeast Alaska. To date trophic linkages among sea otters, eelgrass communities and intermediate predators like crabs result in indirect positive effects on eelgrass mediated through sea otter predation on crabs. Through investigation of crab abundance along a sea otter gradient from 2017-2019, we find that crab abundance and size distribution decreases with increasing sea otter occupation. Larger crabs are completely absent in the presence of sea otters, but interestingly the diversity of crab species increases in the presence of sea otters. Our future studies will examine variation in recruitment as well as explore species interactions among crab species along this sea otter gradient. By developing a baseline of crab abundance and identifying size and abundance changes over time, we can further analyze the relationship between crabs and sea otters within this trophic cascade, with the ultimate goal to support ecosystem based management that may account for the coexistence of sea otters and fisheries.

Prince William Sound Herring Research and Monitoring Program

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The Pacific herring population in Prince William Sound (PWS) collapsed shortly after the Exxon Valdez oil spill (EVOS). Since that event in 1989, the EVOS Trustee Council has funded considerable research on herring. Beginning in 2009 they chose to fund research through integrated programs and in 2012 the Herring Research and Monitoring program began. The program currently has projects that monitor the population level and disease prevalence to allow us to track the status of the population. We are also conducting research to determine when the herring mature to the spawning population, tracking movement in and out of PWS, how disease and pathogens impact the populations, growth, how the herring population is effected by environmental conditions and the long-term impacts of oil exposure on herring. A modeling effort pulls information from the different projects to help us better understand the factors influencing the population. A general overview of the program and a highlight of results will be provided. We will show how the various projects tie together to provide a better understanding of this important forage fish. In particular, beginning in 2015 we saw a decline in the PWS herring population. We use the data from this program to examine how the environmental conditions associated with the warm oceanic conditions may have played a role in the decline.

Visualizing and Communicating Spatiotemporal Trends in Kachemak Bay Fish Communities Using ArcGIS Story Maps

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Kachemak Bay, AK is a highly productive estuarine ecosystem containing diverse biological communities that support a wide array of local fisheries and tourism industries. Fish communities are especially important for the economies of nearby cities and towns, so clear and effective communication between researchers and the public, especially individuals whose careers rely on local fish communities, is imperative. ArcGIS Story Maps offer a streamlined and easily accessible way to establish this communication using a combination of satellite imagery, maps, photos, videos, and text. The goal of this project was to use Story Maps as a platform for visualizing a current fish project examining the effects of glacial change on estuarine fish communities in Kachemak Bay, and as an outreach tool to strengthen the communication between local scientists and resident stakeholders. As part of Alaska EPSCoR “Fire & Ice” and through NOAA’s Kasitsna Bay Laboratory, this study investigates trends in nearshore fish community structures over time and across five watersheds along a glacial gradient. Sites were sampled for species distribution and abundance using monthly beach seines from April to July 2019. Species distributions were then integrated into the Story Map to create an immersive presentation of the results for public access. Though spatiotemporal trends in community structure cannot be identified with certainty at this point, there is evidence of emerging differences in species distribution and abundance among watersheds that may become more apparent with more sampling. Looking to the future, as the study continues the Story Map can be updated and expanded with current results to maintain the connection between local fish research and stakeholders in fishing, tourism, and other important industries. The continued use of Story Maps for outreach will help raise awareness about current fish research, educate interested stakeholders in a streamlined, immersive way, and serve as a useful platform for visualizing many other current fields of research in Kachemak Bay.

Pacific Halibut (*Hippoglossus stenolepis*) Maturity Status Explored Via Histology and Macroscopic Maturity Staging Methods

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Accurate reproductive information is foundational to successful fisheries management. Presently, female Pacific halibut (*Hippoglossus stenolepis*) maturity stage assignments are derived from macroscopic assessment of ovaries sampled over a limited 2-3-month period during yearly fisheries-independent setline surveys conducted by International Pacific Halibut Commision. This relatively narrow sampling window may not be adequate to describe the actual potential reproductive contribution of stages occurring over an annual cycle. Further, histology stages have yet to be defined for the species therefore the relative accuracy of macroscopic maturity assessments has yet to be compared to histologically-derived assignments, the highest standard of stage definition. The aims of this study are to 1) define female Pacific halibut maturity stages with histology; 2) examine maturation stages over an annual cycle; and 3) compare staging results from histological and macroscopic assessment methods. From September 2017 to August 2018, ovaries from 30 female Pacific halibut (>90cm in length) were staged each month using the standard macroscopic approach and ovarian samples were prepared for histological assessment. Results from the histology examination will reveal the seasonal progression of maturity as well as uncover any mismatches with the macroscopic staging method. The resulting refined gonadal staging process will enhance our understanding of the species reproductive potential and accordingly allow for better management of the resource.

Preliminary Assessment of the Spatial Distribution of Nearshore Fishes Near, Yakutat, AK

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Yakutat is a community along the northeast coast of the Gulf of Alaska that is currently considering utilizing renewable, wave-based electricity generation to lessen their reliance on diesel fuel for electricity generation. To advance and develop this innovative wave energy technology in an environmentally responsible manner, it is necessary to conduct studies to assess the potential and realized impacts of the devices on fishes occupying areas near potential deployment sites. To document fish species encountered near the proposed wave energy site, we sampled nearshore waters adjacent to Cannon Beach, Yakutat, AK, with both bottom (n = 6) and surface trawls (n = 6) in May of 2018, and by hook-and-line in May–November 2019. Additionally, datasets from all known previous sampling programs in the vicinity of Yakutat were aggregated (n = 4 datasets), and a list of all fish species captured, by gear type was generated. Previous sampling programs used bottom trawl (n = 51), mid-water trawl (n = 48), and beach seining (n = 25) at locations throughout Yakutat Bay, adjacent to Cannon Beach, and the Situk River lagoon. In total, we documented 107 fish species present near Yakutat, Alaska near the proposed wave energy site. Higher catches and species richness were documented with beach seining activities very close to shore, compared to bottom trawls or surface trawls. Catches were highest in May, and richest by species in July. The high relative abundance of many important forage fishes (e.g., Pacific Herring, Pacific Sand Lance, Capelin, Eulachon) and overall high species richness, suggest that nearshore waters of Yakutat are highly productive and may be important feeding areas for upper trophic level predators including marine mammals, sea birds and Pacific salmon. The high diversity of fish species is likely due the unique and vast habitat types that exist in nearshore areas of Yakutat, AK.

Regional Differences in Walleye Pollock Size, Condition, and Prey Selectivity Suggest Density-Dependent Effects on the Western Gulf of Alaska 2013 Year Class

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During the 2013 western Gulf of Alaska (WGOA) fall survey, age-0 walleye pollock (*Gadus chalcogrammus*) were found in higher abundance compared to other years: an average of 0.42 m2, compared to 0.06 m2 (2011) and 0.00087 m2 (2015). To assess the potential for density-dependent resource competition due to these higher abundances, diet and condition of age-0 fish were examined from the 2013 year class. It was hypothesized that fish from different areas along the WGOA shelf would show differences in size, condition, and diet. An inverse relationship between fish abundance and condition was observed. High abundances of smaller, lower condition age-0 fish were found at stations southwest of the Shumagin Islands compared to low abundances of higher condition fish found near and around Kodiak Island. Fish in the Shumagin Islands region showed a higher intake of pteropods and larvaceans compared to fish from the Kodiak Island region that had consumed mostly large copepods and euphausiids. However, Prey-specific Index of Relative Importance analysis showed age-0 fish from the entire study area primarily preferred large copepods and euphausiids as prey. These results suggest that the lower condition fish found near the Shumagin Islands were the result of density-dependent food limitation as higher quality prey may be been depleted. In contrast, the higher condition fish found near Kodiak Island did not deplete the available prey at did not experience density-dependent food limitation. The results suggest that density-dependent mortality in the Shumagin Islands region contributed to the overall population dynamics of the 2013 year class of Walleye Pollock.

High Diversity and Richness at the Top of Giacomini and Quinn Seamounts in the Gulf of Alaska

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Seamounts are biological hotpots in the open ocean due to their interaction with the surrounding deep-sea system that alters mixing, nutrient concentrations, and increases primary production. Globally, more than half of all seamounts are located in the Pacific Ocean, about 35 of them in the Gulf of Alaska. In summer 2019 we compared benthic species richness on the summits (about 600 -900 m depth) and deep slopes (~ 2500 m depth) of two of these seamounts, Giacomini and Quinn seamounts using imagery from the remotely operated vehicle. For both seamounts, summits had higher species richness and frequency of occurrence than slopes, including fishes, crustaceans, echinoderms and corals. However, benthic community structure between Giacomini and Quinn summits differed as well, with higher frequency of occurrence and a larger richness, especially in corals, on Giacomini.

Observing the Behavioral Thermoregulation of Common and Thick-billed Murres (*Uria aalge* and *U. lomvia*) with Thermal Imaging

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The interaction between seabirds and their habitat has become increasingly important due to recent evidence of population declines associated with rising temperatures and habitat loss. Shifts in the spatial ecology of the pelagic and coastal habitats used during stages of seabird life cycles determines the timing of breeding and reproductive success of many seabird species. Fluctuating ocean temperatures, prey abundance, and habitat availability has led to significant impacts in the survival of multiple seabird species occurring along the Gulf of Alaska, exhibited by the die-off Common and Thick-billed Murres in 2018. This study focuses on utilizing infrared thermal imaging technology to investigate the behavioral thermoregulation of Common Murres (*Uria aalge*) and Thick-billed Murres (*U. lomvia*) in relation to the sun-orientation of their contrasting black and white plumage coloration. Boat-based surveys were conducted during summer 2019 to collect thermal data of these species in the Chiswell Islands of the Alaska Maritime NWR using a thermal camera (FLUKE Ti50) and a thermal video camera (FLIR Rev 110 H-series). Thermal data was collected of Common and Thick-billed Murres engaged in various activities such as resting, swimming, flying, foraging, and incubating to study energetic costs of these activities and how heat is displaced within the body. In addition, thermal images were collected of large assembles of these species utilizing diverse substrates such as water, rock and vegetation in contrasting weather conditions and sun exposure to determine how substrate type and microclimate affect thermoregulatory needs. Thermal images were also collected of Common Murres at the Alaska SeaLife Center aviary during different stages of life ranging from nestlings to mature adults to assess how thermoregulation mechanisms may change and develop over the lifetime of an individual. These data may elucidate trends in posture and sun-orientation among individual Common and Thick-billed Murres and this improved understanding of the thermophysiological needs of these species may better inform management and conservation practices for at-risk seabirds in the Gulf of Alaska.

Seabird Colonies in Decline Along the Coast of Katmai National Park and Preserve

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Katmai National Park and Preserve (Katmai) in Alaska includes nearly 500 miles of coastline which provides nesting and nearshore foraging habitat for seabirds. Many of Katmai's seabird colonies have not been inventoried since the early 1990s. A series of boat-based surveys were conducted in the summer months of 2016-18 to revisit known colonies and document new colony locations. Species and count data were summarized and compared to historical colony data. Analyses indicate declines in colony counts for most seabird species along the Katmai coast. For many species at risk of further decline, development and increased shipping traffic pose risks for oil spills and groundings, introducing contaminants that could affect nesting seabirds, their prey, and their habitat. In addition to direct anthropogenic risks, changing ocean conditions and recent seabird die-off events in the Gulf of Alaska may continue to impact seabird populations as well. Colony data will be added to the North Pacific Seabird Colony Data Portal (seabirds.net) while concurrently aiding Katmai management in determining future monitoring efforts.

An Integrative Method for Characterizing Marine Habitat Features Associated with Predation on Juvenile Steller Sea Lions (*Eumetopias jubatus*)

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In terrestrial systems, characterizing habitat associated with predation events has been used to explore predator-prey dynamics. However, quantifying and characterizing the role predation plays in marine ecosystems is challenging due to the cryptic nature of pelagic predators and the difficulty of observing predatory behavior. Implantable Life History Transmitters (LHX tags) use the Argos satellite system to provide post-mortem data that identifies the occurrence and location of an at-sea predation event in tagged individuals without direct observations. From LHX data, it was found that predation is a primary, contemporary cause of mortality for juvenile Steller sea lions (SSL, *Eumetopias jubatus*) in the Gulf of Alaska, and may be a proximate driver behind the lack of recovery of the endangered western stock of SSL. In this study we aimed to assess if particular habitats are associated with a greater risk of predation for juvenile SSL in the Gulf of Alaska. From 2005 through 2018, 13 predation events with post-mortem tracking data were confirmed in 45 LHX-tagged SSL. We developed a multi-step method to characterize habitat associated with predation. First, we identified each predation event location, with spatial uncertainty, using movement-based approaches. From this, we generated a utilization distribution (UD) from predation events across the region, distributed points within the UD based on isopleth weighting, and extracted habitat variables (i.e. slope, depth, distance to haulout-rookery) associated with these locations. This final dataset represented 'used' spaces (n=115) in terms of predation and was compared to the habitat associated with 'available' spaces (n=1000), locations within juvenile SSL distribution in this region (i.e. population home range), in a resource-selection function. We found that predation events were associated with habitats characterized by greater depths and farther distances from SSL haulouts and rookeries. This information enabled us to generate a risk-map for juvenile SSL in the Gulf of Alaska, spatially representing areas of high predation probability. Our study provides important information about threats to this vulnerable age-class, and establishes a novel approach to characterizing risk in marine ecosystems that can be applied to other management and ecosystem concerns.

Local Collapse of a Humpback Whale Population During the 2014-2016 Marine Heatwave: Where Have All the Whales Gone?

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Most humpback whales (*Megaptera novaeangliae*) who feed seasonally in the Gulf of Alaska (GOA) migrate to Hawaii for mating and calving. In 2016, the Hawaii Distinct Population Segment (DPS) was removed from the list of endangered species. The 2014-2016 marine heatwave appears to have derailed recovery causing starvation, mortality, reduced fecundity and local population declines. In Prince William Sound (PWS) the decline in numbers of whales and calves seen in the fall pre and post marine heatwave was significant. In 2008, a high of 140 unique whales and 17 calves were documented using photographs of the black and white pattern on ventral surface of the flukes. The lowest number of whales occurred in 2017 when 12 whales and no calves were identified following the same survey route. The fate of the missing whales remains unknown. A collaborative research effort across the North Pacific Basin was initiated in winter of 2019 by happywhale.com and the North Pacific Humpback Whale Photo ID Study Group (North Pacific Group). Multiple research groups are contributing their catalogs of whale flukes to happywhale to increase the understanding of movements of humpback whales across the North Pacific. Happywhale compared images of ~400 whales in the PWS catalog using automated image recognition, with images managed within the happywhale system. This system provides rapid automated comparisons of, at present, photos of more than 24,000 individual humpbacks, thus greatly reducing the time required from labor-intensive manual matching. The catalogs (some incomplete) that have been compared to date are from Russia, Hawaii, Mexico, California, Oregon, Washington, British Columbia, Southeast Alaska, summer PWS, Gulf of Alaska, Kodiak, and Alaska Peninsula. Happywhale matching will be ongoing as catalogs are completed and updated and new catalogs are submitted. Preliminary new findings have found one match with Russia and strong connections to the Kodiak area. Final results will be presented and evaluated to determine if the missing whales moved to alternate feeding areas or possibly died. How this population recovers will be dependent upon the reoccurrence of marine heatwaves and the outcome of finding the missing whales.

Characterization of Killer Whale (*Orcinus orca*) Diet in the Northern Gulf of Alaska Through Genetic Analysis of Fecal Samples

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In recent years techniques have been developed to study feeding habits of the endangered Southern Resident killer whales in Washington State. Here we apply those techniques to further examine feeding ecology of southern Alaska resident killer whales. In a pilot program in 2016 and 2017, fourteen fecal samples were collected from known resident pods in Kenai Fjords and Prince William Sound. Based on the success of the pilot program, an additional 40 samples were collected in 2018 and 2019. Visual searches for floating and suspended feces were conducted during focal animal follows, primarily investigating upwellings left by whale surfacings. Collected samples were stored in sterile glass jars or polyethelyne tubes labelled and frozen for laboratory analysis the Conservation Genetics Laboratory (NWFSC, NOAA Fisheries) in Seattle, WA. Total genomic DNA was extracted from fecal sample allquots using previously established methodologies. Chinook and Chum salmon were the dominant prey species represented across the samples. Chinook represented more than 10% of prey species sequences in 9 of the 14 samples and more than 70% in 5 samples. Chum salmon represented more than 10% of prey species sequences in 8 samples and more than 70% in 5 samples. Sockeye represented more than 10% of sequence reads in only one sample. Neither Coho nor Pink salmon were detected in any of the fecal samples, however these fishes are far more abundant in months that were not sampled. Halibut represented more than 10% of prey species sequences in 4 samples, and Arrowtooth Flounder represented more than 10% in 2 samples. Both occurrences of Arrowtooth Flounder and 3 of 4 occurrences of Halibut came only from the AE pod, which is known to have a much smaller range than other pods in the region. Salmon scale samples from predation events were also collected from the same regions and times as feces, and contained primarily Chinook, secondarily Chum, then sockeye salmon. These similar results suggest that scale sampling is effective in determining salmon prey, but may not include all prey taken. Additional sampling will further characterize diet composition for resident killer whales in this region.

FLOAT-BY SAMPLING: Development of a Simple and Quick Methodology for Vessel-Based PSOs to Collect Biological Samples from Floating Marine Mammal Carcasses

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Protected species observers (PSOs) are an essential component of monitoring and mitigation programs for industry projects that have the potential to expose marine mammals to noise that may result in injury or disturbance. PSOs are responsible for monitoring designated zones around the project activity to observe and visually track marine mammals which may approach or enter the zones, and to implement required mitigation (e.g. shut down of noise-making operations). In Cook Inlet, vessel-based PSOs have closely approached floating marine mammal carcasses, including Cook Inlet beluga whales, to photograph the carcass for reporting and analyses. Given the currents and limited infrastructure along most of Cook Inlet's coastline, these sightings may be the only time the animal is observed, and thus opportunities to collect biological data about the species are lost. This is particularly unfortunate for a species like the endangered Cook Inlet beluga whale, whose numbers have declined nearly 75% since the late 1970s and for which there is no clear threat hindering their recovery. As such, any biological data that can be collected is extremely valuable to helping improve the knowledge of the species. In an attempt to prevent this loss of data, a study was designed to assess the feasibility of vessel-based PSOs collecting biopsy samples from floating carcasses in the project vicinity. The equipment had to be portable, easy, and inexpensive, with quick and safe methods not requiring extensive training (~30 minutes). The kit consisted of a "screw on/off" system connecting custom biopsy tips to two styles of adjustable length (4-16 ft) poles, and a tacklebox of miscellaneous items. From September through October 2019, vessel-based PSOs for Hilcorp Alaska's offshore activities in lower Cook Inlet tested the kit and successfully sampled a dead beluga whale, noting pole rigidity was a key factor to success or failure. Samples were transferred to the Alaska Marine Mammal Stranding Network upon the vessel's return to shore. The results prove that biopsies can be collected from floating marine mammal carcasses by vessel-based PSOs without impeding their primary responsibility of monitoring and mitigation, or requiring extensive training, experience, or funds.

Abundance and Distribution of Harbor Porpoise (*Phocoena phocoena*) and Other Cetaceans in Inland Waters of Southeast Alaska in the Summer 2019

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The inland waters of Southeast Alaska (SEAK) are an important habitat for many cetacean species, including harbor porpoise (*Phocoena phocoena*) for which bycatch in the gillnet fisheries may be unsustainable. A ship-based line transect survey was carried out in this region by the Marine Mammal Laboratory of the Alaska Fisheries Science Center (MML/AFSC) between mid-July and mid-August 2019. The main goals of this study were to assess cetacean distribution and abundance, and to better understand the population genetic structure of harbor porpoise. The survey encompassed the inland waters of SEAK between Cross Sound and Dixon Entrance. Survey tracklines were allocated following a randomized survey design with uniform coverage probability. The survey area was divided into two strata. Stratum A covered the main waterways within the region and largely coincided with areas previously surveyed by MML/AFSC between 1991 and 2012. Stratum B included small fjords, inlets and narrow passages, the majority of which had not been sampled by previous studies. A total of 1,687.6 nautical miles were surveyed in sea conditions ranging from Beaufort 0 to 4 (with nearly 75% of the tracklines being covered in sea conditions equal to or calmer than Beaufort 2). A total of 916 cetacean sightings were recorded. Harbor porpoises (202 sightings) were more frequent near Glacier Bay and Icy Strait, Frederick Sound, and around Wrangell and Zarembo Islands. Abundance estimates calculated using design-based distance sampling approaches will inform whether contemporary estimated bycatch levels are sustainable in the region. Targeted environmental DNA (eDNA) sampling was used to collect 24 marine eDNA samples from surface waters near harbor porpoise groups. These will further elucidate population structure in SEAK inland waters. Other cetacean species observed included humpback whales (*Megaptera novaeangliae*, 414 sightings), Dall's porpoise (*Phocoenoides dalli*, 227 sightings), killer whales (*Orcinus orca*, 20 sightings) and minke whales (*Balaenoptera acutorostrata*, 2 sightings). The outcomes of this study will contribute to better understand the current management needs of cetacean populations in SEAK.

Marine Mammal Sightings in Lower Cook Inlet in the Fall of 2019

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A marine mammal monitoring and mitigation program (program) was implemented from September 10 to October 31, 2019 in the lower, central zone (zone) of Cook Inlet, Alaska as part of Hilcorp Alaska's Lower Cook Inlet Seismic Project. This program provided a unique opportunity to document species presence in the late fall as there are limited marine mammal data in this zone for all species. Observers were stationed on two vessels (six on the source vessel and four on the mitigation vessel) to monitor a 7.1-kilometer zone and implement a shut-down zone of 500-meters if marine mammals approached or entered. The mitigation vessel was positioned approximately three to five kilometers on the track line directly ahead of the source vessel and maintained the same heading and speed. This monitoring strategy was devised to detect marine mammals at a greater distance from the sound source. Observations were conducted during daylight hours, defined by civil twilight, and night vision devices were employed during periods of darkness. Additionally, marine mammal aerial surveys were conducted daily, weather permitting. We present species, numbers, locations, and the behaviors observed. A large variety of marine mammals were observed, dominated by northern sea otters (*Enhydra lutris*) and followed by porpoises and humpback whales (*Megaptera noveangliae*). We also present information on a newly required assumed take analysis and discussion of mitigation measures. These data highlight the importance and potential for industry, regulatory agencies, and the scientific community to collaboratively gather data relevant to areas of biological and environmental concern to inform future development projects in Cook Inlet.

Mortality of Endangered Cook Inlet Beluga Whales: Information from Pairing a Long-Term Photo-Identification Study with Stranding Records

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Survival and reproduction are fundamental metrics crucial for understanding current status and future prospects of an endangered, isolated population such as Cook Inlet beluga whales (CIBWs: Delphinapterus leucas). CIBWs are known to have declined in recent decades, but rates of historic and current mortality, survival, and reproduction are not well estimated, making management particularly challenging. To address the scarcity of data on CIBW mortality and survival, we combine long-term photo-identification (photo-id) data from over 400 individually identified belugas with data from 95 reported carcasses during the 2005-2017 study period in order to discern any patterns in age, sex, geographic range, and cause of death. We also use cessation of resightings of individuals in the photo-id catalog to estimate the number of unreported deaths in the population. We found that mortality rates were greatest for adults of reproductive age, followed by calves (n=95 carcasses: 54% adults, 26% calves, 4% adult/subadult, and 16% subadults). Very old adults (from the last 20+ years of possible lifespan) are not in the stranding dataset. Dead females and males are reported at approximately the same rates. The predominant cause of stranding of identified individuals, when it can be assigned, is from live stranding, but this only explains ~25% of the examined deaths.It is unknown what is causing most of the other deaths, and it is unknown what is causing the live-strandings. CIBW mortality estimates remain high decades after the cessation of hunting and implementation of ESA protective measures, and are likely much higher than indicated by stranding reports. Mortality within the tracked individuals of the photo-id catalog ranged between 6% and 12% (depending on which subset of the data are used: right-, left-, or dual-side photographed whales) over the 13-year study period. Of 95 reported CIBW carcasses, 97% were reported during the ice-free season and 87% were reported in the upper Inlet, indicating underreporting of deaths occurring during the other six months of the year and throughout the range of CIBWs. A better understanding of how many CIBWs are dying annually and why may be key to understanding and reversing lack of recovery.

Using Whale Alert in Southeast Alaska: Creating Safe Waters for Both Mariners and Whales

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After discussions among stakeholders about whale strike avoidance in Southeast Alaska, the maritime community sought the ability to avoid whales and take proactive measures (i.e. reducing their speed) in areas where whale aggregations occur. In response, NMFS Alaska Region and National Park Service (NPS) biologists have worked together since 2011 to produce weekly whale sightings maps that improve situational awareness for bridge teams on cruise ships and the Alaska Marine Highway state ferries. Cruise ships and state ferries are the target audience because their prior experience with whale strikes motivates them to improve situational awareness and avoid collisions. These weekly maps helped to inform mariners' whale avoidance and proactive measures, however the sightings were up to a week old when delivered in this format. Real-time whale sightings were a mutual goal realized in May 2016, when mariners and biologists were able to share sightings in the Whale Alert online mapping system and smart phone applications. After the first 3 seasons of digitally capturing and reporting sightings, we'll present lessons learned and a path forward for continued conservation.

Rapid, Real-Time Detection of Paramyxoviruses in Avian and Marine Mammal Species with Nanopore (MinION) Next Generation Sequencing

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Emergence of RNA viral infections is a growing concern among North American marine mammal and avian species. Paramyxoviruses (morbilliviruses and avian paramyxoviruses) are pathogenic, negative sense RNA viruses that cause serious infections in the respiratory, gastrointestinal and sometimes central nervous systems. Paramyxoviruses have affected species throughout multiple regions in North America, including the 2018 outbreak of phocine distemper virus in grey seals (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) along the Atlantic coast (NOAA UME 67), or the Newcastle disease outbreak in California poultry farms. Surveillance for paramyxoviruses in avian and marine mammal hosts is important because of gregarious behavior and diverse migration patterns. Existing viral diagnostic methods are not optimized for understanding genotypic variation, pathogenicity or transmission properties across different wildlife interfaces. We are analyzing complete virus genomes using Oxford Nanopore Technologies MinION to map virus variation among different geographical regions. MinION offers an inexpensive and portable means of genetic sequencing virus genotypes and host biomarkers in real time. Following an RNA extraction and purification protocol, we used a panel of virus-specific primers in a multi-segment tiling (RT-PCR) approach for morbilliviruses (marine mammals) and avian paramyxoviruses (wild and domestic birds) to obtain full genome amplicons as input cDNA in library preparation. Raw nanopore read data was processed and mapped to viral genomes using reference-based assembly, to generate consensus sequences for evolutionary analysis and virus genome annotation. Analysis of viral genome variation is crucial for understanding virulence, transmission, and susceptibility of marine mammal species to RNA viruses among different environmental interfaces. This data can be integrated into evaluation of how ecological and physiological factors impact the health of marine mammal populations in Alaska.

Distribution and Habitat Use by Cook Inlet Beluga Whales: Insights from a Long-Term Photo-Identification Study for Management and Recovery of an Endangered Population

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Cook Inlet beluga whales (CIBWs; *Delphinapterus leucas*), are an isolated and declining endangered population in Alaska, USA. Their critical habitat has been broadly defined with few details on habitat use to direct management actions. This poster summarizes data from a long-term photo-id study to gain insight into use of critical habitat by CIBW groups and individuals, with a focus on areas where belugas were observed feeding, calving, rearing young, and in transit. It also describes patterns of group distribution, size, and composition according to sex and age class to better understand how CIBWs are distributed throughout critical habitat during the ice-free season. Results are presented according to survey month and survey area to aid managers in evaluations of how human activities occurring in CIBW critical habitat may overlap with CIBW use of these areas. There were 575 beluga groups encountered during 477 photo-id surveys conducted in CIBW critical habitat 2005-2017. CIBW locations were mapped and tested for statistically significant patterns, taking into account temporally and spatially uneven sampling effort. Approximately 400 individual whales were identified, and their sighting histories were compiled to examine residency and movement patterns. CIBWs were found seasonally in distinct areas where they aggregate in large groups of both sexes and all age-classes while rearing calves and feeding. These areas, namely the Susitna River Delta, Chickaloon Bay, Turnagain Arm, and Knik Arm, and the general corridors connecting them, represent important beluga habitat that may warrant focused management attention and protection efforts.Although CIBWs cluster in seasonal hotspots, the sighting histories of individual CIBWs photographed throughout the study area indicate CIBWs do not display fidelity to any single area of Cook Inlet, but move throughout the entire study area. Whales travelling among distinct areas of Cook Inlet increase their likelihood of exposure to multiple, localized threats. Habitat protection and regulation of anthropogenic activities should consider cumulative effects of all activities in the range of CIBWs and their potential to affect the entire population.

Multi-Tissue Analysis of Heavy Metals in Harbor Seals and Steller Sea Lions

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The coastal, indigenous communities around Alaska have subsisted on marine animals for generations, often focusing on large apex predators such as seals, sea lions, and whales. Archived vibrissae (whiskers) and body tissues from these two species were available from the Bering Sea and throughout the Gulf of Alaska from the 1990s. Nine heavy metals (cadmium, cobalt, copper, lead, manganese, mercury, nickel, selenium, zinc) were analyzed in vibrissae and body tissues from harbor seals and Steller sea lions. Harbor seals and Steller sea lions body tissues varied significantly ($X2(110) = 454.81$, $p<0.001$) and ($X2(66) = 310.88$, $p <0.001$), respectively. Significant differences of heavy metal concentrations in vibrissae were detected compared to body tissues for both harbor seals ($p<0.001$) and Steller sea lions ($p<0.001$). Steller sea lion body tissues typically had higher concentrations of most metals than the harbor seals. Zinc concentrations were highest among all analyzed metals and found in 90% of the 80 tissue samples. Harbor seal liver and blubber, lipid rich tissues, typically had the highest concentrations of most analyzed metals while Steller sea lion vibrissae, fur, tendon, and muscle, keratinous and protein rich tissues, typically had the highest concentrations. The potentially highly toxic metals mercury and lead were found in 76% and 59% of tissues samples, respectively. Mercury concentrations were highest in harbor seal liver and, interestingly, Steller sea lion vibrissae. Steller sea lion keratinous and protein rich tissues contained the highest concentrations of mercury, copper, and lead while blubber was dominanted by cobalt. Harbor seal muscle had the highest concentrations of lead while the remaining seal tissues were most concentrated in the essential metal zinc. Sea lion vibrissae had higher lead concentrations than seal whiskers. Trophic differences likely contribute to variations in metal concentrations between the two species. This study has served to determine which tissues are more susceptible to heavy metal accumulation, and, possibly, toxicity.

Hot Tub Time Machine: Stable Isotopes in Baleen Reconstruct Humpback Whale Nutritional Ecology

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From late 2013 through 2016, the strongest marine heatwave ever recorded for the region occurred in the Northeast Pacific ocean. An unusual mortality event (UME) for humpback (*Megaptera novaeangliae*) and fin whales was declared in 2015-2016. Food web dynamics were disrupted during the marine heatwave and whale forage species' abundance or distribution changed as a result, which may have caused nutritional stress in humpback whales and contributed to the UME. For the first time in this population, we investigated nitrogen and carbon stable isotopes recorded in northeast Pacific humpback whale baleen. We hypothesized that changes in foraging ecology would be reflected in baleen isotopic patterns after the marine heat wave. We found that individual baleen plates record up to 4-5 years of isotopic data in adult whales, similar to results seen in the Australian/Ssouthern ocean humpback whale population. The oldest baleen sample analyzed was taken in 2001, placing our earliest records in approximately 1996. The majority of samples spanned the period from ~2011-2017, before, during, and after the marine heatwave. We were able to determine likely forage types for individual whales (e.g. krill/zooplankton vs. forage fish) in each year and we observed apparent differences for nearshore vs offshore feeding among individuals. We also found an anomalous increasing 15N pattern in the most recently grown portion of some whales that died during the UME, potentially indicating severe nutritional stress or starvation. The increasing 15N pattern is only apparent in the samples near the base of the baleen plate, possibly grown in the few months preceding death. This indicates that whales may have to be in a state of extreme nutritional stress before it is reflected in the baleen isotopic signal. These findings corroborate physical evaluations of the deceased humpbacks which were characterized as having poor body condition. These results further demonstrate that isotopic analysis of whale baleen opens a window onto multiple years of retrospective dietary and physiological ecology data that can help researchers better understand normal patterns of whale foraging and determine possible nutritional stress prior to mortality or during a UME.

