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

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2018 Alaska Marine Science Symposium Abstracts and Poster Presentations

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The 2018 AMSS Keynote and Plenary speaker abstracts
are presented in chronological order

Poster presentations are grouped by day per Wave category

Contents

Monday Workshops and Keynote Speakers	1
Keynote Abstracts, Monday, January 22	3
Tuesday Plenary Agenda.....	11
Plenary Session Abstracts, Tuesday, January 23	13
Wednesday Plenary Agenda	45
Plenary Session Abstracts, Wednesday, January 24.....	47
Thursday Plenary Agenda	79
Plenary Session Abstracts, Thursday, January 25.....	81
Poster Presentations.....	107
William A. Egan Civic and Convention Center floor layout.....	109
Monday, Wave 1	111
Monday, Wave 2	191
Tuesday, Wave 1	272
Tuesday, Wave 2	345
Workshops	413

Opening Day - Monday, January 22

Workshops and Keynote Speakers: Monday, January 22

TIME	TITLE	PRESENTER	SECTION
9:00 - NOON	2018 Communicating Ocean Sciences Workshop	Chris Linder	WORKSHOP
10:00 AM	Registration Opens		
1:00 - 1:30 PM	Opening Remarks		
1:30 - 2:15 PM	Keynote	RDML Timothy Gallaudet (USN ret.)	Keynote
2:15 - 3:00 PM	Visitors from Distant Seas: Typhoons and Tropical Cyclones in Alaska	Rick Thoman	Keynote
3:00 - 3:30 PM	BREAK		
3:30 - 4:15 PM	PanArctic Benthic Monitoring: a Fast-Changing Environment	Lis Lindall Jørgensen	Keynote
4:15 - 5:00 PM	Science on Ice	Chris Linder	Keynote
6:30 - 7:45 PM	POSTER SESSION - Wave 1 - Gulf of Alaska and Bering Sea-Aleutians		
7:45 - 9:00 PM	POSTER SESSION - Wave 2 - Gulf of Alaska and Bering Sea-Aleutians		

Keynote

RDML Tim Gallaudet, USN (ret.)

Assistant Secretary of Commerce for Oceans and Atmosphere and Acting Under Secretary of Commerce for Oceans and Atmosphere

Timothy Gallaudet was confirmed by the U.S. Senate on October 5, 2017, as the Assistant Secretary of Commerce for Oceans and Atmosphere for the Department of Commerce's National Oceanic and Atmospheric Administration.

Gallaudet was previously a rear admiral in the U.S. Navy, where his most recent assignment was Oceanographer of the Navy and Commander of the Navy Meteorology and Oceanography Command. During his 32 years of military service, Gallaudet has had experience in weather and ocean forecasting, hydrographic surveying, developing policy and plans to counter illegal, unregulated and unreported fishing, and assessing the national security impacts of climate change. He has led teams of Navy sailors and civilians performing such diverse functions as overseeing aircraft carrier combat operations, planning and conducting humanitarian assistance and disaster response efforts, assisting Navy SEAL Teams during high visibility counter-terrorism operations, and developing the Navy's annual \$52 billion information technology, cyber security and intelligence budget.

Gallaudet holds a bachelor's degree from the U.S. Naval Academy and master's and doctoral degrees from Scripps Institution of Oceanography, all in oceanography.



Photo: NOAA

Keynote

Science on Ice

Chris Linder

Conservation Photographer and Storyteller

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Chris Linder is a professional photographer, filmmaker, and lecturer. He holds a Master's degree from the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution. His education and training as an oceanographer give him a special insight into photographing science. For over a decade, he has focused on communicating the stories of scientists working in the Arctic and Antarctic. He has documented 50 scientific expeditions and has spent over 2 years of his life exploring the polar regions.

Linder's images have appeared in museums, books, calendars, and international magazines, including Smithsonian, Audubon, Nature's Best, and Wired. A solo exhibition of his photographs, titled "Exploring the Arctic Seafloor," was displayed at the Field Museum in Chicago and the Carnegie Museum of Natural History. He is the author of the hardcover book *Science on Ice: Four Polar Expeditions* (University of Chicago Press, 2011) (scienceonice.com) and was the lead cinematographer for the documentary film *Antarctic Edge: 70° South*. He has been recognized with awards from the BBC Wildlife Photographer of the Year, Nature's Best Photography, and International Conservation Photography Awards competitions.



Photo: Chris Linder

Keynote

Visitors from Distant Seas: Typhoons and Tropical Cyclones in Alaska

Rick Thoman

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The southern and Caribbean portions of the United States were devastated in 2017 by a series of Category 5 hurricanes with direct and indirect casualties, billions of dollars in economic damages and unprecedented precipitation, flooding and storm surge. These events were likely exacerbated by climate change. In Alaska, we don't have "hurricanes," but western Pacific typhoons and their offspring can be just as severe climatically and atmospherically as those experienced by the lower 48, producing significant damage to coastal communities and infrastructure and bringing copious moisture to inland areas of Alaska. In this talk, the speaker will describe these events, their characteristics, and how they are similar and different from lower 48 hurricanes.

Thoman grew up in the Amish country of Pennsylvania dreaming of life in Alaska. He has worked in the weather and climate business for the past 34 years in both the private and public sectors, and realized his childhood dreams when he joined the National Weather Service Alaska Region in 1988. He currently works as the National Weather Service Alaska Region Climate Science and Services Manager. He is the author or co-author on a dozen papers on aspects of Alaska climate and climate variability including basic climate analysis, wildfires and marine heatwaves. He holds a B.S. in meteorology from Penn State and an M.A. in Athabascan Linguistics from the University of Alaska. He lives with his wife in Fairbanks, and, after 30 years, is now comfortable calling himself an Alaskan.



Photo: ACCAP

Keynote

PanArctic Benthic Monitoring: a Fast-Changing Environment

Lis Lindal Jørgensen

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Global climate change, harvest of marine resources, exploitation and invasion of new species place pressure on marine ecosystems. To be able to identify and follow impacts on the ecosystem, long term monitoring is necessary, which can provide a cost and time-efficient Pan-Arctic baseline overview of megabenthic invertebrate distribution and diversity. A trait-based approach is used, resulting in maps of temperature sensitivity and trawl vulnerability for the Barents Sea, Chukchi Sea and Bering Sea. These analyses show areas where different stressors can act on different species components of the community and cause a possible rapid change in biodiversity and habitat complexity. Such findings are critical and call for increased awareness from management authorities and global awareness of community impact from multiple, rather than single stressors.

Lis Lindal Jørgensen has been a senior scientist at the Institute of Marine Research (IMR) Norway since 2003. The focus of her work has been to understand how communities of benthic species are structured in space and in time by the surrounding natural and anthropogenic settings in the Northern Atlantic and Arctic Seas. Together with Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Russia, Jørgensen and colleagues annually identify the megabenthos taken with trawls in the Barents Sea. Questions such as “how does the benthic community change” when impacted by invasive species such as king crab and snow crab, and increased temperature and bottom trawling, have become increasingly important with climate change.

In 2017 Jørgensen started a PanArctic network with the seven Arctic member states to investigate changes of megabenthos in time and space. Together with scientists from the Alaska Fisheries Science Center (NOAA), this network will be used to evaluate how benthic distribution and vulnerability are distributed in the Eurasian and in the Pacific Arctic.



(Photo: Alberto Grohovaz/Arctic Frontiers 2016)

Plenary Session Abstracts

Tuesday, January 23

Plenary Sessions: Tuesday, January 23 -- Gulf of Alaska

TIME	TITLE	PRESENTER	SECTION
8:00 - 8:15 AM	Toxic Tides: To Clam or Not to Clam? Tracking Shellfish Toxins in Southeast Alaska	Kari Lanphier	Climate and Oceanography
8:15 - 8:30 AM	Assessing Ocean Acidification and Harmful Algal Blooms in Southeast Alaska	Esther Kennedy	Climate and Oceanography
8:30 - 8:45 AM	The Relationship Between Ocean Acidification and Respiration in the Gulf of Alaska	Richard Feely	Climate and Oceanography
8:45 - 9:00 AM	A Profiling Observatory for High Resolution Oceanographic, Biogeochemical, and Plankton Observations in Prince William Sound	Robert Campbell	Lower Trophic Levels
9:00 - 9:15 AM	A Mountainous Coastline Fertilizes the Ocean	John Crusius	Lower Trophic Levels
9:15 - 9:30 AM	Dispersal, Cross-Shelf Transport, and the Delivery of Larval Arrowtooth Flounder (<i>Atheresthes stomias</i>) to Suitable Nursery Habitats in the Gulf of Alaska	Esther Goldstein	Lower Trophic Levels
9:30 - 10:00 AM	BREAK		
10:00 - 10:15 AM	Refining Monitoring Efforts for Improved Stock Assessment of East Side Cook Inlet Razor Clams	Mike Booz	Fishes and Fish Habitats
10:15 - 10:30 AM	Metagenomic Assays to Assess Alaska Marine Community Species Identities, Diversity, Representation, and Population Patterns	Carol Stepien	Fishes and Fish Habitats
10:30 - 10:45 AM	Salmon Blitz: Engaging Citizen Scientists in Documenting Salmon Habitat in the Copper River Watershed	Kate Morse	Fishes and Fish Habitats
10:45 - 11:00 AM	Puffins as Samplers of Forage Fish: Variation in Length and Condition Relative to Ocean Climate in the Gulf of Alaska	William Sydeman	Fishes and Fish Habitats
11:00 - 11:15 AM	Interseasonal Movements and Non-breeding locations of Aleutian Terns (<i>Onychoprion aleuticus</i>)	Michael Goldstein	Seabirds
11:15 - 11:30 AM	Investigating Aleutian Tern Breeding and Foraging Ecology Using Satellite Telemetry	Don Lyons	Seabirds
11:30 - 1:00 PM	BREAK - LUNCH PROVIDED		

Plenary Sessions: Tuesday, January 23 -- Gulf of Alaska

TIME	TITLE	PRESENTER	SECTION
1:00 - 1:15 PM	Experimental Harvests of Gull Eggs in Glacier Bay National Park	Tania Lewis	Seabirds
1:15 - 1:30 PM	Combining Spatiotemporal Models and Aerial Photographic Techniques to Estimate Sea Otter Colonization and Abundance in Glacier Bay, Alaska	Jamie Womble	Marine Mammals
1:30 - 1:45 PM	Estimating the Population Size of a Coastal Cetacean with Highly Variable Group Sizes From Serial Survey Data	Charlotte Boyd	Marine Mammals
1:45 - 2:00 PM	It's Not What You Might Think – DNA Profiling From 'SnotBot' Samples of Whale Blows	C. Scott Baker	Marine Mammals
2:00 - 2:15 PM	Watching Whales in Juneau, Alaska: The Many Dimensions of This Thriving Tour Industry	Suzanne Teerlink	Human Dimensions
2:15 - 2:30 PM	A Holistic Approach to Reducing the Chance of Lethal Ship-Whale Collisions in Alaska	Scott Gende	Human Dimensions
2:30 - 3:00 PM	BREAK		
3:00 - 3:15 PM	An Agent-Based Model for Examining Parallel and Divergent Fishery Management Strategies for Transboundary Stocks	Benjamin Williams	Human Dimensions
3:15 - 3:30 PM	Data Upstream: A Design Charrette for Data Visualizations	Sarah Inman	Ecosystem Perspectives
3:30 - 3:45 PM	Ecosystem Variability in Lower Cook Inlet Across Trophic Levels, Space, Seasons, and Climate Regimes	Martin Renner	Ecosystem Perspectives
3:45 - 4:00 PM	Nonstationary Gulf of Alaska Ocean-Atmosphere and Climate-Biology Relationships Under Different Modes of North Pacific Climate Variability	Mike Litzow	Ecosystem Perspectives
4:00 - 4:15 PM	Detecting and Inferring Cause of Change in an Alaska Nearshore Marine Ecosystem: an Approach Using Sea Otters as a Component of the Nearshore Benthic Food Web	Jim Bodkin	Ecosystem Perspectives
4:15 - 4:30 PM	Changes in Forage Fish During the Winter 2015-16 Seabird Die-off and the North Pacific Marine Heat Wave	Mayumi Arimitsu	Ecosystem Perspectives
4:30 - 4:45 PM	Unprecedented Scale of Seabird Mortality in the NE Pacific During the 2015-2016 Marine Heatwave	John Piatt	Ecosystem Perspectives
4:45 - 5:00 PM	Have Gulf Of Alaska Humpback Whales Reached Carrying Capacity or has the Blob made the Food Web Screwy?	Jan Straley	Ecosystem Perspectives
5:00 - 7:00 PM	Alaska Climate Integrated Modeling (ACLIM) Project	WORKSHOP	
5:00 - 6:15 PM	NPRB Special Session	SPECIAL SESSION	
5:00 - 7:00 PM	Ocean Educator Night	WORKSHOP	
6:30 - 7:45 PM	POSTER SESSION - Wave 1 - Bering Sea-Aleutians and Arctic		
7:45 - 9:00 PM	POSTER SESSION - Wave 2 - Bering Sea-Aleutians and Arctic		

Toxic Tides: To Clam or Not to Clam? Tracking Shellfish Toxins in Southeast Alaska

Kari Lanphier

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Shellfish are an important and reliable subsistence food for Southeast Alaska Natives, especially during the winter months when fish and game are less plentiful. While shellfish are plentiful and easy to harvest, Southeast Alaska also has a long history of Harmful Algal Blooms (HABs). As rising ocean temperatures expand the time frame for blooms, traditional ecological knowledge related to harvest periods and techniques has become unreliable. Southeast Alaska Tribal Ocean Research (SEATOR), a partnership of fifteen tribal communities, tests toxin levels of shellfish on thirty local beaches throughout Southeast. SEATOR's partners send twice monthly samples to the Sitka Tribe of Alaska Environmental Research Lab (STAERL) where they are analyzed for saxitoxin using the Receptor Binding Assay. Using RBA, SEATOR can generate accurate, low-cost toxin levels for samples in under 48 hours. The quick processing time allows communities to harvest shellfish with confidence or to advise communities immediately when high toxin levels are detected. Over 1,200 individual samples have been tested in the region, spanning from January 2016 to present, providing baseline data associated with the current climatic conditions. The results gathered in the last two years of monitoring suggest large variances in toxin levels throughout Southeast. In June of 2017, toxin levels ranged from 500 to 3,000 μg of toxins per 100 g of shellfish tissue in Ketchikan, while in Petersburg, toxin levels were consistently too low to be detected. With such variance, it is clear that for shellfish to be available as a subsistence food, continuous monitoring of these beaches is necessary.

Assessing Ocean Acidification and Harmful Algal Blooms in Southeast Alaska

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Harmful algal blooms (HABs) are common in Southeast Alaska, but the impact on their duration and severity from rising seawater temperature and ocean acidification (OA) is still being determined. Trends in Washington, California, and Alaska make it clear that harmful algae benefit from the longer growing season; however, OA impacts are less resolved. The Southeast Alaska Tribal Ocean Research (SEATOR) partnership has been monitoring HABs and biotoxins across 15 communities since early 2016 to limit the negative impact HAB events have on subsistence harvests. As long-term offshore OA datasets around Alaska show increasingly alarming trends for subsistence resources, the SEATOR partnership has begun a pilot near-shore OA monitoring program in a few Southeast Alaska communities to link OA, HABs, and the vulnerability of local subsistence resources. SEATOR's existing infrastructure allows partner communities to add OA sampling to their existing environmental programs with minimal effort and expense, while immediately tying their observations to the health or toxicity of the local phytoplankton and shellfish populations. Participating communities collect a weekly surface water sample for analysis of OA parameters, along with phytoplankton and biotoxin samples. Phytoplankton samples are qualitatively analyzed by SEATOR for the presence or absence of harmful species. Biotoxin samples are shipped to the Sitka Tribe of Alaska Environmental Research Lab for analysis using the Receptor Binding Assay. Water samples were analyzed on the Sitka Tribe of Alaska's "Burke-o-Lator" to calculate total alkalinity and aragonite saturation levels. Here, we present preliminary data from three Southeast communities and the project's next priorities.

The Relationship Between Ocean Acidification and Respiration in the Gulf of Alaska

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Inorganic carbon chemistry data from the surface and subsurface waters of the Gulf of Alaska have been studied to demonstrate how future changes in CO₂ emissions will impact coastal waters affected by respiration-induced hypoxia ($[O_2] \leq \sim 60 \mu\text{mol kg}^{-1}$). In subsurface waters the increases in acidification are enhanced due to the changes in the buffer capacity (i.e., increasing Revelle Factor) with decreasing oxygen concentrations, with the largest impacts on pH and CO₂ partial pressure (pCO₂) occurring in the colder subsurface waters. As anthropogenic CO₂ concentrations begin to build up in subsurface waters, increased atmospheric CO₂ will also expose organisms to hypercapnic conditions (pCO₂ > 1,000 μatm) within subsurface depths. The extent of subsurface exposure will occur sooner and be more widespread in colder waters due to their capacity to hold more dissolved oxygen and weaker acid-base buffer capacity. This study demonstrates how different biological thresholds (e.g., hypoxia, CaCO₃ undersaturation, hypercapnia) will vary asymmetrically because of local initial conditions that are affected differently with increasing atmospheric CO₂.

A Profiling Observatory for High Resolution Oceanographic, Biogeochemical, and Plankton Observations in Prince William Sound

Robert Campbell

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An autonomous profiler has been deployed annually in Prince William Sound since 2013. The profiler consists of a positively buoyant instrument frame with a winch and associated electronics that profiles the frame from a park depth (~ 60 m) to the surface by paying out and retrieving a thin polyethylene tether. The profiler measures temperature, salinity, chlorophyll-a fluorescence, turbidity, and oxygen and nitrate concentrations at approximately 5 cm resolution. An in situ plankton imager for the profiler was designed and built in 2016. The system, based on the Scripps Plankton Camera, was designed to image mesozooplankton and features a 0.137 × telecentric lens and a 12 MP digital camera. It has an imaged volume of ~400 ml per frame at full resolution, with a pixel size of ~20 μm. Operating at 4 Hz, the imager samples approximately 300 liters per cast. Twice daily casts (during solar minima/maxima) were done during 2016 and 2017 deployments, collecting a high resolution record of the annual succession of the surface plankton community in Prince William Sound. As well as taxa shifts over time, individual behaviors (e.g., patch feeding, observable from the images and fluorometry) may be discerned. Diel changes in the distribution of some taxa were also very obvious. Moving forward, color information is being used to aid classification of the images, as well as the extraction of features giving information on the imaged plankters (e.g., gut fullness, size of lipid stores).

A Mountainous Coastline Fertilizes the Ocean

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The Gulf of Alaska (GOA) is known to be one of the ocean's largest iron-limited ecosystems, yet we lack a quantitative understanding of its sources of iron (Fe). An abundant supply of Fe in coastal regions permits complete utilization of the macronutrient nitrate there, driving high productivity. In turn, it is the reduced flux of Fe to surface waters farther offshore that prevents complete nitrate utilization and therefore limits productivity. However, despite the known importance of Fe as a micronutrient, the mechanisms that supply Fe to coastal and offshore surface waters, and thereby sustain the productive GOA ecosystems, are not well quantified. In this work we identify key mechanisms that supply Fe to northern GOA surface waters seaward of the continental shelf. Using wind speeds and directions inferred from NASA's QuikSCAT satellite, we show how the geomorphology of the landscape plays an indispensable role in driving the transport of Fe from Fe-rich coastal sites to open-ocean surface waters where Fe is in short supply. Strong offshore winds channeled through mountain gaps occurring at several locations across ~1,000 km of the southern Alaska coastline transport Fe from glacial flour-derived dust to surface waters. Published work also shows that these same winds induce Fe transport to surface waters from upwelling and eddies. Finally, the curvature of the coastline from ~Cordova to ~Kodiak causes eddies to travel along the continental shelf as they move westward, also enhancing offshore Fe transport. The geomorphological configuration of the landscape itself thus drives fluxes of Fe to the marine ecosystem from dust, eddies and upwelling. This iron supply sustains marine ecosystems seaward of the continental shelf, where iron is the limiting nutrient. This iron supply therefore likely enhances the survival and return of salmon to terrestrial landscapes of southern Alaska, where they, in turn, supply essential marine-derived nutrients. Many of the processes driving the Fe fluxes are undergoing change, with unknown consequences for ecosystems.

Dispersal, Cross-Shelf Transport, and the Delivery of Larval Arrowtooth Flounder (*Atheresthes stomias*) to Suitable Nursery Habitats in the Gulf of Alaska

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For marine fish with ontogenetic habitat requirements such as a pelagic larval stage and a demersal juvenile stage, survival is dependent upon dispersal and transport trajectories that facilitate spatial and temporal coupling between life-stage transitions and access to suitable habitats. Arrowtooth flounder (*Atheresthes stomias*), an ecologically important predator, spawns along the continental slope in water depths of ~400-500 m, and after a pelagic larval duration that spans multiple months, late-stage larvae settle to obligate juvenile nursery habitats in shallower water on the continental shelf. The successful transition between the pelagic larval stage and benthic associated juvenile stage is influenced by two major processes: 1) dispersal and along-shelf transport of larvae, and 2) cross-shelf transport from offshore pelagic environments to high quality nursery habitats on the continental shelf. Here we utilize an Individual-Based Biophysical Model (IBM) for the years 2000-2011 paired with a juvenile nursery habitat suitability model to determine the mechanisms and transport trajectories that promote coupling between these critical processes for arrowtooth flounder. IBM results suggest that inter-annual oceanographic variability influences larval along-shelf transport with implications for local retention, long distance dispersal, and connectivity across the Gulf of Alaska. For larvae that are advected offshore, submarine canyons that are spatially and temporally persistent features are important conduits of shelf-ward transport. However, transient oceanographic features such as eddies influence local retention and the geographic location of cross-shelf transport as well as the degree to which larvae are transported to high quality nursery habitats. These findings suggest that in heterogeneous marine environments, dispersal, retention, and transport trajectories are mediated by the interaction between persistent topographic features and transient climatic and oceanographic processes that ultimately affect survival and recruitment.