Best Practice Recommendations for the Use of External Telemetry Devices on Pinnipeds

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Pinnipeds spend large portions of their lives at sea, submerged, or hauled-out on land, often on remote off-shore islands. This fundamentally limits access by researchers to critical parts of pinniped life history and has spurred the development and implementation of a variety of externally attached telemetry devices (ETDs) to collect information about movement patterns, physiology and ecology of marine vertebrates when they cannot be directly observed. ETDs are less invasive and easier to apply than implanted internal devices, making them more widely used. However, ETDs have limited retention times and their use may result in negative short- and long-term consequences including capture myopathy, impacts to energetics, behavior, and entanglement risk. From our collective experiences, we synthesized 15 best practice recommendations for the use of ETDs with pinnipeds that address experimental justification, animal capture, tag design, tag attachment, effects assessments, preparation, and reporting. These best practice recommendations are presented here, and are intended to provide current guidance to mitigate known potential negative outcomes for individuals and local populations. These recommendations were developed specifically for pinnipeds; however, they may also be applicable to studies of other marine taxa. We also identify four desired future directions for the use of ETDs in technology development, validation studies, experimental designs and data sharing.

Microwaving Marine Mammals: Development of a Novel Technique for Rapidly Estimating Body Condition of Pinnipeds

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Body condition (physiologically defined as relative lipid mass) is a crucial measure for evaluating an individual marine mammal's physical health and its ultimate effect on population trajectories. Dilution of deuterium oxide is a reliable method of determining body lipid stores (via measures of total body water content), but is expensive, time-consuming, and logistically difficult. Morphological measures of external anatomy are an inexpensive alternative, but their accuracy has been shown to be limited. We investigated the potential of a portable FatMeter – a device commonly used in fisheries science to ascertain body fat content in large fish via the transmission of low-energy microwaves to estimate total body water content – as a novel technique for rapidly estimating body condition of pinnipeds. A series of measurements were taken on 8 adult female Steller sea lions at different planes of nutrition (to produce a range of body conditions), when animals were wet and dry, and during different seasons, as well as from 17 harbor seal pups over the course of their rehabilitation. Microwave transmission rate and blubber ultrasound depth were measured at 10 standardized sites. A suite of external morphological measures was also taken, including length, body mass, and 5 axial girths at these same standardized sites. We concurrently performed a deuterium oxide dilution to measure total body water. We fit the data to a linear mixed-effects model to determine which combinations of data (FatMeter, morphological measures) best predicted total body water as determined by deuterium oxide dilution. We found that a small number of FatMeter readings taken when the animal was wet, in combination with a small number of readily obtained morphological measures, were the best at predicting both Steller sea lion and harbor seal body condition. Furthermore, we found that the model yielded reasonably accurate results, suggesting this new potential method would be suitable for most ecological field studies where deuterium dilution may not be feasible or desired.

Winter Distribution of Endangered Belugas in Cook Inlet, Alaska

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Cook Inlet belugas (CIB) were listed as endangered in 2008 with a recovery plan finalized in 2016. The CIB is also one of NOAA's https://www.fisheries.noaa.gov/topic/endangered-species-conservation/species-spotlight Species in the Spotlight; an effort to save the most highly at-risk marine species. In 2018, NOAA and the Bureau of Ocean Energy Management (BOEM), undertook a multi-year project to document the winter distribution of CIB using aerial surveys. Long-term NOAA surveys show the summer range of CIB has contracted to areas of upper Cook Inlet (UCI). However, CIB winter distribution is not nearly as well documented.The last winter surveys and satellite-tagging studies occurred in 2002. With concerns that CIB may be adversely affected by increasing development in lower Cook Inlet (LCI) a broader picture of distribution is needed. In 2018, we began winter shoreline surveys and sawtooth transects throughout Cook Inlet. Survey sightings showed belugas in both UCI and LCI. A relatively ice-free November 2018 survey recorded belugas only in UCI. Notable LCI beluga sightings occurred in Tuxedni Bay March 2018 and 2019. Previous studies have also documented beluga presence in Tuxedni in March where whales may be taking advantage of spring herring runs. March sightings near Kalgin Island (LCI) may also coincide with a herring run. Belugas were also observed in the Kenai River (LCI) in March. Historically Kenai has been an important foraging location year round but a dramatic increase in human activity may be contributing to belugas utilizing the river only during the 'off" season. Although our initial results show belugas utilizing LCI in the winter, their winter range still appears more contracted compared to the range in the 1970s,. Additionally, CIB are now remaining in UCI waters year round.Winter range information is important to take into consideration as oil and gas exploration expands in this increasingly ice-free and accessible environment.

Breeding and Calving Seasonality in the Endangered Cook Inlet Beluga Whale Population: Application of Captive Fetal Growth Curves to Fetuses and Newborns in the Wild

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Cook Inlet beluga whales (*Delphinapterus leucas*) are Critically Endangered (IUCN Red List) and listed as an Endangered Distinct Population Segment under the U.S. Endangered Species Act. A lack of basic life-history information has hampered attempts to determine causes for the continued lack of recovery. We present results from the youngest portion of this population, deceased fetuses and calves-of-the-year, to provide insights into breeding and calving seasonality for this endangered population. Fetuses (n = 10) were extracted from belugas necropsied between late March and mid-October. Stranded neonates (n = 4) occurred in late July and early August. Calves-of-the-year (lacking neonatal folds, n = 14) were found from early July to mid-October. To determine if fetal, neonatal, and calf data from this wild population could be used to further define seasonality of reproductive events, we applied the fetal growth formulas developed for captive belugas for total body length and thoracic circumference measurements. For conception dates based on total body length, we had length data for 26 whales. Of these, 58% (88% when including estimated variation) fell within the peak ovulation period of March-May observed in captive whales (whereby 70% of ovulations and 80% of conceptions occurred). For predicted birth dates, 65% (81% when including predicted variation) occurred within the July-October period, the interval during which neonates and calves-of-the-year stranded and photo-identification studies observed newborns. Thoracic circumference measurements produced similar results although the sample size was smaller. These data also suggest that calving could occur as early as April and continue through the entire ice-free period through October. While more data are needed to both evaluate and improve the accuracy of these models, they provide a necessary template for understanding and validating the wide potential range of seasonal reproductive events and can be used to help target population management periods during these critical life history events.

Intertidal Community Structure and Function Across a Gacial Gradient

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High-latitude coastal ecosystems, such as those found in the Gulf of Alaska (GOA), are experiencing a dramatic change in environmental conditions due to climate warming. Alaskan glacier discharge rates have doubled in the past decade and have modulated downstream temperature, salinity, nutrient, and sediment stratification profiles in coastal embayments. These fast changing environments are thus predicted to influence the biological response and ecological function of local communities. Here we examine the intertidal community structure and accompanying environmental drivers across a glacial gradient in two regions of the GOA. Intertidal quadrat surveys and biomass collections were completed from April – September 2019 across five sites (spanning a glacial gradient of 0-60%) in both Kachemak Bay and Lynn Canal, southcentral and southeastern Alaska, respectively. At each site, percent coverage and mobile counts were estimated at ten random quadrats (0.25 m2) along a 50 m transect, while biomass collections were collected from ten separate quadrats (0.0625 m2) and brought to the lab for identification and biometric processing. Multiple sensors were also deployed in the subtidal to measure an array of environmental parameters (i.e., salinity, conductivity, temperature, dissolved oxygen, irradiance, current flow and direction) during this sampling period. Biological community structure and variance was analyzed in relation to the local environmental profile. Percent coverage of sessile organisms showed greater variability in Lynn Canal communities than in Kachemak Bay communities. Differences in the mobile invertebrate communities are primarily driven by the mussel, Mytilus and the limpets, Lottia and Littorina. Preliminary results suggest regional, as well as local differences across the glacial gradient.

Distribution of Hydrocarbon Seeps on the Alaska Seafloor: Gulf of Alaska/Cook Inlet and Beaufort/Chukchi Seas

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Oil and gas seeps on land have been reported in Alaska for over 100 years, and similar hydrocarbon seeps are also found offshore on the Alaska seafloor. As the name suggests, hydrocarbon seeps are areas where hydrocarbon-rich fluids, especially methane (natural gas), actively ooze from underneath the Earth's surface. The fluids may ooze out slowly or bubble vigorously into the ocean. Onshore seep locations tend to occur in particular geologic rock types and along faults; the same is true offshore, although seafloor faults and geologic units are more difficult to determine. The patterns of these natural seep locations tell us about the source of the fluids and give clues to the geologic pathways they follow up to the seafloor. This is important for assessment of oil and gas resources, identifying the source of hydrocarbons in the ocean water (natural or anthropogenic), marine habitat characterization, and locating chemosynthetic seafloor ecosystems that use the hydrocarbons as a food source. This project is using a century of reports, publications and archived data to construct a georeferenced map of known seep locations with an emphasis on the Gulf of Alaska/Cook Inlet and the Beaufort/Chukchi Seas.These reports extend from the first days of Alaskan oil and gas exploration a century ago up through modern charting and fisheries surveys. The database focuses on seep locations with confidence rankings on the accuracy of each location and key geochemical measurements where available. Patterns of seep occurrence are assessed using the geologic context combined with seafloor characterization from publicly available multibeam sonar bathymetric and backscatter maps, as available. Here we will show our findings to date and also discuss the importance of high resolution seafloor maps collected with multibeam echo sounders. These maps can define geologic features that are used as hydrocarbon pathways to the surface, as well as give clues about the character of the seafloor that supports important benthic habitats.

Volunteer Photographers Continue Capturing Inter-Annual Variability of Rocky Intertidal Biota in Western Prince William Sound: 2019 Update

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Long-term annual photo monitoring of inter-tidal locations in Western Prince William Sound (PWS) was extended into summer 2019 by volunteers, bringing to 31-years images at several sites that document inter-annual and long-term variability of conspicuous rocky shore marine life.Viewed together, these landscape-scale images clearly show multi-year variations in the percent cover of Rockweed (*Fucus spp*.), mussels *(Mytilus trossulus*), barnacles and bare rock. At all sites we have documented five swings (episodes) of alternating high and low abundances occurring at intervals of 4 to 7 years. In the summer of 2019 the cover of Rockweed at six sites reached peaks after low cover seen two to three years earlier. At one mussel-dominated site in Shelter Bay, the cover of mussels also increased after their near absence in 2016, and after four previous swings in cover. However, at a tombolo in Upper Passage, a thick mussel bed as not returned since it disappeared in the mid-1990s. New photo sites, on the breakwater at Cordova Harbor in Eastern PWS , also document recent increases in Rockweed cover. This kind of variability needs to be accounted for when evaluating the recovery of shoreline marine life following disasters, such as the March, 1989 Exxon Valdez Oil Spill. It is clear that several decades of annual monitoring are required to confirm multi-year swings in the abundances of rocky intertidal biota. Annual landscape-scale photos at fixed intertidal photo-points offers a simple way to document these basic trends, provides the public with images that inspire awareness of variability, adds value to more detailed quantitative monitoring surveys, and could also be valuable in documenting trends due to climate change. We encourage scientists, educators, students and citizens to adopt shoreline sites for longterm photo monitoring.

Improving Understanding of Coastal Ecosystem Issues & Research in Kachemak Bay, Alaska with Esri Story Maps

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Summary: Kachemak Bay, a designated NOAA Habitat Focus Area, is a dynamic ecosystem that will be presented through Story Maps to help the community grasp the science conducted to understand challenges from environmental changes. Introduction: Located in southern Cook Inlet, Kachemak Bay supports fishing communities as well as marine transportation, tourism, and threatened and endangered species. The bay is monitored by NOAA's Kasitsna Bay Laboratory (KBL), Kachemak Bay National Estuary Research Reserve, University of Alaska Fairbanks, and others. Creating Story Maps about the various research conducted around Kachemak Bay will illustrate and help educate glacial change effects on nearshore ecosystems for its residents and visitors. Story Maps will spark discussions between researchers, local businesses, and community leaders about directions or opportunities for additional research. StoryMaps. The intention of the project is to illustrate Alaska's dynamic ecosystem through a series of ArcGIS Story Maps to help the community grasp the science conducted to understand challenges from environmental changes. Story Maps are web-based applications that allow viewers to delve into a topic with immersive text, interactive maps, and videos. In addition, these Story Maps will serve to communicate information about Kachemak Bay research to other scientists and individuals interested in working in the region. Four Story Maps were created as part of a summer internship project at NOAA's National Centers for Coastal Ocean Science's Kasitsna Bay Laboratory. These Story Maps focus on benthic habitat mapping, Sea Star Wasting Syndrome (SSWS), fjords, and fieldwork in Kachemak Bay. The Story Maps help communicate the types of field research by multiple organizations conducted in Kachemak Bay, as well as some results from that research. These Story Maps were developed as initial tools to communicate about Kachemak Bay's ecosystem and changes it experiences. Future Work: An immediate next step would be to receive feedback from stakeholders in regions to ensure the content meets the needs of the community.

TUESDAY, JANUARY 28, 2020

WAVE 1
BERING SEA & ARCTIC

(6:30 PM TO 7:30 PM)

POSTER PRESENTATIONS: TUESDAY, WAVE 1, 6:00PM-7:30PM
BERING SEA & ARCTIC

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Improved Biophysical Observations from a Profiling Moored Observing Platform in the Southeast Bering Sea	Calvin Mordy, Phyllis Stabeno, Carol Ladd, Scott Stalin, Chris Meinig, Ryan McCabe, Shaun Bell	Climate and Oceanography	Row 9 | P105
Diets of Plankton-Eating Auklets Reveal Consequences of Recent Oceanographic Changes in the Alaskan Subarctic	Alexei Pinchuk, Alexis Will, Akinori Takahashi, Jean-Baptist Thiebot, Kathy Kuletz, Alexander Kitaysky	Lower Trophic Levels	Row 9 | P107
Age-0 Walleye Pollock Diets: A Window into Ecosystem Change and Future Recruitment Success in the Southeastern Bering Sea	Alex Andrews, Mary Auburn-Cook, Elizabeth Siddon, Andrew Dimond	Fishes and Fish Habitat	Row 10 | P109
Walleye Pollock Responses to an Approaching Survey Bottom Trawl	Stan Kotwicki, Alex De Robertis, Kresimir Williams, Liz Dawson, Jeremy Harris, Lyle Britt	Fishes and Fish Habitat	Row 10 | P111
The Future of Yukon River Chinook Salmon in a Warming World	Sabrina Garcia, Katie Howard, Jim Murphy	Fishes and Fish Habitat	Row 10 | P113
The Seabird Observer Notes: 25-year Overview of Seabird Related Observations in Alaska Groundfish Fisheries 1993–2018	Elizabeth Labunski, Shannon Fitzgerald, Jennifer Ferdinand	Seabirds	Row 10 | P115
Geographic Differentiation of Avian Influenza Virus (AIV) Subtype Diversity in Breeding Seabirds of Beringia	Maile Branson, Amy Klink, Ralf Dagdag, Matthew Redlinger, William George, Xiao Bai, Douglas Causey, Eric Bortz	Seabirds	Row 10 | P117
Evaluation of Filter Papers Soaked in Whole Blood for *Brucella pinnipedalis* and *Coxiella burnetii* Analyses in Northern Fur Seals	Stephanie Rouse, Marianne Lian, Margaret Castellini, Lorrie Rea, James Berner, Kristy Pabilonia, Todd O'Hara	Mammals	Row 10 | P119
Catastrophic Destruction of Raykoke Island Steller Sea Lion Rookery by Volcanic Eruption: June, 2019	Vladimir BURKANOV, Nikolay PAVLOV, Thomas GELATT	Mammals	Row 11 | P121
Understanding the Use of Contact Calls by Beluga Whales	Kathleen Mager, Manuel Castellote, Aran Mooney, Russel Andrews, Caroline Goertz, Lori Quakenbush	Mammals	Row 11 | P123
DECLINED - Using Stable Isotope Analysis of Vibrissae from Northern Fur Seal Pups and Juveniles to Establish Individual Foraging and Migratory Patterns	Tonya Zeppelin, Brian Brost, Christina Kelleher, Brandon Güell, Rolf Ream, Carolyn Kurle	Mammals	Row 11 | P125
Persistent Organic Pollutants in Bristol Bay Beluga Whale	Jennifer Trevillian, Carrie Goertz, Rod Hobbs, Lori Quakenbush, Rebecca Pugh	Mammals	Row 11 | P127
Evaluating Effects of Telemetry Devices Surgically Implanted in Wild Harbor Seals	Shawn Dahle, Paul Conn, Josh London, Peter Boveng, Markus Horning	Mammals	Row 11 | P129
Relationships Among Blubber Depth, Body Condition, and Morphometric Measurements in Alaska Phocids	Heather Ziel, Brett McClintock, Peter Boveng	Mammals	Row 11 | P131
DECLINED - ShoreZone Imaging and Mapping - Over 122,000 Kilometers of Imagery and Mapping Data	Cindy Hartmann Moore, Steve Lewis, Sarah Cook, John harper, susan Saupe, mandy Lindeberg	Ecosystem Perspectives	Row 12 | P133
Signs of Large-cale Recent Patterns of Dynamic Change in Beringian Food-Webs Using Seabirds as Indicators	Alexzandrea DePue, Brittney DePue, Veronica Padua, Douglas Causey	Ecosystem Perspectives	Row 12 | P135
Intoduction to the IARPC Bering Sea Action Team	Amy Holman, Sara Bowden	Ecosystem Perspectives	Row 12 | P137
An Observational Description of Currents Over the Chukchi Sea Continental Slope	Ryan McCabe, Phyllis Stabeno, Edward Cokelet, Dongxiao Zhang	Climate and Oceanography	Row 12 | P139
Why is Barrow Canyon a Benthic Hotspot?	Robert Pickart, Michael Spall, Peigen Lin, Kevin Arrigo, Jacqueline Grebmeier	Climate and Oceanography	Row 12 | P141

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Continuous, High-Frequency Measurement of pH, Salinity, and Temperature Reveals Extreme Seasonal Variability in Arctic Lagoons	Nathan McTigue, Christina Bonsell, Amanda Kelley, Arley Muth, Ken Dunton	Climate and Oceanography	Row 12 | P143
Towards a Real-Time Coastal Flooding and Erosion Forecast System for the Alaska North Slope	Tyler Miesse, Andre de Souza de Lima, Kristopher Ford, Celso Ferreira, Thomas Ravens	Climate and Oceanography	Row 13 | P145
Heat Over the Pacific Arctic Continental Shelves: Recent Changes in Content, Surface Fluxes and Throughput	Seth Danielson, Tyler Hennon	Climate and Oceanography	Row 13 | P147
Interannual Variability in Stratification, Nutrients, and Water Mass Structure in the Chukchi Sea	Carol Ladd, Calvin Mordy, Phyllis Stabeno	Climate and Oceanography	Row 13 | P149
Underway Time Series of Physical and Biological Measurements from the Gulf of Alaska, and the Bering and Chukchi Seas	R. John Nelson, Di Wan, Svein Vagle, Francis Wiese	Climate and Oceanography	Row 13 | P151
The Variability of Arctic Sea Ice Variability	Stephanie Pfirman, Bruno Tremblay, Robert Newton	Climate and Oceanography	Row 13 | P153
The Effect of Upwelling on Turbulence in Barrow Canyon	James Churnside, Richard Marchbanks, Svein Vagle, Shaun Bell, Phyllis Stabeno	Climate and Oceanography	Row 13 | P155
Hydrographic Patterns and Source Water Contributions in Beaufort Sea Lagoons	Christina Bonsell, Emily Bristol, Ken Dunton, Jim McClelland, Nathan McTigue	Climate and Oceanography	Row 14 | P157
Circulation in the Vicinity of Mackenzie Canyon from a Year-long Mooring Array	PEIGEN LIN, Robert Pickart, Francis Wiese, David Fissel, Ed Ross, Jeremy Kasper, Frank Bahr, Daniel Torres, Jeff O'Brien, Humfrey Melling, Keath Borg, Rowenna Gryba	Climate and Oceanography	Row 14 | P159
Atmospheric Circulation Characteristics Associated with Extreme High-Water Level Events at Foggy Island Bay, Alaska	Peter Bieniek, Jeremy Kasper, Li Erikson	Climate and Oceanography	Row 14 | P161
Decadal Variability in Mesozooplankton Communities of the Northeastern Chukchi Sea: 2008 – 2017	Jennifer M. Questel, Caitlin A. Smoot, Cheryl Clarke, Russell R. Hopcroft	Lower Trophic Levels	Row 14 | P163
High-Latitude Benthic Bivalve Biomass and Recent Climate Change: Testing the Power of Live-Dead Discordance in the Pacific Arctic	Caitlin Meadows, Jacqueline Grebmeier, Susan Kidwell	Lower Trophic Levels	Row 14 | P165
Seasonal and Annual Patterns in Fatty Acid Dynamics of Arctic Seston from the North Bering-Chukchi Sea Regions	Kelia Axler, Louise Copeman, Jens Nielsen, Lisa Eisner	Lower Trophic Levels	Row 14 | P167
Arctic Plankton Communities: The Northwest Passage Project and its Interdisciplinary Approach	Andrea Nodal, Jacob Strock, Zak Kerrigan, Ericka Schulze, Tristan Rivera, Yoana Boleaga, Korenna Estes, Melvin Kim, Alessandra D'Angelo, Brice Loose, Holly Morin, Kevin Boswell, Linda Fernandez, Maria Tzortziou, Amy Denton	Lower Trophic Levels	Row 15 | P169
Preliminary Results of a 2019 Acoustic-Trawl Survey in the U.S. Continental Shelf Region of the Chukchi Sea	Robert Levine, Alex De Robertis, Christopher Wilson, Daniel Grunbaum, Edward Farley	Fishes and Fish Habitat	Row 15 | P171
Trophic Dependencies of Arctic and Saffron Cod in the Nearshore Beaufort Sea, Alaska	Ashley Stanek, Vanessa von Biela, Sarah Laske, Kenneth Dunton	Fishes and Fish Habitat	Row 15 | P173
Habitat Associations and Distribution of Arctic Cod (*Boreogadus saida*), Saffron Cod (*Eleginus gracilis*) and Snow Crab (*Chionocetes opilio*) in the Alaskan Arctic	Jennifer Marsh, Franz Mueter, Jodi Pirtle, Chris Rooper, Matthew Eagleton	Fishes and Fish Habitat	Row 15 | P175
Individual Plasticity and Not Evolutionary Change Drives a Seabird's Response to Earlier Snowmelt in Arctic Alaska	Drew Sauve, George Divoky, Vicki Friesen	Seabirds	Row 15 | P177
Muscle Physiology of Ice-Associated Alaskan Seals	Mariah Tengler, Anna Bryan, Colleen Reichmuth, Jennifer Dearolf, Nicole Thometz	Mammals	Row 15 | P179

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Balancing the Budget: Seasonal Energy Demands of Ice-Dependent Arctic Seals	Colleen Reichmuth, Nicole Thometz, Holly Hermann-Sorensen, David Rosen	Mammals	Row 16 | P181
Variability in Lipid and Fatty Acid Content in the Blubber of Pacific Walruses (*Odobenus rosmarus divergens*)	Chadwick Jay, Sara Iverson, Anthony Fischbach	Mammals	Row 16 | P183
Gastrointestinal Parasitism in Pacific Walrus	Danielle Sweitzer, Justin Sanders, Heather Broughton, Shea Steingass, Brianna Beechler	Mammals	Row 16 | P185
Quantifying Ringed Seal Lair Habitat and Emergence Timing in the Eastern Bering and Chukchi Seas	Jessica Lindsay, Kristin Laidre, Paul Conn, Peter Boveng	Mammals	Row 16 | P187
Helminth Fauna of Ice Seals in the Alaskan Bering and Chukchi Seas, 2006–2015	Anna Bryan, Heather Walden, Antoinette McIntosh, Pam Tuomi, Anne Hoover-Miller, Raphaela Stimmelmayr, Lori Quakenbush	Mammals	Row 16 | P189
Bowhead Whale Calf Nurseries in the Canadian Beaufort Sea, August 2019	Amelia Brower, Amy Willoughby, Janet Clarke, Megan Ferguson, Corey Accardo, Lisa Barry, Suzie Hanlan, Rachel Hardee	Mammals	Row 16 | P191
Dietary Adaptations to Climate Change: Nutrient Analysis of Pacific Walrus Tissue	Breanna Caywood, Brianna Beechler, Sheanna Steingass, Rachel Mitchell, Heather Broughton	Mammals	Row 17 | P193
Blunt Trauma Involving the “Stink-Sac" (Post-Anal Sac) in a Beach Cast Gray Whale (*E. Robustus*), Alaska	Raphaela Stimmelmayr, Rita Acker, David Rotstein	Mammals	Row 17 | P195
Dietary Adaptations to Climate Change in the Pacific Walrus (*Odobenus rosmarus divergens*): Influence of Foraging Niche on Parasitic Burden of *Trichinella nativa*	Rachel Mitchell, Brianna Beechler, Sheanna Steingass, Breanna Caywood, Heather Broughton	Mammals	Row 17 | P197
Deterrence of Polar Bears to Prevent Human-Bear Encounters	Kimberly Klein	Mammals	Row 17 | P199
Movement and Haul-Out Behaviors of Bearded Seals During Minimum Ice Extent, July - October	Justin Olnes, Justin Crawford, Lori Quakenbush	Mammals	Row 17 | P201
The Summer of ABA*, ASAMM Bowhead Whale Abundance	Janet Clarke, Megan Ferguson, Amelia Brower, Amy Willoughby, Corey Accardo, Lisa Barry, Laura Ganley, Suzie Hanlan, Rachel Hardee, Richard Holt, Katie Jackson, Nicholas Matheny	Mammals	Row 17 | P203
Determining the Total Lung Capacity of Living Ringed Seals (Pusa hispida) Using CT Imaging Techniques	Holly Hermann-Sorensen, Kathleen Woodie, Nicole Thometz, Colleen Reichmuth	Mammals	Row 18 | P205
Ringed, Bearded, and Spotted Seal Productivity in Alaska Using Harvest-Based Monitoring, 1960s-1980s and 2000-2018	Lori Quakenbush, Anna Bryan, Justin Crawford, Louise Biderman, Ryan Adam	Mammals	Row 18 | P207
Development of New Interagency Arctic Research Plan	Meredith LaValley, Kelley Uhlig, Colleen Strawhacker, Catherine Coon	Humans	Row 18 | P209
Biological Time Series Observations in the Pacific Arctic: A Key to Understanding Ecosystem Change	Jacqueline M. Grebmeier, Lee W. Cooper, Karen E. Frey, Sue E Moore	Ecosystem Perspectives	Row 18 | P211
The Relationship Between Surface and Subsurface Ecosystem Properties and Coastal Erosion in a Beaufort Sea Coastal Lagoon	Sasha Peterson, Emily Bristol, Craig Tweedie, Vanessa Lougheed, James McClelland	Ecosystem Perspectives	Row 18 | P213
The Kitikmeot Sea, Northwest Passage: Biogeochemical and Bio-Physical Connections	Bodil Bluhm, Kristina Brown, Eddy Carmack, Seth Danielson, Lina Rotermund	Ecosystem Perspectives	Row 18 | P215
Land-Ocean Connectivity of Inorganic Carbon Dynamics in Small Coastal Watersheds and Lagoon Systems on the North Slope of Alaska	Alina Spera, Vanessa Lougheed	Ecosystem Perspectives	Row 19 | P217
Sunlight and Microbial Effects on Dissolved Organic Carbon (DOC) Degradation in Elson Lagoon on the Beaufort Sea coast.	Christopher Sandoval, Vanessa Lougheed,	Ecosystem Perspecitives	Row 19 | P219

Improved Biophysical Observations from a Profiling Moored Observing Platform in the Southeast Bering Sea

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The M2 mooring site (56.9°N, 164.1°W) has been deployed in the Southeast Bering Sea for 25 years (1995-present). It has served as a long-term biophysical platform for monitoring the local ecosystem and continues to serve as a sentinel for ecosystem change. This site has also served as a testbed site for advancements in observing platforms. For the past four years (2016-2019), the summer season has had a Prawler deployed at this station. This mooring consists of a wave powered profiling crawler occupying the upper 50 m of the mooring, operationally completing a profile once an hour with additional discrete depths sampled daily for field characterization of instruments. Sampling strategies can be altered as power permits for varying science goals. This allows for high vertical and temporal resolution measurements of temperature, salinity, chlorophyll fluorescence, and dissolved oxygen (as well as any other parameter that could be incorporated into the Prawler platform) during the summer season. A preliminary investigation into the features/events that the Prawler has captured in comparison to the coexisting standard M2 "Peggy" mooring is presented here. The Prawler provides a much more detailed picture of the thermal structure and the subsequent air/sea interactions with implications for regional heat content estimation. Enhanced vertical resolution of oxygen and chlorophyll fluorescence also permit enhanced characterization of seasonal transitions and interannual variability of the chlorophyll bloom .

Diets of Plankton-Eating Auklets Reveal Consequences of Recent Oceanographic Changes in the Alaskan Subarctic

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The Pacific Arctic marine ecosystem is undergoing rapid changes manifested by retreating sea ice and increasing influx of warmer Pacific water. This apparent transformation influences primary productivity and zooplankton communities, which, in turn, may affect food availability of anadromous and forage fish, marine mammals, and seabirds in the region. The main goal of this project is to determine if there has been a change in the diet of planktivorous seabirds breeding on St. Lawrence Island in relation to changing oceanographic conditions over the past two decades. The island is situated on the Northern Bering Sea Shelf, a dynamic area influenced by water masses of different origins, and hosts one of the largest seabird breeding colonies in the region. Two planktivorous species of auklets (*Aethia spp*.) rely on locally available meso-zooplankton prey to feed their chicks during the short breeding season. Shifts in their diets reflect changes in local oceanographic conditions and impact auklet reproductive success. We analyzed a 4-year time series of chick diet samples of Least (*A. pusilla*) and Crested (*A. cristatella*) auklets collected near Savoonga on the northern shore of St. Lawrence I. during July-August of 2016 – 2019 to compare the taxonomic composition, abundance, and biomass of zooplankton prey with those in the 5-year time-series collected at the same location during 2000-2004. The observation period included sequences of cold and warm years, the 2016-17 heat wave, and the period (2018-19) of record low winter sea ice coverage in the Bering Sea, allowing examination of contrasting scenarios in seabird foraging habitats. Both auklet species depended on oceanic *Neocalanus spp*. copepods brought onto the shelf by northward currents and a mixture of shelf-originated euphausiids, hyperiids, and copepods. Relative abundance of each group changed between the years as did chick survival and levels of nutritional stress incurred by parents, indicating profound influences of climate variability on the zooplankton communities that support these auklet species and the broader Pacific Arctic marine ecosystem.

Age-0 Walleye Pollock Diets: A Window into Ecosystem Change and Future Recruitment Success in the Southeastern Bering Sea

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Thermal conditions affect Walleye pollock (*Gadus chalcogrammus*) recruitment success through bottom up changes to the prey base. Previous research indicates that zooplankton composition (i.e., ratio of small and large copepod taxa) changes with thermal regime. Changes in the composition and reductions in the quality of age-0 pollock prey have been correlated to lower energetic content of age-0 pollock and thus poor overwinter survival and recruitment success. Under the current warm conditions (beginning in 2014 and continuing through 2019), prey quality and diet energy content are expected to be low and therefore age-0 pollock energy density is also predicted to be low. Age-0 diet energy density can be calculated from on board diet analyses and may provide a useful leading indicator of age-0 pollock energy density. Age-0 pollock diets may also provide insight into the overall health of the southeastern Bering Sea ecosystem.

Walleye Pollock Responses to an Approaching Survey Bottom Trawl

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In recent years conceptual models of semipelagic fish behavior in front of the fishing trawl have been used to obtain whole water column abundance estimates by combining acoustic and trawl data. However these models require validation of the assumptions necessary to obtain abundance estimates. The primary goal of this study was to validate key underlying assumption of existing models: that pollock dive prior to encountering a trawl towed by a survey vessel, and that the catch efficiency of the BT is density-dependent. The secondary goal was to describe pollock behavior in response to the approaching trawl. To achieve these goals direct observations of pollock behavior between the survey vessel and a bottom trawl were conducted in the eastern Bering Sea (EBS) in 2018 using a remotely operated catamaran (ROC) equipped with acoustic system. The ROC is a new observation platform that can be towed behind a trawling vessel, and is remotely steered to acoustically image locations between the vessel and the front of the trawl. The ROC combined with equivalent vessel-mounted acoustic systems allowed for a comparison of pollock vertical distribution and density under the survey vessel and at pre-determined distances in front of the trawl. The observations indicate that pollock behavior in front of the trawl is more complex than previously assumed in the models combining bottom trawl and acoustic data. Overall, at the center of the trawl, we observed that pollock initially ascend after vessel passage, followed by a slow diving response as the trawl approached confirming pollock diving behavior in response to the trawl. Additionally, there is a significant density-dependent effect in pollock responses to the trawling vessel and the trawl at all parts of the water column. On average, when pollock backscatter detected by the vessel as low, backscatter behind the vessel observed by the ROC were generally higher than observations from the vessel. However, when pollock densities detected by the vessel were high, ROC densities were generally lower than observations from the vessel.

The Future of Yukon River Chinook Salmon in a Warming World

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Yukon River Chinook salmon run size dramatically declined since the late 1990s, leading to unprecedented uncertainty for subsistence, commercial and recreational fisheries dependent on these stocks. Since 2003, juvenile Yukon River Chinook salmon have been monitored after their first summer at sea in the northeastern Bering Sea using pelagic trawl gear. Size, condition, diet and abundance data were collected annually through these surveys. Stock composition from genetic mixed stock analysis and juvenile catch per unit effort data were used to estimate stock-specific abundance of juvenile Yukon River Chinook salmon. A linear regression model of juvenile abundance to adult returns was used to predict the number of adult survivors returning from each juvenile cohort, and maturity schedules based on established brood tables were used to apportion those returns to run year. Juvenile Chinook salmon data coupled with adult spawner and return data, and inriver smolt data revealed important changes that have occurred for these stocks with warming river and ocean conditions. Particularly warm conditions in recent years were correlated with changes to life history characteristics: earlier outmigration timing, younger age at maturity, and larger size of juveniles. Rearing juvenile Yukon River Chinook salmon and other Bering Sea species were also distributed more northerly in warmer years, potentially affecting their early marine ecology and food web dynamics. Despite these changes, later marine survival (after the first summer at sea) appeared to be relatively stable. Cohort strength appeared to be defined by September of the first year in the ocean, highlighting the importance of survival during freshwater and/or early marine life stages in stock productivity patterns. Juvenile abundance-based forecasts predicting up to three years into the future, have provided managers and stakeholders with some perspective on longer term stock trends. Based on recent juvenile Yukon River Chinook salmon abundance, it is expected that adult run size will decline in upcoming years. Managers and fishermen are being cautioned that while Yukon River adult Chinook salmon run abundance will likely provide for spawning escapement needs, substantial fishery restrictions may be warranted through the near future.

The Seabird Observer Notes: 25-year Overview of Seabird Related Observations in Alaska Groundfish Fisheries 1993–2018

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The Seabird Observer Notes (SON) were instituted in 1993 by the NOAA Fisheries Observer Program to record opportunistic seabird observations made by NOAA observers in Alaskan groundfish fisheries. The SON is a cooperative effort between the U.S. Fish and Wildlife Service and NOAA Fisheries to improve accessibility to the seabird information collected by fishery observers. Initial observations were handwritten on datasheets in the field, and later transcribed into a searchable database format. In 2010 NOAA developed an automated data entry system where the SON could be electronically entered in the field by the observer and sent back to the Observer Program in Seattle. The SON record seabird related information such as species, date, location, weather, gear type, and potential interactions between the seabirds and fishing vessel. The information is valuable resource to identify seabird-fishery related issues including gear interactions, discard feeding, vessel strikes, rare bird sightings, and mapping seasonal distribution of seabirds near vessels. Data archived in the SON is under the purview of the Magnuson-Stevens Act, and release of data or products requires review by NOAA to protect confidentially agreements with fishers.

Geographic Differentiation of Avian Influenza Virus (AIV) Subtype Diversity in Breeding Seabirds of Beringia

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The marine environments of both the Arctic and Subarctic lie along the path of many migratory birds and can therefore serve as an ecological reservoir for avian viruses, particularly avian influenza (AIV). The introduction of novel strains to high-density breeding sites along these migratory pathways may pose a significant threat to ecosystem stasis, particularly during periods of environmental change. While viral surveillance in wildlife is a regular component of public health, little is known about the potential dynamics of transmission of AIV among migratory species and resident breeding seabirds of Alaska. This research seeks to document the AIV subtype diversity in breeding colonies located throughout the Aleutian Islands and northern Bering Sea. This is an initial evaluation of both the migratory and resident avian species that utilize these distinctive habitats to determine the frequency and nature of AIV infection at breeding sites. Samples obtained from 14 species of breeding seabirds collected during the summers of 2018 (n = 75) and 2019 (n = 90) at nine breeding sites will be tested for AIV using RT-PCR and virus genome sequencing methods. Distribution of AIV subtypes and phylogeny will determine if reassortment of AIV occurs during high levels of interspecific interaction at marine breeding grounds, suggesting antigenic shift and subtype-specific immunity. As AIV has high potential for both interspecific and zoonotic movement, an examination of its disease sequelae, ecological correlates, and prevalence among breeding Beringian seabirds may help to elucidate a clearer understanding of the disease ecology of this virus in marine environments.

Evaluation of Filter Papers Soaked in Whole Blood for *Brucella pinnipedalis* and *Coxiella burnetii* Analyses in Northern Fur Seals

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Coxiella burnetii and *Brucella pinnipedialis* are widespread zoonotic diseases implicated as potential agents of population decline in northern fur seals (NFS, *Callorhinus ursinus*) of the Pribolof Islands of Alaska. In this study, we examine the efficacy of an alternative serologic sampling technique, which could provide an increased number of animals represented with simplified collection and processing. Advantec Nobuto® cellulose filter paper (FP) has proven effective in measuring organochlorines, total mercury and selenium concentrations, and C and N stable isotope ratios in marine mammal blood. It has also been validated for assessing Brucella spp. serology in caribou and Toxoplasma gondii serology in bottlenose dolphins. FP sampling is inexpensive, simply dipped in uncoagulated free flowing whole blood, and does not require venipuncture or blood centrifugation. NFS adult females were captured and sampled at two rookeries on St. Paul Island, October 2017. FP were soaked in whole blood in EDTA tubes. The FP's were air-dried and stored at room temperature. Plasma was pipetted into cryovials for competitive enzyme-linked immunosorbant assays (cELISA) and indirect immunofluorescence assays (IFA). cELISA and IFA results were used as the gold standards for B. pinnipedialis and C. burnetii serology, respectively. We found that eluates from whole blood FP samples were not representative of the C. burnetii or B. pinnipedialis antibody prevalence indicated by our gold standard assays. However, there was some utility related to binary results (+ and -) for B. pinnipedialis. All individuals who were positive for phase 1 (chronic) C. burnetii were also positive for phase 2 (acute). There was a significant difference in phase 2 C. burnetii titers between the two sampled rookeries, and a significant association between body mass and C. burnetii titers for both phase 1 and phase 2 strains. Individuals who were positive for one pathogen (C. burnetii or B. pinnipedialis) were more likely to be positive for the other as well. In summary, samples collected on FP do not accurately represent serological statuses of C. burnetii or B. pinnipedialis in NFS with the elution and assays used in this study. The categorical interpretations for B. pinnipedialis could possibly be used with caution.

Catastrophic Destruction of Raykoke Island Steller Sea Lion Rookery by Volcanic Eruption: June, 2019

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Raykoke Island is a major Steller sea lion (SSL) breeding site in the Kuril Islands, Russia, and an active volcano. The 1st report of SSL's was made by Henry Snow in the late 19th century. The island is approximately 550 m tall and about 2 km in diameter. There is no record of permanent inhabitants, but historically the island is regularly visited by ainu people to harvest seals and birds. Recorded volcanic eruption history begins in 1778 when a severe eruption killed 15 Russian cossacks camping on the island. Another eruption occurred in 1924 changing the shape of the island and destroying a northern fur seal rookery which has never been restored. The presence and abundance SSL on the island has been recorded since the mid-1950s. We began observations in 2002 with an annual summer field camp. We branded 1239 SSL pups between 1989-2016 and seasonal biologists monitored SSL breeding performance demography, abundance, and mortality annually. Observers were replaced by high-resolution remote cameras in 2012, serviced 1-2x/year. On July 9, 2018 we counted 336 non-pup of which 39 were breeding age branded animals (18 females and 21 males) and 138 new born pups on Raykoke. On June 23, 2019 we approached the island during early morning fog and heard several thunderstorm-like blows and two loud roaring SSL. We couldn't see a thing or figure out what was happening. As we approached the rookery we discovered a wall of falling volcanic ash and steaming water so we immediately turned back. We revisited the island on July 12 and September 8 when we were able to land and survey the rookery and coastline around the island. The rookery was completely buried with multimeter volcanic debris. We found only 35 SSL males of various ages on the side of the island opposite the rookery. No females nor pups were seen around Raykoke during three separate visits. After the eruption we surveyed other SSL sites in the Kuril Islands, but observed only one single female from the list of marked animals previously seen on Raykoke in 2018. We intend to review remote camera images from other nearby rookeries but as now we conclude that the June 22-23 eruption likely killed all of the new-born pups and many non-pup SSL.

Understanding the Use of Contact Calls by Beluga Whales

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Beluga whales (*Delphinapterus leucas*) have a complex call system used to communicate and maintain group coherence. Unique contact calls similar to those of other species have been found to exist in beluga whales, however acoustic monitoring applications have not yet used these calls in the context of individual identification or social structure analysis. Understanding the vocal use and context specificity of these contact calls will allow better-informed decisions with regard to management of small populations such as those in Bristol Bay and Cook Inlet, Alaska, which are chronically exposed to different types of human threats. Recordings from acoustic tags deployed on eight Bristol Bay belugas were analyzed to identify and describe the acoustic properties of contact calls, as well as to determine whether these calls were located in a specific position within a vocal exchange sequence. A total of twelve distinct contact call types were identified across five tagged individuals. Acoustic parameters in 108 of these calls were measured: maximum and minimum frequencies, duration, number of inflections, average pulse repetition rate, and bandwidth, as well as proportion of usage. To describe the sequence in which contact calls are used when tagged belugas joined a group, 118 hours of acoustic data from tags documenting group encounters after separation were analyzed, and a total of 15,666 calls were identified and classified. Contact call usage and call type distribution across vocal exchanges was observed to be nonrandom. Contact calls significantly differed among tagged belugas and were the predominant call type used in one of the deployments. These results suggest that beluga whale vocal behavior is produced in complex patterns, where information is codified not only in the call type but in the order in which these are emitted. This study provides a starting point for future research in understanding the social structure of the endangered Cook Inlet beluga whale population.

DECLINED - Using Stable Isotope Analysis of Vibrissae from Northern Fur Seal Pups and Juveniles to Establish Individual Foraging and Migratory Patterns

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The population of northern fur seals (NFS; *Callorhinus ursinus*) on the Pribilof Islands, Alaska, has declined by approximately 70% since the mid-1970s. Mortality rates of pups and juveniles can have a strong influence on NFS population stability. However, information on foraging and migratory strategies that impact survival during this time is limited; pups depart on their first migration at ~4-5 months and typically do not return until 2 years of age. We used stable isotope analysis of NFS vibrissae, a tissue that grows continuously throughout their lifetime, to examine individual foraging and migratory patterns during this cryptic time. We serially sampled the longest vibrissae from 8 known age male juveniles (2-4 year-old) and 57 pups (~4-5 month-old) killed in subsistence harvests on the Pribilof Islands and measured stable carbon (δ13C) and nitrogen (δ15N) isotope values to provide a temporal record of their foraging ecology and habitat use. An isotopic shift in δ13C and/or δ15N signatures was evident at birth and weaning. The lack of fluctuation in δ15N in pups prior to ~4-5 months of age and distinct drop thereafter suggests that NFS abruptly wean when they depart on their first migration. We found annual oscillations in δ15N and δ13C values associated with age reflecting annual migrations from the Bering Sea in winter and return in summer. Mean vibrissae growth rates were calculated based on annual migratory oscillations in δ13C values. The average vibrissae growth rate for 0-1 year-olds (4.6 ± 1.1 mm/month) was faster than the growth rate found in 1-4 year-olds (3.0 ± 1.1 mm/month). Although there was a high level of variability in growth rate between individuals and sample size was small, our results were consistent with other pinnipeds. Differences in δ13C patterns among 0-1 year-old juveniles and older juveniles suggests that they are utilizing different foraging habitats. Annual oscillations in δ15N values were less distinct than δ13C values suggesting trophic level of prey consumed was not as variable through time as changes in foraging habitat. Our results provide important insights into the ontogeny of foraging and migration for individual NFS during their critical juvenile years.

Persistent Organic Pollutants in Bristol Bay Beluga Whale

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Remote locations, such as the Arctic, are often sinks for persistent organic pollutants (POPS) which can ultimately bioaccumulate in local wildlife, such as beluga whales (*Delphinapterus leucas*). Of those inhabiting Alaskan waters, Bristol Bay belugas represent a healthy and stable population with approximately 2000 individuals. Conversely, the Cook Inlet beluga population has been in decline, and despite protective measures, is not recovering with roughly only 300 individuals remaining. In an attempt to understand the plight of this sensitive population, health assessments of Bristol Bay belugas were conducted to obtain baseline parameters from a stable population from which to compare. This highly collaborative effort (i.e., National Marine Fisheries Service, Alaska SeaLife Center, Alaska Department of Fish and Game, Georgia, Mystic and Shedd Aquariums, Alaska Veterinary Pathology Services and Aleknagik Traditional and Cuyrung Tribal Council members) was conducted between 2008 and 2016 and resulted in the collection of a suite of information and samples. Of the samples collected, blubbers from 52 individuals are being measured for POPs (i.e., polychlorinated biphenyls (PCBs), chlorinated pesticides (i.e., DDTs), polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDs)) and the data will be presented here. Variants such as sex, animal length and temporal trends will also be discussed.

Evaluating Effects of Telemetry Devices Surgically Implanted in Wild Harbor Seals

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Harbor seals (*Phoca vitulina*) in the Aleutian Islands of Alaska declined dramatically during the 1980s and 1990s, and have shown little sign of recovery since. As part of a research program to understand the ecology and demography of these seals, we deployed life history transmitter (LHX) tags in 10 individuals during September 2016. Two LHX tags were surgically implanted in the abdominal cavity of each seal, both configured to log temperature and light levels throughout the seal's life. When the tags are released from the seal's body during or after death, they transmit their archived data through the Argos system providing data on time, location, and possible cause of death. An abrupt transition from internal body temperature to ambient temperature suggests disgorgement of the devices by a predator, whereas a gradual transition indicates a non-predatory cause of death such as disease or starvation. For female seals, the temperature record also provides inference about the occurrence and timing of parturition. Because this study was the first deployment of LHX tags at sea in wild harbor seals, our first objective was to determine whether there were any detectable effects from the implantation surgeries or tags on the seals' behaviors in the first 3.5 months post-release. We used a generalized linear mixed model framework to analyze a suite of haul-out, dive, and movement metrics that were obtained from external, Argos-linked telemetry devices deployed on both the 10 experimental seals and a group of 25 controls without LHX tags. Statistical tests indicated no acute or chronic effects for any of the behavioral metrics analyzed. These results suggest that LHX tags can continue to be safely deployed in Aleutian harbor seals to collect valuable demographic data for managing and conserving this at-risk population.

Relationships Among Blubber Depth, Body Condition, and Morphometric Measurements in Alaska Phocids

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In marine mammals, the blubber layer is a critical adaptation to surviving in the aquatic environment. It is particularly important for phocid seals because it serves as their primary method of thermoregulation and energy source when feeding is reduced during key life history events (e.g. pupping, breeding, molting). Blubber content has been used as an indicator of body condition in phocids, but measures of body condition based on blubber content in Alaska phocids are limited and primarily from harvested, not live-captured animals. Obtaining current information about body condition of Alaska phocids is essential, as these populations may be particularly vulnerable to a warming climate and diminishing ice habitat. We used an ultrasound machine to measure blubber depths at four different sites on the body from ribbon, spotted, and harbor seals in Alaska, during capture studies in 2010 and 2014-2018. Using linear regression, we modeled body condition (mass/standard length) and morphometric measurements as a function of blubber depth. Across species, body condition ($F_{9,170}$=185.4, p<.001; adjusted R^2=0.90), axillary girth ($F_{9,170}$=193.0, p<.001; adjusted R^2=0.91), and hip girth ($F_{9,170}$=122.6, p<.001; adjusted R^2=0.86) all were well explained by sex, age class, blubber depth, year. All three measurements were highest in adult males and lowest in female pups. The best blubber depth predictors for body condition, axillary girth, and hip girth were at the right lateral hip, the dorsal axillary, and the right lateral hip, respectively. Body condition decreased by year, and axillary girth was lowest in 2018 and highest in 2015. For spotted seals only, hip girth was significantly lower in 2018, and spotted seals had greater hip girths than ribbon or harbor seals. We also ran these analyses for only spotted seal pups and YOY from 2014, 2016, and 2018. Body condition for spotted seal pups decreased significantly by year, and both hip and axillary girths were lowest in 2018. As expected, we found blubber depth was positively related to both body condition and morphometric measurements; therefore, it can be a useful predictor of condition, which will be valuable in assessing potential effects of changing environmental conditions for these species.

DECLINED - ShoreZone Imaging and Mapping - Over 122,000 Kilometers of Imagery and Mapping Data

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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 and species research, and coastal resource management. Coastal vulnerability has been assessed for some locations with ShoreZone mapping. The Alaska ShoreZone imaging and mapping project is on-going with approximately 93% of the coast imaged and mapped or with mapping in progress. Areas remaining to be imaged include the central and western Aleutian Islands, the Bering Sea Islands, and Forrester Islands. The Alaska ShoreZone program is built on a foundation of multiple funding and contributing partners, including federal agencies, state agencies, nonprofit organizations, and private industry. The multi-organization program provides a framework to build on and supports a contiguous, integrated coastal resource database that extends from Oregon to the Beaufort Sea. The program goal is to have all of the Alaskan shoreline imaged and mapped using the ShoreZone protocol and to continue to make all the data and imagery web accessible. The Alaska imagery can be viewed online at http://alaskafisheries.noaa.gov/shorezone/ and at http://www.shorezone.org/ www.shorezone.org. The first ShoreZone imaging survey was in British Columbia in 1979. Forty years later over 90% of the coastline, from where Alaska meets Canada to where California meets Mexico, has ShoreZone imagery and mapping data.

Signs of Large-cale Recent Patterns of Dynamic Change in Beringian Food-Webs Using Seabirds as Indicators

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The Arctic regions are experiencing rapid change in marine and terrestrial environments from many sources, primarily caused by climate change and anthropogenic impacts of increased development and pollution. Several endemic species, such as Red-faced Cormorants (*Phalacrocorax urile*) are currently undergoing dramatic population declines, likely related to climate-related change in food availability and trophic structure of the local marine environment. In this study, we are analyzing the constituent stable isotopes (eg. C, N, S) of muscle and feather samples collected from 16 avian species collected in the far Western Aleutian Islands (eg., Near, Rat, and Delarof Islands) since 2000, and northern Bering Sea (St. Matthew and Hall Islands) in 2018 & 2019. Our preliminary results indicate that the community-wide spatial and temporal dynamics of marine bird ecosystems are far greater in the last decade (2009 – present) than has been evident over recent decades. We also find that the magnitude of change is lesser here in the low Arctic (e.g., western Aleutian Islands 53°N) compared to High Arctic coastal marine ecosystems (e.g., 78°N). In particular, we show that the ecological patterns observed within such widespread arctic species as puffins (*Fratercula spp*.), Northern Fulmars (*Fulmarus glacialis*), and Black-legged Kittiwake (*Rissa tridactyla*) indicate diets are strongly perturbed on small geographic and temporal scales of 101 km and decades. Moreover, we find that the variance in environmental and ecological parameters is increasing rapidly over time. We hypothesize that these fine-scale changes are related to mid-scale oceanographic and trophic-level changes (eg., the “Warm Blob” in 2013, possibly now in 2019), in addition to larger-scale perturbations possibly related to a cascade of climate-related factors.

Intoduction to the IARPC Bering Sea Action Team

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Changes are taking place so quickly in the Bering Sea ecosystem that research results, forecasts, guidance, and other products from Federal agencies are needed faster than usual. As a consequence, the Interagency Arctic Research Policy Committee (IARPC) staff group is standing up a Bering Sea Action Team to consider what IARPC agencies can do to respond. Work of the team will include evaluating what research is already funded, considering stakeholder input to determine the most critical research needs for the region, and consider how IARPC agencies and collaborators can respond in the short- (12-24 months) and long- (2-5 years) term. Through initial discussions among Federal agencies and subsequently expanding to broadly inclusive meetings as needed, this team will bring together representatives of Federal agencies and other groups supporting research in the Bering Sea region. Activities will include: Gathering existing documentation and learn current manager and decision support needs. Mapping needs to existing research programs and tools. Producing and conveying a priority list of short- and long-term research needs to the IARPC staff group and Principals The team will meet for six months and make recommendations to staff group and Principals by April 2019.

An Observational Description of Currents Over the Chukchi Sea Continental Slope

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Understanding the structure and variability of currents and water properties over the Chukchi Sea continental slope is important because they determine the pathways and fate of heat, salt, nutrients, and biota exchanged between the shelf and deeper basin. A three-year time series of current and water property measurements made at a single mooring site in approximately 1000 m of water on the Chukchi Sea continental slope is presented. The water column is divided into three distinct layers: a near-surface layer to approximately 200 m depth with predominantly northwestward along-slope flow (the Chukchi Slope Current); a predominantly southeastward-flowing interior layer encompassing depths of approximately 200–850 m and comprised primarily of Atlantic Water (the Arctic Ocean Boundary Current); and a near-bottom layer with weak currents comprised of Arctic Deep Water. Temporal variability of observed currents, from daily to seasonal time scales, was common. Along-slope flows in the surface and interior layers were enhanced during the ice-free summer months. Under ice cover, current magnitudes were weaker, and in some months even reversed direction. The upper-layer currents were not significantly correlated with local winds nor with wind stress curl, even when using a variety of low-pass filter window lengths. We hypothesize that this surface, northwestward flowing Chukchi Slope Current is a manifestation of the Beaufort Gyre. The mooring data will be augmented with recent snapshots of upper ocean velocity collected across the continental slope by a fleet of saildrones outfitted with acoustic Doppler current profilers, allowing for an estimate of the cross-slope extent of the surface current.

Why is Barrow Canyon a Benthic Hotspot?

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The center of Barrow Canyon is characterized by extremely high levels of benthic biomass, indicating strong pelagic-benthic coupling and a large export of carbon to the sediments. Here we use repeat shipboard hydrographic and velocity observations, together with a set of dynamical equations, to demonstrate the physical mechanisms that pump carbon and oxygen to the canyon floor. The observations reveal that during the summer months, under weak wind, the northward flow through the canyon transports on the order of 1 Sv. The flow is strongly sheared both laterally and vertically -- the former corresponding to large relative vorticity and the latter associated with steeply sloped isopycnals. Under this configuration, plumes of high fluorescence and oxygen extend vertically to the canyon floor along the isopycnals in the region of the hotspot. To explain the presence of the plumes we analytically specify the horizontal flow field in the canyon, fashioned after the observations, and solve for the vertical velocity using the quasi-geostrophic omega equation. This reveals strong downward velocity on the western side of the current and upward velocity on the shoreward side. By integrating a tracer in this three-dimensional flow field we find that a plume develops that transports material to the canyon floor in about a day. This can explain the existence of the observed benthic hotspot. We demonstrate how this process depends on flow strength and stratification, and show that sub-surface blooms lead to greater carbon export than surface blooms.

Continuous, High-Frequency Measurement of pH, Salinity, and Temperature Reveals Extreme Seasonal Variability in Arctic Lagoons

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The diverse and productive food webs in Arctic lagoon ecosystems are renown for thriving despite the extreme conditions of the dark, cold polar winter. However, in addition to the polar night, the extreme variability of hydrographic parameters that benthic fauna are subjected to throughout the year is often overlooked due to the paucity of high-resolution, continuous annual data in these remote lagoons. As part of the Beaufort Lagoon Ecosystems Long-term Ecological Research (BLE LTER) Project, we present pH, salinity, and temperature data at hourly resolution in Kaktovik Lagoon for an entire year. The first-ever year-long pH data for Kaktovik Lagoon, which spanned from 7.438 to 8.401, exemplifies the extreme environment that organisms, particularly calcifiers like bivalves, must tolerate. This dramatic range of pH also has direct implications to the carbonate system that regulates dissolved inorganic carbon speciation, carbon storage, and carbon fluxes in lagoons. Temperature, which ranged from -2.1 to 12.0 °C, and salinity, which ranged from 0 to 39.2, accentuates the extreme environmental variability of the ecosystem, and also provides insight into how seasonality, particularly freshwater inflow, regulates pH. These findings highlight the importance of continuous data collection in the rapidly changing Arctic. Our approach facilitates a holistic understanding of the Beaufort Sea lagoon ecosystems that would otherwise be unrealized from short-term or single timepoint sampling.

Towards a Real-Time Coastal Flooding and Erosion Forecast System for the Alaska North Slope

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Climate change is reducing sea ice extent and extending the open water period. It is also causing stronger and more frequent summer and fall storms in the Arctic, resulting in storm surges and flooding that can dramatically impact coastal regions and its infrastructure. Changing environmental conditions are also expected to increase permafrost thawing, resulting in even larger coastal susceptibility to erosion, leading to loss of homes, businesses and threatening maritime infrastructure. This poster will present the first steps towards building a real-time coastal flooding and erosion forecast system for the Alaska North Slope region. The forecast system is based on an integrated, multi-model, multi-scale, multi-physics framework to forecast coastal dynamics and to provide coastal flooding and erosion information to local communities and stake holders. The initial modeling framework is based on an ADCIRC+SWAN and ADCIRC+WWIII models to simulate coastal hydrodynamics and wave energy in the Bearing, Chukchi and Beaufort Seas. The initial modeling tests include evaluating different schemes for the impact of ice cover on storm surge and wave generation and propagation, wind and pressure fields for real-time modeling and coastal geometry for numerical mesh development. These models will provide boundary conditions to the process-based, coastal geomorphic change modeling framework ("Arctic Xbeach") that accounts for thermal and mechanical process at the local scale, to forecast coastal erosion and flooding for the local communities. A study case will be presented demonstrating the initial findings and validating the initial modeling framework based on information collected by the local communities in Utqiagvik, where they have been documenting flood levels and coastal topographical profiles. Finally, a real time forecast system will be implemented and combined with the Integrated Flood Forecasting System iFLOOD (http://iflood.vse.gmu.edu/ http://iflood.vse.gmu.edu/). This work is part of a 5-year project funded by the National Science Foundation studying the implications of the expanding maritime network in the Artic and its supporting infrastructure. The poster will present the proposed work of the coastal dynamics group and provide an opportunity for the team to connect with and learn from the Artic scientific community.

Heat Over the Pacific Arctic Continental Shelves: Recent Changes in Content, Surface Fluxes and Throughput

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The warm thermal state of the Pacific Arctic coupled ocean and sea ice system attained previously unobserved conditions in recent years, suggesting fundamental alterations to the regional storage, modification, and throughput of heat. We examine the manifestation of these changes on the Bering and Chukchi Sea continental shelves using a combination of in situ moored and ship profile temperature and salinity data, atmospheric reanalysis data, and remotely sensed sea ice data. Analyses reveal a system responding strongly to the positive feedbacks of the well-known ice-albedo system superimposed upon long-term trends of oceanic warming. Mid-winter observations of ocean heat fluxed into the Arctic help explain the historically low sea ice concentrations observed in 2017, 2018 and 2019. Using integrations of a Pan-Arctic (PA) Regional Ocean Modeling System (ROMS) ice and ocean circulation hindcast model that does not use data assimilation, we assess the skill of this hindcast model in reproducing the basic nature of the recent changes. Such changes in the thermal environment have some known and many unknown but likely important consequences for the regional ecosystem and for the earth climate system.

Interannual Variability in Stratification, Nutrients, and Water Mass Structure in the Chukchi Sea

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Striking changes in the physical environment of the Chukchi Sea have been observed over the past decade. As a seasonally ice-covered sea, the advance and retreat of sea ice plays a dominant role.This seasonal evolution of ice is linked to variability in stratification and water mass structure, which have been shown to influence the ecosystem from phytoplankton to fishes and seabirds. Using mooring and shipboard data, we quantify variability in stratification, water mass structure and associated nutrients. During winter, nutrients are replenished over the shelf. Nitrate concentrations are lowest in newly formed WW, and rates of local nitrate replenishment appear low relative to the nutrient flux through Bering Strait. Stratification over the shelf increases over the summer until mid-September when increasing winds and surface cooling begin to mix the water column. Salinity stratification typically accounts for more than half of the total stratification during summer but the effects of temperature are not insignificant. Stratification and water mass structure are tightly linked. Timing of the transitions between WW and Summer Water are correlated with the timing of ice retreat in spring and ice arrival in fall. During winters with highest transport (2010 – 2011 and 2017 – 2018), pre-bloom (May 15) nitrate concentrations were high and closely resembled nitrate concentrations in the Bering Sea. Anomalously low nitrate concentrations were observed in the winter of 2011-2012 when transport was negligible. While transport of water masses from the south is likely important to water mass transitions, transport at the Icy Cape line is not significantly correlated with the timing of Summer Water arrival or the timing of ice retreat. However, the strongest average spring transport (March to May) in our record was observed in 2017, a year that both ice retreat and Summer Water arrival were more than a month earlier than average. The open water season in 2017 and the amount of time that Summer Water was present were both unprecedented in our record.

Underway Time Series of Physical and Biological Measurements from the Gulf of Alaska, and the Bering and Chukchi Seas

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Potential widespread warming of surface ocean waters in the Gulf of Alaska, Bering Sea and Chukchi seas in the coming decades, coupled with high variability, will drive ecological change. Multiple trophic levels, as well as physical and geochemical parameters are currently monitored in these systems.The decadal-scale, continuously collected sea surface data collected from the Sir Wilfrid Laurier represents one such data set. Analysis of long-term, multi-trophic data sets such as those collected from Laurier, can improve mechanistic and quantitative understanding of the relationship between local, regional and global drivers; this can allow for insightful and accurate prediction of the broader ecological consequences of climate-driven changes, and allow for adaptation and more pro-active resource management . Here we describe results of the spatio-temporal analysis of eleven years of surface temperature, salinity, chlorophyll, and net community production data collected in the Northern Bering and SE Chukchi seas from 2007 to 2017, with preliminary updates from the years 2018 and 2019. Notable within this time series are increases in surface temperature in recent years. We will present results examining how variability in surface conditions correlate with large scale meteorological patterns and data sets (some collected concurrently) regarding zooplankton, sea birds, marine mammals and benthic organisms.

The Variability of Arctic Sea Ice Variability

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As the summertime ice edge retreats further and faster, modeling studies indicate that the Bering, Beaufort and Chukchi seas are likely to experience large increases in variability. For coastal communities, changes in the variability at interannual, seasonal and day-to-day timescales translate to uncertainties, which can be as impactful as longer term trends in the extent or duration of the ice cover. We explore the evolution of "hot spots" of variability as measured by sea ice conditions: mean sea ice concentration, the thinnest and thickest ice category, snow depth, ice drift velocity, and freeze-up and break-up onset dates. These diagnostics are used to quantify aspects of inter-annual variability in sea ice that are important to for planning purposes, such as false freeze-up and break-up onset dates, and expected locations of ice-obligate species (e.g. snow depths critical for ringed seal rearing). Our assessment of hot spot variability is based on the CESM-LE (Community Earth System Model - Large Ensemble), 40-ensemble-member simulation; it is supported by the National Science Foundation: NNA Track 1: Collaborative Research: ARC-NAV: Arctic Robust Communities-Navigating Adaptation to Variability. We integrate CESM-LE output with our newly expanded, publicly available, Lagrangian Ice Tracking System: LITS (http://icemotion.labs.nsidc.org/IceMotion/PlotCSVtest13.html http://icemotion.labs.nsidc.org/IceMotion/PlotCSVtest13.html). LITS allows planners, including residents of coastal communities, to backtrack ice to reveal sea-ice age, origin and pathways, and to integrate various factors along ice pathways that influence habitats of ice-associated species. The ice motion vectors are based on the Polar Pathfinder dataset (https://nsidc.org/data/nsidc-0116 https://nsidc.org/data/nsidc-0116: AVHRR, AMSRE, SMMR, SSMI, and SSMI/S sensors; IABP buoys; and NCEP/NCAR Reanalysis forecasts). For historical analyses, drifts are calculated using optimal interpolation of buoy drift, satellite-derived, and free-drift velocity estimates. LITS now incorporates basin-wide contextual information including: bathymetry, ice concentration, ice age, ice motion, air temperature, pressure, wind speed, extending from 1979 to 2018, and will eventually include CESM-LE output for forward-looking simulations. These new perspectives and tools contribute to developing an understanding of heterogeneous conditions, increased uncertainty, and emerging responses within a rapidly changing Arctic.