Refining Monitoring Efforts for Improved Stock Assessment of East Side Cook Inlet Razor Clams

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In Alaska, the largest Pacific razor clam sport fishery occurs on a roughly 50-mile sandy, intertidal beach in East Cook Inlet along the western shore of the Kenai Peninsula. This stock and fishery has been monitored by the State of Alaska Department of Fish & Game (ADF&G) since 1965. Currently ADF&G's Division of Sport Fish assesses the status of the stock with: 1) harvest trends, 2) size and age compositions of the harvest, and 3) abundance within specific beaches. Beginning in the mid-2000s this stock experienced a shift in productivity which ultimately led to the closure of the sport fishery in 2015. During this shift in productivity, annual monitoring efforts. Additionally, refinement of historical data has been done for comparing recent trends and the use of UAVs has facilitated habitat quantification and assessment. This work has identified that clam recruitment to these beaches has been highly variable between beaches and years. Natural mortality rates in recent years has been well above the assumed historical rate and differ annually between beaches. In 2015 and 2016, two large recruitments occurred which have potential to support some sport harvest opportunity in a few years. The refinement of monitoring efforts has led to a better understanding of the productivity of this stock and has identified the current limitations to rebuilding of the stock.

Metagenomic Assays to Assess Alaskan Marine Community Species Identities, Diversity, Representation, and Population Patterns

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Ecological sampling depends on accurate taxon identification, delineation, and abundances, yet is time consuming, expensive, involves considerable taxonomic expertise, and often is thwarted by lack of diagnostic morphological characters. Targeted metagenomic analyses entailing field sampling, high-throughput sequencing, and bioinformatics offer means to rapidly and accurately simultaneously characterize the species diversity and compositions of entire communities, including rare and cryptic taxa, along with their relative representation and population genetics. We present results of diagnostic high-throughput Illumina MiSeq assays developed to analyze communities of invertebrates and fishes for environmental (e)DNA water samples from the field, zooplankton net tows, and aquarium experiments. These analyses are especially useful for assessing species diversity responses of marine communities to changing conditions, including ocean acidification, temperature, and hypoxia. We also present examples of their use to discern population genetic variation, in context of temporal and spatial patterns. In our procedure, samples are quantified using synthetic internal standards for representative key taxa during PCR, and used to establish thresholds for potential error. Our custom bioinformatic pipeline assesses sequence read quality and output, and matches with database taxa reference sequences. Results from these metagenomic analyses demonstrate considerable application across marine ecosystems at a scale, accuracy, complexity, and capacity for automation not otherwise feasible.

Salmon Blitz: Engaging Citizen Scientists in Documenting Salmon Habitat in the Copper River Watershed

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An understanding of Pacific salmon habitat use at all life stages is necessary to protect and sustain Alaska's wild salmon populations into the future. Alaska Department of Fish & Game's (ADF&G) Anadromous Waters Catalog (AWC) is used to document all known rearing and spawning habitat of anadromous fish. However, due to the vast number of streams in Alaska and limited resources, not all salmon streams are currently listed or have detailed information about their use (e.g., rearing and/or spawning). The Copper River Watershed Project has worked with ADF&G and other partners throughout the watershed to develop and implement Salmon Blitz, a citizen science program designed to engage community volunteers in field surveys to collect data needed to nominate additional habitats to the AWC, and to provide more spatial and temporal detail for habitats currently listed in the catalog. This project provides important data to inform management of salmon as well as hands-on learning opportunities for participants. By connecting people with their surroundings and deepening their understanding of the resources on which they depend, we hope to instill a greater sense of engagement and responsibility for the long-term health of the region's salmon. Over the course of four field seasons, over 450 volunteers completed 98 surveys at 80 sites, resulting in 36 nominations. Nominations included 34.5 new stream kilometers, 221 acres of new lakes and wetland complexes, and 10.2 km of upstream extent added to cataloged streams. New species were nominated for 20.5 km of cataloged streams and life stage designation was added for 31.3 km of cataloged streams. With 100% of nominations accepted by ADF&G to date, Salmon Blitz demonstrates the effectiveness of citizen science for collecting quality data to inform salmon management efforts in Alaska.

Puffins as Samplers of Forage Fish: Variation in Length and Condition Relative to Ocean Climate in the Gulf of Alaska

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To better understand food web dynamics in remote regions of the North Pacific, we examined how ocean climate variability affects forage fish size and body condition, an index of "prey quality" for predators. We hypothesized that body size and condition varies on multiple temporal and spatial scales relative to the ocean- climate conditions that regulate ecosystem productivity in the Gulf of Alaska. To test this hypothesis, we examined body size and condition of forage fish sampled by puffins at sites in the region using data in the Alaska Puffin Diet Database (APDD), which contains length and mass records of forage fish based on collections made from 1978 to 2015 by several organizations. We extracted ~70,000 records from the database for length and mass of age-0 and age-1+ individual forage fish. In our initial analyses, we describe temporal and spatial variation in length and condition as related to variability in ocean climate (sea level pressure, sea surface temperature, current flow rates) at three sites in the Gulf of Alaska. We found differences between sites and within and between seasons for length and condition measurements, some of which appear to be related to variation in growth in different sub-regions of the Gulf of Alaska. These differences may also explain variation in population age structure (proportion age 0 vs. age 1+) between coastal southeast, central offshore, and coastal western regions. This work demonstrates the utility of using predator diets to promote a greater understanding of marine ecosystem form and functions over time.

Interseasonal Movements and Non-breeding Locations of Aleutian Terns (*Onychoprion aleuticus*)

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The Aleutian tern (ALTE; *Onychoprion aleuticus*) is an iconic and rare colonial nesting seabird whose basic biology is poorly understood. ALTE numbers in Alaska have declined on the order of 80% or more over the past 30 years to an estimate of little more than 5,000 birds, which is, at best, 15% of the global population (combining Alaska and eastern Russia). In comparison to many migratory seabirds, essentially nothing is known about non-breeding migration and distribution of ALTE, except anecdotal evidence that the species has been observed in Southeast Asia. We present the known information on migration and non-breeding areas from published notes and non-published records. We also provide detailed information on the migration pattern, timing, and non-breeding locations of Aleutian Terns deployed with geolocators from Yakutat, AK (2010-2016). Data from the recaptured birds ($n = 6$) showed a one-way migration over 10,000 mi (one of the longest bird migrations recorded) to and from Southeast Asia and Austral-Asia with primary destinations of Indonesia, the Philippines, and Papua New Guinea. There were fall migratory bottlenecks in the Luzon Strait between southern Taiwan and the Philippines and in the Sea of Japan. Bottlenecks on the spring return were located in the northern Philippines, the Taiwan Strait close to mainland, and in pelagic waters east of Japan. Southern migration took 1 - 3 month and the return took < 1 month. We discuss our September 2016 surveys in Indonesia (Sunda Strait, Jakarta Bay, and west Bali), the initial outreach with agencies, universities, and non-governmental organizations in Indonesia, as well as conservation insights from across the East Asian Flyway. We also discuss how resolution of location data has been enhanced with current projects and future efforts to improve assessments for ALTE conservation in Indonesia.

Investigating Aleutian Tern Breeding and Foraging Ecology Using Satellite Telemetry

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Observed numbers of Aleutian terns (*Onychoprion aleuticus*) at known breeding colonies in Alaska have dramatically declined over the last several decades (Renner et al. 2015). To further interpret these data, we investigated the use of satellite telemetry to observe breeding season movement patterns. Fifteen Aleutian terns were fitted with 2 g satellite telemetry tags early in the 2017 breeding season (n = 8 near Dillingham and n = 7 near Yakutat) and eleven tags provided movement data throughout the breeding season. Tagged terns exhibited moderate scale movements, with the maximum distance from their respective capture sites ranging from 42 to 282 km by individual. No tagged terns displayed extended fidelity to their capture location and follow-up surveys indicated nest and/or colony failure at both sites, presumably due to a large suite of documented predators. In the Yakutat area, tagged terns visited the majority of previously documented colony sites and spent extended periods at locations with active nesting. In the Dillingham area, movements of tagged terns indicated several previously undocumented colony sites, with successful fledging at least two locations. Tern foraging activity was focused in marine and brackish waters. Around Yakutat, terns foraged across the continental shelf with some trips to the shelf break up to 100 km offshore. Around Dillingham, terns foraged closer to shore and in the estuarine habitats of Bristol Bay. Our initial results demonstrate that sufficiently miniaturized satellite telemetry tags are useful tools to study movements of Aleutian terns and can help assess within-season colony attendance patterns, identify previously unknown colony sites, and help characterize important foraging habitats.

Experimental Harvests of Gull Eggs in Glacier Bay National Park

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In 2014, congressional legislation was passed to allow harvest of glaucous-winged gull (*Larus glaucescens*) eggs at up to 15 locations in Glacier Bay National Park by Hoonah Indian Association (HIA) tribal members. While the National Park Service (NPS) works toward promulgating the park regulations necessary to implement a legal harvest of gull eggs, park biologists and HIA are collaborating on experimental harvests to determine best-practices and potential impacts of a harvest. In 2015, we conducted an experimental egg harvest to determine the effects of harvest on egg size in first clutches versus replacement clutches as decreasing egg size is correlated with lower chick survival and may indicate limited food resources. We found no significant difference in egg size of harvested (n = 97) versus replacement (n = 20) eggs. In 2016, an experimental egg harvest was planned but not conducted due to record low numbers of gull eggs. In 2017, we conducted the second experimental egg harvest in the park to determine whether egg quality, as determined by human consumption of harvested eggs, varies depending on the number of eggs present in a nest. Glaucous-winged gulls typically lay 3 eggs over the course of 5 days and begin incubating once the clutch is complete. Eggs do not begin to develop into chicks until incubation begins. For this reason eggs from 3-egg nests may be further developed than eggs from nest with 1 or 2 eggs, and the edibility of these developing eggs may be compromised. Harvesters collected 75 eggs from 1- or 2-egg nests and 68 eggs from 3-egg nests. Survey results from egg recipients found that 13% of the eggs from 3-egg nests were inedible due to chick development compared to 3% from 1- and 2-egg nests. This information can help harvesters make decisions on nest selection to maximize edibility of eggs during future egg harvests. The NPS and HIA will continue to collaborate by joining traditional ecological knowledge and practices with park research to ensure long-term stability of our resources.

Combining Spatiotemporal Models and Aerial Photographic Techniques to Estimate Sea Otter Colonization and Abundance in Glacier Bay, Alaska

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Following extirpation by the commercial fur trade prior to 1911, sea otters (*Enhydra lutris*) were reintroduced to southeastern Alaska in the late 1960s. By the late 1980s, sea otters had expanded their range to lower Glacier Bay and in recent years their distribution has extended into the upper East and West Arms of Glacier Bay. Currently, sea otters are one of the most abundant marine mammals in Glacier Bay. To facilitate a robust long-term monitoring program for sea otters in Glacier Bay, we developed 1) a Bayesian spatiotemporal model to understand the ecological processes that influence sea otter distribution and abundance; and 2) aerial photographic techniques using manned aircraft to monitor sea otters over space and time. The statistical framework accounts for several issues including multiple levels of detection probability, multiple data sources, and computational limitations that occur when making inference over a large spatiotemporal domain. The aerial photographic methods result in high-resolution (< 2 cm) digital images that can be used to count sea otters, reduce observer bias, and provide a permanent record that can be independently verified. The digital images of sea otters also provide opportunities for developing automated techniques for counting sea otters from digital imagery and for quantifying nearshore habitat covariates, such as kelp. Combining the statistical framework with aerial photographic techniques results in an adaptive monitoring design that allows for minimizing uncertainty, maximizing survey efficiency, and maximizing safety. Collectively, these new methods provide a foundation for long-term monitoring of the spatial distribution and abundance of sea otters and for understanding the influence of sea otters on nearshore communities in Glacier Bay. Ultimately, these methods could be extended to unmanned aerial systems (UASs) and could be applied to estimate sea otter distribution and abundance in other regions of the North Pacific Ocean.

Estimating the Population Size of a Coastal Cetacean with Highly Variable Group Sizes From Aerial Survey Data

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Group size estimation is a major source of uncertainty in abundance estimates for species that aggregate in groups ranging from a few individuals to several hundred, including many small cetacean, pinniped, and seabird species. While substantial research effort has been dedicated to estimating group detection probabilities and group densities in vessel- and aerial-based surveys, less effort has been focused on group size estimation. Our research objective was to develop a modeling approach for estimating the abundance of species that aggregate in a range of group sizes. Here we demonstrate this approach through an application to the endangered population of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, using video aerial survey data. Conventional methods for estimating group sizes and abundance using video/observer data from aerial surveys involve application of a series of correction factors to account for groups that were available to the survey but not detected, and individuals within groups that were not available for counting or were available but not detected during a count. Conventional methods generally cannot account for groups that were not available because they were outside the survey area. Our modeling approach incorporates two significant innovations: 1) an objective and transparent approach to account for groups that were not available to the survey, and 2) a new method for estimating the number of individuals that were available during video scans but not detected. While surveys are typically designed to be consistent across years, factors beyond the control of the survey team (such as weather and the distribution or behavior of the surveyed population), imply that some interannual variation in the observation process is inevitable. Our modeling approach partitions variation in the observed data between two sources: true changes in abundance and variation in measurement error. Our results thus strengthen understanding of the uncertainty surrounding abundance estimates and allow for clear probabilistic statements about population size and trends for Cook Inlet beluga whales over the period 2004 to 2016. Key aspects of the modeling approach demonstrated here are relevant to abundance estimation for other Alaska marine species that aggregate in a wide range of group sizes.

It's Not What You Might Think – DNA Profiling From ‘SnotBot’ Samples of Whale Blows

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Unmanned Aerial Vehicles (UAVs) are finding a role in an increasing number of wildlife studies. For whales and dolphins, UAVs offer the potential to collect high definition video and photographs with little or no disturbance. Through photogrammetry, these images can be used for assessment of physiological condition, individual health and scarring from past entanglement. Here we assessed the potential to extract and amplify both nuclear and mitochondrial DNA from ‘blow’ samples collected as part of ‘SnotBot’ trials with humpback whales in southeastern Alaska (2016 and 2017) and blue whales in the Gulf of California (2017). The primary objective was to link the aerial images to the individual identification and sex of the whale by DNA profiling, allowing integration with extensive life history records of individuals in these populations. A parallel effort attempted to extract hormones for assessing stress and pregnancy. For the trials, a UAV fitted with sterile Petri dishes was flown into the vaporous exhalation of the whale. We tested several methods for preserving the blow condensation in the field and for subsequent extraction of DNA in the laboratory. The results to date confirm the potential to provide partial or complete DNA profiles sufficient for mtDNA haplotypes (400 bp), sex and individual identification by genotyping. From a total of 47 samples analyzed to date, 30 provided an mtDNA haplotype, 22 provided sex identification and 8 provided 4-6 microsatellite genotypes for individual identification. Two of the humpback whales were matched by DNA profiles to a large collection of genetic samples for this regional population. One of these was first sampled in northern British Columbia in 2005

and the other in southeast Alaska in 2014. The individual sampled in northern British Columbia was also linked by an associated photo-identification record to a migratory destination in Hawaii. Given the success to date, we consider that further field trials and laboratory optimization are likely to provide substantial improvement to the recovery of full DNA profiles.

Watching Whales in Juneau, Alaska: The Many Dimensions of This Thriving Tour Industry

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Juneau's booming whale-watching industry has grown to include over 70 commercial vessels and caters to nearly 250,000 tourists each summer, making it one of the largest in the world. This industry generates substantial economic revenue for Juneau and provides hundreds of seasonal job opportunities. However, as vessel activity around whales has increased along with passenger traffic in local harbors, so too have concerns for 1) the welfare of whales being exposed to heightened vessel traffic and 2) the community culture and infrastructure which has had to adapt to accommodate this growing industry. Here, we consider recent and ongoing research to help explain the complicated dynamics at play related to this industry, identify the elements that are problematic, and investigate which elements can be managed. We discuss the options and hurdles in management for this wildlife resource, including impact to humpback whales, existing legal protections, human dimensions, the role of NOAA fisheries, and an overview of existing programs and efforts to alleviate issues within this industry. Specifically, we highlight NOAA Fisheries' Whale SENSE program, a voluntary stewardship and recognition program for whale-watching operators developed on the East Coast and adapted to Alaska in 2015. Participants in the program agree to operate vessels responsibly following precautions above and beyond existing approach regulations, encourage ocean stewardship by setting an example for other boaters, provide educational and conservation material to passengers, and notify appropriate networks about marine mammals in distress. NOAA Fisheries recognizes participants for their efforts via local media outlets, the Whale SENSE website, social media, and an industry award program. In Juneau, the program has been adopted by nearly all whale-watching tour companies and, based on industry feedback, has improved vessel behavior, education, collaboration, and stewardship. Additional tools may be necessary to address further angles of this complex management challenge. By presenting a holistic examination of Juneau's whale-watching industry, which considers biological and human dimensions as well as management obligations and limitations, we hope to provide a case study which includes practical tools that can be explored for similar resource management challenges.

A Holistic Approach to Reducing the Chance of Lethal Ship-Whale Collisions in Alaska

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Lethal ship-whale collisions (ship strikes) constitute a recurring threat to large cetaceans across the globe. While re-routing ships around historically important whale aggregation areas is often effective in reducing the relative or absolute risk of collisions, in many areas this management approach is not feasible. In those instances, managers have focused on reducing ship speeds to allow mariners more time to avoid whales or conveying near real-time information to mariners that whales have been detected in an area. The effectiveness of these efforts is contingent, in part, upon the largely unexplored assumption that operators of large vessels, such as cruise ships in Alaska, can play an active role in whale avoidance. Using data collected by observers aboard more than 700 cruise ships and work with marine pilots using a ship simulator, here we conceptualize active whale avoidance by defining observational and operational constraints. Observational constraints are defined by the availability process, such as how often a whale provides cues (e.g., spout frequency) that it's in the vicinity of an approaching ship, and the detection process, which represents the probability one of those cues is detected given it is available. Operational constraints encapsulate processes that affect a ship operator's ability to change course or speed, which includes the steps necessary to confirm a whale's direction of travel once detected, choose and communicate an appropriate avoidance maneuver, and factors that dictate how quickly the commanded operation, such a new course or speed, is achieved once initiated. Using a cruise ship simulator to help parameterize these factors, we introduce the concept of a Minimum Detection Distance (MDD) defined as the context-specific, minimum ship-to-whale distance at which bridge personnel must detect a whale to allow for an effective and safe avoidance maneuver. Using simulation, we found that the MDD varied from 1,100 to 2,300 m depending upon conditions. We close with recommendations for future training and encourage consideration of whale avoidance constraints in conservation and management efforts.

An Agent-based Model for Examining Parallel and Divergent Fishery Management Strategies for Transboundary Stocks

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Fisheries managers select from a suite of management measures and strategies to promote social benefits while preserving the productive capacity of fish stocks. However, where stocks are distributed across jurisdictions, then legal, social, or political considerations may prevent adoption of coherent management strategies. Lack of coherence in management of a transboundary stock could affect sustainability and reduce social benefits. We used an agent-based model to examine the viability of, and likely economic impact to, a nascent Alaska state-waters trawl fishery for walleye pollock (*Gadus chalcogrammus*) as it relates to a suite of available federal and state management strategies (e.g., individual fishing quotas, fishery cooperatives). Results were compared in terms of indicators such as variance of catch and quasi-rent value for the four communities most directly impacted by the pollock fishery in the Gulf of Alaska. The model may be used to inform managers of the underlying structure of catches and revenues in order to avoid undesirable consequences and improve the likelihood of reaching fishery management objectives.

Data Upstream: A Design Charrette for Data Visualizations

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This research seeks to make visible the complexity of long-term data archives and to document the labor that goes into data interoperability so that it does not get black boxed or subsumed into databases. Using qualitative research methods such as trace ethnography, participant-observation, and interviews, this research explores the work of the data task force team in synthesizing large data sets about Pacific salmon in Alaska. Created in varied social and technological eras, these data register the organizational structures and values of their time. This research is situated in a larger study focused on synthesizing the state of salmon data with the assistance of the National Center for Ecological Analysis and Synthesis and eight different working groups focusing on various research questions. To understand salmon fisheries in Alaska in such a comprehensive way, there is a need for datasets that are temporally and spatially distributed. The heterogeneity of this data contributes to potential for data limitations and gaps. However, the synthesis project aims to fill in those gaps or smooth over missing data in a number of ways. Ethnographic studies of scientific practices lays the groundwork for exploring design interventions. As such, this presentation will engage the audience in a number of ways to facilitate design perspectives on data visualizations of Alaska wild salmon data.