The Effect of Upwelling on Turbulence in Barrow Canyon

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To investigate turbulent mixing in Barrow Canyon, we measured power spectral density levels of airborne lidar returns and 150 kHz Acoustic Doppler Current Profiler (ADCP) returns from a ship. We used lidar returns from depths of 10 and 20 m on five different days. We used acoustic returns from depths of 11, 19, and 39 m on one of those days. The corresponding Bakun upwelling index was calculated using the hourly wind speed and direction at the Wiley Post-Will Rogers Memorial Airport in Utqiaġvik, Alaska. The power spectral density of the fluctuations in lidar signal were very close to a power law with exponent of -5/3 for all five passes over Barrow Canyon and for both depths. The correlation between upwelling and turbulence level was 0.91 (P = 0.03) at 10 m and 0.88 (P = 0.05) at 20 m. During periods of downwelling (negative index), turbulence levels were all below 10-17, and the differences between the levels at the two depths were 10% or less of the value at 10 m. During upwelling conditions, turbulence levels were higher (> 10-17) and the difference was 60% or greater, with the lower values at the greater depth. The acoustic spectra are very similar to the lidar spectra; a power law with slope near -5/3. These data were collected over too short a time period to investigate the effects of upwelling on turbulence level, but we did find a significant increase of turbulence with depth (R = 0.76, P = 0.005) over the three depths investigated. Lidar measurements suggested that the level of turbulence and its vertical distribution were affected by local upwelling winds. The vertical distribution of acoustic scattering was different from that of the lidar, which we interpret as different vertical distributions of phytoplankton and zooplankton gradients, since the lidar return is primarily a function of phytoplankton concentration and the acoustic return is primarily a function of zooplankton concentration.

Hydrographic Patterns and Source Water Contributions in Beaufort Sea Lagoons

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Lagoon ecosystems across the Arctic are vital habitats for coastal fishes and lower trophic level organisms. Ongoing sea ice loss, warming, intensification of coastal erosion, and changes in freshwater input are altering lagoon physical and chemical characteristics, with repercussions for biogeochemical cycling and habitat function. The Beaufort Lagoon Ecosystem Long Term Ecological Research program (BLE LTER) focuses on five lagoon systems across the North Slope (Elson Lagoon, Simpson Lagoon, Stefansson Sound, Kaktovik Lagoon, and Jago Lagoon), which allows for assessment of change, as well as spatial comparisons. We present data on lagoon temperature and salinity (from in situ benthic dataloggers and sonde measurements at a wider range of depths), and source water composition (calculated from salinity and water δ18O) from the first year of BLE LTER data collection (August 2018 to August 2019). All lagoons exhibit large fluctuations in salinity, with range from a maximum of 40 in the winter to a minimum of 0 in the spring. Source water calculations indicate the relative contribution of meteoric water and sea ice meltwater to these low salinity conditions, and demonstrate differences among lagoons and seasons which can be explained by lagoon geomorphology and river inputs. Spatial variation in hydrographic phenology (e.g. onset and end of winter conditions) also reflects geomorphology, as well as connectivity to the Beaufort Sea. For example, winter conditions commenced and ended approximately one week earlier in Kaktovik and Jago lagoons than in Elson Lagoon.These distinctions in hydrography and source water contributions among lagoons impart spatial differences in organic matter cycling and distribution of lagoon biota.

Circulation in the Vicinity of Mackenzie Canyon from a Year-ong Mooring Array

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Data from a five-mooring array extending from the inner shelf to the continental slope on the western flank of Mackenzie Canyon are analyzed to elucidate the components of the boundary current system and their variability. The array, part of the Marine Arctic Ecosystem Study (MARES), was deployed from October 2016 to September 2017 and included measurements of physical, chemical, and biological variables. Here we focus on physical attributes of the system. Three distinct currents were identified: a westward-flowing, surface-intensified jet on the outer-shelf; a mid-depth intensified shelfbreak jet flowing to the east; and a recirculation at the base of the continental slope. The outer-shelf current transports 0.11 Sv in the mean; it is primarily wind-driven, although the response is modulated by the presence of fast-ice in the winter months. The shelfbreak jet transports 0.034 Sv in the mean, which matches well with the value measured upstream in the Alaskan Beaufort Sea. It is strongest in summer and weakens in winter, at times reversing. The deep recirculation appears to be the result of local dynamics whereby a portion of the westward-flowing southern limb of the Beaufort Gyre is diverted up the western flank of the canyon. This is supported by the fact that the monthly variability of the recirculation is correlated with that of the wind-stress curl in the Canada Basin. The seasonality of the measured water masses is not related to the strength of the flow components. Notably, the presence of meteoric and sea ice melt water is more prevalent at this location than farther west in the Alaskan Beaufort Sea boundary current. The nature of the Mackenzie river water signal over the course of the year is addressed.

Atmospheric Circulation Characteristics Associated with Extreme High-Water Level Events at Foggy Island Bay, Alaska

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The northern coast of Alaska is experiencing significant climatic change enhancing hazards from reduced sea ice and increased coastal erosion. This same region is home to substantial offshore oil/gas resources and future development plans need to account for the changing climate. High water levels specifically impact infrastructure through erosion and flooding hazards. In this study, 21 high water level events exceeding the top 95th percentile were identified at the gauge in Prudhoe Bay, Alaska over 1990-2018. All events were associated with strong westerly winds according to adjacent weather station records. The atmospheric circulation characteristics such as mean sea level pressure, 500hPa heights, temperature and winds along with storm tracks associated with these events are evaluated using ERA5 reanalysis data. The ultimate goal is to develop a set of circulation parameters/characteristics that can be used as analogs to determine the future frequency of high water extremes in Global Climate Model projections for 2005-2100 for Foggy Island Bay.

Decadal Variability in Mesozooplankton Communities of the Northeastern Chukchi Sea: 2008 – 2017

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Seasonal and interannual patterns observed in high-latitude planktonic communities develop from complex biophysical interactions between organisms and their underlying physical environment. The Chukchi Sea is currently experiencing rapid rates of ecosystem change resulting in unprecedented patterns of sea ice loss and increasing ocean temperature, further complicating our ability to accurately predict regional biological responses. Seasonally, the Chukchi Sea shelf ecosystem undergoes a transformation in water column structure where Chukchi Winter Water (CWW) and Chukchi Melt Water (CMW) are replaced by Bering Sea Summer Water (BSWW). This exchange in water masses consequently alters the composition of the zooplankton communities tightly coupled to water types. Here, we show how seasonal variability in the timing and prevalence of these water masses shape the composition, abundance, and spatial distribution of zooplankton species during a decade of sampling the northeastern Chukchi Sea ecosystem. In warm years coupled with early sea ice loss, BSSW penetrates further northward allowing Pacific expatriates (e.g., *Metridia pacifica*, and *Neocalanus spp*.) to dominate the system. Alternatively, cold years associated with prevalent sea ice cover results in slower water mass replacement, allowing larger lipid-rich Arctic species (e.g., *Calanus glacialis*) to thrive. In all years, small-bodied copepods of the Pseudocalanus species complex numerically dominate, with highest abundances observed during the warmer years resulting in a decrease in copepod biomass available to planktivorous predators. A decade of continuous fixed-station sampling highlights the high level of ecosystem variability on small spatial scales and the architectural role water masses play in shaping high-latitude pelagic ecosystems.

High-Latitude Benthic Bivalve Biomass and Recent Climate Change: Testing the Power of Live-Dead Discordance in the Pacific Arctic

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Time-averaged molluscan death assemblages sampled from tropical to temperate open continental shelves commonly disagree in species composition with local living communities only in areas that have changed in response to anthropogenic eutrophication and other locally intense human stresses, providing a means of recognizing shifted baselines. In contrast, the ability of live-dead discordance to resolve the spatially heterogeneous effects of human-induced climate change has not been tested in high-latitudes, where climate change entails substantial changes in nutrient cycling with consequences for benthic biomass and where cold waters are antagonistic to carbonate shell preservation. North Pacific Arctic and Subarctic seabeds offer ideal conditions for testing the resolving power of molluscan live-dead discordance, using well-documented ecologic changes in nutrient cycling and benthic biomass in response to reduced sea ice. Ecosystem monitoring since 1980 has established that the boundary between the Arctic and the Subarctic on the Bering Sea continental shelf, maintained by ice-influenced bottom water, shifted northward between 1998 and 2001. The benthic community in the transitioned area now experiences new pelagic predators, more variable quantity and quality of deposited food, and altered sediment grain size, and macrofaunal dominance has shifted from diverse communities of specialized suspension or deposit feeders to facultative deposit feeding guilds. We find that in habitats where either Subarctic or Arctic conditions have persisted, bivalve death assemblages agree closely with counterpart living communities in taxon and guild composition and with little significant post-mortem bias. Significant live-dead discordance occurs only in areas with documented changes in carbon delivery, sediment grain size, and community composition over the last several decades; there, death assemblages are mixtures of shells from pre- and post-transition communities, as confirmed by monitoring data. This spatial pattern is robust to both numerical abundance- and biomass-based measures of community composition. In fact, biomass is especially powerful in revealing station-level discordance at sites with known benthic change. Live-dead discordance can thus reliably differentiate between stable and rapidly changing habitats in cold, high-latitude settings, relevant to evaluating climate change, and biomass-based currencies of community composition are as robust as numerical abundance data, and in fact, improve spatial resolution.

Seasonal and Annual Patterns in Fatty Acid Dynamics of Arctic Seston from the North Bering-Chukchi Sea Regions

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Phytoplankton play a fundamental role in the Arctic marine ecosystem due to their ability to synthesize essential fatty acids for higher trophic level organisms such as zooplankton, fishes, birds, and marine mammals. However, rising Arctic temperatures and sea ice loss may contribute to decreased ice-edge blooms, increased stratification, and reduced nutrient supply, potentially shifting phytoplankton communities towards a greater fraction of smaller, less lipid-rich organisms. More baseline data are needed to track such potential changes in the nutritional quality of phytoplankton that comprise the base of the Arctic food web. To foster a better understanding of the spatial, seasonal, and annual variation in the lower trophic levels due to variable climate, seston were sampled during three surveys: two during the spring of 2017 and 2018 (ASGARD, spanning the North Bering and Chukchi Seas) and one during the late summer/early fall of 2017 (Arctic IERP, Chukchi Sea). Fatty acids were extracted and derivatized to fatty acid methyl esters and their composition analyzed by gas chromatography. Multivariate and PERMANOVA analyses revealed significant differences in the seston fatty acid composition among the three surveys, likely driven by differences in the total lipid content per volume (ng/mL) of the samples, which was significantly higher in the two spring surveys than the late summer/early fall survey. Biomarker indicators of diatoms, large phytoplankters that provide more efficient energy transfer to higher trophic levels, were also higher during the spring (highest in 2018) and accounted for much of the observed fatty acid variation among surveys. In an era of climate change, our analyses highlight important seasonal and annual dynamics in fatty acid composition and thus nutritional quality of the Arctic phytoplankton community. Such data can help strengthen predictions of food web functioning and energy transfer to the upper trophic levels.

Arctic Plankton Communities: The Northwest Passage Project and its Interdisciplinary Approach

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As lower trophic level organisms, plankton are considered the foundation for many marine food webs. Despite their importance, in Arctic regions, there exists major uncertainties in the ecology of plankton, and how variable ice coverage impacts their distribution, composition, and function. As part of the Northwest Passage Project (NPP), a multidisciplinary group of students, scientists, filmmakers, and other professionals embarked on an 18-day expedition through the Canadian Arctic Archipelago (CAA), led by the University of Rhode Island and funded by the National Science Foundation (NSF) and the Heising-Simons Foundation. Undergraduate student research teams, along with two members of the Inuit-led Ikaarvik program, conducted hands-on oceanographic research, in an effort to better understand plankton community structure and function, amongst other data collection goals. In tandem with gathering planktonic community data, the students collected and observed details regarding water mass properties and circulation patterns, water column chemistry and greenhouse gas fluxes, and seabird and marine mammal distributions in the CAA. This presentation focuses on the experiences and contributions of the NPP microscopic communities team and their efforts to fill critical knowledge gaps regarding plankton communities in the changing Arctic. Microscopy, size-fractionated extracted chlorophyll, and FlowCAM particle imaging were used to characterize phytoplankton community structure across diverse habitats. Onboard incubation experiments measured phytoplankton growth, microzooplankton grazing and community compositional changes as a function of changes in the light environment associated with changes in sea-ice cover and composition. Microscopy data also revealed the presence of microplastics in CAA waters and multi-year sea ice. This presentation will review student research experiences and preliminary findings.

Preliminary Results of a 2019 Acoustic-Trawl Survey in the U.S. Continental Shelf Region of the Chukchi Sea

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An acoustic-trawl (AT) survey was conducted in the Chukchi Sea during August - September 2019 as part of the Arctic Integrated Ecosystem Research Project. Previous summer AT surveys in the area (2012, 2013, and 2017) determined that pelagic fishes were dominated by large numbers of age-0 Arctic cod (*Boreogadus saida*), but that very few adults were present in the region. The lack of adults suggests that survivorship of age-0 Arctic cod is either very low or that these juvenile Arctic cod emigrate to other areas as they grow. In 2017, acoustic backscatter from age-0 Arctic cod was substantially greater than previously observed. The objectives for the 2019 fieldwork were to a) use the AT survey data to establish whether the relatively abundant age-0 Arctic cod observed in summer are a characteristic feature of the Chukchi Sea and b) determine if the high abundances of age-0 Arctic cod observed in 2017 were anomalously high. The 2019 summer AT survey was conducted from 66.5 to 73.1 °N across the U.S. continental shelf. Midwater trawls were conducted at 42 locations. Trawl catches indicated that sound-scattering organisms north of 71 °N were dominated by age-0 Arctic cod. The backscatter attributed to age-0 Arctic cod was substantially less than observed in 2017. Consistent with previous surveys, very few age-1+ gadids were captured on the Chukchi Shelf. The 2019 survey was anomalous in that species composition differed south of 71 °N compared to previous years. For example, age-0 walleye pollock, which were only present in trace amounts during previous surveys, were the most abundant species in more than half of the trawl samples. Pacific herring were present in high abundance just north of Bering Strait. Although this is a short time series, it is clear that there is high variability in species abundance and composition of midwater fishes on the Chukchi Sea shelf. The changes in species composition observed during the 2019 survey suggest that environmental conditions are now such that species from the south are able to colonize the central and southern Chukchi Sea, at least on a seasonal basis.

Trophic Dependencies of Arctic and Saffron Cod in the Nearshore Beaufort Sea, Alaska

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Long-term changes in environmental conditions are associated with a shift in fish assemblages across the Arctic. In the nearshore Beaufort Sea, a shift in cod species (family: Gadidae) from Arctic cod (*Boreogadus saida*) to saffron cod (*Eleginus gracilis*) has been particularly pronounced. Differences in the life history of these two gadids will likely have important consequences for Arctic food webs. Arctic cod are a small bodied forage fish that thrive in cold, offshore water (<5 °C) and play a key role in food webs. Saffron cod prefer warmer waters associated with the nearshore zones and are not considered a forage fish as they grow to much larger sizes. Here, we use stable isotopes (13C and 15N) to contrast trophic dependencies of Arctic cod and saffron cod captured at several sites in the nearshore Beaufort Sea across three summers (2017–2019). We examined whether the current isotopic niches of Arctic cod and saffron cod captured in the nearshore Beaufort Sea (<10m depth) overlap, and the potential degree of shared resource (or carbon) use between these two species. The minimal overlap in isotopic niches of Arctic and saffron cod likely reflects differences in their habitat selection, supporting the idea that there should be little competition for resources between these two species. While stable isotope values of nitrogen indicate that they feed at a similar trophic level, difference in carbon values are suggestive of distinct basal resources.Of note however, is that Arctic cod are depleted in 13C relative to saffron cod, suggesting a greater reliance on offshore primary production by saffron cod. This contrasts with the expectations that Arctic cod isotope values would fall beyond the carbon isotope range of nearshore fishes and reflect wind advection to nearshore habitats, and that saffron cod would use more terrestrial carbon given their stronger association with nearshore habitats. Additionally, the separation in carbon values of saffron cod caught at different sites reflects spatial variability in the amount of terrestrial carbon in these nearshore systems. Stable isotope values of less-mobile, resident fishes will provide a critical context for interpreting the isotopic niches of these gadids.

Habitat Associations and Distribution of Arctic Cod (*Boreogadus saida*), Saffron Cod (*Eleginus gracilis*) and Snow Crab (*Chionocetes opilio*) in the Alaskan Arctic

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In the 2009 Arctic Fisheries Management Plan (FMP) by the North Pacific Fishery Management Council (NPFMC), Arctic cod (*Boreogadus saida*), saffron cod (*Eleginus gracilis*) and snow crab (*Chionocetes opilio*) were identified as the three potential target species in the Arctic Management Area. For the FMP, a qualitative assessment of their essential fish habitat (EFH) based on presence-absence survey data was done for the late juveniles and adults. The descriptions and maps of EFH were further updated in 2017. To quantitatively assess EFH, we use species distribution models to link habitat characteristics to species occurrence and catch per unit effort (CPUE) data from surveys for larval, juvenile and adult life stages. We present preliminary species distribution models that identify key habitat characteristics and habitat suitability for these species in the US Chukchi and Beaufort Seas. Survey catch and environmental data will continue to be added and updated in the models and alternative modeling methods will be evaluated. The finalized resulting maps from this research will be included in the next update to EFH information by NPFMC.

Individual Plasticity and Not Evolutionary Change Drives a Seabird's Response to Earlier Snowmelt in Arctic Alaska

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Arctic Alaska has experienced some of the most rapidly increasing temperatures on the globe. Mean annual air temperature has increased >6°C since 1976, resulting in the date of snow disappearance at Utqiagvik advancing almost 3 days per decade. We examined a unique long-term data set on the breeding phenology of Black Guillemots (*Cepphus grylle mandtii*), a long-lived seabird whose nesting cavities are inaccessible until the snowmelt. Since 1975 the date of clutch initiation has been recorded for all nests at a breeding colony on Cooper Island, 35 km southeast of Utqiagvik, where the timing of annual reproduction has been shown to respond to the disappearance of snow. The population consists primarily of marked (banded) individuals, many with known lineages, allowing determination of the importance of individual behavioural response (plasticity) or evolution (genetics) in phenological change. Few studies have investigated both these processes in Arctic environments. While individual behavioural changes might allow a population to cope with short-term environmental change, they are unlikely to allow the long-term adaptation provided by evolutionary change. We found that most of the observed change in timing of breeding was driven by changes in individual behaviour in response to annual variation in snowmelt, and found little evidence that changes in breeding time are driven by evolutionary change. Mean clutch initiation date (date the first egg in a clutch was laid) advanced 7.8 days since 1976. Earlier breeding was associated with earlier snowmelt and experienced individuals. Females advanced egg-laying at different rates as they aged but at similar rates in response to variation in snowmelt. Heritability of clutch initiation was negligible, and with no evidence of evolution contributing to egg-laying changes. The analysis suggests individuals that consistently laid earlier also tended to be more successful at fledging chicks and were more likely to survive to the next year suggesting that the egg-laying changes are adaptive and are driven by phenotypic plasticity, but not genetic responses. We propose that species with a constrained breeding season (like many Arctic species) may have a limited ability beyond existing plasticity to respond to changing environmental conditions.

Muscle Physiology of Ice-Associated Alaskan Seals

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Given their reliance on sea ice for a number of critical life-history periods, understanding species-specific physiology of Arctic seals is necessary to better predict the potential consequences of rapid sea ice loss. To gain insight into how skeletal muscle physiology relates to diving and foraging behavior we evaluated myoglobin content ([Mb]), non-bicarbonate buffering capacity (β), and fiber-type profiles of a major locomotor muscle in three Arctic seal species. Longissimus dorsi muscle was collected and analyzed from subsistence harvested ringed (*Pusa hispida*; n=11), bearded (*Erignathus barbatus*; n=41), and spotted (*Phoca largha*; n=12) seals. We found adult ringed seal muscle [Mb] to be 6.4±0.5 g Mb 100 g wet tissue-1, while adult spotted seal muscle averaged 5.5±0.5 g Mb 100 g wet tissue-1. These data agree with previously reported values for other phocid species. In contrast, adult bearded seals had much lower muscle [Mb] at 4.6±0.4 g Mb 100 g wet tissue-1, suggesting their aerobic capacity is more similar to benthically foraging walruses than to other phocids. Adult β was fairly similar across all species (ringed, β = 84±1.0 slykes; bearded, β = 81±1.1 slykes; spotted, β = 77±0.6 slykes). Fiber-type analyses revealed species-specific differences in the relative proportion of fast- and slow- twitch muscle fibers. Spotted seals exhibited an even mix of fast- and slow-twitch fibers (52% : 48%), while ringed and bearded seals had higher proportions of fast-twitch fibers (62% and 70%, respectively). These results provide a comprehensive overview of the aerobic and anaerobic properties of locomotor muscle in several ice-associated seal species. Together, these properties can be used to predict routine diving behavior and define physiological limits for ringed, bearded, and spotted seals. Our data suggest a strong link between muscle physiology, life-history strategies, and foraging behavior, and provide insight into the diving capacities and limitations of data-deficient species.

Balancing the Budget: Seasonal Energy Demands of Ice-Dependent Arctic Seals

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Alaskan seals use sea ice as a substrate for various critical functions including rest, pupping, and molting. These activities may become disrupted or more costly in the absence of sea ice. For example, during the annual molt seals shed several layers of epidermis and fur, and regenerate a new coat. Thermoregulatory costs associated with molt are predicted to increase if appropriate haul-out substrate is unavailable. Similarly, energetic costs will increase if haul out platforms and foraging areas are spatially separated. Measures of energy intake and metabolism can be used to evaluate the potential impact of environmental change on energy budgets. Working with eight trained seals representing three species [bearded (*Erignathus barbatus*), ringed (*Pusa hispida*), and spotted (*Phoca largha*) seals], we documented longitudinal changes in daily gross energy intake (GEI) and body mass, and monitored fine-scale changes in resting metabolic rate (RMR). Further, we examined the relative importance of air and water temperature, age, body mass, and physiological state on changes in GEI and RMR. We found clear seasonal patterns in GEI, defined by alternating periods of hyperphagia and hypophagia. In spotted and ringed seals these cycles became more pronounced with age but did not necessarily lead to commensurate changes in body mass. Increasing food intake over the molting interval was associated with simultaneous decreases in body mass, indicating a period of high energy expenditure. The severity of this pattern was related to molt duration. Weekly measures of metabolism revealed seasonal changes in RMR that corresponded to the distinct molting strategies of each species. For species that molt over a relatively short interval (spotted: 36±4.6 days, ringed: 29±2.5 days), RMR increased sharply (range: 26-47%) across the molt. In contrast, molting over a longer interval (bearded: 107±14.8 days) appeared to limit energetic costs as indicated by a more stable annual RMR. Our findings reveal dynamic relationships between GEI, RMR, and body mass, and highlight a previously unknown relationship between molting strategy and seasonal energy budgets. Ultimately, this work contributes quantitative data that can be used in predictive models to assess the consequences of sea ice loss on ice-dependent seals.

Variability in Lipid and Fatty Acid Content in the Blubber of Pacific Walruses (*Odobenus rosmarus divergens*)

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The variability of lipid and fatty acid content with blubber depth and among body sites are important considerations for diet and condition studies of marine mammals. We investigated this variability among years and lactation status of Pacific walruses using blubber samples from the flank, rump, and sternum of adult females collected from subsistence-harvested walruses in spring 2007-2010. A difference in percent lipid content between the inner and outer blubber layers was evident at the rump where the inner layer was 4% higher than the outer layer but was not evident at the flank and sternum. Differences in percent fatty acid content between the inner and outer blubber layers were not evident among body sites; however, within body site differences between blubber layers were evident for several fatty acids, but all differences were small, ranging from 1.5% to -1.7%. Percent lipid content was 4% higher in lactating females (79%) than non-lactating females (75%) (years pooled because sample sizes from non-lactating walruses were low for some years). Within lactating females, percent lipid decreased from 88% in 2007 to 70% in 2009, and then increased to 78% in 2010. Within fatty acid, differences in fatty acid content ranged from 1.5% to 4.9%. The largest between year differences (those ≥ 3%) occurred within 18:1n-9 because of a relatively low content in 2009 and 20:1n-7 because of relatively high content in 2007, which corresponded to years with the lowest and highest percent lipid content of blubber, respectively. This study demonstrates that blubber samples collected from the sternum were useful for investigating lipid and fatty acid content relationships with time and potentially with indices of condition and female reproductive status.

Gastrointestinal Parasitism in Pacific Walrus

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The large pinniped *Odobenus rosmarus divergens* (Pacific Walrus) is found in the Laptev, Chukchi, and Bering Sea, and has a reliance on stable sea ice for nursing, breeding, and resting after periods of feeding. With the rapid rise in global temperature, the sea ice along with walrus ecology is changing. Thus, it is imperative that we are able to understand the impact of parasites on the Pacific Walrus in correlation with their reduced habitat. This pilot study focuses on evaluating the parasite communities of 22 walrus individuals in Alaska. Fecal material was collected from the walrus carcasses during hunting activities by the residents of Savoonga & Gambell. Extracted DNA was isolated to identify gastrointestinal parasites using sequencing of a variable region of the 18S ribosomal gene. Additionally, a portion of the feces was evaluated using fecal egg/oocyst counts to quantify the parasite burden, as well as provide morphological evidence to match with the molecular methods. Results suggest that walrus host a large diversity of parasites, and that a small percent of individuals carry the majority of the parasites. These results encourage further data collection to investigate possible linkages between changes in parasite community and changes in environmental conditions.

Quantifying Ringed Seal Lair Habitat and Emergence Timing in the Eastern Bering and Chukchi Seas

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Climate warming presents considerable challenges for Arctic marine mammals that have evolved a strong dependence on snow and sea ice. Ringed seals (Phoca hispida) are ice-associated Arctic pinnipeds that are a vital resource for Arctic indigenous peoples, and are ecologically important as the primary prey for polar bears. These seals rely on snow-covered lairs in the spring to protect their pups from hypothermia and predation when they are young and vulnerable. There is a paucity of information on the amount and duration of snow required for pupping, and the timing of seal emergence from snow lairs. In this study, we use observations of ringed seals during the spring denning period from two extensive aerial surveys conducted in the Bering (2012-2013) and Chukchi Seas (2016). In total, these surveys covered 116,000 km of survey track and detected 8,449 ringed seals. Both surveys were a product of U.S.-Russian collaboration, and used a combination of thermal and color cameras to detect ringed seals on sea ice. We use generalized additive models to describe increases in the number of ringed seal detections over the spring denning period (April-May) as they emerged from snow lairs. This time series of emergence provides information on the optimal timing for future aerial surveys, information sorely needed to quantify trends in abundance. We further relate trends in emergence to environmental covariates that are expected to shift under climate change, including snow depth, melt onset, and temperature derived from satellite passive microwave data and regional reanalysis. This study thereby provides valuable information on the importance of snow and sea ice to ringed seal reproductive ecology, with implications for the species' future in a warming Arctic, and will inform successful monitoring and management.

Helminth Fauna of Ice Seals in the Alaskan Bering and Chukchi Seas, 2006–2015

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During 2006–2015, 141 ice-associated seals of four species (ringed (*Pusa hispida*), bearded (*Erignathus barbatus*), spotted (*Phoca largha*), and ribbon (*Phoca fasciata*)) harvested for subsistence purposes in Alaska from the Bering and Chukchi Seas were sampled for internal helminth parasites. With warming ocean temperatures novel parasites are predicted to spread farther north and endemic parasites may increase in prevalence. Helminths were present in 133 (94%) of the seals sampled. Nematodes were found in all seal species with bearded and spotted seals having them most often (97% and 93%, respectively). Cestodes were mostly found in bearded seals (82%), trematodes were only found in bearded (64%) and ringed seals (5%), and acanthocephalans were mostly found in ringed (61%) and spotted (64%) seals. Although none of the helminths found were new to the Bering-Chukchi region, this study found the first host record of the lungworm *Parafilaroides (Filaroides) gymnurus* in a ribbon seal. This is also the first report of the lungworm *Otostongylus circumlitus* in a ribbon seal and P. (F.) gymnurus in bearded seals from the Bering-Chukchi region (previously identified in the Sea of Okhotsk). We found a lower prevalence of the cestode genus Pyramicocephalus in bearded seals (2.7%) than reported previously for the species *Pyramicocephalus phocarum* (44–100%) in the Bering-Chukchi region. The acanthocephalan genus Bolbosoma was not identified, but was found in ringed, spotted, and ribbon seals previously. As of 2015, no novel parasite species were identified, and the prevalence of endemic parasites has not increased, although some may have decreased.

Bowhead Whale Calf Nurseries in the Canadian Beaufort Sea, August 2019

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A new and unique aerial survey was conducted in the Alaskan and Canadian Beaufort seas and Amundsen Gulf, from 119°W to 158°W, during 5-27 August 2019 by the Aerial Surveys of Arctic Marine Mammals (ASAMM) project. The new aerial survey, ASAMM Bowhead Abundance (ABA) was a line-transect survey designed to estimate the population abundance of the Western Arctic stock of bowhead whales (*Balaena mysticetus*), funded by BOEM and NOAA in partnership with several US and Canadian organizations. Bowhead whales migrate from wintering grounds in the Bering Sea to summer feeding grounds in the Beaufort Sea, with concentrations of whales feeding off the Mackenzie River Delta and Tuktoyaktuk Peninsula. Calves are typically born during the spring migration and accompany adults to the summer feeding grounds. During ABA, 317 bowhead whales were sighted on effort and distributed from 119°W to 152°W; of these, 54 were calves. Calves were seen only in the Canadian Beaufort Sea, distributed from 127°W to 140°W. Calf sightings were concentrated in two main areas: near Herschel Island and Mackenzie Bay (20-60 km offshore, 60-350 m depth) and off the Tuktoyaktuk Peninsula (40-130 km offshore, 30-75 m depth). A few calves were also sighted off Cape Bathurst (10-90 km offshore, 10-140 m depth). Bowhead whales were also concentrated in Franklin Bay, though no calves were seen there. Cow-calf pair behaviors included swimming, milling, and resting, and calf-specific behaviors included breaching, playing with a log, and rolling and pectoral flipper slapping. Four of the cows were large individuals with white on their flukes and peduncles, suggesting they were older individuals. One cow had mud on her head, suggesting she had been feeding at the ocean floor. Bowhead whale calves were sighted in cow-calf pairs, by themselves without an adult, and in groups consisting of one cow with two calves or multiple cows and calves together, suggesting these areas served as calf “nurseries”.

Dietary Adaptations to Climate Change: Nutrient Analysis of Pacific Walrus Tissue

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Pacific walruses are a flagship species and a subsistence food source, playing an important role throughout their home range along the coasts of Alaska and Siberia – a home range directly and immediately impacted by climate change. This research seeks to investigate whether changes in prey source are reflected by alterations in key dietary immune mediators and to determine what impacts, if any, shifts in walrus diet may pose for human consumption and nutrient availability. Utilizing tissue samples from 37 walruses harvested during the 2019 St. Lawrence Island, AK spring hunt as part of a collaboration with the Eskimo Walrus Commission, US Fish and Wildlife Service, local hunters, and Texas Women's University, nutritional analysis was performed employing HPLC and fatty acid analysis to identify and characterize fatty acid content and fat-soluble vitamins. These metrics were compared against stable isotope analysis for identification of trophic level prey source to establish associations between target prey and nutrient content of walrus meat specifically pertaining to immunogenic vitamins and fatty acids, both with regards to walrus immunity and human nutrition. Results from this study will serve as a baseline for understanding the multitude of implications that climate change may bare for Arctic marine wildlife adaptability and survival, as well as the compounding consequences that these dynamics may have for the human population. Understanding nutrient content of walrus meat in response to prey choice will help to inform future subsistence practices, with the goal of maximizing human health and nutrition while informing walrus management.