Ecosystem Variability in Lower Cook Inlet Across Trophic Levels, Space, Seasons, and Climate Regimes

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Over 5 years (2012-2016), we collected data on physical oceanography, phytoplankton, zooplankton, and seabird community composition in lower Cook Inlet quarterly throughout the year, and monthly for some stations and datasets. Of these years, 2012 and 2013 were part of the large-scale cold spell that started in 2007. Water temperatures rose dramatically in 2014 and remained elevated through 2016. This provided us with an exceptional opportunity to study how this shift in water temperature percolates through the physical marine environment and up the food web. Spatial and temporal effects were analyzed in separate steps. We interpolated data spatially from all samples combined using ordinary kriging. The relative contributions of the seasonal and climate regimes were quantified using a Bayesian generalized linear mixed model (GLMM) with using station-ID and year as random variables, season and climate regime (warm vs. cold years) as fixed variables. Models of physical parameters were fit using a Gaussian, models of plankton and seabird species densities were fit using an exponential error term. Spatial analysis revealed two main gradients, first an east-west component, primarily distinguishing Kachemak Bay from the rest of the inlet. The second major axis contrasted the western part of the inlet from the central and western parts. The Bayesian GLMM showed that temperature-related variables were most affected by the seasonal and climate-regime effects, as expected. For these variables, the seasonal component was about four times larger than the difference between warm and cold years. Salinity variables responded in the opposite direction, being fresher in summer and warm years than in winter or cold years. Phytoplankton, zooplankton, and seabird taxa showed diverse responses, with only phytoplankton taxa showing a positive correlation in the responses to and climate signals. Of the seabirds, common murre and shearwaters responded particularly strong to the climate signal. Our study, part of Gulf Watch Alaska, exemplifies the relative magnitude of the ecological response to a sudden step-like change in the physical environment of a

subarctic estuary. It remains to be seen how the system responds after reverting back to the long-term mean.

Nonstationary Gulf of Alaska Ocean-Atmosphere and Climate-Biology Relationships Under Different Modes of North Pacific Climate Variability

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The 1988-89 North Pacific climate shift was characterized by the deterioration of previously strong temperature-recruitment statistical relationships for a range of Gulf of Alaska (GOA) populations. These sorts of nonstationary biological responses to environmental variability are a long-standing problem in fisheries oceanography. Here, we present a new hypothesis to explain changing climate-biology relationships: nonstationary relationships among ecologically-important climate processes. Prior to 1988-89, the PDO mode dominated North Pacific climate variability, and Aleutian Low variability was high. Strong variability in the Aleutian Low co-occurred with strong covariance between GOA sea surface temperature (SST) and a suite of parameters driven by large-scale variability in sea level pressure (SLP), such as downwelling, freshwater input, salinity, and wind mixing. During this period, SST indexed a suite of intercorrelated climate parameters that acted on biological processes in a concerted way, which apparently contributed to strong SST-recruitment correlations. After 1988-89, the NPGO mode explained more variability in North Pacific climate, and Aleutian Low variability declined precipitously. This change was reflected in dramatic changes in spatial loadings for the leading axes of North Pacific SLP variability. Correlations between GOA SST and climate parameters associated with SLP variability weakened, producing diffuse climate forcing of biological processes, and SST-recruitment relationships largely disappeared. Statistical models invoking nonstationary climate-climate and climate-biology relationships in the GOA generally outperform stationary models, supporting our hypothesis of nonstationary relationships among ecologically-important climate processes. We conclude that the strength of correlation between SST and climate processes related to SLP variability may be important for understanding climate effects on the GOA ecosystem. We also propose a conceptual model for climate shifts, distinguishing between “driver-response” shifts like 1976-77 and “non-analogue” shifts like 1988-89. Distinguishing between these two types of climate shifts may aid efforts to understand the consequences of contemporary climate perturbations.

Detecting and Inferring Cause of Change in an Alaska Nearshore Marine Ecosystem: an Approach Using Sea Otters as a Component of the Nearshore Benthic Food Web

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Community composition, species abundance and distribution are expected to change while monitoring ecosystems over time, and effective management of natural resources requires understanding mechanisms contributing to change. Marine ecosystems in particular can be difficult to monitor, in part due to large, multi-dimensional spatial scales and complex dynamics. However, within temperate marine ecosystems, the nearshore food web is reasonably well described. This food web is ecologically and socially important, spatially constrained, and has been the focus of extensive experimental research that describes underlying mechanisms important to system dynamics. Here we describe a monitoring program initiated in 2006 that focuses on the nearshore benthic food web in the Gulf of Alaska, whose design anticipates potential causes of ecosystem change to improve rigor, resolution and confidence in understanding mechanisms underlying change. Employing a spatial design that allows broad spatial inference and selecting species with direct food-web linkages, we demonstrate the ability of our monitoring program to simultaneously detect change and assess potential mechanisms underlying of that change. Specifically, we provide an example focusing on the sea otter (*Enhydra lutris*) that illustrates how 1) analytical methods are used to evaluate changes on various scales and infer potential mechanisms of change, 2) food-web linkages can enhance understanding of changes and their

effects, and 3) data can be used to inform management. Detecting change and understanding mechanisms can help guide management and conservation policy.

Changes in Forage Fish During the Winter 2015-16 Seabird Die-off and the North Pacific Marine Heat Wave

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In the midst of an extended period of anomalously warm ocean temperatures in 2013–16 there was a widespread die-off of common murrelets in the northeast Pacific Ocean. Necropsies of beachcast birds from Prince William Sound and elsewhere in the Gulf of Alaska in the winter of 2015–16 revealed that birds were extremely emaciated, and evidence suggests that most deaths were due to the food supply, rather than disease, biotoxins or other factors. Concurrent with the die-off we observed several signs of declining quality and quantity of key forage fish species. Capelin had lower body condition in 2015 compared to 2012–14; these fish were longer but weighed less than they had in previous years. We also observed an absence of age-1 capelin during 2016 acoustic-trawl surveys in Prince William Sound, suggesting recruitment failure by the 2015 year class. Likewise for sand lance the 2015 year class exhibited low energy density as young-of-the-year fish in 2015 and as age-1 fish in 2016. Evidence from sand lance otolith annual growth rings indicated extremely slow growth from 2015 to 2016. Additionally, acoustic indices of forage fish abundance in 2015 were lower than 2014 or 2016. This was largely driven by low abundance of age-0 walleye pollock, which were widespread and abundant in the system in other years, particularly in 2012. Changes in the forage fish community were also observed on Middleton Island in 2014–16, when preferred species like capelin and sand lance were largely replaced by sablefish, salmon, and herring in seabird diets. Together this evidence suggests that the 2015–16 winter seabird die-off in the Gulf of Alaska was triggered by changes in quality and quantity of the prey base resulting from the persistence of warm ocean conditions in the preceding years. Continuing efforts by the Gulf Watch Alaska long-term monitoring program will provide important information on predator-prey interactions and their response to changes in the marine environment over time.

Unprecedented Scale of Seabird Mortality in the NE Pacific During the 2015-2016 Marine Heatwave

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Unusually large numbers of common murres (*Uria aalge*) washed ashore in pulses of mortality from May 2015 to March 2016 along the west coast of North America, and especially in the Gulf of Alaska. Following a shift in their distribution from offshore to nearshore environments, more than 58,000 dead or moribund birds were counted on beaches. However, total mortality was likely in the hundreds of thousands because only a fraction of dead birds are usually detected in such events. Whereas additional stressors (e.g., extreme winds, molt, biotoxins) may have contributed synergistically to mortality in some cases, we identified starvation as the principle cause of mortality. Given that murres can traverse the length and breadth of continental-shelf foraging habitats in days to hours, respectively, and forage throughout most of the water column

(to 200 m), mass starvation of murrens implies a shelf-wide scarcity of dense forage fish aggregations. Providing further evidence of prey scarcity, murrens also experienced an unprecedented frequency of total reproductive failure at multiple breeding colonies in Alaska during the summers of 2015 and 2016. Several other marine bird and mammal species in the region experienced mass starvation events or breeding failures during this same period. All mortality events coincided with a marine heatwave that developed in winter 2013-2014, intensified through 2015-2016, and ultimately created a zone larger than the continental United States where water temperatures exceeded long-term average by 2-3 standard deviations. We hypothesize that these sustained warm-water conditions reduced the abundance and availability of high-quality forage in the ecosystem by 1) creating thermal barriers to normal fish distributions, 2) reducing fish body condition and energy content, 3) lowering recruitment and adult survival, and, 4) massively increasing predation pressure on forage stocks by increasing the metabolic rates of ectothermic predatory fish. In summary, common murrens are sensitive indicators of changing prey resources owing to their high metabolic rates and energy demands. Thus, the unprecedented magnitude and geographic extent of the recent murre die-off may signal that a major disruption of food webs occurred in NE Pacific ecosystems as a result of the marine heatwave of 2014-2016.

Have Gulf of Alaska Humpback Whales Reached Carrying Capacity or Has the Blob Made the Food Web Screwy?

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North Pacific humpback whales in the Gulf of Alaska may be experiencing population level change. In Sitka Sound, along the outer edge of the eastern Gulf of Alaska, since 1980, long-term monitoring of humpback whales has documented abundance, prey choice, associations, rates of increase and reproductive parameters. Across 1986-2016, there was a significant decrease in the number of calves documented ($F_{1,27} = 33.2$, $p < .001$) with no calves sighted since 2013. In February 2017, an unusual number of whales stayed to feed in Sitka Sound, when typically the whales should be headed to or on the breeding grounds. An estimated 1 in 5 whales showed bones visible under the skin (skinny) or had heavy parasite loads with their bodies covered with cyamids (whale lice). The decline in calving rates, coupled with higher than normal number of whales present on the feeding grounds in winter with some individuals clearly unhealthy, may indicate the whales are experiencing nutritional stress. Two plausible hypothesis will be considered to account for decline. First, these whales may have reached or exceeded carrying capacity. Second, oceanic conditions, possibly from the blob, may have changed the food web sufficiently to alter the prey base, potentially creating a trophic shift. Either scenario would result in whales in poor health and low reproduction. While whale numbers have increased since the end of commercial whaling, making this a success story for recovering populations, intraspecific competition for food makes it harder for humpback whales to meet their annual energetic needs. To meet their energetic demands whales may need to lengthen their time feeding in the northern latitudes or by skipping the annual migration altogether. If humpback whales extended their time feeding in Alaska waters during the winter months, the result would likely be an increase in herring predation and a shift in ecosystem dynamics.

Plenary Session Abstracts

Wednesday, January 24

Plenary Sessions: Wednesday, January 24 -- Bering Sea/Aleutian Islands

TIME	TITLE	PRESENTER	SECTION
8:00 - 8:15 AM	What is the Crystal Ball Indicating with Respect to Extreme Climate Forcing Events in Alaska Waters?	Nicholas Bond	Climate and Oceanography
8:15 - 8:30 AM	Coastal Hazards 2012—Five Year Report Card on Baseline Data	Jacquelyn Overbeck	Lower Trophic Levels
8:30 - 8:45 AM	King Crab Zombification – Can Metabolites Tell Us How It Happens?	Leah Zacher	Lower Trophic Levels
8:45 - 9:00 AM	Estimating Krill Abundance and Spatial Distribution Using an Optical Plankton Imaging System and Multifrequency Echo Sounder	Hongsheng Bi	Lower Trophic Levels
9:00 - 9:15 AM	Sea Urchin Demography and Ecosystem Consequences Across the Aleutian Archipelago: A Story From the Top-Down, Bottom-Up, and Side-to-Side?	Benjamin Weitzman	Lower Trophic Levels
9:15 - 9:30 AM	Quantifying Seafloor Contact and Clearance in Commercial Fishing Gear	Brianna King	Fishes and Fish Habitats
9:30 - 10:00 AM	BREAK		
10:00 - 10:15 AM	Monitoring survival of Trawler Deck-Released Pacific Halibut, Using Satellite Reporting Accelerometer Tags	Craig Rose	Fishes and Fish Habitats
10:15 - 10:30 AM	Juvenile Chinook Salmon Abundance in the Northern Bering Sea: Implications for Future Returns and Fisheries in the Yukon River	Jim Murphy	Fishes and Fish Habitats
10:30 - 10:45 AM	How Consistent are Declines in the Size and Age of Alaska Salmon?	Krista Oke	Fishes and Fish Habitats
10:45 - 11:00 AM	Exploring the Potential Role of an Apex Marine Predator: Prey Consumption Estimates of Salmon Sharks in North Pacific	Kaitlyn Manishin	Fishes and Fish Habitats
11:00 - 11:15 AM	Using red-legged kittiwakes to understand spatial and oceanographic patterns of mercury in the northwestern Pacific and Bering Sea	Abram Fleishman	Seabirds
11:15 - 11:30 AM	Plastics and Phthalate Plasticizers in Aleutian Seabirds	Veronica Padula	Seabirds
11:30 - 1:00 PM	LUNCH - BREAK ON YOUR OWN		

Plenary Sessions: Wednesday, January 24 -- Bering Sea/Aleutian Islands

TIME	TITLE	PRESENTER	SECTION
1:00 - 1:15 PM	Fasting Status of Steller Sea Lion Pups as an Index of Potential Nutritional Stress in Decreasing and Increasing Metapopulations	Stephanie Crawford	Marine Mammals
1:15 - 1:30 PM	Fur Seals, Fish, and Saildrones: A Test of Unmanned Surface Vehicles to Examine Relationships Between Northern Fur Seals and Their Prey	Carey Kuhn	Marine Mammals
1:30 - 1:45 PM	Habitat Selection and Seasonal Movements of Young Bearded Seals (<i>Erignathus barbatus</i>) in the Bering Sea	Michael Cameron	Marine Mammals
1:45 - 2:00 PM	Ecological Atlas of the Bering, Chukchi, and Beaufort Seas	Melanie Smith	Human Dimensions
2:00 - 2:15 PM	Patterns and Trends in Salmon Fishing on the Yukon River	Caroline Brown	Human Dimensions
2:15 - 2:30 PM	Predicting Future Management and Catch Under the Bering Sea and Aleutian Islands Ecosystem Cap	Amanda Faig	Human Dimensions
2:30 - 3:00 PM	BREAK		
3:00 - 3:15 PM	Aleutian Archipelago Nearshore Community Variation Following the Loss of a Keystone Species	Jacob Metzger	Ecosystem Perspectives
3:15 - 3:30PM	Examining the Ecological Role of Jellyfish in the Eastern Bering Sea Ecosystem	Jim Ruzicka	Human Dimensions
3:30 - 3:45 PM	Effects of Warming Climate, Fishing, and Basin-Scale Stocking on Life-History Characteristics of Alaska Sockeye Salmon	Daniel Schindler	Ecosystem Perspectives
3:45 - 4:00 PM	Differential North-South Ecosystem Response of Juvenile Marine Growth Rates for Chinook Salmon (<i>Oncorhynchus tshawytscha</i>) from the Yukon and Kuskokwim Rivers in the Eastern Bering Sea, 1972-2010	Ellen Yasumiishi	Ecosystem Perspectives
4:00 - 4:15 PM	A Qualitative Modeling Approach to Assess the Potential Effects of Management Actions and Environmental Changes on Pribilof Islands Blue King Crab (<i>Paralithodes platypus</i>)	Jonathan Reum	Ecosystem Perspectives
4:15 - 4:30 PM	The Evolution of a Management-Operational Atmosphere-to-Fish Ecosystem Modeling Suite From the Bering Sea Project	Kerim Aydin	Ecosystem Perspectives
4:30 - 4:45 PM	Using Alaska Marine Ecosystem Science to Inform Fisheries Management	Stephani Zador	Ecosystem Perspectives
4:45 - 5:00 PM	Best Student Poster Presentation Winners Announced		

What is the Crystal Ball Indicating with Respect to Extreme Climate Forcing Events in Alaska Waters?

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The frequency and magnitude of extreme physical oceanographic conditions in Alaska waters during the next 50 years are being investigated using the global climate model simulations carried out for the Coupled Model Intercomparison Project Phase 5 (CMIP5) in support of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). Our analysis considers separately four different habitats: the southeast Alaska panhandle, western Gulf of Alaska, southeast Bering Sea shelf, and Aleutian Islands. We focus on variables in the global model projections that are relevant to the ecosystem, including surface and sub-surface temperatures, mixed layer depth, upper ocean stratification, and transport associated with major ocean currents. A multi-model ensemble approach is used towards the development of robust estimates of probability density functions (pdfs) for the regions of interest. This approach provides a means for quantifying the “structural” uncertainties associated with differences in model formulations and for ranking the models in terms of the magnitudes of their projected changes. The latter information is crucial for related studies that consider a subset of global climate models in dynamical downscaling of the effects of the climate forcing on regional ecosystems and marine resources.

Coastal Hazards 2012—Five Year Report Card on Baseline Data

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Many of Alaska's rural communities are adversely impacted by coastal hazards such as flooding, erosion, or a combination of both. An ad hoc working group led by the Alaska Ocean Observing System, Western Alaska Landscape Conservation Cooperative and USGS Alaska Climate Science Center conducted a workshop in 2012 to identify research priorities to address these hazards. Specific data needs identified from the workshop fell into five broad categories: (1) water levels, (2) waves, (3) bathymetry, (4) topography, and (5) sea-ice. These data are necessary for flood mapping and forecasting, estimates of sea level rise or fall, shoreline mapping, erosion modeling, and many other incidental but important uses not associated with coastal flooding or erosion. Baseline data are also necessary for engineering mitigation structures in the nearshore, community planning for coastal resilience and adaptation, and prioritizing needs-based resource distribution from state and federal agencies. Considerable progress has been made over the last five years to collect some of these baseline datasets. This presentation will highlight the progress of statewide efforts to collect baseline data in the coastal zone, identify existing gaps as they affect each region of Alaska and suggest a possible path forward for continuing progress. A second presentation focuses on the progress associated with coastal mapping tools and models.

King Crab Zombification – Can Metabolites Tell Us How It Happens?

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King crab are an essential component of Alaska seafloor ecosystems, and they support highly productive fisheries; thus, changes in king crab abundance can have far-reaching impacts. Parasites can represent a substantial stressor in crustacean populations, rendering previously healthy stocks more vulnerable to fishing pressure. The parasitic (rhizocephalan) barnacle, *Briarosaccus*, can infect all commercially harvested Alaska king crab species. Once infected, the crab act like “zombies”, becoming mere bodies controlled by this internal parasite. Infected crab can no longer reproduce. Instead, they raise and tend the parasite’s eggs. Currently, infected crab are rare in Alaska waters (< 1% prevalence); however, localized outbreaks have historically occurred. Despite the ability of this parasite to prevent host reproduction and potentially alter host abundance, very little is known about environmental factors influencing prevalence or the physiological changes that occur in an infected crab. We applied the newly emerging metabolomics technique to compare the metabolite profiles (e.g., signaling molecules and products of body’s metabolism) of infected and healthy red (*Paralithodes camtschaticus*) and golden (*Lithodes aequispinus*) king crab. Tissue samples (hemolymph, hepatopancreas, and muscle) were collected in Southeast Alaska during surveys and on commercial vessels with observers. After processing, hundreds of metabolites were identified and used to distinguish infected and healthy crab. These findings help us understand how the internal physiology and reproduction of king crab is altered when infected by the parasite, *Briarosaccus*.

Estimating Krill Abundance and Spatial Distribution Using an Optical Plankton Imaging System and Multifrequency Echo Sounder

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Euphausiids are key components of Bering Sea food web as they link lower and higher trophic levels by preying on small plankton while serving as a primary food source for upper trophic levels including fish, whales, and seabirds. Existing estimates of their abundance showed extreme large variation among different techniques. Acoustics have been used in region to estimate krill abundance, but the accuracy was hampered by the ability of distinguishing krill from large copepods, determining krill orientations, and identifying signals for different developments stages. In the present study, we deployed an optical imaging system, PlanktonScope, and a Simrad multifrequency echo sounder simultaneously in the southeastern Bering Sea in May 2016 to estimate euphausiid abundance. An automated image processing procedure was used to extract information on euphasiid from the imagery data from PlanktonScope including abundance, size, and orientation. Empirical models were developed to summarize information size and orientation which could then be used to calibrate estimates from acoustics. A concrete estimate of euphausiid abundance and spatial distribution will provide insights on predator distribution.

Sea Urchin Demography and Ecosystem Consequences Across the Aleutian Archipelago: a Story From the Top-Down, Bottom-Up, and Side-to-Side?