Blunt Trauma Involving the "Stink-Sac" (Post-Anal Sac) in a Beach Cast Gray Whale (*E. Robustus*), Alaska

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The post anal sac " stink-sac" is a unique anatomical structure specific to gray whales. It is located mid ventral between the blubber and tail stock muscles within a distance of 56-120 cm posterior to the anus. We report on the gross and histopathological findings of blunt force trauma of the tail stock involving the "stink sac" in an adult female beach cast grey whale (2018 GW 0914 FD Tag 193; TBL 11.70 m; Carcass condition IV), Alaska. A large ~ 30 x 30 cm swelling was notable on the ventral side of the tail stock within a distance of 65 cm to 1m posterior to the anus. No external scarring was noted. On dissection, pale yellow turbid fluid (8-10 l), with white particles emptied from a 25 x 20 x 20 cm cavity lined by a well-developed fibrous capsule. Surrounding blubber was discolored red and had lost typical firm blubber texture. Both chevron bones were well attached to the respective vertebrae but the 3rd chevron bone could be tilted up and down while in situ. No fractures were observed. Gross findings of discolored red blubber with loss of typical texture surrounding the post anal sac and mobility of the 3rd chevron bone suggest this was a prior site of trauma. On histology the presence of cholesterol clefts would also support a site of prior hemorrhage and adipocyte degeneration. Bone formation was also present indicating a site of osseous metaplasia. We hypothesize that the tail stock most likely sustained blunt soft tissue trauma (i.e. ship strike; conspecific trauma) that also involved the post anal sac. Proximate cause of death (COD) was killer predation (fresh tissue defects of rostrum/ head region). To what extent the tail stock injury contributed to COD remains undetermined. Given the importance of the tail stock for propulsion and predator deterrence, blunt force trauma to the region even in the absence of vertebral fractures is likely to have functional consequences. Poor carcass condition and lack of noticeable swelling are probably contributing factors why the post anal sac is rarely being examined in beach cast gray whales.

Dietary Adaptations to Climate Change in the Pacific Walrus (*Odobenus rosmarus divergens*): Influence of Foraging Niche on Parasitic Burden of Trichinella nativa

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Climate change, and resulting sea ice loss, has compounding consequences in the Arctic that extend beyond conservation of marine species and into management of human health due to the potential for spillover of novel parasites from infected wildlife sources. In particular, utilization of new prey sources due to prey depletion or lack of access/handling success in overcrowded or novel environments may have profound impacts for parasite exposure in Pacific walruses (*Odobenus rosmarus divergens*), which serve as a valuable subsistence food source for Alaska Native Communities.This presentation will address how climate driven changes in foraging ecology of Pacific walruses are contributing to changes in both walrus health concerns and human exposure to the zoonotic parasite Trichinella nativa. Using T. nativa isolation via artificial digestion techniques and genetic identification via PCR, and pairing this information with demographic parameters and stable isotope analysis to identify prey source, we will examine how walrus foraging habits can predict parasite exposure in order mitigate human and walrus parasite risk.

Deterrence of Polar Bears to Prevent Human-Bear Encounters

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Polar bear encounters can be dangerous. This poster discusses instances of recent polar bear encounters and options available for responding safely to polar bears. Passive and preventive techniques, such as noise, lights, and fences, can be used by everyone. Active techniques, including the use of pyrotechnics (bangers, screamers, and crackershells), rubber bullets, and bean bag rounds, require authorization from the U.S. Fish and Wildlife Service. Authorized users are required to report the use of active deterrents and the responses of polar bears to the Service. Summary statistics are provided here. These statistics demonstrate the effectiveness of deterrents for prevention of polar bear encounters.

Movement and Haul-Out Behaviors of Bearded Seals During Minimum Ice Extent, July - October

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Bearded seals (*Erignathus barbatus*) are ice-associated seals that use sea ice for pupping, molting and resting. As benthic foragers, they also prefer shallow waters on the intercontinental shelf. In the Pacific Arctic, sea ice is rarely present over much of the intercontinental shelf from July to October, meaning bearded seals spend this time in open water, follow sea ice as it retreats off the shelf, or haul out on land. Using satellite telemetry, we explored the movements and haul-out behavior of 22 juvenile bearded seals during the minimum sea-ice period (July – October), 2014 – 2018, to better understand seal behavior in the absence of sea ice. During this time, seals were primarily in open water. Five seals spent 26 – 50 consecutive days in open water away from land or sea ice and their tags did not produce any haul-out records during this time. Seals that did haul out were either on land near Bering Strait, or on ice in the northern Chukchi and Beaufort seas. Seals that hauled out on land had significantly shorter minimum haul-out durations than seals that were hauled out on ice, likely because of greater risk of being disturbed. Adult bearded seals are not thought to haul out on land in the Pacific Arctic. However, Alaska Native hunters from Utqiaġvik noted that large bearded seals will haul out on land in the fall. In September 2019 we observed, captured and tagged an 11+ year-old male bearded seal that was hauled out on land. After its release, this seal also spent considerable time (20 consecutive days) in open water before hauling out on land again. Observations from this adult suggest that behaviors described for juvenile bearded seals during minimum ice extent may apply to adults. That juvenile bearded seals can remain in open water for long durations without hauling out and will haul out on land during ice-free months bodes well for their potential to adjust to reductions in sea ice extent and duration. Adults likely share these abilities, however, more data for adults are needed.

The Summer of ABA*, ASAMM Bowhead Whale Abundance

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In August 2019, the Aerial Surveys of Arctic Marine Mammals (ASAMM) project extended its already prodigious study area, normally encompassing the eastern Chukchi and western Beaufort seas in Alaska, to include the eastern Beaufort Sea shelf and Amundsen Gulf in Canada. The primary focus of this international effort (known as ABA for ASAMM Bowhead Abundance) was to collect data suitable for estimating the abundance of the Western Arctic stock of bowhead whales (*Balaena mysticetus*), although data were collected on all marine mammals seen. Three survey teams, based in three locales, flew line transect surveys from 5 to 27 August, in a study area extending from 119°W to 157°W. Most transects were oriented north-south and extended offshore to the 200-m isobath, with a few transects extending to the 2000-m isobath. Transects west of Banks Island, Northwest Territories, Canada, were oriented east-west. Over 43,000 km (167 hours) were flown, with nearly 16,000 km (76 hours) on effort. The primary study area, located in the Beaufort Sea and Amundsen Gulf south of Banks Island, was thoroughly surveyed. Bowhead whales (331 sightings of 440 whales) were distributed from 119°W to 152°W. Most bowhead whale sightings were in Franklin Bay, near Cape Bathurst, and offshore of the Tuktoyaktuk Peninsula in the Northwest Territories, and north of Herschel Island in Yukon Territory, Canada. Relatively few bowhead whales were observed in the western Beaufort Sea. Belugas (*Delphinapterus leucas*, 625 sightings totaling 1,124 whales), polar bears (*Ursus maritimus*, 49 sightings totaling 150 bears), and pinnipeds were also seen. Surprisingly, 15 gray whales (*Eschrichtius robustus*) were seen just east of the Tuktoyaktuk Peninsula! This work was funded by the Bureau of Ocean Energy Management and the National Oceanic and Atmospheric Administration, and benefitted greatly from the assistance of several additional agencies, organizations, and individuals in the US and Canada. * not to be confused with the 70s Swedish pop group.

Determining the Total Lung Capacity of Living Ringed Seals (*Pusa hispida*) Using CT Imaging Techniques

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Marine mammals rely on oxygen stored in blood, muscle, and lungs to support breath-hold diving and foraging at sea. Relative to terrestrial mammals, they have enhanced capacity to store oxygen in their blood and muscles. Due to the difficulty of studying respiratory systems in living animals, few in vivo studies have focused on the role of lungs in oxygen storage capacity. Although lung collapse is a mechanism by which many marine mammals avoid dysbaric injuries, gas exchange between the blood and lungs occurs until the point of lung collapse. Further, many species do not dive to the depth of predicted lung collapse – thus, the lungs must be accounted for when studying oxygen reservoirs in free-ranging individuals. We examined lung volume and oxygen storage capacity through the use of non-invasive, high-resolution CT imaging of living ringed seals (*Pusa hispida*). Ringed seals are among the smallest phocids. They are relatively shallow divers that exhibit moderate dive durations (typical dives < 100 m and < 8 min) and thus may rely on lung oxygen stores to a greater extent than deeper-diving seals. Here, five ringed seals undergoing rehabilitation at the Alaska SeaLife Center were anesthetized and intubated for scheduled veterinary procedures. Full body scans were obtained by CT in 0.65-2.5 mm sections at several lung pressures (0, 30, and/or 37 mm Hg) in both dorsal and ventral recumbency. The data were used to create 3-dimensional models of the respiratory tract so that total lung capacity, respiratory dead space, and minimum air volume could be determined. This study provides insight into how the lung capacity and respiratory characteristics of ringed seals compare to other species. Further, these data can be combined with previous assessments of blood and muscle oxygen stores to produce more accurate estimates of the relative contribution of the lungs to diving oxygen stores in one of the smallest marine mammals.

Ringed, Bearded, and Spotted Seal Productivity in Alaska Using Harvest-Based Monitoring, 1960s-1980s and 2000-2018

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Declines in sea ice are predicted to negatively affect ice associated seals (ringed, *Pusa hispida*, bearded, *Erignathus barbatus*, and spotted, *Phoca largha*), important to Alaska Natives for food and materials, by reducing their time to rest, pup, nurse, and molt on sea ice. Concurrent with declines in sea ice are predicted reductions in snow depth used by ringed seals to construct pupping lairs. Such changes are expected to lower productivity and pup survival by providing less protection from weather and predators. Estimates of ice seal abundance cannot be used to detect population trends in Alaska; however, data from the subsistence harvest can be used as an index of population health and status. We compared seal productivity during the 2000s to the 1960s, 1970s, and 1980s before sea ice decline. Pregnancy rate from 2010–2016 (2010s) was higher for bearded (99%) and spotted (97%) seals than during the earlier periods, and although slightly lower now for ringed seals has remained relatively high (80%). A decrease in annual pregnancy rate was detected for ringed seals during an Unusual Mortality Event (UME) in 2010 (63%) and 2011 (47%), however, it recovered to 80% by 2012. The average age of maturity for all three seal species was lower in the 2010s than the earlier periods; with ringed seals at 3.6 (vs. 4.6) years old, bearded at 2.8 (vs. 3.4), and spotted at 3.2 (vs. 3.6). Additionally, a high proportion of pups were harvested in the 2010s indicating that pups are being produced, weaned, and surviving to be harvested. As of 2016, we had not detected negative effects in ringed, bearded, or spotted seal reproduction as was predicted to occur with declining sea ice, however, record low winter sea ice extent in the Bering Sea in 2017 and 2018 may have affected productivity.Here we update our results through 2018.

Development of New Interagency Arctic Research Plan

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The Interagency Arctic Research Policy Committee (IARPC) coordinates Arctic research among Federal agencies through implementation of a 5-year Arctic research plan. There are many challenges and opportunities to interagency coordination, including the diverse research questions these agencies seek to answer. One of the strengths of the Plan's implementation is that it is open to input and contribution from a wide variety of non-governmental organizations, research institutions, and community members. This input is helpful in understanding for understanding the most pressing science needs. IARPC will develop a new Arctic Research Plan for 2021-2027. The Plan's development team consists of an Oversight Committee, a Planning Development Team, and an Engagement Strategy Team. There will be a spring 2020 initial planning workshop leading to a summer release of a first Federal Register Notice for comments on the Plan's policy drivers and goals. These comments will be used in the development of the full version of a draft Plan to be released through a second Federal Register in spring of 2021. The new Plan is scheduled to be released at the end of 2021. We are near the beginning of the Plan writing process and would welcome input on what should be prioritized in the Plan, critical research questions, and the best ways for achieving these priorities. Insight from scientists on the ground is highly valued, and this poster will encourage space for input by gathering blurbs from relevant agency representatives on critical questions they are/will be funding and allowing space for conference participants to provide what critical questions they think is of the mot importance.

Biological Time Series Observations in the Pacific Arctic: A Key to Understanding Ecosystem Change

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The Pacific Arctic region is experiencing major reductions in seasonal sea ice and increases in sea surface temperatures. A key question is how the marine ecosystem will respond to these rapid environmental shifts. Variations in upper-ocean water hydrography, stratification, light penetration, planktonic production, pelagic-benthic coupling and sediment carbon cycling are all influenced by sea ice and temperature changes. To evaluate these responses, the Distributed Biological Observatory (DBO) was initiated in 2010 as a change detection array for the identification and consistent monitoring of biophysical responses to environmental change in the Arctic. The ecological trends approach embedded in DBO sampling is facilitated by repeated sampling each year through multiple international occupations of agreed-to transect lines, along with more continuous data collections obtained through mooring and satellite observations. This presentation will provide an overview of key results observed during multiple cruises that have been part of the DBO effort. In particular, biological changes in the northern Bering Sea resulting from the dramatic reduction in winter sea ice and warming seawater since 2018 are being linked to changes in the sediment-based prey for diving seaducks, walruses, gray whales, and bottom-feeding fish.

The Relationship Between Surface and Subsurface Ecosystem Properties and Coastal Erosion in a Beaufort Sea Coastal Lagoon

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At the nexus between land, ocean, atmosphere, and cryosphere, Arctic coastlines are recognized as one of the most vulnerable ecosystems to climate change. The rapid retreat of permafrost coastlines in the North Slope of Alaska is a threat to arctic ecosystems, infrastructure, and indigenous communities. In the last fifty years, erosion rates have increased and with it, the pressure to better understand the biophysical processes that control erosion. In this study, we investigate surface features (satellite and UAV captured geomorphic classifications) and their relationship to subsurface features (geochemical data) in order to better understand the processes, patterns, and potential to predict Arctic coastal erosion in Elson Lagoon, near Utqiagvik, Alaska. Twenty sites of contrasting geomorphology (high center polygon, drained lake basin, etc.) were chosen and a total of 107 soil samples were collected (20 cores within the active layer, 9 thawed grab samples, and 78 horizontal permafrost cores taken from varying depths). These samples have been analyzed for for grain size, density, ice content, organic carbon and total nitrogen content. Results are paired with estimates of areal and volumetric loss and to better assess the relationship between surface and subsurface properties and spatiotemporal patterns of coastal erosion in arctic ecosystems.

The Kitikmeot Sea, Northwest Passage: Biogeochemical and Bio-Physical Connections

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As the 'New Arctic' opens up, new research foci, research stations and previously inaccessible geographic areas move into the focus of current Arctic research. The Kitikmeot Region Marine Science Study was initiated in 2014 to provide the newly established Canadian High Arctic Research Station a scientific basis for long-term ecological monitoring and research. The Kitikmeot Sea – which includes Coronation Gulf, Bathurst Inlet, Queen Maud Gulf and Chantrey Inlet in the Canadian Arctic Archipelago – is unique in the pan-Arctic system due to its massive freshwater input relative to the area's size, and its shallow (<30 m) bounding sills to the north and west. Because of this, three foci guide the study: the Pacific-origin estuarine through-flow, which sets the oceanographic structure of the region; the origin and pathways of freshwater components, which influence nutrient balances and stratification; the tidally influenced biological communities whose structure and functioning differ between shallow sills / narrow constrictions and away from those. We apply a suite of oceanographic tools and year-round moorings deployed from the R/V Martin Bergmann to investigate these themes. Our results so far show that the Kitikmeot Sea is characterized by two-layer estuarine flow, with surface outflows and sub-surface inflows across the primary bounding sills at Victoria and Dolphin-Union straits. River inputs along the southern boundary deliver freshwater, terrestrially derived nutrients, and carbon to the riverine-coastal domain, which subsequently spreads throughout the system. Strong tidal currents through shallow sills and narrow passages enhance vertical heat and nutrient flux to maintain ice-free conditions in winter and tight pelagic-benthic coupling in summer. These sites are characterized by a predominance of hard bottom substrate with high proportions of suspension feeders, while away from these constricted flow regions, soft sediments inhabited by deposit feeders are prominent. This analysis reveals a dynamic ecosystem characterized by pelagic-benthic coupling forced by the physical flow field and external inputs of nutrients and freshwater.

Land-Ocean Connectivity of Inorganic Carbon Dynamics in Small Coastal Watersheds and Lagoon Systems on the North Slope of Alaska

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Surface air temperatures in the Arctic have increased at twice the global rate in recent decades, and resulting changes to hydrology and biogeochemistry of aquatic systems on the North Slope of Alaska have already been documented. Rapid warming and greening of small arctic watersheds, along with changes to precipitation, trigger permafrost thaw and changes to groundwater flow, two mechanisms which potentially drive mobilization and flux of soil organic carbon into coastal or lagoon systems. Increased delivery of organic matter, inorganic nutrients and major ions from terrestrial systems to the coast can alter carbon cycling and primary productivity in arctic lagoon systems. The fate of carbon in coastal arctic ecosystems is poorly understood, specifically, the seasonality of land-ocean relationship of carbon dynamics is understudied due to the logistical challenges of winter/spring sampling. However, small watersheds along the North Slope have proven to be a substantial pathway for CO2 flux to estuaries. The purpose of this study was to further investigate the seasonality of arctic lagoon carbon cycling and better understand the terrestrial influence on coastal carbon chemistry. We measured surface and bottom CO2 concentrations in five North Slope lagoon systems (Elson, Simpson, Kaktovik, Jago and Stefansson Sound) in spring (April), freshet/ice break up (June) and late summer (August) 2019. Preliminary results suggest that in many of the lagoon systems, spring and ice break up conditions are characterized by stratification and elevated bottom water CO2 concentrations. For two weeks in July and August, CO2 was continuously measured at a shallow site in Elson Lagoon and in 3 small rivers which flow into this system. During monitoring, the shallow lagoon site acted as a slight CO2 sink, except following large rain events when peak CO2 concentrations were likely reached because CO2 was flushed from the small rivers. Further investigations of seasonal and daily trends in dissolved CO2 will help identify sources of carbon to the lagoons and understand the role of terrestrially derived carbon in arctic lagoon productivity and carbon cycling.

TUESDAY, JANUARY 28, 2020

WAVE 2
BERING SEA & ARCTIC

(7:30 PM TO 9:00 PM)

POSTER PRESENTATIONS: TUESDAY, WAVE 2, 7:30PM - 9:00PM
BERING SEA & ARCTIC

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Variations in Abundances of Lipid-Rich Copepods in Response to Size Fractioned Chlorophyll-a in the Eastern Bering Sea	Jeanette Gann, Sarah Hardy, Franz Mueter	Lower Trophic Levels	Row 9 | P106
Body Size of Yukon River Chinook Salmon Declined, So as Yukon River Chum Salmon	Toshihide Hamazaki	Fishes and Fish Habitat	Row 9 | P108
Announcing a Newly Accessible Pool of Alaska Salmon Knowledge: Regional, Species-Specific, and Cultural Data from the State of Alaska Salmon and People Project	Sarah Warnock	Fishes and Fish Habitat	Row 10 | P110
Effects of Temperature and Size on the Overwintering Survival and Energetic Condition of Age-0 Walleye Pollock (*Gadus chalcogrammus*)	Carlissa Salant, Louise Copeman, Michelle Stowell, Ron Heintz, Benjamin Laurel	Fishes and Fish Habitat	Row 10 | P112
Thermal Sensitivity of Juvenile Growth Rates in the Alaska Shallow-Water Flatfish Complex	Thomas Hurst, Michele Ottmar	Fishes and Fish Habitat	Row 10 | P114
Confirmation of Breeding of the Red-Legged Kittiwake at St. Matthew Island, Alaska	Marc Romano, Bryce Robinson, Robert Kaler, Aaron Christ	Seabirds	Row 10 | P116
Combining Drone Imagery and Machine Learning Algorithms to Obtain Steller Sea Lion Brand Re-Sight Data	Ivan USATOV, Anna KIRILLOVA, Vladimir BURKANOV, Alexey ALTUKHOV, Thomas GELATT	Mammals	Row 10 | P118
Exploring the Utility of Immune Function Testing in the Northern Fur Seal (*Callorhinus ursinus*) to Evaluate Health Status and Susceptibility to Disease	Valerie Johnson, Colleen Duncan, Claire Simeone, Tom Gelatt, Kelly Patyk, Rachel Conway, Jacqueline Harrison	Mammals	Row 10 | P120
Using Drones and Computer Vision to Survey Northern Fur Seals: Automating Counts from Aerial Images	Ivan USATOV, Vladimir BURKANOV, Thomas GELATT	Mammals	Row 11 | P122
The Aleutian Islands' Westernmost Steller Sea Lion Rookery Population Status Update, 2019	Vladimir BURKANOV, Evgeny Mamaev, Thomas Gelatt	Mammals	Row 11 | P124
Mercury, Monomethyl Mercury, and Selenium Concentrations of Steller Sea Lions (*Eumetopias jubatus*) in Alaska: Age Cohorts and Tissue Types	J. Margaret Castellini, Todd O'Hara, Julie Avery, Lorrie Rea	Mammals	Row 11 | P126
2018-2019 Ice Seal Unusual Mortality Event in Alaska	Barbara Mahoney, Gay Sheffield, Deborah Fauquier, Kate Savage, Bonnie Easley-Appleyard, Jill Prewitt, Tammy Olsen, Sadie Wright	Mammals	Row 11 | P128
Is Maternal Foraging Trip Duration a Good Index of Northern Fur Seal Pup Survival?	Greg Merrill, J. Ward Testa, Jennifer Burns	Mammals	Row 11 | P130
A Participatory Research Approach to Investigate Juvenile Chinook Salmon Outmigration on the Yukon Delta	Courtney Weiss, Ragnar Alstrom, Jennifer Williams, Katharine Miller	Humans	Row 11 | P132
Be A Voice: Our Plastic Ocean, Our Clean Ocean—An Interactive Pop-Up Book	Herminia Din, Veronica Padula	Ecosystem Perspectives	Row 12 | P134
NIST Environmental Reference Material Production and Cryogenic Homogenization Procedure	Amanda Moors, Jennifer Trevillian, Jennifer Ness, Debra Ellisor, Denise Grieg, Teresa Rowles, Rebecca Pugh	Ecosystem Perspectives	Row 12 | P136
Saildrone Observations of Heat Flux in Open Water and at the Retreating Ice-Edge in the Chukchi Sea	Calvin Mordy, Chidong Zhang, Dongxiao Zhang, Muyin Wang, Qiong Yang, Edward Cokelet, Phyllis Stabeno	Climate and Oceanography	Row 12 | P138
Changing Freshwater Fluxes in the Arctic: A Tale of Melted Ice, River Runoff and the Bering Strait	Lee W Cooper, Cédric Magen, Jacqueline Grebmeier, R. Max Holmes	Climate and Oceanography	Row 12 | P140
Seasonal and Spatial Variability of Benthic Metabolism and Nutrient Fluxes in Beaufort Sea Coastal Lagoons	Brian Kim, Amber Hardison	Climate and Oceanography	Row 12 | P142

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Bering Strait Surface Current Project	Rachel Potter, Seth Danielson, Hank Statscewich, Jordan Maisch, Molly McCammon, Carol Janzen	Climate and Oceanography	Row 12 | P144
Changing Characteristics of Runoff and Freshwater Discharge from Northern Alaska Rivers and Associated Dissolved Organic Carbon Export to the Beaufort Sea Coast	Michael Rawlins, James McClelland, Craig Connoly	Climate and Oceanography	Row 13 | P146
Quantifying Annually-Resolved Climate Variability in the Chukchi and Beaufort Seas Over Past Decades to Centuries	David Reynolds, Bryan Black, Vanessa von Biela, Ken Dunton	Climate and Oceanography	Row 13 | P148
Waves, Currents and Suspended Sediment in Foggy Island Bay and Stefansson Sound	Jeremy Kasper, Li Erikson, Peter Bieniek, Rob Bochenak, Carol Janzen, Tom Ravens	Climate and Oceanography	Row 13 | P150
Seasonal Variation in Benthic and Pelagic Nutrients and Microalgae in the Beaufort Sea Coastal Lagoons	Amber Hardison, Brian Kim	Climate and Oceanography	Row 13 | P152
Community-Based Observations of Coastal Alaskan Arctic Change	Joshua Jones, Donna Hauser, Olivia Lee, Billy Adams, Steven Patkotak, Robert Schaeffer, Hajo Eicken	Climate and Oceanography	Row 13 | P154
Measuring Ice Acceleration before Ice Breakout near Utqiagvik, Alaska	Mark Johnson, Andy Mahoney, Chris Polashenski	Climate and Oceanography	Row 13 | P156
Forecasting Arctic Coastal Erosion at Utqiagvik, Alaska	Kristopher Ford	Climate and Oceanography	Row 14 | P158
Linking Offshore Oceanography to Alaskan Lagoon Dynamics	Tyler Hennon, Seth Danielson, Tahzay Jones	Climate and Oceanography	Row 14 | P160
Implementation of the World Meteorological Organization (WMO) Arctic Regional Climate Center (ArcRCC)	Renee Tatusko	Climate and Oceanography	Row 14 | P162
The Influence of Environmental Drivers on Functional Diversity Across Alaskan Arctic Epibenthic Shelf Communities	Lauren Sutton, Katrin Iken, Franz Mueter, Bodil Bluhm	Lower Trophic Levels	Row 14 | P164
Calanoid Copepod Egg Production and Growth Rates in the Northern Bering and Southern Chukchi Seas	Alexandra Poje, Caitlin Smoot, Russ Hopcroft	Lower Trophic Levels	Row 14 | P166
Tracking Sympagic Primary Production Contributions to the Benthic Food Web in the Chukchi Sea with Sea Ice Algal Lipid Biomarkers	Chelsea Wegner, Thomas Brown, Catherine Lalande, Jacqueline Grebmeier, Lee Cooper	Lower Trophic Levels	Row 14 | P168
Divergent Thermal Effects on the Over-Winter Survival, Condition and Lipid Storage of Juvenile Age-0 and Age-1 Arctic Cod (*Boreogadus saida*)	Louise Copeman, Carlissa Salant, Michelle Stowell, Michele Ottmar, Mara Spencer, Paul Iseri, Benjamin Laurel	Fishes and Fish Habitat	Row 15 | P170
Summer 2018 Repeat Autonomous Vehicle Surveys Indicate Age-0 Arctic Cod are Largely Retained over the Chukchi Sea Shelf	Robert Levine, Alex De Robertis, Daniel Grunbaum, Rebecca Woodgate, Calvin Mordy, Edward Cokelet, Noah Lawrence-Slavas, Heather Tabisola	Fishes and Fish Habitat	Row 15 | P172
Pacific Cod Habitat and Diet in the Chukchi Sea	Daniel Cooper, Elizabeth Logerwell, Kristin Cieciel, Nissa Ferm, Robert Levine, Bob Lauth, Lyle Britt, Lorenzo Cianelli	Fishes and Fish Habitat	Row 15 | P174
Winter Migration and Carry-Over Effects in Planktivorous and Piscivorous Seabirds Breeding on St. Lawrence Island	Alexis Will, Jean-Baptiste Thiebot, Akinori Takahashi, Alexander Kitaysky	Seabirds	Row 15 | P176
Training Machine Learning Models to Detect and Classify Ice Seals and Polar Bears in Aerial Survey Imagery	Erin Moreland, Stacie Hardy, Cynthia Christman, Benjamin X. Hou, Yuval Boss, Neel Joshi, Dan Morris, Peter Boveng	Mammals	Row 15 | P178
Abundance of Bearded and Ringed Seals in the Chukchi Sea During Spring 2016	Paul Conn, Erin Moreland, Irina Trukhanova, Vladimir Chernook, Nikita Platonov, Peter Boveng	Mammals	Row 15 | P180
Occurrence of Arctic and Saffron Cod in the Diet of Ringed Seals at Shishmaref, 1975–2018	Louise Biderman, Anna Bryan, Justin Crawford, John Citta, Lori Quakenbush	Mammals	Row 16 | P182

TITLE	PRESENTER	SECTION	LOCATION (row & poster)
Investigating Reproductive Biomarkers in Polar Bears	Monica Brandhuber, Shannon Atkinson, Erin Curry, Terri Roth	Mammals	Row 16 | P184
Growth Layer Groups in Beluga Teeth as Indicator of Life History Events	J. G. M. 'Hans' Thewissen, David Waugh, Joseph D. Ortiz, Robert Suydam	Mammals	Row 16 | P186
Age, Sex Composition and Body Condition of Harvested Pacific Walruses (*Odobenus rosmarus divergens*) in Chukotka, 2017-2018	Natalia Kryukova, Leonid Skurikhin, Ivan Krupin, Stanislav Lobovikov, Andrei Pereverzev, Alexander Shevelev, Danila Skorobogatov, Vladimir Burkanov	Mammals	Row 16 | P188
Seasonal Variation of the Stress Hormone Cortisol in Alaska Polar Bear Hair, 1983-1989	George Durner, Todd Atwood, David Douglas, Susannah French, Anthony Pagano, Karyn Rode, Kristin Simac	Mammals	Row 16 | P190
Detection of Polar Bear Tracks on the Ice of the Chukchi Sea, Spring 2016	Vladimir Chernook, Nadezda Chernook, Irina Trukhanova, Stanislav Belikov, Alexandr Vasilev, Denis Litovka, Dmitrij Glazov	Mammals	Row 16 | P192
A Yarn of Wayward Whales in the Eastern Chukchi and Eastern Beaufort Seas, 2019	Amy Willoughby, Janet Clarke, Amelia Brower, Megan Ferguson, Lisa Barry, Rachel Hardee, Suzie Hanlan, Nicholas Matheny, Heather Foley	Mammals	Row 17 | P194
Incidental Findings of Lens Yellowing and Cataracts in Beachcast Grey Whales (*Eschrichtius robustus*), Alaska	Raphaela Stimmelmayr	Mammals	Row 17 | P196
The Influence of Winds on Bowhead Whale Foraging in the Chukchi Sea	John Citta, Steven Okkonen, Lori Quakenbush, John "Craig" George, Lois Harwood, Mads Peter Heide-Jorgensen	Mammals	Row 17 | P198
Age Structure of Subsistence Harvested Ice Seals in Alaska 2000 – 2018	Ryan Adam, Anna Bryan, Lori Quakenbush, Justin Crawford, Louise Biderman	Mammals	Row 17 | P200
Establishing Baseline Ringed Seal Spring Snow and Sea Ice Habitat in the Chukchi Sea	Donna Hauser, Kathryn Frost	Mammals	Row 17 | P202
Clinical Sedation of Alaskan Phocid Seals	Kathleen Woodie, Colleen Reichmuth, Carrie Goertz, Jane Belovarac, Sarah McMillen	Mammals	Row 17 | P204
Oceanographic Characteristics Associated with Movements and High-Use Areas of Spotted Seals (*Phoca largha*) in the Chukchi and Bering Seas	Justin Crawford, Lori Quakenbush, Mark Nelson, Ryan Adam, Anna Bryan, John Citta, Andrew Von Duyke, Stephen Okkonen	Mammals	Row 18 | P206
Science & the Arctic Expeditionary Capabilities Exercise	Amy Holman, Sadie Wright, Louise Fode, Bart Buesseler, Jeff Williams, Lisa Spitler	Humans	Row 18 | P208
Developing the Next AOOS Strategic Plan: FY21-25	Molly McCammon, Carol Janzen	Humans	Row 18 | P210
Spatiotemporal Trends and Controls of Coastal Erosion Along the Elson Lagoon Coast Near Utqiagvik, AK 1955-2019	Craig Tweedie, Stephen Escarzaga, Adrian Aguirre, Ryan Cody, Allison Gaylord, William Manley, Sasha Peterson, Sergio Vargas, Vanessa Lougheed	Ecosystem Perspectives	Row 18 | P212
Algal Nutrient Limitation in a Beaufort Sea Lagoon and its Inflowing Rivers	Paris Velasquez, Alina Spera , Vanessa Lougheed	Ecosystem Perspectives	Row 18 | P214
Validation of a Sonar Method to Classify Marine Sub-Littoral Habitats in a Coastal Lagoon Near Barrow, Alaska	Hector Dominguez	Ecosystem Perspectives	Row 18 | P216
Alaskan Arctic to the World: A Data Catalog Design for Open Ecological Data	An T. Nguyen, Tim Whiteaker, Gastil Gastil-Buhl, Li Kui, Margaret O'Brien	Ecosystem Perspectives	Row 19 | P218

Variations in Abundances of Lipid-Rich Copepods in Response to Size Fractioned Chlorophyll-a in the Eastern Bering Sea

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Phytoplankton is paramount in supplying energy to lower trophic consumers. However, by primarily using total chlorophyll a (chla) biomass as a proxy for available food, we assume that all phytoplankton are created equal. In fact, they are not. The vast size difference alone in phytoplankton is astounding. However, we still don't fully understand the impact of varying phytoplankton species on the quality of zooplankton as prey for young fish. In polar and sub-polar regions, larger copepod species tend to accumulate large lipid stores thought to benefit higher trophic levels, while in tropical and sub-tropical regions, zooplankton generally do not store large amounts of lipids. Larger lipid-rich phytoplankton like diatoms tend to inhabit colder ocean biomes and upwelling regions, whereas the smaller, lipid-poor phytoplankton tend to inhibit warmer waters. It's logical, therefore, to presume that the underlying phytoplankton community contributes directly to lipid stores in lower trophic level consumers. Due to our changing climate, Alaska has seen some significant warming periods, most notably, the recent 'blob' seen in the Gulf of Alaska during 2015-2016, which spawned an unprecedented toxic diatom bloom along the entire west coast of the U.S. and Canada, including the GOA. We can no longer assume that all phytoplankton are created equal in our utilization of total chla biomass. Despite the shortcomings of measuring chla alone, it is a quick, easy, cost effective method to use, and data are plentiful. Therefore, a first step in understanding how phytoplankton may contribute to zooplankton quality is to relate phytoplankton size composition from filtered size-fractioned chla samples to the abundance of lipid-rich copepod species. We hypothesize that larger phytoplankton species, like Diatoms, which contain beneficial lipids and fatty acids are conducive to the production of lipid-storing species of zooplankton. In this poster, we present results from analyzing associations between size fractionated chla (GFF and >10 µm) and abundances of lipid-rich zooplankton species to help reveal underlying mechanisms leading to variations in zooplankton quality.