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The productivity of nearshore ecosystems across the Aleutian Archipelago have varied substantially as a result of both environmental change and food web modification. Following sea otter population declines in the 1990s, their dominant prey, sea urchins began to deforest the rich kelp forests and the benthic ecosystem shifted to an urchin barren state. The degree of deforestation varies, as sea urchin grazing impacts to benthic food webs depend on local urchin density and size structure. However, the majority of Aleutian nearshore ecosystems have existed in an urchin-dominated state for over 20 years, and a phase shift due to sea otter recovery does not appear likely in the foreseeable future. A deeper understanding of factors shaping sea urchin demographics will provide research and management agencies with needed information on drivers shaping ecological patterns in the absence of sea otters. Here, we report on spatial patterns of sea urchin demography over last 40+ years and elucidate probable drivers of these patterns, from biotic and abiotic sources. At broad spatial scales, patterns of sea urchin density and size structure were correlated with major oceanographic regions of the western, central, and eastern Aleutians, delineated by large oceanic passes between island groups. Within these regions, patterns of variability also emerged among islands as a result of differing apparent recruitment rate, time elapsed since sea otters declined, and degree of physical variability. Contemporary patterns of apparent sea urchin recruitment likely reflect climatic and oceanographic effects on larval life stage, as well as complex species interactions with the surrounding community immediately post-settlement. Understanding the drivers of sea urchin demography will provide insights to the processes governing ecosystem structure and productivity across the Aleutian Archipelago in the face of global climate change and the continued ecological absence of sea otters.

Quantifying Seafloor Contact and Clearance in Commercial Fishing Gear

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The act of pursuing and catching benthic and demersal fish species requires operating fishing gear on or very near the seabed, resulting in direct gear-seabed contact. Although Alaskan walleye pollock is targeted with midwater trawl gear, pollock are often located in the demersal zone, resulting in direct gear-seabed contact. Based on expert opinion from the industry, the current contact-adjusted swept area index used in the Fishing Effects model (used by the North Pacific Fishery Management Council for monitoring adverse fishing effects on Essential Fish Habitat) ranges from 20% to as high as 90%. These adjustments are not based on empirical observation of the gear, because to date there has only been one study (Rose et al. 2016) that has quantified contact of midwater gear, and this study focused on alternative materials for a footrope. This study builds on the work of Rose et al. (2016) by observing bottom contact on a standard pelagic footrope (bare chain). Field work was conducted in August 2017, in which multiple accelerometry-based bottom-contact sensors were deployed on pollock gear. A camera was deployed to monitor the behavior of the sensors to ground-truth their results. Further ground-truthing was conducted in land-based trials to verify the data obtained on the vessel. Preliminary analyses suggest that less contact is occurring than what is assumed in the current Fishing Effects model. The data obtained from this charter will provide insight into pelagic trawl net near-seafloor performance and behavior, provide better data for seafloor contact mitigation, and inform a 3-dimensional clearance-indexed Fishing Effects model. This talk will present the results from the August 2017 fieldwork.

Monitoring Survival of Trawler Deck-Released Pacific Halibut Using Satellite Reporting Accelerometer Tags

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Under existing catch handling regulations for Bering Sea trawl fisheries, trawl-caught Pacific halibut, *Hippoglossus stenolepis*, cannot be released prior to observer sampling in vessels' fish processing factories. The resulting delayed release can increase halibut discard mortality. In response, trawlers are working with NMFS to develop methods to quickly sort and release halibut from catches on deck, while accounting for their numbers, size, and viability score. To evaluate expedited release efforts, we used satellite tags equipped with accelerometers to monitor activity of 160 halibut for up to 60 days following their deck-release from three trawlers targeting flatfish in the Bering Sea. Twenty tags were also deployed to provide context for interpreting fish survival following trawl releases. Ten longline-caught halibut selected to be in excellent condition were tagged to characterize 'natural' fish activity, along with tags on six seafloor anchors and four on halibut carcasses. At 2-hour intervals, tags summarized and recorded two acceleration metrics for transmission upon tag surfacing, either through timed release or earlier separation from the fish (e.g., attachment failure or breakup after death). Changes in tag tilt beyond pre-defined thresholds were assumed to represent active swimming behavior; continued lack of activity indicated mortality events. Environmental, operational data, as well as fish size and viability were collected to quantify the capture and handling experience for each tagged halibut. Survival outcomes from two sampling trips corresponded well with estimates associated with observer-based viability scores, but were much lower from the third trip. In lieu of viability assessment scores, we found that time-on-deck, fish length, and tow duration, were the best predictors of halibut survival. Together, these factors had comparable explanatory power as viability scores alone, but best predicted survival in combination with viability. This suggests a range of available methods to monitor halibut survival.

Significant variability between vessels and target fisheries suggest that additional data will be needed to fully characterize survival rates for deck-sorting operations.

Juvenile Chinook Salmon Abundance in the Northern Bering Sea: Implications for Future Returns and Fisheries in the Yukon River

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Juvenile Chinook salmon abundance in the northern Bering Sea is used to provide insight into future returns and fisheries in the Yukon River. The status of Yukon River Chinook salmon is of concern due to recent production declines and subsequent closures of commercial, sport, and personal use fisheries, and severe restrictions on subsistence fisheries in the Yukon River. Surface trawl catch data, mixed layer depth adjustments, and genetic stock mixtures are used to estimate juvenile abundance for Canadian-origin stock group from the Yukon River. Abundance ranged from a low of 0.62 million in 2012 to a high of 2.58 million in 2013 with an overall average of 1.5 million from 2003 to 2017. Although abundance estimates indicate that average survival is relatively low (average of 5.2%), juvenile abundance was significantly correlated ($r = 0.87$, $p = 0.005$) with adult returns, indicating that much of the variability in survival occurs during early life history stages (freshwater and initial marine). Juvenile abundance in the northern Bering Sea has increased since 2013 due to an increase in early life history survival (average juveniles-per-spawner increased from 29 to 59). The increase in juvenile abundance is directly related to larger runs during 2016 and 2017 and the data were utilized in management decisions for Chinook salmon subsistence fishing opportunities in the Yukon River during 2016 and 2017.

How Consistent are Declines in the Size and Age of Pacific Salmon in Alaska?

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For decades, researchers, fishers, and Alaskans have noted that Pacific salmon seem to be getting smaller and, in some cases, maturing at younger ages. Declines in size and age of salmon could have negative ecological and economic impacts, including reduced marine-derived nutrient subsidies to freshwater and terrestrial habitats, decreased population abundance and stability, and reduced fisheries value. Despite the vital

importance of salmon to Alaskans and Alaska ecosystems, a broad synthesis of salmon size and age trends across the state is lacking. The purpose of our analysis is to synthesize all available salmon size and age data from across Alaska to address the following questions: 1) have size and age declined in salmon and 2) are patterns of size and age change consistent across regions and species? Importantly, reductions in average size can occur within a population either due to declines in individual growth rates or due to shifts in age structure, such that younger, small fish make up a larger proportion of the population. Thus, we also ask the question: are changes in average size due to changes in size-at-age or age composition? To this aim, we analyze a dataset of unprecedented temporal and spatial scale, including data on over 14,000,000 individual salmon. Overall, our results support previous studies that document declining age- and size-at-maturity in Pacific salmon in most regions. However, our results show important region-specific and especially species-specific patterns. For example, size declines seem to be more severe in Chinook salmon populations than in populations of other species. Thus, size changes may be driven by different factors in different species and regions. Decomposing size trends into the relative contributions of change in age versus growth rate suggests that changing age composition often explains far more of the trends in size over time than does changing size-at-age. Our results will inform ongoing research into the causes and, ultimately, consequences of size and age declines of Pacific salmon in Alaska.

Exploring the Potential Role of an Apex Marine Predator: Prey Consumption Estimates of Salmon Sharks in North Pacific

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Apex predators can exert top-down pressure on the ecosystems in which they reside and influence the abundance and dynamics of prey populations. As interest increases in adaptive ecosystem-based management, understanding trophic interactions in ecosystems is important. In the North Pacific Ocean, salmon sharks (*Lamna ditropis*) are an endothermic apex predator that prey upon species that have commercial and cultural significance. The extent of prey consumption by salmon sharks, their potential for competition with commercial fisheries, and their potential role in the North Pacific ecosystem are unknown. This study quantified potential levels of biomass consumed by individual, adult salmon sharks using three methods: a daily ration requirement, a bioenergetic mass balance, and a von Bertalanffy growth function fit using hierarchical Bayesian methods. The total range of per capita consumption from all methods was 1,480 – 16,900 kg-yr⁻¹. The lowest estimate was produced by the daily ration requirement that was based on parameter estimates from related species, while the highest estimate was produced by the growth model that used the most salmon shark-specific data. When comparing to consumption estimates of closely related species, our results suggest that the nutritional requirements of salmon sharks could be higher than other lamnids and potentially an extreme for any shark species. The consumption rate of salmon sharks could result in the removal of a large amount of biomass of prey from the North Pacific leading, possibly leading to top-down forcing on its prey species. This level of intense predation highlights the potentially large contribution of salmon sharks to cumulative mortality in the North Pacific and underscores the potential role of this species as apex predators in North Pacific ecosystems.

Using Red-legged Kittiwakes to Understand Spatial and Oceanographic Patterns of Mercury in the Northwestern Pacific and Bering Sea

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Oceanographic processes that are important to upper trophic level marine organisms also influence the distribution of environmental contaminants. Mercury is one of the most toxic environmental contaminants and, as a neurotoxin, exposure can lead to altered behavior, reproductive failure, and increased mortality. Methylmercury is the bioavailable and most toxic mercury species and is found in high concentrations in the mesopelagic zone of the ocean. Surface foraging seabirds, like red-legged kittiwakes (*Rissa brevirostris*), may have higher methylmercury exposure if they target mesopelagic prey that make diel vertical migrations to surface waters. Oceanographic processes like upwelling and eddies can also serve to increase prey availability to surface foraging seabirds. We combined red-legged kittiwake tracking data with remotely sensed oceanographic data (e.g., SST, eddy kinetic energy) to understand the influence of spatial and oceanographic patterns on mercury exposure. We measured total mercury in nuptial plumage grown during late winter from red-legged kittiwakes carrying geolocation light loggers during five winters (2011 and 2013-2017; n = 77). Mercury is acquired through consumption of contaminated food and mercury in feathers is related to blood mercury levels at the time of feather growth. Feather mercury concentrations represent recently acquired dietary mercury and mercury redistributed into the blood from other tissues during feather growth. Kittiwakes' mean mercury concentrations were 4.63 ± 0.97 ppm (dry weight), and there were no differences in mercury concentration among years. During January and February, kittiwakes were distributed in the southwestern Bering Sea and the Western Subarctic Gyre. Most birds did not winter in the Bering Sea or spent only part of January and February there. Mercury concentrations declined with the number of days spent in the Bering Sea and decreased

with the median latitude that birds were located during winter. Using seabirds as biomonitors of ocean pollution can be effective to monitor contaminants over large regions that are difficult or expensive to sample using traditional ship-based methods.

Plastics and Phthalate Plasticizers in Aleutian Seabirds

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We are investigating the levels of phthalates and PCBs in various seabird species inhabiting the far western Aleutian Islands. The plastic debris that enters the Pacific Ocean eventually reaches the seabird communities of the Bering Sea. Seabirds and the fish upon which seabirds feed may mistake plastic debris for food items and ingest them. They are consequently exposed to numerous plastic-associated chemical adjuncts, particularly endocrine-disrupting compounds like phthalates. This is the first contaminants work ever done in the most western region of the Aleutian archipelago, thus establishing baseline contaminant levels in an isolated region. This is also the first study quantifying phthalates – the plasticizing chemicals that coat plastic objects – in any seabird species globally. Currently these islands have no point sources of contamination, but they are influenced by ocean currents carrying contaminants and debris from other regions of the Pacific Ocean. We are using species from different trophic levels in our analyses: crested auklets (planktivores), tufted puffins (mid-trophic), and pelagic and red-faced cormorants (upper trophic). Differences in contaminant levels in tissues from these species may be indicative of biomagnification of phthalates and PCBs through the food chain. To date, we have detected DMP (Dimethyl phthalate), DEP (Diethyl phthalate), BBP (Benzyl butyl phthalate), DBP (Dibutyl phthalate), and DEHP (Diethyl hexyl phthalate) in muscle tissues from individuals, representing ten seabird species that breed in the Bering Sea ecosystem, with and without inorganic matter in their stomachs. Additionally, we detected phthalates within reproductive tissues (enlarged ovarian follicles) from many female seabirds, indicating that these compounds are metabolically active and labile within the adult bird. This raises the question of whether or not exposure to endocrine-disrupting compounds such as phthalates impacts chick development and long-term health. We plan to use our data to investigate associations between elevated phthalate levels and elevated PCB levels, and with the presence and type of microplastics in tissues from seabirds.

Fasting Status of Steller Sea Lion Pups as an Index of Potential Nutritional Stress in Decreasing and Increasing Metapopulations

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Steller sea lion (SSL; *Eumetopius jubatus*) pups routinely alternate between feeding and fasting, corresponding to dams' absence during foraging trips. Prior research suggests dams extend foraging trips when prey resources are limited. We propose that comparing proportions of recently fed pups sampled on rookeries over a broad spatio-temporal range can provide information regarding variation in the dams' foraging duration and identify localities where the potential for nutritional stress exists. We applied published metabolite thresholds derived during experimental fasts on captive SSL pups to concentrations of blood urea nitrogen and β -hydroxybutyrate in plasma of free-ranging SSL pups ($n = 1,600$, collected 1990-2016) to categorize fasting phases: recently fed, Phase II fasting (utilizing predominantly lipid stores), transitioning Phases II–III, and Phase III (reversion to catabolizing protein). Using a cross-sectional approach, we compared proportions of recently fed pups on 41 rookeries in 11 metapopulations from western Russia to southeastern Alaska. The overall mean proportion of recently fed pups was 0.71 ± 0.03 . Two metapopulations had significantly lower proportions of recently fed pups: 1) western Aleutian islands (mean: 0.49 ± 0.11 , $p = 0.03$) and 2) southern southeastern Alaska (mean: 0.55 ± 0.05 , $p < 0.01$). The western distinct population segment (DPS), including the western Aleutian Islands, underwent a precipitous decline ($\sim 80\%$ decline) from the 1970s–1990s. The eastern DPS, including southeastern Alaska rookeries, however, has been increasing at $\sim 3\%$ annually since the 1970s. Additionally, we found a significant difference in the proportion of recently fed pups between newly-established rookeries (established 1990-2002) within the northern extent of the eastern DPS and the historical rookeries of the southern portion (means: 0.79 ± 0.04 and 0.54 ± 0.06 , respectively; $p = 0.04$). We suggest that the southern southeastern Alaskan metapopulation may be experiencing nutritional stress due to intraspecific competition resulting from continued population growth, while the western Aleutian SSLs are responding to a different ecological pressure as that population has not yet recovered.

Fur Seals, Fish, and Sairdrones: a Test of Unmanned Surface Vehicles to Examine Relationships Between Northern Fur Seals and their Prey

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Understanding predator-prey relationships for the depleted northern fur seal (*Callorhinus ursinus*) is critical to help identify potential causes for the recent unexplained population decline, which has resulted in a historic low for the largest U.S. colony. However, for wide-ranging marine predators, measuring prey landscapes can be a large undertaking, which is costly in terms of time and resources. This study combined measures of northern fur seal at-sea behavior with a novel prey survey method to examine relationships between fur seals and their primary prey, walleye pollock (*Gadus chalcogrammus*). The at-sea behavior of 29 fur seals from St. Paul Island, Alaska, was examined using dive recorders and GPS/satellite instruments from July to October 2016. During the same period (July-August), two Sairdrones, solar- and wind-powered unmanned surface vehicles, equipped with low-power fisheries echosounders, were used to measure pollock abundance and depth distribution within the fur seal foraging area. The Sairdrones covered the foraging area by conducting two survey grids, resulting in 3,700 km of survey effort. Echosounder backscatter was classified into two categories: widespread aggregations of age-0 pollock in the upper ~30 m and adult pollock in deeper water, based on observed aggregation characteristics and nearby trawl sampling conducted in July. Fur seal foraging metrics, summarized within 10 × 10 km grids, were examined in relation to multiple prey factors (e.g., backscatter by age class and depth distribution). Preliminary results show that the time fur seals spent in a grid cell was positively related to age-0 backscatter. Fur seal dive depths were negatively related to age-0 backscatter but positively related to adult backscatter, reflecting changes in foraging strategies relative to the availability of the different pollock age-classes. Finally, we tested the feasibility of using Sairdrones to conduct

remote focal-follow studies. Two fur seals were followed in near-real time for ~2 days each by programming the Saildrone to track the seals' transmitted at-sea locations. The results of this study will be used to fill significant gaps in our understanding of how northern fur seals respond to variation in prey resources, which is essential to develop ecosystem-based approaches for northern fur seal conservation and fisheries management.

Habitat Selection and Seasonal Movements of Young Bearded Seals (*Erignathus barbatus*) in the Bering Sea

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The first years of life are typically the most critical to a pinniped's survival, especially for Arctic phocids, which are weaned at a few weeks of age and left to locate and capture prey on their own. Their seasonal movements and habitat selection are therefore important factors in their survival. During a cooperative effort between scientists and subsistence hunters in October 2004, 2005, and 2006, 13 female and 13 male juvenile bearded seals (*Erignathus barbatus*) were tagged with satellite-linked dive recorders (SDRs) in Kotzebue Sound, Alaska. Shortly after being released, most seals moved south with the advancing sea-ice through the Bering Strait and into the Bering Sea where they spent the winter and early spring. The SDRs of 17 (8 female and 9 male) seals provided frequent positions in the Bering Sea, which were used in our analysis. To investigate habitat selection, we simulated 20 tracks per seal by randomly selecting from the pooled distributions of the absolute bearings and swim speeds of the tagged seals. For each point in the observed and simulated tracks, we obtained the depth, sea-ice concentration, and the distances to sea-ice, open water, the shelf break and coastline. Using logistic regression with a stepwise model selection procedure, we compared the simulated tracks to those of the tagged seals and obtained a model for describing habitat selection. The regression coefficients indicated that young bearded seals selected locations near the ice edge. In contrast, aerial surveys for bearded seals, predominantly composed of adults, indicated higher abundances in areas farther north and in heavier pack ice. We hypothesize that this discrepancy is the result of behavioral differences related to age. Ice concentration was also shown to be a statistically significant variable in our model. All else being equal, areas of higher ice concentration are selected for, up to about 80%. The effects of sex and bathymetry were not statistically significant. The close association of young bearded seals to the ice edge in the Bering Sea is important given the likely effects of climate warming on the extent of sea-ice and subsequent changes in ice edge habitat.

Ecological Atlas of the Bering, Chukchi, and Beaufort Seas

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To inform sustainable management in a time of growing human influence, there is a need to synthesize and disseminate spatial information to policy makers, scientists, and the public in a format that is useful and accessible. The goal of the Ecological Atlas of the Bering, Chukchi, and Beaufort seas was to create a comprehensive, trans-boundary atlas that represents the current state of knowledge on subjects ranging from physical oceanography to species ecology to human uses. Layer by layer, the Ecological Atlas provides a cumulative representation of what is happening in the region to better understand ecological patterns through spatial data, maps, and written summaries. The atlas was a project by Audubon Alaska, in collaboration with Oceana and the blog “somethingaboutmaps”. Numerous agencies and organizations assisted by providing spatial data, expertise, and review, including the Bureau of Ocean Energy Management, Kawerak, National Oceanic and Atmospheric Administration, University of Alaska Fairbanks, U.S. Fish and Wildlife Service, U.S. Geological Survey, and agencies in Canada and Russia. Community engagement focused on the Kawerak region, where a robust traditional knowledge spatial dataset was available for mapping walrus, ice seals, and other subjects. Traditional knowledge was integrated with science data and reviewed by Kawerak and subsistence experts from the Bering Strait region. Our data-to-design process involved intensive research and consultation with experts, as well as gathering and analyzing the most recent or otherwise best available data. We synthesized data to create more than 100 seamless maps that integrate disparate datasets into cohesive data layers that visually describe a particular process or species’ activities across the three seas. The Ecological Atlas represents a data-rich foundation upon which to understand the complex dynamics of the Arctic marine ecosystem. The atlas database will be publically available through the Alaska Ocean Observing System; the data can be

applied toward managing human uses such as assessing effects of offshore energy, oil spill response planning, vessel traffic routing measures, fisheries management, and identifying ecologically important areas.

Patterns and Trends in Salmon Fishing on the Yukon River

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Since the 1990s, declines in Yukon River salmon runs led to the collapse of Chinook salmon commercial fisheries and severe subsistence restrictions, creating multiple economic and social challenges for many Yukon River residents. Using a combination of ethnographic and statistical methods, we explored factors associated with household and community subsistence salmon harvests. First, we conducted interviews with households in six communities across the Alaska portion of the Yukon drainage to document the socio-economic, environmental, and regulatory factors that affect household subsistence harvests over time. Informed by the ethnography, we then explored statistical associations among the factors and salmon harvests levels at multiple levels using historical harvest data from across the drainage. Factors included household size, number of dogs, and community size. Significant correlations existed, but varied by species and district, highlighting important differences in how the factors affect fishing across the drainage. Using Gini coefficients to quantify the distributions of annual harvests among households in each community, we explored how distributions of harvests changed over time and whether these distributions were associated with harvest levels. The combination of ethnographic and statistical analyses of harvest patterns and trends along the Yukon River provides a grounded approach to the drivers of subsistence salmon harvests and an initial quantifiable step in demonstrating the value of those harvests beyond simply providing food resources. Our results will also assist the Alaska Board of Fisheries, the Federal Subsistence Board, the Yukon River Salmon Panel, and salmon managers in exploring alternatives for salmon fishing regulations within existing legal parameters that are more acceptable to communities.