Body Size of Yukon River Chinook Salmon Declined, So as Yukon River Chum Salmon

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While much attentions have been paid on the decline of the body size of Yukon River Chinook salmon since 1980s, little attentions have been paid that body size of Yukon River chum salmon (summer and fall) have also declined. Here, I compared fishery selectivity, length and age at maturity trends of Yukon River Chinook, and summer and fall chum salmon from 1964 to 2017. Overall, mean length and length-at-age trends of Chinook and chum salmons were synchronous. There overall mean length increased from 1964 to 1980s and declined from 1990 to 2017, and mean length-at-age of Chinook salmon (ages 1.4, and 1.5) and chum salmon of all ages increased from 1964 to 1970s and declined from 1980 to 2017. But, length-at-age of Chinook salmon ages 1.2 and 1.3 did not change. On the other hand, age trends differed between the two. Chinook salmon mean age declined from 1964 to 1980, increased during the 1980s and declined since 1990, whereas chum salmon mean age increased largely during the 1980s and were stable for other years.

Announcing a Newly Accessible Pool of Alaska Salmon Knowledge: Regional, Species-Specific, and Cultural Data from the State of Alaska Salmon and People Project

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Alaska's salmon management has long been based on a firm science foundation, but it can be difficult for stakeholders of Alaska's salmon systems to readily access up-to-date, accurate and integrated information. Beginning in 2016, the State of Alaska's Salmon and People (SASAP) project fostered a collaboration of more than 100 academic, tribal, agency, industry and community leaders who gathered, synthesized and archived knowledge about Alaska salmon and the people who depend upon them. A major goal of this multidisciplinary, cross-cultural and integrated approach is to share new knowledge with the full spectrum of salmon users, advocates, and decision-makers. The recently launched AlaskaSalmonandPeople.org website offers salmon users unique access to the biological, cultural, economic and governance-related knowledge available for each of Alaska's salmon regions. The poster highlights engaging stories linked directly to a vast collection of data sets stored on the KNB Data Portal administered by the National Center for Ecological Analysis and Synthesis (NCEAS). This combination of information and data reflects the project's integration of different ways of knowing, with the aim of providing inclusive information to support decision-making that can lead to a more equitable salmon system.

Effects of Temperature and Size on the Overwintering Survival and Energetic Condition of Age-0 Walleye Pollock (*Gadus chalcogrammus*)

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The overwintering habitat of Alaskan age-0 walleye pollock (*Gadus chalcogrammus*, pollock) populations is likely to change due to recent warming events throughout the region. As an initial component in a multi-year investigation to better define winter habitats, an overwintering laboratory experiment was conducted to explore how temperature and size affect overwintering energetics and survival. In August 2017, age-0 pollock were collected from Kodiak Island, Alaska, and later subjected to a six-month overwintering experiment with four temperature-controlled treatments (-1, 1, 3, 5 ºC) over a range of sizes (standard length 50-120 mm) for 136 days. The mortality rates were both temperature- and size-dependent; both larger fish and fish subjected to intermediate temperatures lived longer. Condition indices of sampled fish (n=64) and mortalities (n=71) were assessed for variation in bioenergetic criteria (hepatosomatic index-HSI, Fulton's K, total lipids, lipid class composition and energy density). Further, bioenergetic metrics were used to develop temperature-dependent overwinter energetic loss models. Using HSI, we estimated both a value at which mortality occurs and a rate-loss model based on temperature. Age-0 pollock were also analyzed from winter field collections to compare with laboratory fish held under known environmental conditions. Between September 2017 and March 2018, pollock were collected at multiple time points from Prince William Sound, Alaska (n = 63). HSI values of field-collected pollock decreased from fall (~4.0) to spring (~1.5). Similarly, total lipids per wet weight of muscle decreased from fall (22.0 mg/mg) to spring (13.70 mg/mg), as did paired calorimetric measurements of energy density. The field-collected pollock were in the same size range as the experimental pollock and also exhibited similar HSI values across experimental temperatures and through time. Future experiments and additional field collections will help determine relevant criteria for energetic loss models, further elucidating essential fish habitat for overwintering age-0 walleye pollock in the Bering Sea and Gulf of Alaska.

Thermal Sensitivity of Juvenile Growth Rates in the Alaska Shallow-Water Flatfish Complex

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The Gulf of Alaska and Bering Sea support a diverse assemblage of flatfish species, several of which support major regional fisheries. Previous work examined the temperature-dependence of three species common in the Gulf of Alaska, Pacific halibut, northern rock sole, and English sole, demonstrating species-specific thermal sensitivities. Here we expand these analyses with growth rate measurements in three additional species which are more abundant in the Bering Sea: yellowfin sole, Alaska plaice, and longhead dab. Fish were reared in small groups for 6-8 weeks at 5 temperatures: 2, 5, 9, 13, and 16°C. Temperature sensitivities differed among species, with Pacific exhibiting the greatest growth sensitivity to temperature; Alaska plaice and northern rock sole were least impacted by temperature variation. We also describe the effect of age on growth rates of juvenile northern rock sole and yellowfin sole. Despite their high-latitude distribution, juvenile stages of these species live in shallow water habitats where long day lengths and reduced mixing can result in summer temperatures near or above 15°C. Most species exhibited a decline in growth rates between 13 and 16°C. These data suggest that shallow, coastal nursery areas may become less suitable habitat for these species with continued warming. Temperature-induced shifts to deeper, cooler waters may expose juvenile flatfishes to increased competition from "deep-water" species or predation from larger fishes, including larger-bodied flatfishes, both of which could reduce population productivity and shift composition of this important fishery guild.

Confirmation of Breeding of the Red-Legged Kittiwake at St. Matthew Island, Alaska

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The red-legged kittiwake is the only seabird endemic to the Bering Sea and a species of conservation concern due to a relatively small population with few breeding locations. The species has a very restricted breeding distribution, limited primarily to four major locations (the Pribilof Islands, Bogoslof Island, Buldir Island, and the Commander Islands). During June and July, 2018 we observed c. 200 red-legged kittiwakes occupying cliff habitat and exhibiting breeding behavior on St. Matthew Island, Alaska; however, we were unable to confirm breeding at that time. Based on these observations, we returned to St. Matthew Island in July, 2019 to confirm breeding by red-legged kittiwakes and to obtain an estimate of their breeding population. We surveyed the entire coastline of St. Matthew, Hall, and Pinnacle islands, concentrating our efforts on kittiwake nesting habitat. We counted 261 red-legged kittiwakes attending the cliffs, all of which were observed clustered in two primary locations along the northwest coastline of St. Matthew Island. Approximately 65% of the birds we observed were associated with a nest, and approximately 75% of the observed nests appeared to be active. A majority of the active nests contained visible chicks, confirming breeding for the first time at this location.

Combining Drone Imagery and Machine Learning Algorithms to Obtain Steller Sea Lion Brand Re-Sight Data

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Steller sea lion (SSL) demography is widely studied using a mark-recapture approach. However, re-sighting branded animals can be challenging since most SSL sites are difficult to access or have complex terrain that hide animals from view. During field research at Tuleny Island (the largest and fast-growing SSL rookery along Asia coast) we used several models of DJI drones to collect aerial imagery data of SSL during the summer breeding season. We conducted flights on 57 days between June 10 -August 10, 2019. A single image was collected every 30 seconds at an altitude of 13-17 m, 4-5x a day. We captured 109,484 images during the field season. A model based on the UNet segmentation neural network was used to automate branded SSL detection, and a classification model based on theVGG16 neural network was used to automate brand ID recognition. Imagery data for model training were prepared manually. The UNet based models were used to locate and crop images that had a branded animal. All crops created by the UNet based model were analyzed using the VGG16 based model to assign a specific pretrained class name to each crop. All crops were sorted to a specific folder. Unclassified crops were stored in a separate folder for future review by observers. The entire cycle to process one day of approximately 2- 3 thousand aerial images required ~ 2 hours. Resulting predictions consisted of a spreadsheet with a list of identified SSL and a set of folders containing images of each branded animal. Manual verification of prediction accuracy was conducted by experienced observers who reviewed all photos in each folder. Incorrectly assigned images were removed and all unrecognized SSL crops were assigned manually. The algorithm detected and created 31,139 SSL crops for a season with no single miss of a branded animal The classification model assigned names to 15,561 clips with 96.5% accuracy. The 15,575 images that the model failed to classify due an incomplete training catalogue were manually assigned. This method proved to be highly efficient and significantly reduced total processing time and improved the overall quality of collected data.

Exploring the Utility of Immune Function Testing in the Northern Fur Seal (*Callorhinus ursinus*) to Evaluate Health Status and Susceptibility to Disease

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The Northern Fur Seal (*Callorhinus ursinus*, NFS) has undergone a dramatic population decline over the past decade, the cause of which is unknown.For all species immune function is closely related to health and survival.In marine ecosystems there are numerous infectious and non-infectious diseases that may negatively impact the immune system, contributing to increased morbidity and mortality.The aim of this study was to develop a comprehensive panel for the NFS that could be utilized to assess immune function.The project utilized animals from two cohorts, a group of adult females from St. Paul Island Alaska with no visible signs of disease and a second group of animals comprised of stranded or injured NFS that were under managed care for the purpose of rehabilitation at The Marine Mammal Center in Sausalito California.Blood samples from both cohorts were used to evaluate a variety of indicators of immune activation or suppression including multiplex cytokine analysis and C-Reactive Protein (CRP) levels by ELISA (enzyme linked immunosorbent assay).Indicators of increased oxidative stress were evaluated utilizing a reactive oxygen/reactive nitrogen species ELISA. Assessment of further oxidative stress was performed with commercially available kits for oxidative stress markers malondialdehyde (MDA), glutathione and measurements of antioxidants, Vitamin E and Selenium levels were analyzed at a commercial veterinary diagnostic laboratory. Assessment of acute phase proteins and cytokines together with markers of oxidative stress and antioxidants may provide a more comprehensive assessment of NFS health and could be an important diagnostic tool to assist in evaluating the cause of this precipitous decline in population of the NFS.

Using Drones and Computer Vision to Survey Northern Fur Seals: Automating Counts from Aerial Images

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Counting animals in large aggregations is difficult and time consuming process whether counting visually in the wild or from photographs. Both have some level of uncertainty that requires an estimate of accuracy. We monitored Northern fur seal (NFS) abundance by age and sex on Tuleny Island, Russia, from June 10 through August 10, 2019 using a DJI drone to obtain aerial photographs of the rookery. We then utilized Agisoft Photoscan software to stich the images of each survey into an orthophotoplan (OPP), and R software with libraries keras and EBImage to obtain an automated seal count (AC) on the images. We 'trained' a UNet model to identify NFSs on the images by using 15 thousand images. To estimate AC accuracy, we used trained observers to count seals visually on 4-6 model sections randomly selected on each OPP. AC t error was estimated as percent count difference between AC and visual count on the same model section for each OPP. The median of count errors for each OPP/survey was used to describe AC error. Out of a total of 74 days of field work we were able to aerially photograph the rookery 46 days creating one OPP for each day for non-pup count. Four additional surveys were conducted for pup counts on July 28, 31 and August 3 and 4. The non-pup NFS abundance ranged from 6.7 to 35.7 thousand individuals with a median count error 4.5%. Adult Female abundance during the season ranged from 0 to 25.9 thousand with a seasonal median of count error also 4.5%. The OPP for pup surveys on July 28 and 31 were used for visual hand count of pups and for training the UNet for pup AC. Two OPP for August 3 and 4 were used for the pup AC. The mean of two visual hand pup counts on OPP was 41,934, and the mean of two live pup AC was 41,238 individuals. Several factors affected accuracy of the AC, the most important of which was weather (error was much higher in sunny and foggy days), total number and density of NFS aggregations, and type and color of the background. Nevertheless, our study suggests that the method can work to obtain NFS AC in dense aggregations, it can reduce dramatically the time, cost, and observer experience required, and produce reliable and verifiable results and can be therefore recommended for use in other areas.

The Aleutian Islands' Westernmost Steller Sea Lion Rookery Population Status Update, 2019

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Yugo-Vostochny rookery on the southern tip of Medny Island, Commander Islands, Russia is the western most breeding site of Steller sea lions (SSL) in the Aleutian Chain. . During the summer of 2019 we monitored the abundance, breeding performance, and collected observations of branded animals consistent with annual work since 1991. Observations were conducted throughout the season from land without disturbing the rookery using binoculars and an Unmanned Aerial Vehicle (UAV). During the pupping and mating season a maximum up to 212 non-pup individuals were observed. Maximum counts were: 155 mature females, 46 bulls, and 8 juveniles. We counted 166 pups born, two of which died at < one month of age. Compared to 2018, the 2019 counts indicated a decline in pups (7.8%), bulls (14.8%) and juveniles (42.9%). Counts of mature female and non-pups did not differ from 2018. All sex-age classes had an overall decline during the previous 10 year period; non-pups -5.5%, females. -4.5%, and pups -1.6%. A slight positive trend in pup production between 2015-2017 did not continue. Similar to recent years a significant increase in adult female abundance occurred in 2019 (+45%) and in other non-pup age/sex classes after the mating season in late July-early August. This suggests that more SSL use Medny Is. as a haulout/rest site not for breeding. Based on brand re-sight information the majority of SSL seen on land were of local origin. Two migrants branded as pups at Agattu Is., AK were seen; one was subadult male and the other was a mature female who pupped at Medny Is. for the fourth year in a row indicating that she has moved from Agattu Is., to Medny Is. permanently. Overall, despite a strong long-term conservation effort and the complete absence of any commercial fisheries in the area, the SSL population on the westernmost end of the Aleutian chain in 2019 remained near the lowest level for the last 10 years with a negative long-term trend in all age/sex classes.

Mercury, Monomethyl Mercury, and Selenium Concentrations of Steller Sea Lions (*Eumetopias jubatus*) in Alaska: Age Cohorts and Tissue Types

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There is concern about mercury (Hg) exposure in Steller sea lions (*Eumetopias jubatus*; SSL) in the Alaskan western distinct populations segment (wDPS) where lack of population recovery and relatively elevated hair, blood, and other tissue total Hg concentration ([THg]) at some rookeries have been reported. Hg toxicosis is dependent on chemical form and bioavailability. Methylation of environmental inorganic Hg (Hg2+) produces monomethyl mercury (MeHg+) which is readily absorbed when ingested, subsequently crossing placental and brain barriers. Interactions between Hg and selenium (Se) play several roles in mitigating Hg toxicosis but can include functional Se deficiency, with potential impacts on the function of critical selenoenzymes and other Se dependent processes related to offsetting oxidative stress, as may occur during long dives.Archived tissues, carcasses, and subsistence hunted animals are valuable resources for assessing Hg exposure and Se status in SSL in Alaska; noting physiologically driven differences in tissue concentrations may confound interpretation for various cohorts. We summarize age cohort differences in liver [TSe], [THg], [MeHg+], %MeHg+ and molar TSe:THg, and present correlations between liver, kidney, skeletal muscle and heart for [THg] and [MeHg+] across age cohorts. Liver from fetuses and young pups had significantly lower [THg] and [TSe], higher %MeHg and a greater range of TSe:THg than sub-adults and adults. While [THg] varied significantly by muscle type (heart compared to skeletal) and location of skeletal muscle sampling, concentrations were strongly correlated. Bioaccumulation of THg in liver of older animals confounds comparison with other tissues; however, in fetuses and young pups liver [THg] correlated with other tissues. In contrast, liver [MeHg+] correlated with other tissues across all age classes. Correlation among tissues allows for greater usefulness of a variety of tissues for Hg biomonitoring; however, age-cohort and its effects on tissue concentrations must be carefully considered.

2018-2019 Ice Seal Unusual Mortality Event in Alaska

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Since June 1, 2018, elevated ice seal strandings have occurred along the Alaskan coastline of the northern Bering Sea and Chukchi Sea. On September 12, 2019, National Oceanic and Atmospheric Administration (NOAA) declared an Unusual Mortality Event (UME) for bearded seals (*Erignathus barbatus nauticus*), ringed seals (*Pusa hispida hispida*), and spotted seals (*Phoca largha*) in these regions in order to initiate an investigation. The Marine Mammal Protection Act defines an UME as a stranding event that is unexpected, involves a significant die-off, and demands an immediate response. When the UME was declared, ice seal mortality was nearly 5 times the average number of reported strandings, with 119 strandings between June 1 - December 31, 2018 and over 165 ice seals during 2019. Reports of stranded seals were mostly dead ice seals of all age classes. Previous marine mammal UME's have been caused by infections, biotoxins, human interactions, and malnutrition. To assist with the UME investigation, a subset of ice seals have been sampled for harmful algal blooms and other health parameter analyses. Understanding the cause of this UME is crucial because ice seals are essential to the nutritional, cultural, and economic well-being of coastal communities throughout Arctic Alaska. This UME has implications to the status of the ocean's heath and to address food security and public health concerns of western and northern Alaska constituents.

Is Maternal Foraging Trip Duration a Good Index of Northern Fur Seal Pup Survival?

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Many studies have demonstrated a relationship between maternal foraging trip durations (MFTD) of northern fur seals (NFS; *C. ursinus*) in the Bering Sea with indices of prey abundance, particularly walleye pollock (*T. chalcogramma*), however most have focused on individuals. The transfer of food energy to growing dependent pups influences growth rate, which is correlated with MFTD, and pup growth rate is an important determinant of post-weaning pup survival. We monitored MFTD as an index of foraging conditions for NFS from six colonies known to forage in three different oceanic domains around the Pribilof Islands, Alaska: the middle shelf, outer shelf, and oceanic basin. VHF flipper tags were deployed on 264 lactating females across the six colonies and MFTD was monitored between 2010 – 2018 (with variation in sampling effort across colonies and years). The length of foraging trips was examined with respect to colony-specific pup mass in order to establish the validity and utility of a monitoring index (MFTD) for pup survival at the colony scale. Data collection is ongoing and analyses of spatial and temporal variability in MFTD between colonies is forthcoming, however pup mass was negatively correlated with MFTD at one rookery (Polovina Cliffs on St. Paul Island) where ample data is available; Mean female pup mass declined by 1.1 kg for each day mean MFTD prior to the date of weighing was above average, with mean MFTD explaining 57% of the variation in mean pup mass ($F = 6.62$, $p = 0.0498$). This would suggest that colony-specific pup survival may be indexed by MFTD. However, recent estimates of pup survival on the Pribilof Islands are non-linear; pup mass apparently has little impact on pup survival once pups reach a threshold mass of ~ 7.5 kg by late-September (Testa, pers comms), which less than 2% of pups weighed fell below. The contradiction presented here highlights a need to better understand how pup mass influences survivorship, but MFTD is, at the least, a strong indicator of pup body condition.

A Participatory Research Approach to Investigate Juvenile Chinook Salmon Outmigration on the Yukon Delta

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Since 2014, the Yukon Delta Fisheries Development Association (YDFDA) has been working closely with the federal government, the state government, and private contractors to study juvenile Chinook outmigration on the Yukon River. Consistently weak returns of Chinook salmon have resulted in economic hardship and created challenges for subsistence living in local communities. A strong correlation between adult returns and the number of juvenile Chinook captured in the Bering Sea at the end of the summer suggests that factors affecting recruitment likely occur earlier in the salmon life-cycle, during freshwater and early marine (estuarine) life stages. Therefore, understanding the timing, health, and habitat use of outmigrating juvenile Chinook is an area of high research interest. However, the Yukon River Delta is large and extremely complex, presenting significant challenges to traditional research approaches. Here we report on a unique partnership that pairs local fishermen and technicians from the lower Yukon villages of Emmonak and Alakanuk, with scientists in a combined effort to better understand factors affecting Chinook salmon populations. Now in its seventh year, this YDFDA-led effort has created a time-series that provides the only source of information on juvenile Yukon River Chinook salmon smolts immediately prior to ocean entry. This work presents the participatory research approach that has made this partnership a success. We hope this can serve as a model for research and community involvement in other remote Alaska locations.

Be A Voice: Our Plastic Ocean, Our Clean Ocean—An Interactive Pop-Up Book

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The international community is becoming increasingly aware of the growing plastic pollution found in huge amounts on oceans and beaches. Global communities need to be resilient against this environmental threat, particularly in view of the public health, wellness, and economic priorities that affect quality of life. An informed and educated community is fundamental to establishing this resiliency. Among the most important audiences to create awareness are young people, who will inherit the environment consequences of previous generations' actions. Through art education, they can contribute to small but significant changes that could well have an impact on their environments. Combining scientific data and creative activities, e.g. storytelling, place-based art, can help raise student awareness of real-world problems and develop social responsibility and critical thinking skills. Both art and natural science education methods are integrated. This approach can educate students and teachers about a greater understanding of the topic, and it can also serve as a call to action to protect our environments. The purpose of this poster presentation is to share an integrated research project to inspire dialogs about plastic pollution and to show art is a powerful tool for change. Goals are (1) to provide information about plastic pollution in our oceans, (2) to develop a self-guided empowering tool for students and teachers, and (3) to give participants ownership of the problem as they gain knowledge about plastic waste around the world. Learning outcomes include greater knowledge of environmental challenges, marine litter, plastic pollution, and consequences for local communities. This poster will also share implemented outcomes from two remote schools that are facing unwanted marine debris wash off shores. It will present artwork made by students and hope to help participants to rethink the relationship between humans and the ocean in a contemporary culture of consumption. Art is a universal medium that can serve as a catalyst to build understanding of difficult issues. Most importantly, this poster will encourage artistic expression in finding solutions to what can be done to make our ocean cleaner for current and future generations.

NIST Environmental Reference Material Production and Cryogenic Homogenization Procedure

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The National Institute of Standards and Technology's Cryogenic Reference Material Production Facility at the Hollings Marine Laboratory produces raw material for developing Standard Reference Materials (SRMs) and control materials used in the measurement of contaminants in the environment. The facility consists of ISO Class 7 clean room space and the specialized equipment required for producing fresh-frozen, cryohomogenized materials, as well as particle size analysis to determine particle size distribution, homogeneity of size, and to track particle size as a process control indicator. NIST has been developing environmental reference materials since 1980 with the production of SRM 1580, Organics in Shale Oil. Since then, NIST has developed other environmental matrix reference & control materials such as whale blubber (SRM 1945), mussel tissue (SRM 1974 series), seabird egg contents (QC04-ERM1), and fish tissue (SRM 1946 & 1947) all with broad range organic and trace element constituents requested by the research community. Due to an increased interest in baleen collection and analysis, NOAA's National Marine Fisheries Service asked NIST to test if the existing cryogenic homogenization SOPs would efficiently grind baleen material into a homogenous, frozen powder sample, ultimately leading to a possible future reference material. The resulting baleen control material would be useful to help validate methods for baleen (i.e. stable isotopes, hormone analysis) and compare results among different laboratories investigating marine mammal strandings and unusual mortality events (UMEs). In response to a growing demand from the research community for natural environmental matrices with certified values for organic contaminants, NIST has the capability to generate these materials, which provide QA/QC controls, as well as verify analytical results and methods.

Saildrone Observations of Heat Flux in Open Water and at the Retreating Ice-Edge in the Chukchi Sea

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In the Arctic Ocean and subarctic seas, rapid reductions in sea ice have dramatically altered air-sea heat fluxes. Large uncertainties in air-sea surface heat flux arise because in situ observations are sparse and the most advanced surface flux algorithms for numerical models were developed without key observations in the Arctic region. As a result, seasonally averaged shortwave and longwave fluxes from different reanalysis products in the Chukchi Sea can vary by 50 – 100 W/m2. While atmospheric reanalyses are critical tools in our attempts to document and understand the rapidly changing climate system, satellite observations cannot improve flux retrievals without accurate observations at the sea surface. To address this, a five month (June – August) coordinated Saildrone mission was conducted in the Chukchi Sea in 2019. The Saildrones sailed from Dutch Harbor, AK and followed the sea ice northward as it retreated making direct measurements of air-sea fluxes in various scenarios. These observations include open water after ice melt, free-floating ice bands, and at the edge of the marginal ice zone. On multiple occasions, the Saildrones were lodged in retreating ice for hours to days. Measurements were returned in near-real time facilitating immediate comparisons with forecasts of meteorological and oceanographic conditions from several operational centers. The data were used to assess biases and uncertainties in the air-sea surface heat flux in multiple reanalysis products and real-time operational forecasts. Information from autonomous platforms like Saildrone will help more accurately estimate changes in the energy balance of the arctic concomitant with earlier sea retreat in spring and later arrival in fall. The mission demonstrates the usefulness of sailing drones to provide critical observations to operational centers in areas and times that have been difficult to access using traditional methods, and the potential of such measurements to improve storm forecast that are so vital to local communities.

Changing Freshwater Fluxes in the Arctic: A Tale of Melted Ice, River Runoff and the Bering Strait

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The oxygen isotope composition of the upper Arctic Ocean halocline (salinity = 33.1, depth 100-200m) was established as early as the late 1980's as having a d18O value of approximately -1.1‰. More recent data however of the Bering Sea contributions to the upper halocline indicates a shift to a more negative isotopic delta value (~-1.6‰), suggesting an increase in freshwater fluxes through the Bering Strait. Runoff volume from Arctic rivers has also increased in the past century. Both data sets are consistent with observations of added freshwater inventories in the Canada Basin and Beaufort Gyre. Surface water analyses of oxygen isotopes furthermore indicate that a third source of freshwater, melted sea ice, is not as significant despite the accelerated recent loss of seasonal sea ice; in most cases melted sea ice provides no more than a few percent of freshwater contributions to surface seawater. The isotopic time-series of the upper Arctic halocline can be used as an independent index of freshwater flux changes through the Bering Strait. Several reasonable assumptions must be satisfied: 1) Sea ice melt contributions at the depth of the upper halocline must remain negligible, 2) 33.1 must remain the salinity of the brine-injected and influenced nutrient maximum, and 3) the isotopic composition of the freshwater end-member (-21.5‰) present in Bering Strait has not significantly changed. Given those conditions, balancing a simple end-member mixing model requires the volume of freshwater (including runoff and other meteoric water, but not sea ice melt) flowing through Bering Strait to have increased by ~45% over the past two decades to account for a change in the isotopic composition of the 33.1 salinity water from a d18O value of approximately -1.1‰ to -1.6‰. This estimated increase is comparable with independent mooring measurements, which indicated that the Bering Strait freshwater flux rose from 2000–2500 km3 in 2001 to 3000– 3500 km3 in 2011.

Seasonal and Spatial Variability of Benthic Metabolism and Nutrient Fluxes in Beaufort Sea Coastal Lagoons

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Half of the Beaufort Sea coast is outlined by chains of barrier islands that enclose several shallow lagoons. These lagoons experience extreme seasonal variations in temperature, salinity, and ice cover, yet they are home to a high diversity of organisms. Arctic lagoons contain organic matter (OM) from both autochthonous and allochthonous sources and are seasonally influenced by river discharge and coastal erosion. Because of their shallow (<7 m) nature, benthic-pelagic coupling in these lagoons is often strong. Under suitable conditions, sediments can exhibit high rates of primary production and denitrification, removing bioavailable nutrients from the system. Alternatively, benthic OM remineralization can result in release of nutrients from the sediments, fueling water column productivity. As part of the BLE-LTER program, we studied how benthic biogeochemical cycling varied temporally and spatially in these dynamic systems. We measured sediment-water fluxes of O2, N2, and dissolve nutrients (NH4+, NO3-) in light and dark batch incubations. To capture seasonal variability, incubations were conducted during "ice-on" (April), "freshet" (June), and "open water" (August) conditions. To observe spatial variability, sites along the Beaufort Sea coast, from Barrow (AK) to Kaktovik (AK), were selected. Using O2 flux data, we calculated daily rates of benthic gross primary production (GPP), respiration (R), and net ecosystem metabolism (NEM). Across all nodes R was lowest in April (3.4 – 17 mmol C m-2 d-1) and highest in June (4.2 – 49 mmol C m-2 d-1). Although daylight hours were longest during June, GPP was highest during August (-3.2 – -55.7 mmol C m-2 d-1) likely due to higher light intensity at the benthos. Furthermore, colder temperatures may have suppressed GPP until August, which caused NEM to switch from net heterotrophic (April, June) to net autotrophic (August: -4.36 – -31.24 mmol C m-2 d-1). In general, GPP and R were highest in the western node and lowest in the central node. Our R rates were similar to previous studies in deeper Arctic systems (Chukchi Sea, Canadian shelf), although with greater variability, likely driven by shallow depths in the lagoons and a wider range of in-situ temperatures. Analysis of the remaining flux data are underway.

Bering Strait Surface Current Project

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The decline of Arctic sea ice is resulting in increased marine vessel traffic, particularly in high-traffic choke points like Bering Strait and Barrow Canyon. We are expanding the existing real-time surface current network in the Alaskan Arctic to improve maritime domain awareness and navigation safety. In 2019, we began efforts to install and test a new set of high-frequency (HF) radar surface current mapping systems. Two or more HF radar sites work in conjunction to create a 2-dimensional map of surface currents by providing different radial perspectives of the ocean. Spatial coverage of resolved currents depends on station separation, coastline morphology, HF frequency, the ionosphere, sea state, etc. Ideally, each site sees approximately 180 km offshore, and where two systems' offshore ranges overlap, a synoptic map is derived that resolves surface currents at 6 km spatial and 1 hour temporal resolutions. Two villages in the Bering Strait region were selected as initial test deployment sites: Wales, on the eastern shore of the Strait; and Shishmaref, on the northern side of the Seward Peninsula. We installed the HF systems in September, and now maps of data coverage from each site are allowing us to identify siting locations for a final installation in 2020 that will achieve maximal current data. In addition to marine safety applications, the real-time data will be available for search and rescue operations, marine and sea ice forecasts, contaminant spills, scientific research, and harmful algal blooms. We present initial coverage areas from our test installations and options for future buildout of the Alaskan Arctic radar surface current network. With the addition of the two new HF radar installations, there are now five systems covering portions of the western Beaufort and northeastern Chukchi Seas, and now, Bering Strait.

Changing Characteristics of Runoff and Freshwater Discharge from Northern Alaska Rivers and Associated Dissolved Organic Carbon Export to the Beaufort Sea Coast

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The quantity and quality of river discharge exported by Arctic rivers is being impacted by hydrological cycle intensification and permafrost thaw, with potential implications for the magnitude, timing, and forms of biological production occurring along Arctic coastal zones. Measurements of nutrient export from Arctic rivers over recent years have supported major advances in our understanding of biogeochemical cycling in Arctic coastal waters. We used a hydrological model with explicit representation of soil freezing and thawing to quantify baseline conditions and investigate the changing character of hydrological elements within watersheds of Alaska's North Slope draining to the Beaufort Sea coast over the period 1981-2010. We also applied empirically-defined relationships between watershed steepness (slope) and concentrations of riverine dissolved organic carbon (DOC) to estimate DOC export from 24 of the rivers. A synthesis of measurements and model simulations shows that the region annually exports 31.9 km3 yr-1 of freshwater, with 57.7% coming collectively from the Colville, Kuparuk, and Sagavanirktok rivers, the three largest in the region. The model simulations point to significant increases in cold season discharge for several large rivers and for the region as a whole. A significant increase in the proportion of subsurface runoff to total runoff is noted for the region and for a majority of the river basins, with the change most prevalent across the northern foothills of the Brooks Range. Relatively large increases in simulated active-layer thickness suggest a physical connection between warming climate, permafrost degradation, and increasing subsurface flow to streams and rivers. Our synthesis of freshwater export and empirically-defined slope-DOC relationships shows a marked east-west gradient in the relative amounts of DOC export. Our results point to a strong influence from DOC export on the magnitude, timing, and forms of biological production across the region's coastal zones.

Quantifying Annually-Resolved Climate Variability in the Chukchi and Beaufort Seas Over Past Decades to Centuries

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Despite the rapid rate of climate change in the region, our understanding of long-term climate variability in high-latitude Alaskan marine environments remain poorly characterized due to the brevity of modern observational records and absence of climate proxies. Here, we apply dendrochronology techniques to growth increments formed in the shells of the long-lived marine bivalve Astarte borealis collected from the Chukchi and Beaufort Seas. These analyses suggest that A. borealis shells could serve as a key archive of Arctic marine variability on inter-annual to centennial timescales. These traits include: 1) The formation of annually-resolved growth increments that can be crossdated 2) longevities upwards of 200 years; and 3) covariance in growth among A. borealis individuals that allows for the development of well-replicated, exactly dated chronologies that strongly correlate with sea water temperature and sea ice concentrations. Given its broad geographical distribution across coastal Arctic regions, A. borealis could facilitate a step change in our understanding of the mechanisms and drivers of Arctic marine climate variability.

Waves, Currents and Suspended Sediment in Foggy Island Bay and Stefansson Sound

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The decreased extent of sea ice has led to an increase in wave height and longer period waves in the Arctic. In order to understand how this might affect development in the Outer Continental Shelf and adjacent waters, the Bureau of Ocean Energy Management (BOEM) initiated the Central Beaufort Sea Wave and Hydrodynamic Modeling Study. This study is focused in Foggy Island Bay (FIB) east of Prudhoe Bay where Hilcorp, Alaska has proposed developing the Liberty Prospect from an artificial drilling and production island in the center of the Bay. As part of this effort and the Beaufort Lagoons Long Term Ecological Research (LTER), oceanographic moorings were deployed in summer 2018 and recovered in summer 2019. The moorings recorded year-round measurements of wave spectra, currents, hydrography and optical backscatter, a proxy for suspended sediment, within FIB and Stefansson Sound. In addition, inexpensive Spoondrift buoys provided real-time wave conditions in summer 2019. A real-time met-station was established at the southern end of FIB to measure wind velocity, temperature, barometric pressure and coastal change (from camera imagery). A drone and GNSS transects were used to establish coastal position and terrestrial surface elevations adjacent to the proposed shorecrossing of the Liberty Pipeline. A historical synthesis of relevant observations (e.g. bathymetry, currents, water levels, wave heights, hydrography and Total Suspended Solids) from the area was compiled, quality checked and archived with Axiom Data Science. The ultimate goal of the project is to provide successful and validated hindcasts as well as projections for atmospheric forcing, waves, water level, currents and coastal erosion from 1979 through 2049, including the 15 to 20 year projected lifetime of the Liberty project. Information from the study will be useful for predicting the potential for impacts on important and sensitive habitats such as the nearby Boulder Patch. This effort is highly leveraged and builds upon other recent observational (e.g. the newly initiated Beaufort Lagoons Long Term Ecological Research), and modeling efforts in the region (e.g. ongoing USGS' work near Barter Island and Sandia National Laboratory's process-based erosion model development).

Seasonal Variation in Benthic and Pelagic Nutrients and Microalgae in the Beaufort Sea Coastal Lagoons

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Coastal lagoons make up a major part of land margin ecosystems on most continents, yet surprisingly little is known about the fate and transport of nutrients entering shallow lagoons compared to large, deep estuaries. Like deep estuaries, these shallow bays and lagoons are usually highly productive and function as important buffer zones that can reduce or remove nutrients as they move from the land to the ocean. Nearly half of the Alaskan Beaufort Sea coast is made up of an irregular and discontinuous chain of barrier islands that enclose numerous shallow (<7 m) lagoons and sounds. As a result of changing ice and temperature regimes throughout the year, nutrient inputs and uptake within the lagoons are likely highly dynamic over an annual cycle. We analyzed samples collected by the Beaufort Lagoon Ecosystems LTER (BLE-LTER) program in five lagoons spanning the Beaufort Sea coastline from Barrow (AK) to Kaktovik (AK). We measured inorganic nutrient (ammonium, nitrate, phosphate, silicate) and chlorophyll a concentrations in water column and surface sediment samples collected from August 2018 – August 2019 to better understand nutrient cycling and organic matter production. Seasonal samplings in “ice-on”(April), “ice break-up” (June) and “open water” (August) conditions allowed us to assess the impact of associated changes in physical forcings (e.g., freshwater inflow, coastal erosion, ice scour, ocean mixing) on nutrient delivery and cycling in this system. Analyses are underway on what will become a long-term dataset of these parameters.

Community-Based Observations of Coastal Alaskan Arctic Change

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Northern Alaska coastal communities are the “first responders” to experience and detect changes in the ecosystem given a deep connection to place and integral reliance on traditional marine resources. Coordinated community-based observing efforts provide sustained long-term observations of the shifting template of environmental conditions in the Arctic necessary for regional policy-making. The Alaska Arctic Observatory & Knowledge Hub (AAOKH) is an ongoing observing network, with an overarching goal to empower communities with the tools, resources, and support to share their expertise and knowledge through observations of the changing coastal conditions and associated impacts to their access of traditional marine resources. AAOKH focuses on coordinating observations from Indigenous Knowledge Bearers across a network of seven coastal communities that collectively provide a broad-scale and synoptic view of changing coastal sea ice and ocean conditions, and ultimately impacts at the community scale. Local observations are shared via an online portal serving as a forum for observers, scientists, and community members to exchange aspects of seasonal ice and ocean changes, related to traditional harvesting, and how this matters to each community. AAOKH provides examples of the holistic breadth of knowledge in communities, communities tracking Arctic change, and weaving connections between Indigenous and scientific perspectives.

Measuring Ice Acceleration before Ice Breakout near Utqiagvik, Alaska

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During subsistence whaling along the Chukchi Sea coast, sections of landfast ice occasionally detach from the coast or adjacent grounded ice and are subsequently carried away from shore by currents and wind. Such events, while rare, can result in injury and loss of life. To study the forces associated with breakouts and other deformation events, we placed motion sensors on sea ice in three different dynamical regimes: i) level, land-locked ice in Elson Lagoon, Alaska; ii) landfast ice in the Chukchi Sea, near Utqiaġvik, Alaska; and iii) and on drifting first- and multi-year ice in the Beaufort Sea. The sensors are built around the VectorNav VN-100, a micro-electro-mechanical system that includes a high-performance Inertial Motion Unit with 3-axis accelerometers, 3-axis gyroscopes, 3-axis magnetometers, a barometric pressure sensor, and a temperature sensor. Data logging and limited telemetry are included in the sensor package. We recorded data at 10 Hz, attempting first to measure accelerations in ice due to ocean waves, hypothesizing that wave motion could be associated with ice weakening and subsequent breakout events. Instead, the dominant signals we measured were impulses, with measured vertical accelerations as large as 20 m s-2. In March 2018, a deployment of two sensors, placed 50 meters apart near the lead edge of landfast ice off Utqiagvik, Alaska, measured vertical acceleration up to 10 m s-2 just prior to the nearby portion of the ice breaking away and carrying the second sensor with it. That ice and sensor drifted for about a month off Point Barrow, Alaska, before the sensor lost battery power and ceased transmitting. Other measurements show vertical accelerations up to 1 m s-2 that lasted for several minutes when ice ridging was likely taking place. A smaller sensor with additional data telemetry and additional signal processing is under development, with the goal of deploying several sensors next field season that are capable of providing “early warning” to relevant stakeholders about potentially significant ice events.

Forecasting Arctic Coastal Erosion at Utqiagvik, Alaska

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Utqiagvik, Alaska is the largest coastal city located along the North Slope comprised of approximately 5000 people. In recent years, the arctic coastal city has experienced accelerated coastal erosion due to permafrost layer thaw, sea level rise and declination of sea ice. These hazards have led to severe social and economic cost which includes the cost of coastal protection or relocating infrastructure. As a result of the recent increase in storm surges, the local government has launched an effort to build artificial berms during a storm surge to protect infrastructure and public safety. In 2017, a storm breached the artificial berm resulting in 10 million dollars' worth of damage and a disaster declaration through FEMA. Community members and researchers formed the Coastal Observers of Barrow (COB) to monitor storm surge and coastal erosion during a storm event. In this presentation, I will be discussing the development of a coastal erosion model that will be used to determine the geomorphic change of the beach berm during a storm event. The model simulates the hydrodynamic processes from a storm that occurred on August 28th, 2019. Based on the results of the model, the resiliency of the beach berm will be tested using a 2, 5 and 10 year artificial return storm.

Linking Offshore Oceanography to Alaskan Lagoon Dynamics

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Lagoons along the NW Alaskan coast act as moderators to freshwater discharge to the Chukchi Sea, which in turn affects freshwater transport to the broader Arctic Ocean. They also serve as important nursery and habitat areas for fishes that sustain both higher trophic levels and subsistence harvests for local Indigenous communities. Despite their impact on circulation, nutrient exchanges, and ecological systems, the couplings between off-shore oceanography patterns and lagoon dynamics are still relatively poorly understood. Climate change is inducing rapid transformation across these high-latitude systems, and it is becoming increasingly important to understand functional relationships in order to best inform policy, planning, and resource management needs. To quantify the coupling between off-shore regions and Alaskan lagoons we utilize data from a 6-mooring array deployed as part of the Arctic Integrated Ecosystem Research Program, spanning June 2017 to August 2019, in conjunction with ROMS ocean circulation model hindcasts and ECMWF Era5 atmospheric reanalysis outputs to characterize the regional circulation, water mass properties, and associated atmospheric forcings. These are assessed along with tide gauge data from within several lagoons and nearby NOAA CO-OPS stations to show the tightly coupled nature of nearshore and offshore conditions and processes.

Implementation of the World Meteorological Organization (WMO) Arctic Regional Climate Center (ArcRCC)

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Climate change in the Arctic is taking place at a much more rapid rate than in other regions. In Alaska, indigenous peoples and communities, industry, and flora and fauna are experiencing significant and direct impacts. Currently, climate products at a circumpolar/pan-Arctic scale (i.e. International Panel on Climate Change and Arctic Council working group assessments) are not available in near-real time for Arctic decision-makers. To meet growing Arctic adaptation and decision-making needs, an Arctic Regional Climate Center Network (ArcRCC-Network) has been established. The purpose of the ArcRCC is to provide biannual seasonal assessments and forecasts of temperature, precipitation, and sea-ice conditions each October (for the upcoming winter season) and May (for the upcoming summer season). The ArcRCC-Network is based on the World Meteorological Organization (WMO) Regional Climate Center (RCC) concept. Active contributions to the seasonal assessments come from the meteorological and ice services of all Arctic Council member countries and are based on a mutually agreed upon structure of three sub-regional geographical nodes, namely, (i) North America Node, (ii) Northern Europe and Greenland Node, and (iii) Eurasia Node. This presentation will further expand on the structure and objectives of the ArcRCC, the seasonal climate products for the winter 2019-20 period, and the next face-to-face forum in May 2020.

The Influence of Environmental Drivers on Functional Diversity Across Alaskan Arctic Epibenthic Shelf Communities

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Functional diversity is one component of overall ecosystem function that can help explain and predict an ecosystem's resilience to environmental change. Functional diversity can be evaluated using biological traits to express what communities actually "do" through a matrix of life history, behavior, and morphological information. This functional structure of communities is likely influenced by environmental drivers, especially in the Arctic where momentous environmental changes occur due to climate change. Environmental drivers filter species' biological traits through trait selection that structure community function and, therefore, affect ecosystem function. Here, we used generalized linear models and RLQ-fourth corner analyses to compare biological trait-based functional diversity and multiple components of functional diversity to environmental drivers. We focused on the effects of temperature, salinity, sediment grain size, and depth on Alaskan Arctic epibenthic shelf communities across the Beaufort and Chukchi Sea shelves. Functional metrics varied in magnitude along latitudinal and longitudinal gradients and were correlated with environmental drivers to varying degrees. The biological traits driving these patterns were feeding habit, living habit, and movement, which showed strong relationships with sediment grain size, salinity, and temperature. Functional diversity metrics of the communities provided a framework to understand how niche space is occupied and how resources are allocated in an ecosystem. Increasing niche space utilization and resource allocation were observed in a south to north and west to east pattern across the Alaskan Arctic. These results provide building blocks to understand and predict how resilient current functional structure and ecosystem functioning of Arctic epibenthic shelf communities are to environmental change, and which biological traits are most likely to be affected in a changing Arctic Ocean.

Calanoid Copepod Egg Production and Growth Rates in the Northern Bering and Southern Chukchi Seas

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Calanoid copepods are a key component of secondary production in high latitude pelagic marine habitats; therefore, determining their rates of production aids in our understanding of the fundamental dynamics of these ecosystems. In high latitude systems such as the Bering Sea relatively few direct measurements of copepod production rates have been completed. The goal of this study was to determine egg production rates (EPR) and somatic growth rates for common calanoid species in the region (*Pseudocalanus spp*. and *Calanus spp*.). Experiments were conducted as part of the Arctic Shelf Growth, Advection, Respiration, and Deposition (ASGARD) project during June of 2017 and 2018. Preliminary EPR varied for the sacspawner Pseudocalanus species, ranging between 3 and 6 eggs per female per day. The broadcastspawner Calanus spp. EPR's are expected to be higher than that of Pseudocalanus. Weight-specific somatic growth rates for Calanus were estimated to be between 2 and 15% day-1, and for Pseudocalanus spp. were typically half of that, with growth rates decreasing with increasing copepodite size. These rates will contribute to estimations of copepod contribution to total secondary production for this system.

Tracking Sympagic Primary Production Contributions to the Benthic Food Web in the Chukchi Sea with Sea Ice Algal Lipid Biomarkers

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Highly branched isoprenoid (HBI) lipid biomarkers unique to sea ice algae were measured in particle fluxes, surface sediments and macrofaunal invertebrate communities in the Chukchi Sea to determine the phenology of ice algal blooms and the subsequent transfer to the food web. The detection of HBIs in invertebrate tissues collected during the seasonally ice-free period indicates an ongoing utilization of sea ice algal compounds after the ice algae bloom. The use of a sea ice index based on HBIs showed minor differences in uptake among various species and feeding strategies relative to the surrounding sediments. The strongest sea ice algae signatures were detected in subsurface deposit feeders, while suspension feeders showed consistently weaker sea ice algae signatures. The biomarker composition of the surrounding sediments was a significant determining factor in the invertebrate HBI signal, which likely suggests that recent deposition is reflected in the invertebrate tissue. Biomarkers were also observed in particle fluxes collected from the Chukchi Ecosystem Observatory moored sediment trap and surface sediment samples in the region to contextualize the biomarker results in the organisms. Ice algal compounds were present year round in the northeast Chukchi Sea (likely attributed to resuspension and advection) with maximum export occurring following snow cover melt and initiation of sea ice retreat, coinciding with peak sympagic diatom export. The biomarker flux and deposition results suggests that following an ice algae bloom, the particles rapidly settle to the seafloor and are retained in the sediments through burial of freshly deposited organic matter by bioturbation and become available to surface and subsurface deposit feeders. The year round presence of sea ice organic carbon in the particle fluxes, stored in the sediments and in invertebrate tissue highlights the probable importance of ice algae in the Chukchi Sea food web.

Divergent Thermal Effects on the Over-Winter Survival, Condition and Lipid Storage of Juvenile Age-0 and Age-1 Arctic Cod (*Boreogadus saida*)

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In the Arctic, changing environmental conditions and increasing anthropogenic activity poses largely unknown risks to keystone species and the marine ecosystem they support. This includes Arctic cod, *Boreogadus saida*, a lipid-rich forage fish. To address the effect of overwinter temperatures on their energetics and survival, we ran a series of overwintering laboratory experiments on age-0 and age-1 fish.Age-0 Arctic cod were reared from eggs to similar sizes and lipid density (55 mm and 30 mg lipids/g wet weight) to those from wild age-0 fall collections. Juveniles were acclimated and maintained in winter conditions (food deprived, 24-hr darkness) throughout a range of constant overwintering temperatures in the laboratory (-1, 1, 3, 5 °C). Results indicated that juvenile cod survival was highly temperature- and age- dependent.Age-0 cod survival was negatively temperature-dependent, with survival longest at -1 °C (~150 days) and decreasing to ~90 days at 5 °C. In contrast, age-1 cod survival was non-linear, with longer survival times at intermediate temperatures (1 & 3 °C, ~150 days) compared to the coldest, ~ 80 days at -1 °C. The temperature-dependent rates of energy loss (HSI and Fulton's K), as well as total lipid and storage lipid loss in both muscle and liver tissues were determined for both age classes of Arctic cod. These thermally-dependent metrics of energetic status were measured both in surviving fish and fish that experienced mortality, allowing us to determine a lethal condition status for juvenile Arctic cod. Temperature-dependent rate-loss functions have been defined and will be useful in future assessment of juvenile Arctic cod survival potential throughout winter. These data will be discussed in relation to variable energetic condition of juvenile Arctic cod that was measured across the Chukchi Shelf during the fall/late summer of 2013 and 2017.

Summer 2018 Repeat Autonomous Vehicle Surveys Indicate Age-0 Arctic Cod are Largely Retained over the Chukchi Sea Shelf

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Recent summer surveys of the Chukchi Sea indicate that 38 kHz acoustic backscatter is dominated by high densities of age-0 Arctic cod (*Boreogadus saida*) while adults are comparatively scarce. Thus, either overwinter survivorship of age-0 Arctic cod is low or juveniles emigrate to other areas. To examine the displacement of this population over the 2018 summer growing season, we conducted repeat acoustic surveys with Saildrone unmanned surface vehicles. Saildrones' endurance and range enabled us to complete two large-scale surveys; mid-July to mid-August and late-August to mid-September. Backscatter increased from mid-July to mid-September and was highest in regions with sea surface temperatures of 6-8°C. Backscatter was lowest in cold, fresh areas influenced by recent ice melt. A subsection was surveyed two additional times for greater temporal coverage; backscatter in this subsection increased >65% between the first and last survey. As summer progressed, Arctic cod exhibited more extensive vertical migrations, becoming distributed deeper in the water column during daytime. This depth increase, concurrent with a 140% increase in the acoustic target strength of individuals over this period, is typically associated with growth. These increases in diel vertical migration and target strength suggest that changes in backscatter were driven by an increase in the size of the fish in the survey region. Tracking particle trajectories in a regional numerical model indicated extended periods of southward flow during the survey period. This likely acted to retain cod populations over the Chukchi Sea shelf before strong northward flow in late fall transported them to the north. Together with the survey observations, these findings suggest that in summer 2018, age-0 Arctic cod were passively retained in this region during a period of growth before being advected farther north towards the Chukchi and Beaufort shelf breaks.

Pacific Cod Habitat and Diet in the Chukchi Sea

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The goal of this study is to characterize juvenile Pacific cod habitat and diet in the Chukchi Sea, as part of a larger effort of the Arctic Ecosystem Integrated Survey (Arctic EIS/IES) program to document the state of the ecosystem. Pacific cod juveniles (59-101mm TL) were caught in three types of trawl gear in September 2017: Benthic, midwater and surface trawls.The highest catch rates in the benthic and surface trawls were at the most shallow (20-29 m bottom depth range) and southern stations of the survey area.In addition, Pacific cod were caught in the midwater trawl over deeper water (40-60 m depth).Diet analysis indicates that Pacific cod caught in the benthic trawl had recently consumed benthic prey items, while caught in the two pelagic trawls ate predominately pelagic prey items. Juvenile Pacific cod in the Chukchi Sea seem to occupy either demersal habitat in shallow areas or pelagic habitat, which may include deeper areas, and is similar to reports from the southeastern Bering Sea. The same small-mesh benthic trawl was fished at 40 stations in the Chukchi Sea in August and September 2012 over a similar survey area. Pacific cod juveniles were absent in 2012 at all 40 stations, including 7 stations where Pacific cod were present in 2017. This work indicates that Pacific cod are able to survive, feed, and grow in the Southern Chukchi Sea at least up to the juvenile stage, in some years.

Winter Migration and Carry-Over Effects in Planktivorous and Piscivorous Seabirds Breeding on St. Lawrence Island

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In the past two years rapid and unprecedented winter sea ice loss in the Northern Bering Sea has been implicated in spring- and summer-time food-web changes and subsequent starvation events of seabirds. With few exceptions, adult seabirds return to the Arctic for their summer breeding season after spending the winter elsewhere. In this study we examine how that time spent "elsewhere" may affect the ability of seabirds to survive and reproduce in a rapidly changing Arctic. To do this we needed to identify seabird overwintering locations and to evaluate whether costs incurred in one stage of the annual cycle are associated with seabird performance in a subsequent stage. We collected feathers and blood samples from black-legged kittiwakes (*Rissa tridactyla*), thick-billed (*Uria lomvia*) and common (*U. aalge*) murres, and crested (*Aethia crsitatella*) and least (*A. pusila*) auklets breeding on the north coast of St. Lawrence Island in 2016-2019. Feathers were grown during the fall (murres), midwinter (kittiwakes) and late spring (all species). We used light-level geolocation data-loggers to track the migration routes and identify general molt locations of a relatively small number of individuals from each species, then expanded our sample size by comparing stable isotope values of tracked and untracked individuals. Samples were also analyzed for concentrations of the stress hormone, corticosterone, an indicator of exposure to food limitation, and total mercury concentrations. Changes in telomere length were measured to assess changes in long-term molecular damage incurred by birds. Here we discuss 1) whether the non-breeding season affects an individual's physiological state during the breeding season, 2) whether physiological state is linked to the timing of a bird's departure for the Arctic and thus how much time they may be exposed to conditions there, and 3) whether these relationships are the same throughout the Arctic seabird community. This information on the nature of the relationship between the non-breeding and breeding seasons will provide clarity in the use of seabirds as sentinels of Arctic ecosystem change, and guidance to any future conservation efforts to preserve their populations.

Training Machine Learning Models to Detect and Classify Ice Seals and Polar Bears in Aerial Survey Imagery

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Instrument-based surveys for ice associated seals have allowed for extensive coverage of frozen sea basins from small aircraft. We have successfully used infrared (thermal) images to detect warm-bodied animals against the cold background of sea ice, and paired high-resolution color imagery to identify the species of detected animals. This method produces millions of images and requires automation to reduce the delay of abundance and distribution analyses. Through collaborations with private industry, we developed several deep learning models using an annotated training set of images and evaluated the models' performance using a separate test set of images. Here, we present an overview of each approach and an evaluation of how well these preliminary models work for detecting ice seals and polar bears using recall (a measure of how many of the known animals were detected), precision (a measure of how many of the detections were actually animals), and F1 scores (a measure of accuracy that balances the importance of recall and precision). Preliminary testing has yielded successful detections of ice seals and a promising approach for detecting polar bears.

Abundance of Bearded and Ringed Seals in the Chukchi Sea During Spring 2016

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Ringed and bearded seals are of conservation concern because of current and projected declines in spring sea ice, but little is known about their distribution and abundance in many remote Arctic regions.U.S. and Russian survey teams conducted aerial surveys of ice covered portions of the Chukchi Sea during spring (April & May) of 2016. Using infrared cameras to detect the warm bodies of seals against a cold substrate, and coordinated photographs to determine species, we detected a total of 5166 ringed seals and 1157 bearded seals along transects totaling 15720 km (effective area surveyed = 5830 km2) in the U.S.Russian survey teams encountered 94 ringed seals, 54 bearded seals, and 170 seals of unknown species in transects totaling 11604 km (effective area surveyed = 5414 km2). In order to generate abundance estimates, we fitted species distribution models to survey data that extrapolated densities into unsurveyed areas based on species-habitat relationships.Importantly, we accounted for imperfect detection via analysis of auxiliary data sources and by estimating emergence of ringed seals from subnivean lairs as a function of predicted snow melt dates.

Occurrence of Arctic and Saffron Cod in the Diet of Ringed Seals at Shishmaref, 1975–2018

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A warming climate is expected to alter the marine food web by favoring species of fish that thrive in warmer water to the detriment of those that thrive in cooler water. We analyzed data from a long-term study of ringed seals (*Pusa hispida*) harvested near Shishmaref, Alaska to investigate trends in the occurrence and size of the two most common fish found in their stomachs, Arctic cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*). Arctic cod are strongly associated with sea ice and cooler waters, unlike saffron cod, which prefer warmer water and therefore may become more prominent in ringed seal diet. Cod are identified in seal stomach contents by their otoliths (ear bones) which are proportional in size to fish length. The frequency of occurrence (FO) of Arctic cod in the diet of ringed seal pups was similar in 2003–2010 (39%) and 2011–2018 (22%) compared to 1975–1984 (24%). We found the same pattern for saffron cod eaten by pups, the FO in 2003–2010 (62%) and 2011–2018 (50%) were similar compared to 1975–1984 (58%). For non-pups, Arctic cod FO was higher in 2003–2010 (61%) and 2011–2018 (38%) than 1975–1984 (22%). For non-pups, saffron cod FO was higher in 2003–2010 (78%) and 2011–2018 (82%) than 1975–1984 (64%). We also measured the lengths of cod otoliths from stomach contents collected in 2011–2018 and found otoliths in pup stomachs averaged 1mm shorter than otoliths in non-pups. Average length of Arctic cod otoliths did not differ over time from 2011 to 2018, however, average length of saffron cod otoliths increased significantly from 5.6mm in 2011 to 7.9mm in 2018 for both age classes. We found occurrences of both cod species were higher for non-pups since 2003 than 1975–1984, which is contrary to our predictions of saffron cod replacing Arctic cod. The trend in saffron cod otolith size may indicate recent environmental conditions support the growth of larger saffron cod. Continued monitoring is needed to detect changes in the occurrence and size of prey species as marine waters warm.

Investigating Reproductive Biomarkers in Polar Bears

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Polar bears (*Ursus maritimus*) in both wild and zoo populations are under threat due to climate change, habitat disruptions, and poor reproductive success. The polar bear is a seasonally polyestrous species that exhibits embryonic diapause and pseudopregnancy, complicating characterization of reproductive function. Whereas excretion of testosterone and progesterone have been studied extensively in female polar bears in zoos, many questions remain about their reproductive endocrinology. Dehydroepiandrosterone (DHEA) is a steroid hormone precursor that has been correlated to reproductive success, age, and body condition in other species. However, it has not been previously characterized in the polar bear. The purpose of this study is to characterize the excretion of the sulfated form of DHEA, DHEAS, in polar bear feces from zoo populations, and to determine the DHEAS excretion patterns of wild polar bears in Alaska. The DHEAS data will complement existing research on the sex steroids progesterone and testosterone, which are typically used to define polar bear reproductive status. Longitudinal sampling of juvenile female bears, non-breeding females, parturient females, breeding non-parturient females, and breeding males will be conducted to determine the range of DHEAS excretion as it relates to reproductive function in bears housed in human care. Preliminary results show that DHEAS excretion is strongly correlated to testosterone excretion, and that spikes in fecal DHEAS concentration may be related to estrus or ovulation in adult female polar bears. With rapid changes occurring in the Arctic habitat, it behooves researchers to have multiple tools available for monitoring polar bears as they respond and adapt to environmental alterations. In particular, assays to better understand reproductive function could facilitate assessing a population's sustainability and growth, characteristics that are essential for long-term survival.

Growth Layer Groups in Beluga Teeth as Indicator of Life History Events

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Belugas of the Eastern Chukchi Sea (ECS) stock migrate annually between the Bering, Chukchi, and Beaufort seas following the waxing and waning of the sea ice. Endemic to the arctic and subarctic, they are adapted to their ice-dominated environment, and their response to a reduction, or total loss of sea ice will likely be complex. Retrospective studies can play an important role in determining the resilience and adaptability of such populations, as they provide long-term data that establish historical norms and baselines. Marine mammal teeth provide an attractive subject for retrospective population studies because teeth preserve an annual record at decadal scales, are available in existing marine mammal collections, and are durable enough to remain intact on historical, and even geological time scales. The growth layer groups (GLGs) of the teeth of odontocete whales are widely used to estimate age. In addition to providing a means of age estimation, marine mammal teeth preserve records of biological and environmental trends and events. Our study provides preliminary evidence that life-history events are recorded in the GLGs of 12 beluga teeth from Inupiat harvested individuals of the Eastern Chukchi Stock. In particular, reproductive events appear to be recorded in the mineral density of the dentin that composes a GLG. Moreover, pilot data are consistent with the hypothesis that interannual growth rates of dentin and cementum, after removing ontogenetic trends in yearly growth, provide a proxy for somatic growth rate as controlled by nutritional status in belugas.Such links have been shown for other marine mammals by others. Two correlates were recovered for mean GLG thickness for the period of 1985-2013, and both of these are offset by one year.Mean GLG thickness is negatively correlated with October sea ice extent, and is positively correlated to the fluctuations in the Arctic Ocean Oscillation. We suggest that these physical factors affect beluga prey stocks, and then with a one-year delay, beluga GLG thickness.

Age, Sex Composition and Body Condition of Harvested Pacific Walruses (*Odobenus rosmarus divergens*) in Chukotka, 2017-2018

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Rapid climate change in the Arctic might negatively affect Pacific walrus populations which are an important food source for indigenous people in Chukotka and Alaska. Their harvest may also affect walrus populations by reducing abundance and altering age/sex composition. Local communities usually report the number of walrus they harvest but rarely include their age, sex and body condition. In August-October 2017 and 2018 we monitored walrus harvests in 6 of 16 villages in Chukotka where walrus harvest occurs. These included Vankarem, Nutepel'men, Enurmino, Inchoun, Uelen and Lorino. Two walruses were also examined in Ryrkaypiy village where harvest usually does not occur. A total 430 animals were examined which was 19% of the total reported walrus catch (2,297 individuals) in Chukotka in 2017-2018. More animals were harvested and examined in September (n=242) than in August (n=127) or October (n=61). A large portion of our sample (n=306) was collected in Lorino and Inchoun where walruses are actively harvested. In Enurmino village, 60% of the walrus they harvested were females, while males (80-100%) are the dominant sex taken in all other places. Overall, males were the predominant sex harvested with 92% taken in 2017 and 75% in 2018. Among all harvested males, 28% were 15+ years old, 27% were 10-15 years old, 26% were 6-9 years old, 12% were 4-5 years old, and about 5% were 0-3 years old. Only 3% of the total female harvest were females 4-5 years old, 15% were 6-9 years old, 61% were 10-15 years old, 19% were older than 15 years old, and 2% were calves. Blubber thickness on the chest was measured in 162 walruses of which 155 were males and 7 were females. Measurements ranged from 17 to 65 mm and were considered normal according to age and sex of the examined animal. No individuals with poor body condition were recorded. Therefore, most of the walrus harvested in Chukotka in late summer-autumn 2017-2018 were adult males with normal body condition.