Predicting Future Management and Catch Under the Bering Sea and Aleutian Islands Ecosystem Cap

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In the United States Bering Sea and Aleutian Islands, an ecosystem cap constrains the total allowable catch (TAC) across all species in the fishery management plan to be less than 2 million metric tons. After the allowable biological catch (ABC) is proposed for each species by stock assessment scientists and reviewed by several scientific peer review panels, the North Pacific Fishery Management Council (Council) then decides how to allocate the ecosystem cap among all managed species, constrained by both the ABC of each species and the 2 million ton aggregate limit. For most years, the sum of single-species ABCs is considerably greater than 2 million tons, requiring the Council to reduce the TAC below the ABC for many species. Next, catch rarely is equal to the original TAC due to a variety of reasons including the joint nature of catch between certain species, and other fishery regulations. For conducting management strategy evaluations, being able to predict TAC and catch from the ABC is essential. Assuming ABC, TAC, and catch are equal is not realistic and would produce extremely misleading predictions and understate the role of management in the future. We examine and model the historical relationships among species and fleets under the ecosystem cap. This enables us to predict both the TAC and catch of each species in future models including in the Alaska Climate Integrated Modeling (ACLIM) project. This model endeavor provides an essential link for forecasts to provide realistic representations of the management and fishing process. This work also allows us to identify the factors that have led the Council to reduce the TAC of different species, how the TAC setting process has evolved over time to enable the fleet to approach the 2 million ton limit, and what further refinements to the process may be available to the Council. Finally, we discuss a variety of additional impacts that arise from operating under an ecosystem cap.

Aleutian Archipelago Nearshore Community Variation Following the Loss of a Keystone Species

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Across the Aleutian Archipelago, the decline of the sea otter (*Enhydra lutris*) population has resulted in lower densities of this keystone species. Corresponding to this decline, the rocky nearshore ecosystem has experienced a dramatic increase in sea urchin (*Strongylocentrotus* spp.) abundance and a decrease in kelp cover. As a result, the once extensive kelp forests have become scarce and urchin barrens (areas devoid of fleshy macroalgae) abundant. In addition, intermediate forests can also be found. These are areas where urchin grazing has denuded most of the fleshy macroalgae, except for the canopy-forming kelp *Eualaria fistulosa*. These qualitatively distinct habitats have created an unprecedented opportunity to examine differences in community structure after the loss of a keystone species. This study used scientific diving to sample each habitat (kelp forests, intermediate forests, and urchin barrens) across the Aleutian Archipelago to determine differences in epibenthic community structure. Our focus on the entire epibenthic community is a significantly broader view than previous studies, which have mostly addressed only urchin and kelp abundance. Our results suggest that the main shift in community structure occurs with the transition from kelp forest to intermediate forest. Indeed, we do not typically see a significant difference between communities when comparing intermediate forests to urchin barrens. This result is contrary to the common perception that the presence of canopy kelps boosts an area's biodiversity and alters community structure, suggesting that an intact understory algal population is necessary to increase epibenthic biodiversity. Here, we present which species are responsible for driving differences among habitats and elucidate their population trends with this habitat shift. We also investigate species' relationships to determine which species exhibit facilitative or antagonistic relationships with one another.

Examining the Ecological Role of Jellyfish in the Eastern Bering Sea Ecosystem

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Scyphozoan jellyfish have characteristics that place them in an influential position for structuring energy flow through pelagic food webs: high growth and reproduction rates, broad planktivorous diets, and few apparent predators. Within the Eastern Bering Sea (EBS), the abundance of the dominant jellyfish, *Chrysaora melanaster*, has fluctuated widely over recent decades, as has their impact. We examined the role of *C. melanaster* as ecosystem structuring agents by 1) estimating impacts of jellyfish variability throughout the food web via end-to-end ecosystem models, and 2) using pelagic survey data to examine interannual relationships between abundances and spatial distributions of jellyfish and forage fishes (capelin *Mallotus villosus*, herring *Clupea pallasii*, age-0 Pacific cod *Gadus macrocephalus*, age-0 pollock *Gadus chalcogrammus*). Using AFSC survey data of pelagic fish and zooplankton, demersal fish and invertebrates, fish diets, and our own observations of *C. melanaster* diet, we developed spatially resolved end-to-end models of the inner-, mid-, and outer-shelf regions representing the 2004-2012 period. We estimate that 4% of total ecosystem production was required to support the mean mid-shelf *C. melanaster* population -- 20× more energy than required by forage fishes. Estimates using a similar model for the Coastal Gulf of Alaska suggest that only 0.1% of total ecosystem production is required to support its smaller scyphozoan population. EBS model simulations show that the impact of *C. melanaster* upon mid- and upper trophic levels is broadly distributed across groups and inversely related to abundance in low (2004-2007) and high (2009-2012) jellyfish years. Survey observations show that the correlation between fish and jellyfish and the degree of spatial overlap during these periods varied between species. Herring and age-0 pollock biomasses were high during the low jellyfish period and low during the high jellyfish period, while spatial overlap between these species and *C. melanaster* was low during the high jellyfish period -- possibly indicative of avoidance of high jellyfish areas. By contrast, capelin biomass and overlap with jellyfish was high during the period of high jellyfish biomass. Jellyfish are important components in the EBS ecosystem, but their impact through direct and indirect trophic pathways differs between forage fish species.

Effects of Warming Climate, Fishing, and Basin-Scale Stocking on Life-History Characteristics of Alaska Sockeye Salmon

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Diversity in life histories of Pacific salmon is one remarkable characteristic of these species, making them resilient to changing environmental conditions and adaptable to new opportunities and constraints on their population dynamics. Salmon life histories are vulnerable to a wide variety of anthropogenic stressors including climate change, size-selective fishing, and stocking of hatchery fish that has increased competition for finite foraging resources in the sub-Arctic Pacific Ocean. We used multivariate time-series models to quantify changes in the life-history characteristics of sockeye salmon from Bristol Bay, Alaska, focusing on changes in the dominant ages of fish, and how they partition their lives between freshwater habitats and the ocean, over the last half century. We find that climate warming and stocking the ocean are changing both early life-history strategies and age at maturation. Climate warming has increased the proportion of salmon only spending one year in their natal freshwater, presumably in response to enhanced growth opportunity in freshwater ecosystems. In the ocean, increased competition for resources due to hatchery releases, and that fish are leaving their natal freshwaters at earlier ages, have delayed maturation toward spending an additional year feeding in the ocean. Effects of size-selective fishing appear to be negligible. These stressors have decreased the size-at-age of fish returning to commercial fisheries and have the potential to erode age class complexity that sustains this highly reliable resource.

Differential North-South Ecosystem Response of Juvenile Marine Growth Rates for Chinook Salmon (*Oncorhynchus tshawytscha*) from the Yukon and Kuskokwim Rivers in the Eastern Bering Sea, 1972-2010

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Chinook salmon (*Oncorhynchus tshawytscha*) returns to western Alaska were historically high and variable but recently reached record lows. Understanding the differential influence of climatic and oceanic conditions on the growth of juvenile Chinook salmon in the north and south eastern Bering Sea is key in understanding mechanisms and factors affecting the production dynamics of Chinook salmon from western Alaska. The primary hypothesis was that differences in the length of the growing season and the marine growth rates of Chinook salmon from the Yukon and Kuskokwim rivers during the first year at sea are the result of differential north-south and warm-cold year responses to ecosystem variability in the eastern Bering Sea. Specifically, the juvenile marine growth of Yukon River origin Chinook salmon will be higher and less variable in the north eastern Bering Sea and lower and more variable for Kuskokwim River in the southeastern Bering Sea. The objective was to compare the growth rates of juvenile Yukon River Chinook salmon in the NEBS with the growth rates of juvenile Kuskokwim River Chinook salmon in the south eastern Bering Sea, 1972-2010. We correlated the length of the growing season, total juvenile marine growth, and seasonal growth rates during the first year at sea of Chinook salmon from the Yukon and Kuskokwim rivers with environmental variables such as sea temperature, small and large zooplankton densities, and euphausiid densities in the eastern Bering Sea. Seasonal and latitudinal differences occurred in the influences of environmental conditions on growth.

A Qualitative Modeling Approach to Assess the Potential Effects of Management Actions and Environmental Changes on Pribilof Islands Blue King Crab (*Paralithodes platypus*)

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The Pribilof Islands blue king crab (BKC), *Paralithodes platypus*, stock was closed to commercial fishing in 1998 and declared overfished due to low abundance in 2002. Despite no directed fishing, stock abundance has not improved since 2002. The reasons for the decline and lack of recovery are unknown. In Fall 2016, we initiated an NPRB funded project focused on assembling information from published studies, recovered data, and stakeholder input to develop conceptual models to describe the network of interactions (both biological and physical) that are likely to influence BKC. We then cast the conceptual models as qualitative network models (QNM) which were used to: 1) identify management tools likely to promote stock recovery, 2) explore how the stock and associated ecosystem might respond to perturbations such as climate change, and 3) identify key sources of uncertainty to guide future ecosystem monitoring and research priorities. We present simulation results for sets of QNMs that describe key processes believed to influence BKC population dynamics. In addition to providing a concise summary of our current knowledge regarding BKC, the QNMs can be updated rapidly to incorporate new information and, with minor additional work, easily adapted to address a wide range of questions beyond the scope of the current project. The modeling framework we employed is well-suited to data-limited systems and we anticipate that the methods and protocols developed for BKC will have wide relevance for other stocks and systems.

The Evolution of a Management-Operational Atmosphere-to-Fish Ecosystem Modeling Suite From the Bering Sea Project

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A unique part of the Bering Sea Project was its approach to ecosystem modeling. The Project aimed to develop a suite of modeling tools with criteria for validation with field research and with direct applicability to the provision of ecosystem-based management advice. This resulted in a set of models - particularly the regional ocean modelling system (ROMS) for the Bering Sea with a coupled plankton model (BEST-NPZ), and a fish growth and movement model for key forage and groundfish species (FEAST) that were “management-ready” for a range of issues in the Bering Sea. As a result of this focus towards management applicability, these models were adopted by NOAA’s Alaska Integrated Ecosystem Assessment (IEA) Program for ongoing operational use in ecosystem-based fishery management (EBFM). Here, we show a selection of recent results from the modeling system, highlighting its direct use in EBFM. We show model results from seasonal (9-month ahead) predictions of the Bering Sea cold pool presented to the North Pacific Fishery Management Council (NPFMC) for the past 5 years, as well as forecasts of ecosystem productivity, a climate vulnerability analysis for fish stocks, predictions of future essential fish habitat, forage fish habitat modeling with implications for Yukon/Kuskokwim Chinook salmon, and long-term climate forecasts coupled to socioeconomic analyses and management strategy evaluations. Future applications include pollock availability to northern fur seals and an expansion of the use of the seasonal forecasts. Finally, we show how modeling results have fed back to the design of field collections, and discuss the future and evolving role of atmosphere-to-fish coupled ecosystem models for developing policy, for example through the incorporation of modeling into the NPFMC’s developing Bering Sea Fisheries Ecosystem Plan.

Using Alaska Marine Ecosystem Science to Inform Fisheries Management

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Practicing sustainable fisheries, including conserving protected species and habitat, is mandated in the United States. In most cases this requires including ecosystem information in management decisions. In Alaska, the responsibility of managing groundfish fisheries – including species such as pollock, cod, sablefish, and rockfish – falls to the North Pacific Fishery Management Council. There are many ways ecosystem science is incorporated into the Council’s management process. The focus of this presentation will be the contextual inclusion of ecosystem science via ecosystem status reports and demonstrated by presentation of case studies of how this inclusion informs management decisions. Ecosystem status (“Ecosystem Considerations”) reports bring together a diverse array of current ecosystem science to set context for annual discussions of harvest specifications. The science spans climate and oceanography to fish, seabirds, and human dimensions. Status and trends of ecosystem indicators for Alaska’s large marine ecosystems are compiled and synthesized into narratives about the current ecosystem state and to highlight any red flags of potential concerns for managers. The timing of reporting is matched to the annual cycle of determining the following year’s harvest specifications to maximize the uptake and relevance of the ecosystem science. This presentation will review the process of ecosystem reporting to the Council and highlight examples of how NPRB-funded research has informed this process.

Plenary Session Abstracts

Thursday, January 25

Plenary Sessions: Thursday, January 25 -- Arctic

TIME	TITLE	PRESENTER	SECTION
8:00 - 8:15 AM	Ventilation of the Pacific Halocline in the Canada Basin	Robert Pickart	Climate and Oceanography
8:15 - 8:30 AM	The Promise of Real-Time Autonomous Systems in Alaska's Northern Seas	Kevin Wood	Climate and Oceanography
8:30 - 8:45 AM	Arctic Ice-Ocean Circulation Modeling: Recent Improvements and Applications	Katherine Hedstrom	Climate and Oceanography
8:45 - 9:00 AM	Numerical Thermal Model to Predict Thaw Depth in Arctic Coastal Settings With Application to Geomorphic Change Modeling for Barter Island, Alaska	Michelle Wilber	Climate and Oceanography
9:00 - 9:15 AM	Groundwater as a Source of Dissolved Organic Matter and Inorganic Nitrogen to Lagoons of the Eastern Alaska Beaufort Sea Coast	Craig Connolly	Lower Trophic Levels
9:15 - 9:30 AM	Responses of Western Arctic Biogeochemistry and Lower Trophic Level Productivity to Late Season Episodic Nutrient Inputs	Lauren Juranek	Lower Trophic Levels
9:30 - 10:00 AM	BREAK		
10:00 - 10:15 AM	Sea Ice Algal Production in the Chukchi Sea (1979 to present)	Virginia Selz	Lower Trophic Levels
10:15 - 10:30 AM	Temperature Sensitivity in the Eggs and Larvae of Arctic and Sub-Arctic Gadids	Ben Laurel	Fishes and Fish Habitats
10:30 - 10:45 AM	Determining Natal Origin and Early Movement of Arctic Cod (<i>Boreogadus saida</i>) From the Chukchi and Beaufort Seas Utilizing Otolith Microchemistry	Alyssa Frothingham	Fishes and Fish Habitats
10:45 - 11:00 AM	Nearshore Fish Assemblages in a Changing Beaufort Sea	Vanessa von Biela	Fishes and Fish Habitats
11:00 - 11:15 AM	Was the 2017 Breeding Season a Tipping Point for Mandt's Black Guillemot in Alaska? : an Ice-Associated Seabird Continues to Struggle in a Melting Arctic	George Divoky	Seabirds
11:15 - 11:30 AM	Seabirds as Indicators for the Distributed Biological Observatory and Other Long-term Marine Monitoring Programs	Kathy Kuletz	Seabirds
11:30 - 1:00 PM	BREAK - LUNCH PROVIDED		

Plenary Sessions: Thursday, January 25 -- Gulf of Alaska

TIME	TITLE	PRESENTER	SECTION
1:00 - 1:15 PM	Potential Impacts of a Large Offshore Oil Spill on Polar Bears in the Chukchi Sea	Ryan Wilson	Marine Mammals
1:15 - 1:30 PM	Using Remote Techniques to Identify Factors Influencing Annual Productivity of a Colony of Black-legged Kittiwakes (<i>Rissa tridactyla</i>) in the Northern Gulf of Alaska	Casey Clark	Marine Mammals
1:30 - 1:45 PM	Auditory Sensitivity and Masking in Bearded Seals (<i>Erignathus barbatus</i>)	Jillian Sills	Marine Mammals
1:45 - 2:00 PM	Marine Mammals and Noise in the Arctic Marine Environment: Measuring Baselines and Considering Impacts	Stephen Insley	Marine Mammals
2:00 - 2:15 PM	Factors Influencing Harvest Rates of Arctic Cisco During the Annual Colville River Delta Under-Ice Subsistence Fishery	John Seigle	Human Dimensions
2:15 - 2:30 PM	Climate Change, Marine Mammals, and Indigenous Hunting in Northern Alaska: Insights From a Decade of Traditional Knowledge Interviews	Henry Huntington	Human Dimensions
2:30 - 3:00 PM	BREAK		
2:15 - 2:30 PM	Climate Change Impacts on Access to Coastal Resources by Subsistence Harvesters in Arctic National Parks: Implications for NPS Management	Kristen Green	Human Dimensions
3:15 - 3:30 PM	Strengthening Community-Researcher Engagement: IARPC Principles for the Conduct of Research in the Arctic	Candace Nachman	Human Dimensions
3:30 - 3:45 PM	Effective Cross-Cultural Awareness and Communication Strategies with Alaska Native Communities	Sheyna Wisdom	Ecosystem Perspectives
3:45 - 4:00 PM	Determining Primary Production Sources to Benthic Organisms in the Arctic Using Stable Isotope Fingerprinting	Matthew Wooller	Ecosystem Perspectives
4:00 - 4:15 PM	Domoic Acid and Long-Headed Polar Bears: Using Archaeological Sites to Study Marine Species and Ecosystems over Time	Anne Jensen	Ecosystem Perspectives
4:15 - 4:45 PM	Ecosystem Studies of the Stefansson Sound Boulder Patch Connect Environmental Dynamics to Biodiversity and Production in the Nearshore Beaufort Sea	Christina Bonsell	Ecosystem Perspectives
4:45 - 5:00 PM	Best Student Oral Presentations Winners Announced		
	CLOSING REMARKS		

Ventilation of the Pacific Halocline in the Canada Basin

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Using shipboard and mooring data, in conjunction with a regional numerical model, ventilation pathways of the upper halocline in the Canada basin are investigated. The measurements show the presence of an eastward-flowing shelf break jet along the edges of the Chukchi and Beaufort seas, in addition to a more substantial westward flow offshore of the Chukchi shelf break -- the Chukchi Slope Current. The newly revealed slope current is present year-round and is composed largely of water masses that originate from the Chukchi Sea. The regional model produces a similar circulation pattern and is used to show that the halocline ventilation occurs primarily by cross isobath flow in Barrow Canyon that feeds the slope current, with smaller contributions from the bottom Ekman layer of the Chukchi shelf break jet. These transport pathways impact the character of the Beaufort Gyre.

The Promise of Real-Time Autonomous Systems in Alaska's Northern Seas

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Seasonally ice-covered marginal seas are among the most difficult regions in the Arctic to study. Physical constraints imposed by the variable presence of sea-ice in all forms of growth and decay make the ocean and air-sea-ice interface especially challenging to observe. At the same time, the exchange of solar energy through Alaska's marginal seas is one of the most important regulators of its weather and climate, its sea-ice cover, and its ecosystems. The inadequacy of observing systems in this area hampers forecast services in the region and is thought to be a major contributor to large uncertainties in modeling and related climate projections. The Arctic Heat Open Science Experiment helps fill this observation gap with innovative air-deployed autonomous floats and other near real-time weather and ocean-sensing systems. These capabilities allow continuous monitoring of the seasonally evolving state of the ocean, including heat content. ALAMO (Air-Launched Autonomous Micro-Observer) floats deployed in 2016 and 2017 have revealed in real time oceanographic features not otherwise observable. These include, for example, detection in the spring of thin layers of Atlantic Water on the central Chukchi continental shelf below the typical sampling depth of standard oceanographic moorings and CTD casts, and reservoirs of excess heat below the mixed layer in the autumn that likely impact sea-ice formation later in the season. Data collected by this project are distributed in near real-time on project websites and on the Global Telecommunications System (GTS), with the objective to provide timely delivery of observations for use in weather and sea-ice forecasts, for model and reanalysis applications, and to support ongoing research activities across disciplines. This research supports improved forecast services that protect and enhance the safety and economic viability of maritime and coastal community activities in Alaska. Data are free and open to all.

Arctic Ice-Ocean Circulation Modeling: Recent Improvements and Applications

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Regional numerical modeling provides a valuable means to assess important aspects of natural systems when the cost and effort of direct observation is impractical; the Arctic Ocean and its marginal seas and archipelagos represent a domain where such applications abound. We describe the configuration of and results from a set of coupled sea-ice ocean circulation models that are based on the Regional Ocean Modeling System (ROMS). Challenging features include large fresh water fluxes from the major Arctic rivers, seasonal land-fast ice, and ice-covered open boundary conditions in nested models. A broad-scale domain, dubbed the Pan-Arctic ROMS (PAROMS) model, extends from the Aleutian Islands to southern Greenland using a telescoping horizontal grid spacing that varies from 4 km in the Pacific to 8 km in the Atlantic. Higher-resolution domains include nested grids at 3 km and 500 m grid spacing. Coastal discharges are prescribed as lateral inflows distributed over the depth of the ocean-land interface. The model includes tides, sea ice, updated bathymetry, and atmospheric forcing from the MERRA reanalysis. We assess the model's performance with respect to tides, storm surges, wind-driven circulation, and thermohaline fields. A hindcast integrated over 1983-2015 provides a means to assess synoptic, seasonal and inter-annual variability. Applications include investigations of shelf flow field pathways, residence times and advective timescales, and energetics balances.