Seasonal Variation of the Stress Hormone Cortisol in Alaska Polar Bear Hair, 1983-1989

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Cortisol is the primary glucocorticoid hormone expressed by mammals in their response to adverse experiences. Acute elevation of cortisol is beneficial as it increases mobilization of energy stores, allowing mammals to better respond to short-term “flight or fight” experiences. Prolonged negative experiences, however, can result in chronic elevation of cortisol, which may negatively impact physiological functions. Cortisol incorporated into growing hair provides an index of the seasonal adversity experienced by an animal. For polar bears (*Ursus maritimus*), hair cortisol concentration (HCC) has been related to interannual and decadal variation in their preferred habitat, sea ice. Polar bear HCC, however, may be dependent on the season in which hair is collected (i.e., spring versus fall) and reproductive class. Because most hair growth and the primary molt in polar bears likely occurs between spring and autumn, hairs collected at these two time periods likely indicate environmental conditions specific to each season. We assayed HCC in 198 hair samples of independent-aged (≥ 2-years old) male and female polar bears captured between 1983-1989 during spring and autumn in the Alaska Beaufort and Chukchi seas. Spring HCC (4.76 ± 1.57 SD pg mg-1, n = 129) was significantly greater than autumn HCC (3.83 ± 1.04 SD pg mg-1, n = 69; $F_{1,191} = 17.716$, $p < 0.001$) but HCC was not different among reproductive classes ($F_{5,191} = 0.398$, $p = 0.850$). Our analysis suggests that independent-aged bears, including subadult males and females, adult males, single adult females, females with first year cubs and females with yearlings, responded to the environment similarly. Differences in HCC between spring and autumn suggests that environmental conditions associated with these time frames differs. Autumn-collected hair likely represented the timeframe in which most of the new hair growth occurred, which coincided with maximum food availability and body condition. This may, in part, explain seasonal differences. Our results emphasize the importance of seasonal specificity in assessments of the polar bear stress response across study regions or periods.

Detection of Polar Bear Tracks on the Ice of the Chukchi Sea, Spring 2016

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The eastern part of the East Siberian Sea and the Russian economic zone of the Chukchi Sea were surveyed from board of an aircraft between April 18 and May 18, 2016; the size of the surveyed area was 900 x 400 km, and the total length of the transects was 12180 km. The polar bear tracks were first visually detected by the observers who then gave the command to shoot to 3 photo cameras with a swath of about 600 m and a resolution of about 5 cm on the ground. In total, 2,071 sites visited by polar bears were discovered. A database of polar bears tracks now contains 15,373 images with a time-coordinate reference, which allows us to analyze habitat of polar bears during the survey period. Images can be classified based on various parameters: the presence of a track of a single bear, tracks of a female bear with cubs, multiple bear tracks, etc. The maximum density of tracks was found in the coastal areas of the northern coast of Chukotka and Wrangel Island. In some images, the tracks of a female-bear with cubs are clearly visible. Sometimes it is possible to determine whether the female had more than one cub -two tracks with smaller footprints can be distinguished. The number of cub tracks can serve as a reference to an average litter size and, therefore, overall population health. It has been noted that more often polar bear tracks are found near ice cracks and hummocks, as well as in areas where seals were observed. Based on the set of images, a map of the track distribution of adults and cubs combined with actual polar bear sighting locations was developed.

A Yarn of Wayward Whales in the Eastern Chukchi and Eastern Beaufort Seas, 2019

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In 2019, the Aerial Surveys of Arctic Marine Mammals (ASAMM) project observed cetaceans in remarkable locations: fin whales (*Balaenoptera physalus*) were seen farther north in the eastern Chukchi Sea than any previous survey year, and a sizeable aggregation of feeding gray whales (*Eschrichtius robustus*) was seen in the eastern Beaufort Sea. The ASAMM project has conducted line-transect aerial surveys annually from July through October in the eastern Chukchi Sea (1982–1991 and 2008–2013, 68°–72°N, 157°–169°W; 2014–2019, expanded south to 67°N). Fin whales observed in the Pacific Arctic have been described as a sub-Arctic species but in recent years have become regular visitors in the south-central Chukchi Sea. Fin whales were seen during ASAMM in 2008, then every year from 2012 to 2019, primarily south of 69°N. In July and September 2019, several fin whales (n=7) were sighted 170–190 km west of Icy Cape, Alaska, 120–155 km northwest of the previous most northerly sighting; all were recorded as swimming and humpback whales were seen in the surrounding area. Humpback whales are also rare to this area. In August 2019, the ASAMM project extended its standard western Beaufort Sea study area (140°–157°W) to include the eastern Beaufort Sea shelf and Amundsen Gulf in Canada (119°–140°W). On 21 August, 15 gray whales, including one calf, were sighted in two groups west of the Tuktoyaktuk Peninsula in the eastern Beaufort Sea. Eight of these gray whales were feeding, as indicated by mud streaming from their mouths. Sightings of gray whales in the eastern Beaufort Sea exist in historical records; however, this is the largest group of gray whales sighted there. These sightings raise several questions about annual variability in gray whale abundance and distribution, and the behavioral, environmental, and oceanographic factors that influence gray whale expansion eastward from their expected summer distribution. The northward expansion of fin whales and eastward expansion of gray whales may be amplified by an increase in marine mammal surveys, but are likely also related to environmental changes and their effect on the availability of prey.

Incidental Findings of Lens Yellowing and Cataracts in Beachcast Grey Whales (*Eschrichtius robustus*), Alaska

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Age related color changes known as lens brunescence (yellow to deep amber) have been documented in old mature fin whales (~age 120 yrs. SE ± 27.2) and bowhead whales (> 70 - 211 yrs). Cataracts are a rare condition in baleen whales with few documented case reports (fin whale (*Balaenoptera sphysalus*); minke whale (*B. acutorostrata*); bowhead whale (*Balaena mysticetus*). We report on novel incidental findings of age related color changes and cataracts in ⅔ beachcast grey whales (*Eschrichtius robustus*). Bilateral nuclear cataracts were observed in a juvenile female grey whale (carcass condition III), total body length (8.2 m) and multiple focal opacities and lens yellowing in one lens in a mature sex unknown grey whale (carcass condition III-IV), total body length (12.3 m). It is most likely that the bilateral nuclear cataracts are of hereditary etiology, but other causes for acquired cataracts (trauma, inflammation, some toxins, irradiation, nutritional excesses and deficiencies, or hyperglycemia of diabetes mellitus) cannot be excluded. Age related cataract formation with evidence of lens yellowing is the most probable etiology for the second whale. Field of vision reduction in lenses with cataracts ranged between 30 - 50 % and would have had vision implications for these whales, in particular for the juvenile gray whale. Total light transmission in ageing lenses is reduced and the decrease is greater for short wavelengths with reduced blue light transmission (short wavelength) having been reported in humans with lens brunescence. Cetaceans have a blue light shifted photopigment rhodopsin, which improves visual acuity in dim light environments (mesopic). Reduction in blue light transmission caused by age associated lens discoloration theoretically could diminish underwater vision in “old” whales. Implications of ageing related lens discoloration on whale vision have not been explored. This report expands the documented case material for lens associated disorders in free-ranging gray whales.

The Influence of Winds on Bowhead Whale Foraging in the Chukchi Sea

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The paths of satellite-tagged bowhead whales (*Balaena mysticetus*) crossing the Chukchi Sea (excluding the Chukotka coast region) during their fall migrations (2008-2017) were analyzed for occurrences of slow swimming (<1.67 km/hr) behaviors suggestive of foraging. Inferred foraging preferentially occurred in the vicinities of Herald Valley, the Central Channel and Chukchi shelf break; principal circulation pathways crossing the northern Chukchi Sea. The association between bowhead foraging behavior and Chukchi circulation implicates wind forcing as a driver of variability in the north Chukchi foraging environment. We used an iterative correlation analytical methodology to investigate the manner in which year-to-year differences in the time-integrated effects of wind forcing over the Chukchi and adjacent seas are encoded as interannual differences in the north Chukchi foraging environment. This analytical method identifies the start and end dates of wind averaging periods that maximize the geographical extent over which correlations between time-averaged winds and foraging behaviors are statistically significant. Our results indicate that years (2009, 2012, 2014, 2015, 2017) in which foraging behaviors in the northern Chukchi were more common occurred when late-August to early-October winds over the Chukchi and Beaufort Seas were weak and variable. Years (2008, 2010) in which foraging behaviors in the northern Chukchi were less common occurred when late-August-to-early-October winds over the Chukchi and southern Beaufort Seas were easterly, strong and persistent.

Age Structure of Subsistence Harvested Ice Seals in Alaska 2000 – 2018

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Age distribution is an important component for understanding population dynamics. Since 2000, the Alaska Department of Fish and Game has used cementum annuli to age teeth from harvested ice seals: 2,690 ringed seals (*Pusa hispida*), 1,643 bearded seals (*Erignathus barbatus*), 3,519 spotted seals (*Phoca largha*), and 97 ribbon seals (*Histriophoca faciata*). Samples from seals were collected in collaboration with Alaska Native hunters as part of a subsistence harvest bio-monitoring program. The average age of the sampled harvest was 3.7 (SE= 0.13) years old for ringed seals, 4.8 (SE= 0.17) for bearded seals, and 2.9 (SE= 0.09) for spotted seals. We also found bearded, ringed, and spotted seals sometimes live for more than 40 years; in contrast, the oldest ribbon seal was only 25 years old. Due to few samples, ribbon seals were not included in subsequent analyses. We compared the age distribution of three age classes: pup, subadult, and adult during four different time periods: 2000–2004, 2005–2009, 2010–2014, and 2015–2018. The harvested sample consisted of 29–75% pups, 7–42% subadults, and 17–39% adults, by time period. Ringed seals showed the greatest variation in the proportion of pups, ranging from 45% (2010–2014) to the maximum proportion observed among all species and time periods of 75% (2015–2018). Spotted seals exhibited the least variation with pups making up 42% (2005–2009) to 46% (2015–2018) of the sampled harvest. We do not know if the sampled age distribution represents the population-level age distribution; however, we collected hunter preference information and hunters indicated that harvest selection is based on availability rather than age. Therefore, hunter selection may not be a significant bias. Seasonal seal movements by age class may also influence which seals are available to be harvested by location. Current research using satellite telemetry to monitor seal movement patterns may help inform how these data are interpreted. When paired with data on hunter selection and seal movement patterns, age distribution of the harvest could provide insights into the status and dynamics of Alaska's ice seal populations.

Establishing Baseline Ringed Seal Spring Snow and Sea Ice Habitat in the Chukchi Sea

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Environmental change in Alaska's Chukchi Sea has been marked by unprecedented reductions in sea ice extent, thickness, and duration of seasonal cover, with uncertain impacts to the habitat of ice-obligate marine mammals such as ringed seals (*Phoca hispida*). During winter to spring, ringed seals excavate snow and sea ice to build lairs for protection from weather and predators during birthing, nursing, and resting. However, baseline information on snow and ice properties required for lair construction is limited. We aim to fill critical knowledge gaps about the spring snow and sea ice habitat of ringed seals by 'rescuing' and analyzing data collected from two Chukchi Sea landfast ice regions during spring 1983 and 1984. Specially-trained dogs were used during on-ice surveys to search for ringed seal breathing holes and simple, complex and pupping lairs, which were then measured and located on a standardized grid system. Technological advances in geographic information systems now allow the additional ability to digitally map the spatial distribution and configuration of these ringed seal structures detected during the baseline period. Here, we present preliminary results of mapping 242 structures detected in two grids (~33 km2 total area) in Kotzebue Sound and 250 structures detected in five grids (~31 km2 total area) near Cape Lisburne, based on the pacing and angles recorded from study grids in the 1980s. Densities of seal structures in each grid ranged from 6.8-9.7 structures/km2 in Kotzebue Sound and 6.8-10.8 structures/km2 near Cape Lisburne. Approximately 12% of seal structures in the Kotzebue Sound grids were pupping lairs, while pupping lairs were ~21% of the seal structures near Cape Lisburne with a minimum snow depth of 47 cm. Our retrospective analysis will additionally examine the spatial relationships of different lair types to establish patterns in the historical distribution, fine-scale environmental relationships, and proximities among ringed seal structures. Our results establish a baseline against which current and future climate-related changes in sea ice and snow required for ringed seal breeding habitat can be compared.

Clinical Sedation of Alaskan Phocid Seals

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Historically, veterinary handling of phocid seals has been challenging due to their tendency to become apneic under chemical restraint, poor mobilization of chemical compounds in metabolically inactive tissue, resistance to voluntary induction with isoflurane gas, and anatomical considerations when intubating. This long-standing problem in marine mammal medicine has limited routine health assessments and treatment for seals living under human care, or else resulted in increased mortality from necessary clinical procedures, wildlife response activities, and research handling of wild seals. However, the advent of new drugs over the past 20 years with consistently reliable absorption and significantly reduced respiratory depression has allowed for improved safety during sedation of seals, with the added benefit of direct antagonists as reversal agents. Here, we describe sedation protocols for Alaskan seals, spotted (*Phoca largha*), ringed (*Pusa hispida*), and bearded (*Erignathus barbatus*) seals treated in a clinical setting at the Alaska SeaLife Center, Seward, AK. A total of 83 successful sedation procedures were conducted with sick seals handling during rehabilitation, and healthy seals handled for sampling and diagnostic procedures. Sedation protocols were optimized for individual animals, procedures, circumstances, and species and refined over five years. In most cases, a combination of Midazolam (range 0.15-0.55 mg/ml) and Butorphanol (range 0.15-0.7mg/ml) delivered via intramuscular injection was used to induce sedation for up to 2.5h. Typically, sedation was discontinued with an intramuscular injection of Naltrexone. This reversal agent, which acts as both a direct antagonist for Butorphanol and a competitive antagonist for Midazolam, allowed for a smooth, calm recovery and immediate improvement in respiratory rate and oxygenation. The development of chemical sedation protocols in well controlled, clinical settings has enabled safe and predictable examination, sampling, and diagnostics of phocid seals, including Arctic species for which few veterinary data are available.

Oceanographic Characteristics Associated with Movements and High-Use Areas of Spotted Seals (*Phoca largha*) in the Chukchi and Bering Seas

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Spotted seals (*Phoca largha*) are pelagic foragers that use seasonal pack ice for pupping, nursing, and resting when ice is present (December–June) and coastal haulout sites for resting during the open-water season (July–November). Decreases in the extent and duration of ice cover associated with climate change have eased access to the Arctic for development and shipping, prioritizing the identification of areas important to seals. We worked with Alaska Native hunters to deploy satellite-linked tags on 24 spotted seals (including 20 CTD tags) in nearshore areas of the Beaufort and Bering seas during 2016–2018 to study movements and identify high-use areas. Individual seals were tracked for 137–638 days. Seals tagged in the Beaufort Sea moved into the Chukchi Sea and made recurrent east-west movements, spending 1–27 days foraging near Herald Shoal, primarily in warm Alaskan Coastal Water, and 0.1–5.7 days resting on coastal islands. Seals tagged in the Bering Sea also made recurrent east-west movements, spending 1–25 days foraging in the central Bering Sea, primarily between St. Lawrence Island and St. Matthew Island in Alaskan Coastal Water and Bering Shelf Water, and 0.03–6.2 days resting on coastal islands. In December, seals in the Chukchi Sea moved south, ahead of the advancing pack ice, into the Bering Sea. By mid-January, all seals regardless of their tagging location foraged along the pack ice edge in the central Bering Sea. CTD data will be used to identify oceanographic characteristics of the high-use foraging areas.Tagging seals in both the Beaufort and Bering seas allowed us to identify spotted seal movements and high-use areas throughout the continental shelf. Further studies that include additional tagging locations will likely identify other important foraging and resting areas.

Science & the Arctic Expeditionary Capabilities Exercise

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Ever wonder how science agencies interact with big military exercises?Here's an example of how it worked during the 2019 Arctic Expeditionary Capabilities Exercise (AECE). In February 2019, Navy leadership directed the development of a large exercise in Adak by the end of the September 2019. Developed to advance joint readiness in austere/unfamiliar conditions, establish interagency and community relationships, and assess Adak and the Aleutians for future training, the exercise required science agency assistance in planning and offered data, lessons learned, and future opportunities in return. Planning: The short planning window forced Navy staff to scope the exercise to activities without significant impacts on the environment. Working with NOAA and USFWS, they discussed options, gathered physical and biological information for their NEPA analysis, and obtained permits to exercise on Alaska Maritime National Wildlife Refuge lands. Data: The Navy will be providing side scan sonar data they collected in Adak to NOAA to improve nautical charts of the area. Salvage divers also surveyed two sunken tugs in the harbor that will be used to plan future salvage work on these vessels.In addition, Marine mammal observers collected occurrence data during beach operations necessary to inform consultations for future Adak activities. Lessons Learned: Observing the exercise gave NOAA and USFWS better information to help the Navy improve their mitigation plans and suggest authorizations they should request in the future.It also provides the Navy with agency review timelines needed to review expanded exercises. Specifically, Marine mammals (harbor seals, harbor porpoise, and minke whales) were observed daily near the action during the exercise. The avoidance mitigation measures implemented in this exercise could significantly curtail future exercise objectives, therefore the Navy should consider seeking incidental harassment authorization to enable required actions to occur. Additionally, opportunity exists for NOAA and DOD weather forecasters to collaborate and identify new requirements. Summary: National Security interests and development of Defense Support to Civilian Authorities are increasing in the Arctic.With the relationships built during the exercise, science agencies should have more opportunity to engage with exercise planners for mutual benefit.

Developing the Next AOOS Strategic Plan: FY21-25

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The Alaska Ocean Observing System (AOOS) is engaging with stakeholders who use ocean and coastal data and information for decision-making to help determine priorities for the next AOOS 5-year strategic plan (FY 21-25). AOOS is the Alaska regional component of the national Integrated Ocean Observing System, begun in 2004. Stakeholders include the research community, state and federal agency managers, emergency responders, tribes and coastal communities, commercial fishermen, shellfish farmers, recreational boaters and shippers, subsistence users, and others. Key societal benefit areas include maritime safety (ocean conditions, weather stations, vessel tracking, oil spill response, search and rescue); coastal hazards (water level observations, coastal and seafloor mapping); ecosystem and climate trends (long time series using ship surveys and gliders, sentinel stations); and water quality (ocean acidification, harmful algal blooms, marine debris, contaminants). What are your priorities for the next 5 years? What are we missing? We want to hear from you. Comments are welcome until June 1, 2020. Contact: administration@aoos.org.

Spatiotemporal Trends and Controls of Coastal Erosion Along the Elson Lagoon Coast Near Utqiagvik, AK 1955-2019

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Arctic coastal ecosystems have been recognized as one of the most climate-change vulnerable ecosystems on Earth. Although coastal erosion has been studied at multiple locations throughout the Arctic, the majority of studies spanning decadal time scale change has focused on arctic coasts exposed directly to coastal seas of the Arctic Ocean. Lower energy lagoon systems comprise ~50% of the Alaskan Beaufort Sea Coast and are an import nexus between land-aquatic-ocean-atmosphere-cryospheric-and social systems. In this study, we report on the spatiotemporal trends of coastal erosion along ~10km of the Elson Lagoon mainland coast near Utqiagvik, AK between 1955 and 2019. The position of the coastal bluff was digitized from multiple georeferenced air-photo and high spatial resolution satellite image time series (1955, 1979, 2002, 2014), or derived from ground-based differential GPS surveys of the coastal bluff (mostly annually 2003-2019). Changes in the position of the coastal bluff was calculated using the USGS Digital Shoreline Analysis System (DSAS). Analyses suggest that mean rates of erosion between 2003-19 (2m/yr) are twice the mean rate of erosion calculated for 1955-79. The magnitude of change has been greatest for erosion rates close to or lower than the mean. High rates of erosion are still occurring where historically high rates of erosion have occurred. Along this ~10km of coast, approximately 80ha of land has been lost and a model using published soil carbon content suggests ~5ton of carbon per meter of coastline has entered the nearshore environment since 1955. Additional soil nutrient inputs are still being analyzed and the relative importance of different biophysical controls on erosion are being determined. This study highlights the potential importance of integrating changes in coastal landscapes in change assessments of arctic lagoon ecosystems, and biogeochemical cycling in Arctic coastal waters.

Algal Nutrient Limitation in a Beaufort Sea Lagoon and its Inflowing Rivers

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The Arctic is warming at twice the rate of the rest of the planet, and recent observation have shown that this can have important implications for primary producers, in both terrestrial and aquatic ecosystems. In particular, warming is leading to permafrost thaw that releases nutrients into the environment, results in longer and/or warmer growing seasons, and increases rates of coastal erosion. In aquatic environments, warming and increased nutrient inputs can lead to changes at the bottom of the food web, including alterations in both benthic and planktonic algal communities. The goal of this study is to understand how nutrient limitation of algae in an Arctic lagoon of the Beaufort Sea may be associated with the characteristics of inflowing, relatively nutrient-rich, freshwater rivers. Bottle incubations were used to quantify phytoplankton nutrient limitation using known quantities of nitrogen (N), phosphorus (P) or a combination of the two (NP) in late summer 2019. Algal biomass was estimated from chlorophyll-a extracted in 90% acetone and quantified spectrally. Preliminary results indicate that phytoplankton in Elson Lagoon largely experienced N-limitation. Nitrogen may become limiting in the landscape as N is taken up by plants before it reaches the lagoon, or due to benthic denitrification under warming conditions. The strongest response to nutrient enrichment occurred at the eastern end of the lagoon. Conversely, three out of four inflowing river sites exhibited co-limitation by N and P, which is consistent with previous results in freshwater ponds. The relative importance of nutrient inputs may differ among freshwater and marine sites where dominant algal taxa likely differ. The results of this study have important implications for understanding how future changes in nutrient inputs to the coastal waters of the Beaufort due to warming may have important implications for algal growth and community structure.

Validation of a Sonar Method to Classify Marine Sub-Littoral Habitats in a Coastal Lagoon Near Barrow, Alaska

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The ecosystems situated along the Arctic coast are recognized as some of the most threatened ecosystems on Earth. With global temperature rising, permafrost is thawing at an accelerated rate, which is resulting in substantial amounts of soil organic carbon being transferred to the coastal Arctic Ocean via coastal erosion and riverine inflow. The objective of this study was to classify and map the nature of the of sediment in a coastal lagoon of the Beaufort Sea (Elson Lagoon, Barrow, AK) and relate this to high spatial resolution sonar data in order to create a detailed map of the sublittoral habitats in the region. Sonar data along with soil samples were collected throughout the lagoon in August of 2015. A SonarMite Echo Sounder (SeaFloor Systems) was hauled throughout the lagoon, with sonar velocity corrected for the effects of salinity and temperature variations in the water. Sediment samples were collected at 86 sites; each sample was homogenized and dried, with percent organic matter determined after combustion at 500°C. Sediment particle size will be determined by sieving each sediment sample through a composite sieve. Preliminary results indicate that most of the sampled areas contained a high amount of fine sand, furthermore sonar intensity was negatively associated with organic matter content and percent fine sediment. Our results indicate that sonar may be a viable option to classify sublittoral habitats on a broad spatial scale.

Alaskan Arctic to the World: A Data Catalog Design for Open Ecological Data

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Stewardship and sharing of research data matter. They matter at an increasing pace: funding agencies and journals now require data to be publicly available. Above all, open data fosters an open and inclusive research environment. The two new coastal and marine Long-term Ecological Research Network (LTER) sites based in Alaska, Beaufort Lagoon Ecosystems (BLE) and Northern Gulf of Alaska (NGA), in addition to the long-standing Arctic (ARC) site at Toolik Lake, will contribute to Alaskan research while maintaining LTER's excellent standards around data stewardship and sharing. Leveraging information management expertise in the network, we developed a data catalog model that is designed toward ecological and environmental research. The data catalog supports quick and easy export to the Ecological Metadata Language (EML) standard, thus research data can be submitted to the NSF Arctic Data Center or other repositories with minimal revisions. This model also supports semantic annotation to improve data discoverability. Projects, field stations, and research sites are most uniquely placed to take advantage of this resource to manage their collections of data, create online data catalogs, and/or report on their data holdings. The catalog design itself, plus associated tools, are open source, well documented, and available publicly. Here we describe the design, give example use cases (e.g. BLE-LTER), and provide a guide to how to get started with your data.

WORKSHOPS

All Week

Lactation Station
8:00 a.m. – 5:00 p.m., Inquire at Registration

Media Room
8:00 a.m. – 5:00 p.m., Adventure Room

Sunday 1/26

AMERICAN GEOPHYSICAL UNION'S SHARING SCIENCE SCIENCE COMMUNICATION WORKSHOP

All day, NPRB/AOOS Office, 1007 West 3rd Ave, Ste. 100

This year, the Alaska Marine Science Symposium is partnering with the American Geophysical Union and their "Sharing Science" group to deliver a one day science communication workshop. Open to all scientists, science communicators, media, and other audiences. Critique and evaluation of materials, products, and project ideas will be encouraged. Visit their website at: https://sharingscience.agu.org/

Monday 1/27

COMMUNICATING OCEAN SCIENCES WORKSHOP FEATURING DR. BRIAN BRETTSCHNEIDER

9:00 a.m. – 12:00 p.m., Ballroom

Each year, the Communicating Ocean Sciences Workshop provides practical information, great speakers and information on current best practices in education, outreach and media. In this hands-on workshop, Dr. Brettschneider will focus on how to effectively use social media to deliver scientific content. Dr. Brettschneider is one of Alaska's esteemed climatologists with a social media following of over 17,000 people. This workshop is free and space is not limited. Details to follow as the symposium draws closer.

METADATA 411

9:00 a.m. – 12:00 p.m., Whitby Room

Presented by Axiom Data Science, this newly-redesigned workshop includes a general introduction to metadata and its importance to the scientific community, as well as hands-on workbook exercises designed to improve your metadata-writing skills. Using an example dataset and the Research Workspace's metadata editor, workshop attendees will learn how to apply the current best practices for scientific metadata to improve the content of a metadata record. The workshop is aimed at scientists and technicians tasked with writing metadata or who want to better understand metadata and its creation. For more information, email your questions to metadata@axiomdatascience.com.

Tuesday 1/28

OCEAN ACIDIFICATION TOWN HALL

5:00 p.m. – 6:00 p.m., Resolution Room

This session will include 5 minute updates from ocean acidification researchers ranging from open ocean and nearshore monitoring to species response in the lab. Then the floor will open for Q&A and discussion. The intent of this session is to keep the science community updated on current research activities related to ocean acidification and promote collaboration.

Wednesday 1/29

OCEAN EDUCATOR NIGHT

5:00 p.m. – 7:00 p.m., Adventure Room

Educators and scientists - Please join us Wednesday, 5:00 p.m. - 7:00 p.m. at the Hotel Captain Cook for the fourth annual Ocean Educator Night. Featured at this event will include presentations on teacher research experience programs including PolarTREC and NOAA Teacher at Sea led by Janet Warburton, Britta Culbertson, Katie Gavenus, Cara Nelson, and Mark Van Arsdale. A second session will feature a topic addressing increasing Alaska Native and rural Alaskan participation in Arctic STEM.

COMMUNITY SCOPING FOR OCEAN EXPLORATION SCIENCE AND INFORMATION PRIORITIES IN DEEP ALASKAN WATERS

5:30 p.m. – 8:30 p.m., Quarter Deck

Starting in 2021, the NOAA Office of Ocean Exploration and Research (OER) intends to support deep-sea (200 meters and deeper) exploratory fieldwork in the Alaska region. In light of that, we propose to hold an OER informational town hall at AMSS and announce our intentions to put out a call for white papers (Spring 2020) soliciting scientific and technological rationales for multidisciplinary exploration in the region. The town hall will be an opportunity to introduce our program and mission to scientists, marine resource managers, and the interested community doing complementary work off Alaska, to discuss potential areas of collaboration, and to encourage white paper submissions. The white paper call will be platform-agnostic and should not be predicated on current asset holdings of OER or NOAA; submissions will help identify priority investment areas and build out goals for region-specific investigations, and potentially a planning workshop.

ALASKA'S ROLE IN ADVANCING THE WHITE HOUSE SUMMIT ON PARTNERSHIPS IN OCEAN SCIENCE & TECHNOLOGY

5:00 p.m. – 6:00 p.m., Fore Deck

The focus of this town hall, hosted by AOOS and BOEM, is to begin a community discussion on Alaska's role in advancing new ocean science technologies and inter-agency and public-private partnerships on behalf of ocean science. This session follows up on the White House Summit on Partnerships in Ocean Science & Technology hosted by the Office of Science and Technology Policy and Council on Environmental Quality in November 2019, as well as the June 2018 Executive Order on "Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States." This interactive discussion will touch on ocean exploration, ocean science and emerging technologies, and promotion of the Blue Economy. Researchers, agencies, non-profits and the private sector are encouraged to attend.

Friday 1/31

COOK INLET BELUGA WHALE MANAGEMENT, RESEARCH, AND PARTNERSHIP OPPORTUNITIES

8:00 a.m. – 5:00 p.m., Voyager Room

Does your work involve studying, monitoring, managing, permitting, or funding projects related to Cook Inlet beluga whales? Do you want to share your knowledge, collaborate with, or develop partnerships with others conducting similar activities? If so, consider participating in the Cook Inlet Beluga Whale Management, Research, and Partnership Opportunities session during the 2020 Alaska Marine Science Symposium. This year, the Cook Inlet Beluga Whale Recovery Implementation Task Force will also meet during this session and will share progress to date. The session is scheduled for 8:30 a.m. - 4 p.m. on Friday February 21st, 2020.

Friday 1/31

HABS RISK COMMUNICATION

8:00 a.m. – 5:00 p.m., Club Room 2

The job of discussing potential coastal natural hazard risks and solutions—and motivating people to take action—is definitely not a "one size fits all" challenge. In this course, participants will learn how to: respond to difficult questions with more confidence using social science and risk communication principles; develop an effective risk communication strategy that incorporates these principles; recognize differing values within their audience; identify why people perceive and respond to risk the way they do; and practice these new skills.

COORDINATING FUTURE RESEARCH EFFORTS IN THE BERING SEA/STRAIT AND ADJACENT REGIONS

8:30 a.m. – 12:00 p.m., Aft Deck

USARC, NPRB, AOOS, and NOAA invite you to a workshop to discuss a planning framework for new, coordinated, and comprehensive studies of the Bering Sea/Strait and adjacent regions, which are experiencing rapid and extreme climate-related environmental variability unparalleled in recent history. All are welcome to join the conversation, including researchers, indigenous knowledge holders, coastal community and fishery industry representatives, resource managers, policy makers, and potential institutional contributors of financial or in-kind support. Broad and diverse perspectives are sought on: 1) emerging research questions and needs; 2) methods to facilitate research design and implementation that draw on indigenous, traditional, local, and scientific knowledge; and 3) approaches for gathering input from interested audiences on an ongoing basis and communicating back to them the resulting research plans and results in a timely and appropriate manner.

The organizers seek to ensure that any new research efforts will coordinate to: 1) be responsive to local community concerns; 2) build upon the scientific foundations laid by previous studies; 3) complement current research efforts, and 4) facilitate necessary research in the near-term to document the rapid changes underway while planning for longer-term research and monitoring efforts by multiple organizations.

Please be prepared to share: 1. What do you consider to be the most pressing marine research priority for the Bering Sea/Bering Strait and adjacent regions? 2. What do you consider to be the most important data or information gap to fill.

Note that no funding opportunities will be discussed at this meeting. Its purpose is to provide a forum for researchers, community members, funders, and other stakeholders to identify important research needs and gaps and be aware of each other's plans and interests, for possible future coordination.

Finally, we will be hosting a similar session February 12 (2:00-3:15 p.m.) at the Alaska Forum on the Environment (AFE) and inviting AFE participants to share their research priorities. We hope you can join as at AMSS, AFE, or both.

MAPPING ECOLOGICAL AND CULTURAL VALUES IN ALASKA'S WATERS: APPROACHES AND OPPORTUNITIES

9:00 a.m. – 12:00 p.m., Quarter Deck

This workshop invites your insight and input as we discuss the utility and limitations of a variety of methods and approaches to mapping biodiversity, subsistence resources, and ecological processes. We will begin by briefly presenting on multiple efforts before exploring the value and potential applications for this type of work. Presenters will include representatives from work by Audubon Alaska, Oceana, World Wildlife Fund, Aleutian-Bering Sea Initiative, Aleut International Association, Aleut Community of St. Paul Island Ecosystem Conservation Office, and the U.S. Fish and Wildlife Service.

ALASKA COASTAL MARINE INSTITUTE, ANNUAL STUDIES REVIEW

11:30 a.m. – 3:30 p.m., Quadrant Room

This workshop presents updates on ten current environmental research projects, including graduate student works, funded through the CMI Program. The CMI, a collaboration between the University of Alaska, the Bureau of Ocean Energy Management, and the State of Alaska, works to inform management of petroleum resources in Alaska's Outer Continental Shelf regions. The public is encouraged to attend and participate in learning about ongoing research programming.