Numerical Thermal Model to Predict Thaw Depth in Arctic Coastal Settings With Application to Geomorphic Change Modeling for Barter Island, Alaska

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In a warming Arctic, increased coastal and thaw pond erosion are expected. In order to predict and mitigate the harm to infrastructure, communities, and the environment, the thermal and mechanical interaction between soils and water must be understood. A one-dimensional numerical model for heat transfer in soil was developed to predict the thaw depth and temperature profile in the soil under various conditions and to easily integrate with an open-source coastal sediment transport model. The thermal model developed uses an explicit finite difference method, taking into account the latent heat of thawing or freezing. The model was verified by comparing results to those obtained analytically for a constant temperature surface boundary condition (The Stefan solution.) The model can account for convective heat transfer from overlying water to the sediments using a convection heat transfer coefficient derived from mechanical characteristics of the water and an assumed bulk temperature for the ocean water. This thermal model was integrated in an Arctic-capable coastal geomorphic change model, which was developed based on the open-source coastal geomorphic change model, Xbeach. Xbeach simulates the nearshore hydrodynamic (wave, current, water surface elevation) environment and the resulting sediment transport, computing geomorphic change (i.e., erosion or accretion). The thermal model is run from within Xbeach to predict a thaw depth every half hour, which is then returned to Xbeach as a limit on the sediment able to be eroded in that half hour time-step. It was assumed that no currently frozen sediment could be eroded until thawed. For each call to the thermal model, Xbeach sends current parameters important to the thermal modeling – ocean temperature, convective heat transfer coefficient, and sediment profile. Soil temperature profile results obtained from the thermal model show good agreement with borehole data from Utqiagvik.

Groundwater as a Source of Dissolved Organic Matter and Inorganic Nitrogen to Lagoons of the Eastern Alaskan Beaufort Sea Coast

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The Arctic is projected to transition from a runoff-dominated system to a groundwater-dominated system as permafrost thaws due to climate change. This fundamental shift in hydrology is expected to increase groundwater flow to Arctic coastal waters, which may be a significant source of dissolved organic matter (DOM) and inorganic nitrogen (DIN) to these waters—even under present conditions—that has been largely overlooked. DOM and DIN inputs to lagoons along the Eastern Alaskan Beaufort Sea coast were characterized using an approach that combined concentration measurements (NH₄⁺, NO₃⁻, DOC, and DON) and radiocarbon dating (¹⁴C) of groundwater, soil profiles, and soil leachable DOC. Samples were collected in mid-August, when soil thaw depths (active layer) were near their maximum extent. Late summer concentrations of groundwater DOM (3,130 μmol/L DOC; 143 μmol/L DON) and DIN (11 μmol/L NH₄⁺; 19 μmol/L NO₃⁻) are one to two orders of magnitude higher than in river and lagoon waters during the same time period. Comparison of groundwater DO¹⁴C and experimentally leached soil-DO¹⁴C data suggests that groundwater contains an integration of diverse organic matter sources spanning the entire soil profile, including potential contributions from thawing permafrost. In this study we reveal that groundwater supplies highly concentrated inputs of old DOM and DIN to Arctic coastal waters that may contribute significantly to overall land-ocean fluxes of carbon and nitrogen during summer. Results from this work are helping us think about how potential changes in groundwater inputs and sources could affect lagoon ecology in ways that challenge the subsistence and well-being of Kaktovik residents and other local Arctic communities along the coast. Moreover, this work supports on-going and immediate priorities of the Arctic National Wildlife Refuge to collaboratively study and manage coastal waters within Refuge boundaries and will contribute to modelers' efforts to estimate groundwater DOM and DIN fluxes across the northern Alaska coastline.

Responses of Western Arctic Biogeochemistry and Lower Trophic Level Productivity to Late Season Episodic Nutrient Inputs

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Recent work has demonstrated that declining sea-ice extent and thickness is already beginning to impart effects on lower trophic level productivity in the Arctic. Potential shifts in the timing, geographic extent, and community composition have all been suggested from observations, yet we are only beginning to understand the impacts of the profound physical changes in the coupled sea ice-ocean system to Arctic biogeochemistry and ecology. Of particular interest is the importance of lower trophic level productivity in the late open water season, when nutrient inventories previously exhausted by early season blooms might be replenished by episodic storm activity for sustained growth into late summer/early fall. High resolution dissolved O_2 /Ar observations collected in late summer on the Chukchi shelf over six field seasons (2011-2013, 2015-2017) map the spatial patterns of net community metabolism (balance of photosynthesis and respiration) in unprecedented detail. These observations nearly always indicate a significant biological O_2 excess, with implied rates of net community production (NCP) up to $1200 \text{ mg C m}^{-2} \text{ d}^{-1}$. Spatial patterns in biological O_2 excess are often coherent with other biogeochemical tracers such as pCO_2 , despite the very different turnover timescales (~ 1 week vs. > 1 month, respectively). These NCP rates are surprising given observations of persistently low surface nutrient concentrations and chlorophyll fluorescence. This begs the question: what are the primary nutrient-resupply mechanisms at play during the late season? Are observed rates a response to episodic nutrient inputs from late summer storms or upwelling events in Barrow Canyon? We evaluate potential mechanisms in the above context using ship-based surveys of physical (hydrographic, velocity, and turbulence) and biogeochemical data (nutrient, carbon, and oxygen) during two late summer field seasons (2016 and 2017).

Sea Ice Algal Production in the Chukchi Sea (1979 to Present)

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The Chukchi Sea is experiencing rapid climate-induced changes in sea-ice melt, formation, and extent. In spring, sea-ice supports a dynamic ecosystem fueled by rich ice algal blooms that support a diverse suite of upper trophic levels, including seabirds, fish, and marine mammals. Despite the importance of ice algal production in early spring in the Chukchi Sea, there is little information on how changes in sea-ice conditions affect this ecosystem resource. We quantify how the physical changes of sea-ice impact the dynamics of the ice algal bloom over the 1979 to present time period using the data-bounded 1D Sea Ice Ecosystem State (SIESTA) model. Using atmospheric input data, SIESTA simulates freezing and melting of the sea ice and the accumulation and melt of the snow pack. Ice observations from past field campaigns (SBI, ICESCAPE, and SUBICE) including air temperature, snow depth, ice thickness, photosynthetic active radiation, and ice algal biomass are used to validate the model. Years (1979 to present) are characterized based on ice and snow physical parameters: snow and ice thickness and the timing of snow and ice melt. Results from these analyses are used to assess the primary drivers of ice algal bloom variability over the studied period. Ultimately, this study addresses how the physical characteristics of snow and ice have affected the spring ice algal bloom timing, duration, and magnitude from 1979 to present. This ecosystem modeling approach advances our understanding about changes in the dynamics of the ice algal resource to the broader ecosystem in a changing climate.

Temperature Sensitivity in the Eggs and Larvae of Arctic and Sub-Arctic Gadids

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Climatic warming in Arctic and Sub-Arctic seas will impact the development times and metabolic demands of marine fish larvae in a species-specific manner. However, such information is lacking, largely due to our limited ability to sample eggs and larvae during ice-covered months in the winter and spring. In this study, we incubated the eggs and larvae of four ecologically important species of gadids across a range of temperatures in the laboratory. Species included two Arctic residents (Arctic cod *Boreogadus saida* and saffron cod *Eleginus gracilis*), and two Sub-Arctic residents (walleye pollock *Gadus chalcogrammus* and Pacific cod *Gadus macrocephalus*). The goal of the study was to 1) develop temperature-dependent models of hatch characteristics, energy use (lipid) and larval survival across a range of thermal environments, 2) determine whether and what ontogenetic stage these thermal responses differed among species, and 3) determine the amount of risk each species faces under warm and cold match-mismatch scenarios. Collective results indicate Arctic species have a much smaller thermal window for survival, but within this thermal range, individuals can survive for longer periods in the absence of food than related Sub-Arctic species. In contrast, the high food sensitivity of Sub-Arctic species suggests prey mismatches have a higher potential to regulate populations in these regions, a mechanism that will likely be exacerbated by further warming and loss of sea-ice. We hypothesize the narrow thermal range of Arctic gadids at the embryo stage currently restricts their distribution to high latitudes, whereas the low energetic reserves and cold-temperature growth rates of eggs and larvae of Sub-Arctic gadids are insufficient to successfully extend their range into high Arctic environments.

Determining Natal Origin and Early Movement of Arctic Cod (*Boreogadus saida*) From the Chukchi and Beaufort Seas Utilizing Otolith Microchemistry

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Arctic cod *Boreogadus saida* is a relatively short-lived, abundant fish commonly found in two hydrographically unique seas offshore of Alaska: the Beaufort and Chukchi seas. This region faces warming sea temperatures and sea ice reduction, yet population structure of Arctic Cod remains relatively unknown. Recent studies in the western Arctic indicate otolith microchemistry can assist in answering questions regarding patterns of dispersion and migration. For this project, otolith microchemistry was used to assess the potential for determining natal origins of age-0 Arctic cod from the Beaufort and Chukchi seas by comparing elemental ratios of Mg/Ca, Mn/Ca, Ba/Ca, Sr/Ca, and Zn/Ca from otoliths. Elemental signatures were analyzed from the core and outer edge of otoliths using a laser ablation inductively coupled plasma mass spectrometer (LA-ICPMS). Age-0 Arctic cod otoliths were selected from offshore sample sites in the Chukchi Sea from the 2009 Russian-American Long-term Census of the Arctic (RUSALCA) cruise and in the Eastern Beaufort Sea from the 2013 U.S.-Canada Transboundary Fish and Lower Trophic Communities (TB-2013-US) scientific cruise. Trace element concentrations of Mg/Ca, Mn/Ca, Ba/Ca, Sr/Ca, and Zn/Ca from age-0 Arctic cod were successfully discriminated into two groups, the Beaufort and Chukchi seas, indicating otolith microchemistry can be a useful tool in determining natal origin. Elemental ratios measured from the core of the otolith were also significantly different from elemental ratios measured in the edge of the otolith, representing the environment close to capture, suggesting potential early movement across their U.S. distribution. Understanding the movement of Arctic Cod is vital as habitat is expected to change dramatically. As an otolith chemical signature reflects water mass occupation, comparing Arctic cod collected from the Chukchi and Beaufort seas offer an insight into understanding the dispersion of a keystone species in a rapidly changing Arctic.

Nearshore Fish Assemblages in a Changing Beaufort Sea

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Compared to past decades, the Beaufort Sea has now become characterized by longer ice-free seasons, warmer summer water temperatures, and lower salinity. These changes are magnified in the shallow, nearshore systems that are important fish habitat. Recent conditions likely favor Arctic-boreal species over Arctic-specialists and euryhaline species over marine species. To examine fish assemblage change, we revisited fyke net sampling locations during August 2017 in two adjacent lagoons within the Arctic National Wildlife Refuge near Kaktovik, Alaska, and compared fish assemblages to those observed from 1988 to 1991. Preliminary findings from 2017 indicate that early August fish composition in Kaktovik and Jago lagoons differed from initial assemblages, with a more pronounced difference in Kaktovik Lagoon as judged by non-metric multidimensional scaling and PERMANOVA. Differences in composition were primarily related to declines in fourhorn sculpin (*Myoxocephalus quadricornis*) in both lagoons with increases in saffron cod (*Eleginus gracilis*) in Kaktovik Lagoon and arctic flounder (*Liopsetta glacialis*) in Jago Lagoon. The species-specific patterns generally agree with expectations in a warmer and fresher Beaufort Sea. Declines in fourhorn sculpin agree with observations of lower abundance in warmer and fresher nearshore habitats of this predominantly Arctic species. Increases in saffron cod have been predicted based on temperature-dependent growth studies of this Arctic-boreal species and reported by subsistence fishers. Increases in Arctic flounder were more surprising as they are a predominantly Arctic species; however, past studies suggests the species is eurythermal and euryhaline. Increases or decreases of a species in a lagoon may reflect changes in population abundance or habitat use. Continued field work in 2018 and 2019 will expand sampling to more exposed nearshore habitats with cooler and saltier conditions than lagoons that will help clarify the relative importance of abundance and habitat use in driving species-specific catch differences.

Was the 2017 Breeding Season a Tipping Point for Mandt's Black Guillemot in Alaska? : an Ice-Associated Seabird Continues to Struggle in a Melting Arctic

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Mandt's Black guillemot is one of the few truly pagophilic seabirds, occupying the Marginal Ice Zone of Arctic sea-ice throughout the year. In 1972 a colony of ten pairs was discovered on Cooper Island, in the western Beaufort Sea off northern Alaska, with all nests in cavities provided by manmade debris. The colony has been studied annually since 1975 with investigator provisioning of new nest sites increasing colony size to 200 pairs in 1989. Since 1990, coinciding with a phase shift in the Arctic Oscillation that increased the rate of regional warming and melt, the Cooper Island colony has experienced a substantial decrease in breeding success and colony size, with 100 pairs breeding in 2016. Fieldwork in the summer of 2017 found a continuation of the colony's past declines in numbers and breeding productivity but also revealed reductions in additional demographic parameters that could portend the beginning of a period of accelerated colony reduction. Only 85 pairs bred in 2017, the fewest since the early 1980s. For the first time in the four decades of study we saw a number of pairs that included at least one experienced breeder occupy nest sites but fail to lay eggs. Overwinter survival of breeding adults, which has averaged close to 90 % over four decades, was approximately 75 %. Nonbreeding birds, which prospect nest sites before recruiting to the colony in subsequent years, used to constitute up to a third of the birds in colony but were essentially absent in 2017. Early sea-ice retreat north of the island and associated extremely high sea surface temperatures in July and August, resulted in decreased availability of the preferred prey, Arctic cod (*Boreogadus saida*), and the first occurrence of irregular availability of alternative prey during the period of chick provisioning, causing high nestling mortality. Breeding success was only 0.5 fledges per nest, half of what is needed to maintain a stable population. However, three breeding pairs were able to each fledge two chicks, indicating a small number of birds are adapting to the ice-free subarctic conditions now present in late summer.

Seabirds as Indicators for the Distributed Biological Observatory and Other Long-term Marine Monitoring Programs

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Marine birds (primarily, seabirds) are among the upper trophic level groups that can be used to detect change in the Pacific Arctic marine system. Seabirds are highly mobile and seasonal in distribution and abundance, which complicates sampling and interpretation of observations. As a long-term monitoring array, eight Distributed Biological Observatory (DBO) sites extend from the northern Bering to the eastern Chukchi and western Beaufort seas. They were established largely on the basis of benthic diversity and abundance, but now incorporate multiple ecosystem components. The DBO sites are sampled by multiple vessel-based programs, including the Arctic Integrated Ecosystem Research Project and the Arctic Marine Biodiversity Observing Network (both ongoing). Seabird surveys were conducted as part of these and other programs. We used at-sea visual survey data from these surveys totaling ~115,860 km of transects from 2007 to 2015 to 1) compare seabird species richness, community composition, and relative abundance among DBO sites and to their respective surrounding regions and 2) examine the influence of location and water mass on the seabird community. First, we determined if the DBO was representative of its greater respective region (northern Bering, eastern Chukchi, and western Beaufort); this was largely the case, although no DBO site captured all potential species within a region, and sampling effort in the Beaufort was too low to fully evaluate. Species richness was highest in the northern Bering Sea. Species abundance declined slightly with latitude except for an uptick near Bering Strait, with a sharp decline north of 72°N. We identified six community types across all regions, which loosely corresponded to current systems (e.g., Alaska Coastal Current, Anadyr Current) or oceanographic domains, with breeding colony location also influential. Among 12 taxa, variance in abundance was typically much greater by DBO site than by Year; two taxa with greater variance by Year were shearwaters and murrelets, both late summer migrants to these regions. DBOs 2–5 (in northern Bering and eastern Chukchi) have more sampling effort and can be used to examine seasonal and interannual variation. Results will inform future sampling efforts, interpretation of observations, and management decisions related to seabirds.

Potential Impacts of a Large Offshore Oil Spill on Polar Bears in the Chukchi Sea

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Summer sea-ice extent in the Arctic Ocean has been greatly reduced due to global warming. As a result, the region is expected to experience increased human activity, including offshore oil development with the potential for an oil spill to affect marine wildlife populations. It is therefore important to develop and maintain plans on how to respond to oiled wildlife in the event of a spill. In this study, we attempt to understand the impact to polar bears (*Ursus maritimus*) in the Chukchi Sea from large simulated oil spills. Our objectives were to simulate oil spills in two different regions (i.e., off the coast of Alaska and Wrangel Island) to determine, 1) the probability of oil reaching different areas of the Chukchi Sea, 2) time for oil to reach those regions, 3) the amount of important polar bear habitat that could be exposed to oil, and 4) what proportion of the polar bear population that might come into contact with oil. We simulated spills to occur in autumn based on oceanographic conditions from 2008 to 2014, releasing 25,000 barrels of oil per day for 30 days, and assumed no containment efforts were deployed. Alaska and Russian territories were both exposed to oil from spills in each other's waters, but oceanographic conditions tended to make Russian waters more susceptible to oiling. On average, oil reached coastal communities within 3-5 weeks. The area of 'high-value' polar bear habitat exposed to oil was generally low, representing 1-5% available to bears. However, we estimated that up to 40% of polar bears in the Chukchi Sea might be exposed to oil given their preference for ice-edge habitat during autumn and early winter. Given the potentially large number of polar bears that could be exposed to oil, the difficulty of finding and capturing bears on the sea ice, and the limited capacity to clean contaminated bears, oil spill planning should focus on how to best limit exposure of bears to oil rather than relying on post-hoc cleanup efforts. This study also highlights the need for coordination between the United States and Russia on oil spill response planning.

Past Changes in Sea-Ice Cover Drive Shifts in Walrus Diet

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Declines in Arctic sea-ice have raised concerns about the future of the Pacific walrus (*Odobenus rosmarus divergens*) population; however, the ability of walruses to adapt to variable ice conditions remains poorly understood. This study used information from the last 2,500 years to investigate how changes in sea-ice impact walruses. We measured stable carbon and nitrogen isotope ratios ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) of bone collagen from archaeological assemblages ($n = 289$), historic museum collections ($n = 180$), and present day Alaska Native subsistence harvests ($n = 86$) to investigate how walrus diet changed in response to variable ice conditions. Male and female walruses killed after 1880 had lower $\delta^{13}\text{C}$ values ($p < 0.01$) when September sea-ice cover in the Chukchi Sea was low ($< 40\%$), with no sex-related differences during periods of high or low ice cover ($p = 0.18$). This is likely the result of a shift in the types and sources of primary production supporting food webs in this region. Female walruses had similar $\delta^{15}\text{N}$ values during periods of high and low ice cover ($p = 0.31$), whereas $\delta^{15}\text{N}$ of males was lower when sea-ice cover was low ($p < 0.01$), perhaps reflecting changes in prey availability or baseline $\delta^{15}\text{N}$ values in the males' summer habitat. Long-term ice conditions were reconstructed using dinocyst assemblages in six sediment cores from the Chukchi Sea, and archaeological walrus samples were assigned to periods of high, intermediate, and low ice cover. Both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ varied broadly across the last 2,500 years ($\delta^{13}\text{C}$ range: -16.9‰ to -11.5‰ ; $\delta^{15}\text{N}$ range: 9.9‰ to 19.1‰) and differed between periods of high (mean \pm SD: $\delta^{13}\text{C} = -13.0 \pm 0.6\text{‰}$; $\delta^{15}\text{N} = 13.3 \pm 1.0\text{‰}$) and low ($\delta^{13}\text{C} = -13.5 \pm 0.9\text{‰}$; $\delta^{15}\text{N} = 13.9 \pm 1.5\text{‰}$) ice cover. Walruses killed after 2010 had lower $\delta^{15}\text{N}$ values ($12.5 \pm 0.8\text{‰}$) than any other period and similar $\delta^{13}\text{C}$ values ($-13.5 \pm 0.5\text{‰}$) to previous low sea-ice periods, suggesting changes to food webs in this region are different from those observed in the last 2,500 years or are still in their early stages.

Auditory Sensitivity and Masking in Bearded Seals (*Erignathus barbatus*)

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Bearded seals (*Erignathus barbatus*) have a circumpolar Arctic distribution and are closely associated with unstable pack ice, spending nearly all of their lives in remote habitats beyond the reach of scientists and observers. As a result, their biology and behavior remain largely unknown. With respect to sensory biology, bearded seals—like other marine mammals—rely on acoustic cues to support a range of vital behaviors. Passive acoustics monitoring has revealed, for example, a rich repertoire of underwater calls associated with the breeding season. However, the ability of bearded seals to perceive sound has never been investigated. In this study, species-typical auditory profiles were obtained from two young male bearded seals trained to cooperate in a go/no-go behavioral paradigm. Detection thresholds were measured for underwater tonal sounds at frequencies ranging from 100 Hz to 61 kHz, both in quiet conditions and in the presence of octave-band masking noise. The bearded seals displayed sensitive underwater hearing, with peak sensitivity of approximately 50 dB re 1 μ Pa and a broad frequency range of best hearing extending from 350 Hz to 45 kHz. Additionally—like other phocinae seals—the two seals performed particularly well compared to other mammals when detecting target signals embedded within background noise. We can combine these hearing and auditory masking data with measurements of ocean noise from representative environments to evaluate the listening space available to free-ranging bearded seals. Such an integrated analysis can shed light on the complex acoustic world of bearded seals, about which new information is emerging but much remains to be discovered.

Marine Mammals and Noise in the Arctic Marine Environment: Measuring Baselines and Considering Impacts

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Numerous recent studies highlight the importance of understanding noise and its impacts in the marine environment. Of particular interest are behavioral and physiological impacts of noise on marine mammals, as well as the resultant indirect implications of those impacts to indigenous communities who rely on marine mammals, especially in the Arctic. Effective assessments require both seasonal and spatial understanding of marine mammal distributions in the context of natural and anthropogenic sources of noise. In this presentation we focus on the last four years of work being conducted year-round in the eastern Beaufort and northern Bering seas. Our presentation addresses several key areas of current research interest: 1) documenting baseline biological sounds of marine mammals and overlaying with ambient and anthropogenic noise; 2) evaluating changes in baseline noise levels in context of climate change and loss of sea-ice; and 3) understanding detection probability of different components of the marine mammal community. Key findings include the profound changes in natural noise as a result of loss of sea-ice, the relative quiet from shipping traffic as compared to more southerly areas, and the relation between sea-ice and the seasonal vocalizations of different species. Our ultimate goal is to use these results to understand how the marine soundscape is expected to change as a result of warming temperatures and loss of sea-ice, how these changes might affect Arctic marine mammals (e.g., decrease in a species' acoustic active space or displacement away from villages), and to construct effective solutions (e.g., shipping corridor mapping) in a proactive manner.

Factors Influencing Harvest Rates of Arctic Cisco During the Annual Colville River Delta Under-Ice Subsistence Fishery

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The annual under-ice gillnet fishery for Arctic cisco (*Coregonus autumnalis*) in the Nigliq Channel of the Colville River delta, Alaska, is important to the food security of residents of Nuiqsut. In a typical fall fishing season, fishers harvest tens of thousands of this anadromous whitefish species which is prized for its high fat content and quality of meat. Summertime westerly winds transport age-0 fish from spawning grounds in the Mackenzie River system to the Colville River Delta where they spend 7–9 years before returning to Canadian waters where they will spawn and continue to live for up to an additional 10 years or more. We analyzed more than 30 years of long-term monitoring data collected at three sites on the Nigliq Channel and in nearshore waters near Prudhoe Bay, Alaska to determine the importance of young-of-the-year recruitment to Alaskan Beaufort Sea waters on subsequent harvests in the Colville River as adults. We also investigated the importance of intra-annual factors, including seasonal wind speed and direction, water salinity, timing and location of fishing effort, and individual fisher skill on harvest success. Our results confirm that annual young-of-the-year recruitment to nearshore Alaska waters explains much of the variability in annual harvest success 5–7 years later in the Colville River. Timing and location of fishing also contributed to the prediction of harvest rates, which were highest at locations closest to the river mouth. Harvests increased at all sites with increasing salinity up to 25 ppt, above which harvests decline. Wind speed was related to harvest rates only at the middle locations in the Nigliq Channel, as a result of westerly winds pushing saline waters upstream throughout the harvest season, increasing salinity from below preferred levels for Arctic cisco (<15 ppt) in the early fall to an optimal salinity range (15–25 ppt) by late fall. Individual fisher skill appears to have little impact on harvest success. Understanding the factors influencing Arctic cisco harvests in the Colville River Delta will help stakeholders manage the fishery sustainably, particularly in the face of a rapidly changing climate and ongoing infrastructure development in the region.

Climate Change, Marine Mammals, and Indigenous Hunting in Northern Alaska: Insights from a Decade of Traditional Knowledge Interviews

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Iñupiaq, Yup'ik, and Cup'ik hunters in 14 Alaska Native communities described a rapidly changing marine environment in qualitative traditional knowledge interviews conducted over the course of a decade with 110 individuals. Based on their observations, sea ice conditions are the most notable change, with later freeze-up, thinner and less reliable ice, and earlier and more rapid break-up. Marine mammal populations in northern and western Alaska have been affected by changes in the physical environment, with alterations to migratory timing and routes, distribution, abundance, health, and behavior. Despite these changes, marine mammal populations in the region remain generally healthy and abundant. For hunters, access is the biggest challenge posed by changing conditions. Sea-ice is less safe for travel, particularly for more southerly communities, making hunting more dangerous or impossible. Rapid break-up has reduced the time available for hunting amid broken ice in spring, formerly a dependable and preferred season. Social change also affects the ways in which hunting patterns change. Increased industrial development, for example, can also alter marine mammal distribution and reduce hunting opportunity. Reduced use of animal skins for clothing and other purposes has reduced demand. More powerful and reliable engines make day trips easier, reducing the time spent camping. An essential component of adjustment and adaptation to changing conditions is the retention of traditional values and the acquisition of new information to supplement traditional knowledge. Our findings are consistent with, and add detail to, what is known from previous traditional knowledge and scientific studies. The ways in which hunters gather new information and incorporate it into their existing understanding of the marine environment deserves further attention, both as a means of monitoring change and as a key aspect of adaptation. While the changes to date have been largely manageable, future prospects are unclear, as the effects of climate change are expected to continue in the region, and ecological change may accelerate. Social and regulatory change will continue to play a role in fostering or constraining the ability of hunters to adapt to the effects of climate change.

Climate Change Impacts on Access to Coastal Resources by Subsistence Harvesters in Arctic National Parks: Implications for NPS Management

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Human access routes to coastal subsistence resources are being altered or eliminated in the Northwest Arctic Alaska as temperatures warm. Many studies have shown in recent years that coastal habitats where subsistence resources are traditionally gathered and processed are eroding with sea level rise while sea-ice retreat reduces the availability of marine mammals for hunters. The National Park Service (NPS) is responsible for sustainable management of subsistence resources in National Parklands as well as access to those resources; however, a lack of information on factors affecting access routes, including climate change, limits management planning. Our 2-year, joint research project with NPS seeks to document and respond proactively to landscape scale changes that affect subsistence access to marine resources in coastal Western Arctic Parklands. Our study employs a combination of 1) a synthesis of pre-existing harvest and environmental time series data, 2) key respondent interviews, 3) participant observation of NPS Subsistence Resource Commission meetings, and 4) mapping of key Parkland areas vulnerable to changes in access. Our research seeks to understand the perceptions of agency staff in addition to a diverse community of subsistence users to gather information on ways to improve communication between NPS and subsistence users. To date, we have conducted eight interviews with regional and local NPS staff and 35 coastal subsistence users in the Northwest Arctic regarding access to coastal resources in Cape Krusenstern National Monument and Kotzebue Sound, environmental changes to subsistence resources, and how local knowledge is incorporated into management. Emergent themes from interviews include narratives from park staff and harvesters about changes in the land and sea that limit ATV travel and threaten private allotments, shifts in the window of opportunity to hunt marine mammals and fishes in Kotzebue Sound, and the importance of local knowledge in development of NPS policies that facilitate access to subsistence resources. Study results will provide data on key access and subsistence harvest challenges that can be used to improve NPS management of resources and communication with local stakeholders.

Strengthening Community-Researcher Engagement: IARPC Principles for the Conduct of Research in the Arctic

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All researchers working in the North have an ethical responsibility toward the people of the North, their cultures, and the environment. The Interagency Arctic Research Policy Committee (IARPC) published the Principles for the Conduct of Research in the Arctic in 1995 to provide guidance for researchers in the physical, biological, behavioral, health, economic, political, and social sciences and in the humanities. The Principles address the need to promote mutual respect and communication between scientists and northern residents, and these Principles were to be observed when carrying out or sponsoring research in Arctic and northern regions or when applying the results of this research. In the past 22 years, new theoretical and methodological approaches to community engagement and Arctic research have emerged, necessitating a review and update of the current Principles with an aim to including more language on partnerships and collaborations, including increased engagement with Indigenous scholars, enhanced community-based observations, fostering community-based participatory research, and utilizing Indigenous knowledge in the co-production and dissemination of knowledge. In this presentation, we will outline the importance of updating the Principles, describe the general process and opportunities for input and feedback, and share examples of community-researcher engagement. Cooperation is needed at all stages of research planning and implementation in projects that directly affect northern people. Cooperation will contribute to a better understanding of the potential benefits of Arctic research for northern residents and will contribute to the development of northern science by including Indigenous knowledge and experience.

Effective Cross-Cultural Awareness and Communication Strategies with Alaska Native Communities

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Iñupiat people are some of the earliest known inhabitants of the North Slope and continue to rely on a subsistence lifestyle for their nutritional and cultural survival. The Iñupiat philosophy holds that each person is responsible to all others for the survival of culture, values, and traditions. This is the philosophy Fairweather Science (FWS) has adopted in working with the Iñupiat. As the Arctic becomes increasingly accessible to resource development, shipping, tourism, and scientific research; the potential for conflicts with subsistence activities arises. For the last 40 years, interactions between the communities and resource development companies, regulatory agencies, and researchers have continued to evolve and community outreach has become a priority in national policy. The value of subsistence to the Iñupiat lifestyle and the co-existence of residents with resource exploration have resulted in stipulations ensuring that subsistence resources and access to those resources are protected. Since 2008, FWS has worked with Alaska Arctic stakeholders to develop strategies for providing research opportunities without causing conflict with subsistence harvest activities. Presented herein are best practices, which were derived from lessons learned that introduce the historical, environmental, cultural, and subsistence issues on the North Slope, allowing industry and research to be conducted responsibly and respectfully. We discuss methods that have been successful in cultivating strong relationships, as well as methods requiring substantial improvement, but which provided valuable learning experiences. There are people of many cultures living and working on the North Slope. The Iñupiat are faced with decisions that could dramatically impact their way of life, and in some cases their survival unless all of us work together with understanding and mutual respect. Maintaining a healthy balance between a traditional subsistence lifestyle and ongoing changes from outside influences requires thoughtful and effective communication and coordination. With the continued potential increase for conflict, the need for development of long-term relationships and open communication strategies with community members is imperative for the health and existence of the Iñupiat people. Clear, respectful communication is essential in developing meaningful relationships with both residents and our colleagues.

Determining Primary Production Sources to Benthic Organisms in the Arctic Using Stable Isotope Fingerprinting

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Benthic invertebrate communities are an essential component in Arctic food webs, in terms of mineralization and energy transfer to higher trophic levels. Currently, estimates of the proportional contribution from different sources of organic matter (marine, terrestrial and microbial) to benthic organisms in the Arctic are unclear. We provide a better understanding of the organic matter sources consumed by benthic organisms in the Beaufort and Chukchi sea ecosystems, using stable carbon isotope fingerprinting of essential amino acids. Essential amino acids have specific stable carbon isotope “fingerprints” that differ between marine, terrestrial, and microbial producers, which are incorporated into and conserved within consumers. We present results from analyses of a suite of benthic invertebrate species (including *Astarte* sp., *Macoma*, sp. and *Sabinea* spp.) from the Beaufort and Chukchi seas and use both an isotope index and mixing model to illustrate changes in the proportional contributions of microbial, and marine and terrestrial photosynthetic sources of essential amino acids to these species across a water depth gradient. In the Beaufort Sea, we find that over a depth gradient from 20 to 500 m both *Astarte* sp. and *Sabinea* sp. show an increase in the proportional contribution of microbial-derived essential amino acids, based on data from an isoleucine-leucine isotope index. Our data from a mixing model subsequently validate this finding and estimates that the proportional contribution of microbial-derived essential amino acids is greater at depth compared with shallower coastal locations. Index findings and mixing model results are also consistent in that *Astarte* sp. from shallower locations along the Beaufort coast derived a greater proportion of their essential amino acids from a terrestrial source, likely from the greater influence of coastal erosion or river discharge, compared with deeper locations.

Domoic Acid and Long-Headed Polar Bears: Using Archaeological Sites to Study Marine Species and Ecosystems Over Time

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A recent analysis of gastrointestinal content from a mummified ring seal recovered in 2016 at the Walakpa archaeological site (Jensen et al. 2017) has yielded evidence of domoic acid. The seal is known to have been taken in the mid-1940s, thereby demonstrating that it is not a new phenomenon in the Chukchi Sea. Histopathology provided no evidence of parasites, including metazoan and protozoa. Three other seals recovered in 2017 are also being studied. The same site was also the source of a very large morphologically distinct polar bear skull, which raised questions of a possible subspecies (Stimmelmayer et al. 2017). Ongoing DNA analysis has ruled out brown bear admixture. Another morphologically similar cranium was recovered from Walakpa during the 2017 field season. The Arctic is changing rapidly, and there is much concern over the effects of those changes a number of Arctic marine species, and on Arctic marine ecosystems in general. Scientific observations span a very limited period in the Arctic, less than 40 years in some cases. One way to address this would be to extend the period of observation, but the situation is urgent. The two cases highlighted above illustrate one solution. Archaeological sites with good organic preservation are valuable resources for paleoecological reconstruction, with potential similar to other paleoenvironmental proxy records. The sites often are located at or near places that are occupied today, thus providing locally relevant long-term data. They usually incorporate the same species that are important for subsistence and food security today, so that management-relevant information on how changes affected those species can easily be gathered. New advances in radiocarbon dating, in chemical and isotopic techniques, as well as in DNA studies (e.g., aDNA and sedaDNA) make the range of information that can be recovered and questions that can be addressed ever larger.

Ecosystem Studies of the Stefansson Sound Boulder Patch Connect Environmental Dynamics to Biodiversity and Production in the Nearshore Beaufort Sea

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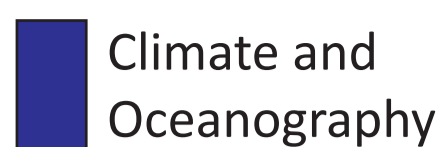
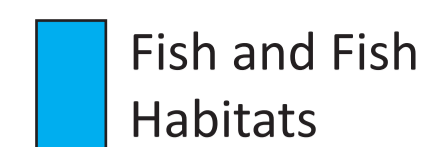
Kenneth Dunton

University of Texas Marine Science Institute, ken.dunton@utexas.edu

The Stefansson Sound Boulder Patch is a large, isolated rocky reef in the Alaska Beaufort Sea, adjacent to the Prudhoe Bay oil field. Cobbles and boulders provide attachment points for a variety of invertebrates and algae that would otherwise not exist in such high concentrations, thereby promoting a regional 'hotspot' of biodiversity and benthic production. Ecosystem studies in the Boulder Patch began in the 1970s, focusing on production patterns of the dominant, endemic Arctic kelp species, *Laminaria solidungula*. Recent research has further expanded our understanding of kelp productivity and ecosystem diversity in relation to water quality variability, providing a mechanism to evaluate ecosystem response to oil and gas development and climatic change. Baseline studies have set the stage for experimental work investigating the processes and mechanisms that structure Arctic kelp bed communities. Key findings include marked spatial and seasonal patterns in physical variables (temperature, salinity, currents, pH, and benthic irradiance) as well as interannual variability, demonstrated by in situ instrumentation at several sites. We are able to place this environmental information within an ecological context, demonstrating that benthic community structure and diversity varies across space in ways that correspond with hydrographic patterns. Algal biomass always exceeds invertebrate biomass and the relative abundance of dominant macroalgae taxa (kelp, fleshy red algae, crustose coralline algae [CCA]) at each site appears to be the primary driver of site community differences. However, there are differences in epilithic and infaunal invertebrate composition between sites. Furthermore, the presence of CCA at offshore sites is associated with higher kelp densities and lower cover by fleshy red algae, whereas inshore sites lacking CCA show the opposite pattern. Four decades of benthic light and *L. solidungula* growth measurements reveal that summer sediment resuspension overshadows ice loss in determining long-term patterns of benthic primary production in this system. Ongoing research in the Boulder Patch investigates the spatiotemporal patterns of epilithic recruitment, the effects of salinity on CCAs, and the population connectivity between *L. solidungula* across the Arctic Ocean. These studies provide vital information to

managers on the effects of development and climate change on ecosystem functions in the Beaufort Sea.

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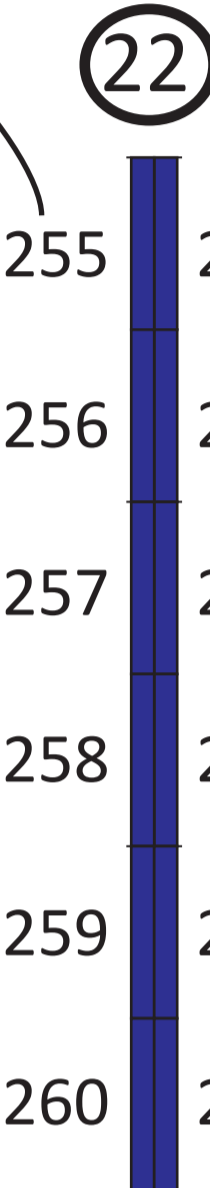
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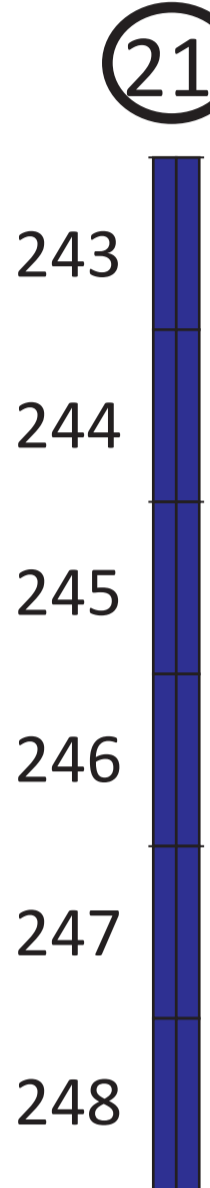
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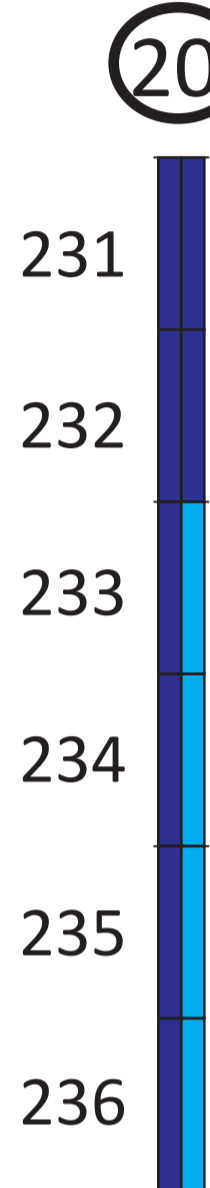
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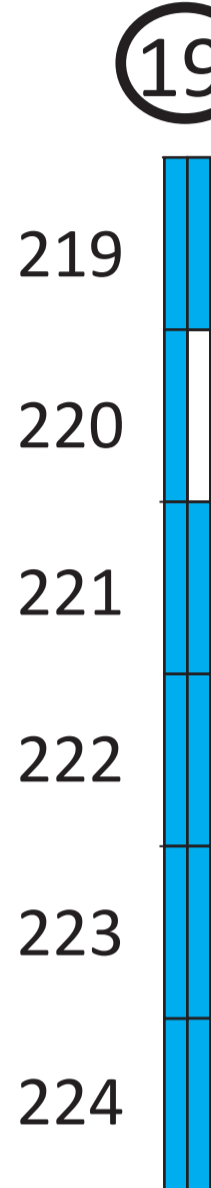
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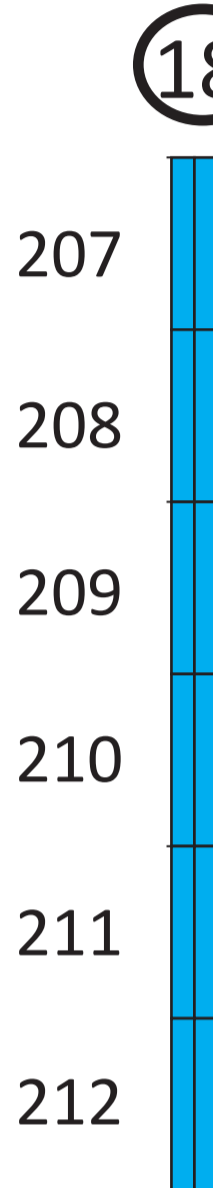
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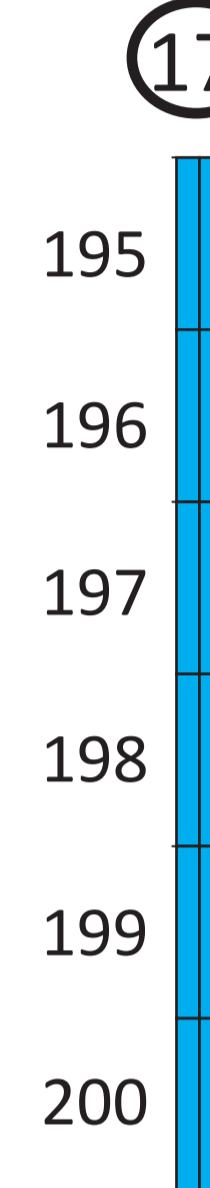
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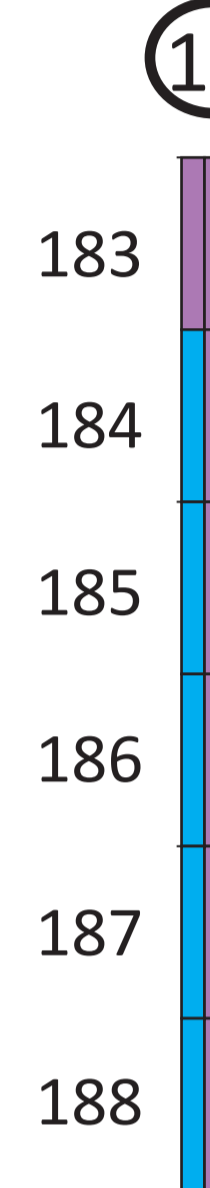
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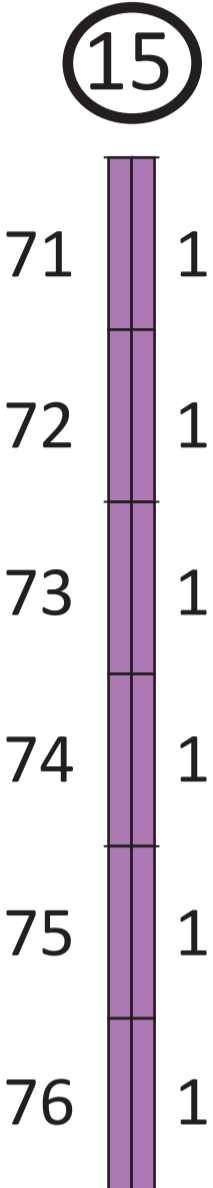
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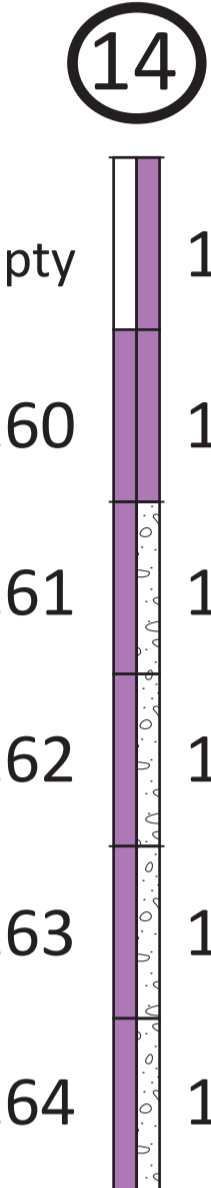
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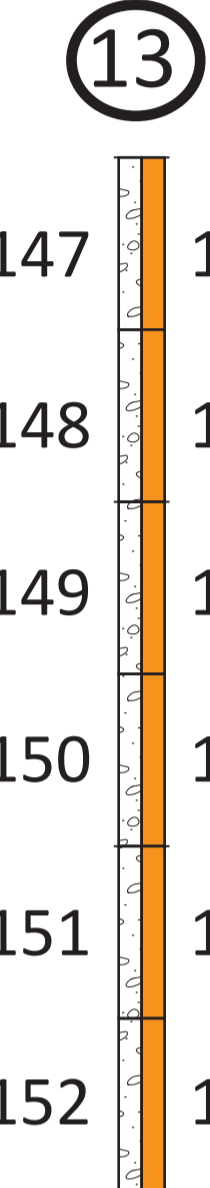
Ecosystem Perspectives



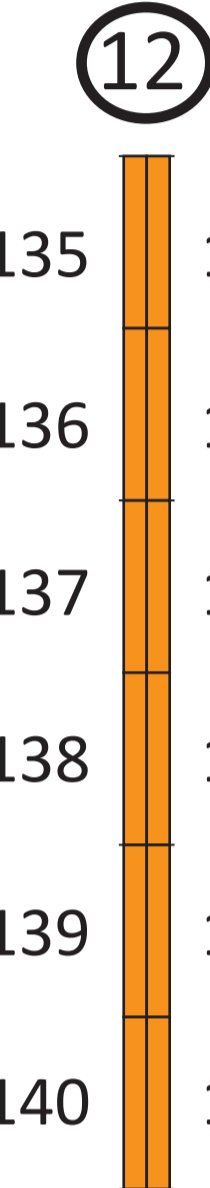
Ecosystem Perspectives



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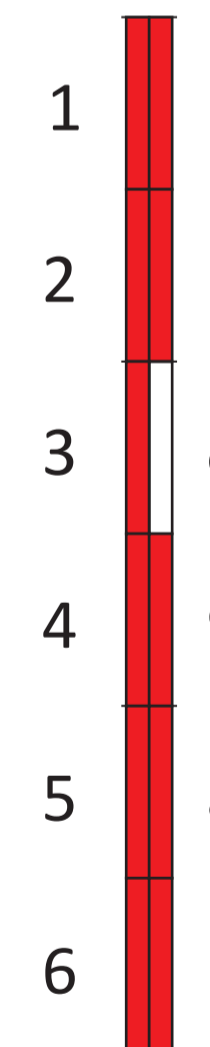


Humans

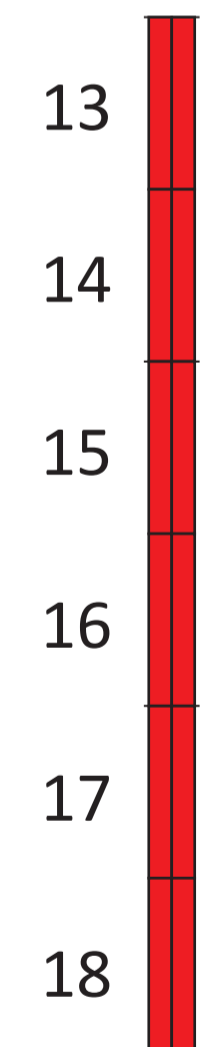


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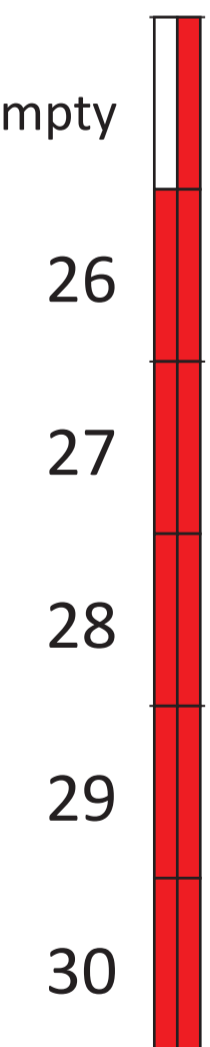
Mammals



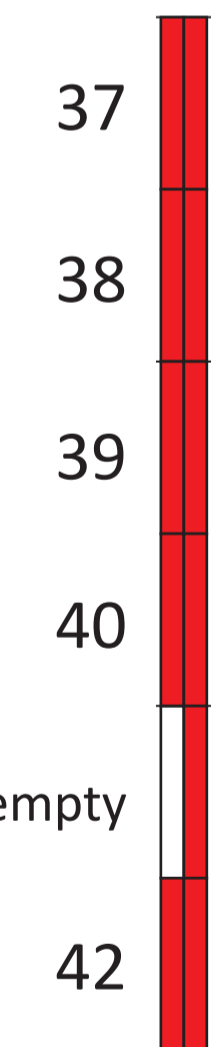
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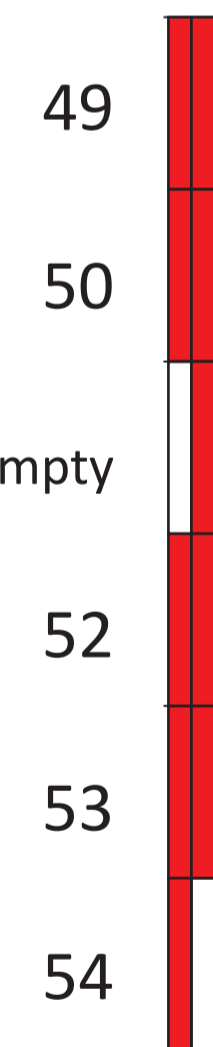
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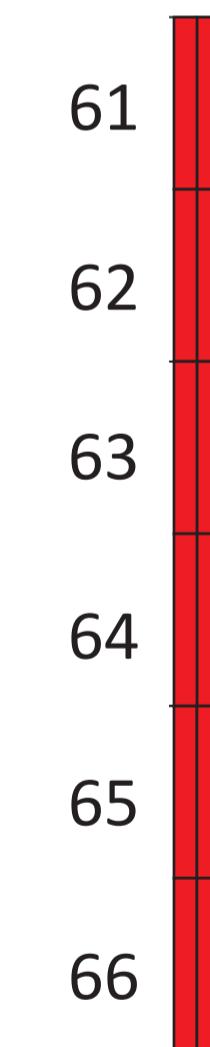
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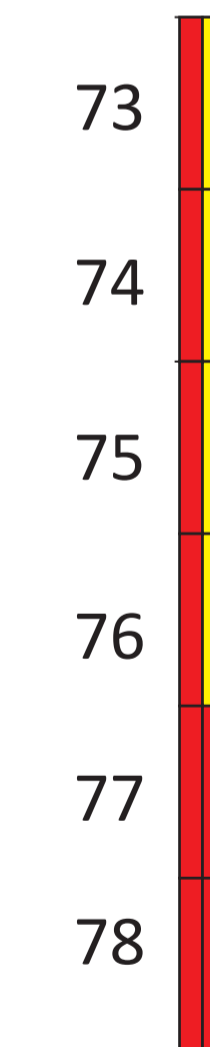
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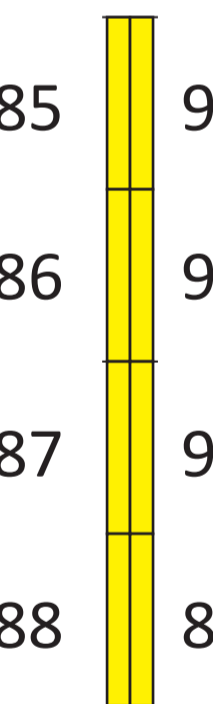
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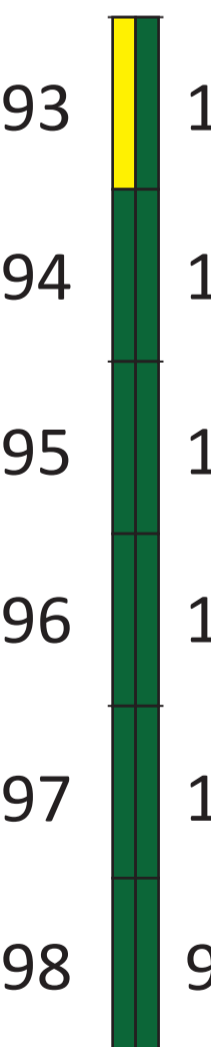
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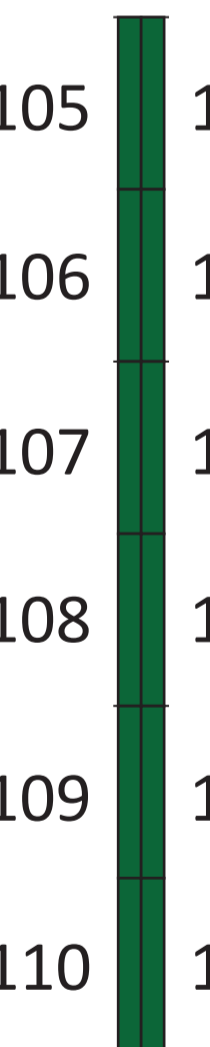
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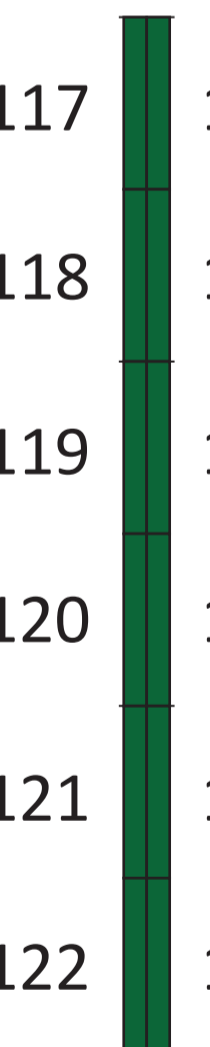
Lower Trophic Levels



Lower Trophic Levels



Lower Trophic Levels



Lower Trophic Levels

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MONDAY, JANUARY 22

WAVE 1

(6:30 PM TO 7:45 PM)

Wave 1
Monday, January 22nd (6:30 pm to 7:45 pm)
W. E. Eagan Civic and Convention Center

Title	Authors	Location (Row, Poster)
A decade of vital rate telemetry: Summarizing results, challenges and opportunities	Markus Horning, Casey Brown, Amanda Bishop	R1 , P2
Endangered species act status change for humpback whales: So what does this mean for Alaska?	Aleria Jensen, Suzie Teerlink, Alicia Bishop, Jon Kurland, Paul Wade	R1 , P5
Susceptibility of Alaskan marine mammal to acute RNA viruses	Amy Klink, Janessa Esquible, Kathy Burek-Huntington, Shannon Atkinson, Jennifer Burns, Eric Bortz, Amanda Bishop	R1 , P8
Sea otter (<i>Enhydra lutris</i>) foraging behavior across a density gradient in Southeast Alaska	Nicole LaRoche, Heidi Pearson, Wendel Raymond, Ashley Bolwerk, Tiffany Stephens, Sonia Ibarra, Ginny Eckert	R1 , P11
Oxidative stress indicators for assessing adverse effects of mercury exposure in Steller sea lions: Baseline values from relatively low mercury exposure	Marianne Lian, J Margaret Castellini, Thomas Kuhn, Lorrie Rea, Mandy Keogh, Brian Fadely, John Maniscalco, Todd O'Hara	R2 , P14
Using whale alert in southeast alaska: Creating safe waters for both mariners and whales	Kristin Mabry, Louise Taylor-Thomas, Christine Gabrielle, Janet Neilson, David Wiley, Virgil Zetterlind	R2 , P17
Southern Alaska resident killer whales may be dependent on more than Alaska salmon: some initial stream of origin genetic data from prey samples	Craig Matkin, Danie I Olsen, Brianna Wright, John Candy	R2 , P20
Spatial distribution of humpback (<i>Megaptera noveangliae</i>) and fin whales (<i>Balaenoptera physalus</i>) in relation to acoustically-sensed prey distribution and environment	Abigail McCarthy, Stan Kotwicki, Alex De Robertis	R2 , P23
Summary of spatial, temporal, demographic, and behavioral characteristics of groups of Cook Inlet beluga whales <i>Delphinapterus leucas</i> encountered during photo-ID surveys conducted 2005-2016	Tamara Mcguire, Amber Stephens, Malcolm Herstand, Susan Dufault	R3 , P26
Reproductive endocrine profiles in blue whales from the eastern North Pacific	Valentina Melica, Shannon Atkinson, John Calambokidis, Diane Gendron	R3 , P31
Recent declines in humpback whale population metrics in Glacier Bay and Icy Strait -- Is their heyday over?	Janet Neilson, Christine Gabriele, Louise Taylor-Thomas	R3 , P35
Remote sedation to capture and handle large otariids: Lessons learned for expanded applications	Kim Raum-Suryan, Lauri Jemison, Kate Savage, Michael Rehberg	R4 , P38
Prevalence of western Distinct Population Segment (DPS) origin Steller sea lions in the eastern DPS	Michael Rehberg, Gregory O'Corry-Crowe, Jamie Womble	R4 , P44
Interactions of <i>Streptococcus infantarius ss coli</i> and <i>Streptococcus phocae</i> in Resurrection and Kachemak bays, Alaska	Natalie Rouse	R4 , P48
Watching people watch whales in Juneau, AK: Assessing passenger attitudes towards regulations and how vessel presence impacts humpback whale behavior	Alicia Schuler, David Steckler, Sarah Piwetz, Heidi Pearson	R5 , P53
Premature extrapolations? Preliminary findings about reproductive status of female belugas from Cook Inlet, Alaska	Kim Shelden, John Burns, Barbara Mahoney, Tamara McGuire, Kathleen Burek-Huntington, Daniel Vos	R5 , P56
Tipping points in marine mammal health: A synthesis of evidence from the Pacific basin	Anne Southam, Shannon Atkinson	R5 , P59
Morphometric and physiological links to survival in Steller sea lions	Kelly Hastings, Mandy Keogh, Lorrie Rea, Stephanie Crawford	R6 , P62
Assessing potential impacts of whale watching on humpback whale respiration rate in Juneau, AK	Dana Flerchinger, Alicia Schuler, Heidi Pearson	R6 , P65
Development of a marine mammal disaster response plan for Cook Inlet and Kodiak	Sadie Wright, Jennifer Dushane-Garner, Mandy Migura, Barbara Mahoney	R6 , P70
Foraging ecology and habitat use of Cook Inlet beluga whales (<i>Delphinapterus leucas</i>)	Mark Nelson, Mathew Wooller, Manuel Castellote, Brian Taras, Lori Quakenbush, Justin Jenniges, Mandy Keogh	R6 , P72

Diving behavior of juvenile Steller sea lions in relation to predation	Alexandra Dubel, Amanda Bishop, Casey Brown, Markus Horning	R7 , P74
Research Strategy Analysis for Cook Inlet beluga whales	Charlotte Boyd, Gina Himes Boor, Sarah J. Converse, Eiren Jacobson, Tamara McGuire, Mandy Migura, Andre Punt, Lori Quakenbush, Paul Wade	R7 , P76
Risky Business: Developing a habitat use model for with inclusion of predation risk	Amanda Bishop, Casey Brown, Leigh Torres, Michael Rehberg, Markus Horning	R7 , P78
Precipitous decline in Steller sea lion pups in the Gulf of Alaska in 2017: Is it the “Blob”?	Katie Sweeney, Lowell Fritz, Tom Gelatt	R7 , P80
Assessment of public perceptions on Pacific razor clam (<i>Siliqua patula</i>) management initiatives following recreational closures.	Kathleen O'Brien, Jonathan Grabowski, Bradley Harris	R12 , P130
Using local and traditional knowledge of fishers to assess long-term ecological change in coastal Alaska	Anne Beaudreau, Philip Loring, Maggie Chan	R12 , P134
Connecting Alaska school systems to Alaska’s marine and aquatic ecosystems	Marilyn Sigman	R12 , P136
Expanding the understanding of ocean acidification processes and consequences through the Alaska Ocean Acidification Network	Darcy Dugan	R12 , P138
Demonstrating the use of local knowledge to inform catch accounting and decision-making in the Pacific halibut (<i>Hippoglossus stenolepis</i>) fishery off Southeast Alaska	Elizabeth Figus, Keith Criddle	R13 , P141
Implementation of community based psp testing for subsistence and recreational shellfish harvesting in southwestern Alaska – year 1 update	Julie A. Matweyou, R. Wayne Litaker, Steve R. Kibler, Bruce A. Wright, D. Ransom Hardison, Patricia A. Tester	R13 , P143
The Alaska Harmful Algal Bloom Network (AHAB) – An Introduction	Julie A. Matweyou	R13 , P144
Changes in marine predator and prey populations in the aftermath of the North Pacific Heat Wave: Gulf Watch Alaska Pelagic update 2017	Mayumi Arimitsu, Mary Anne Bishop, Scott Hatch, Robb Kaler, Kathy Kuletz, Craig Matkin, John Moran, Dan Olsen, Anne Schaefer, Jan Straley	R14 , P158
Building a foundation of decision-support tools integrating existing mapping and monitoring information for the benefit of long-term shellfish sustainability and management in Kachemak Bay and Cook Inlet, Alaska	Syverine Bentz, Marcus Geist, Jessica Shepherd, Steve Baird, Jamie Trammell, Angela Doroff, Jeff Hetrick, Rodger Painter, Megumi Aisu, Laurie Daniel	R14 , P160
Sea Otter Impacts on Subsistence Resources of the Southeast Alaskan Rocky Intertidal	Ashley Bolwerk, Ginny Eckert, Sonia Ibarra, Steve Langdon	R14 , P162
Using Small Unmanned Aircraft Systems (sUAS) to map intertidal topography in Katmai National Park and Preserve, Alaska	Parker Martyn, Daniel Monson, Heather Coletti, Dan Esler, Amy Miller	R15 , P163
A decade’s worth of data: Key metrics from a large-scale, trophic web based long term monitoring program in the northern Gulf of Alaska	Heather Coletti, Daniel Esler, Brenda Ballachey, James Bodkin, Thomas Dean, George Esslinger, Katrin Iken, Kimberly Kloecker, Brenda Konar, Mandy Lindeberg, Daniel Monson, Brian Robinson, Benjamin Weitzman	R14 , P164
Demographic and environmental influence on Steller sea lion pup condition reflects long-term changes at Marmot Island, Alaska	Brian Fadely, Lowell Fritz, Tom Gelatt	R15 , P166
Living in a watery world: Linking environmental variables to Pacific herring (<i>Clupea pallasii</i>) productivity	Jessica Gill, Sean Cox	R15 , P168
The Northern Gulf of Alaska Long-term Ecological Research program	Russell Hopcroft, Suzanne Strom, Ana Aguliar-Islas, Seth Danielson, Jerome Fiechter	R15 , P171
Variability in intertidal prey availability and diet preferences of <i>Enterocarpus dofleini</i> in Prince William Sound, AK	Caitlin Marsteller, David Scheel, Tania Vincent	R15 , P173
Twenty-eight years of intertidal biological variability based on volunteer visits to photo sites in Western Prince William Sound	Alan Mearns, David Janka, Pamela Marloff, Rob Campbell, Scott Pegau, Dan Esler	R15 , P176
Oceanographic characteristics associated with spring zooplankton community structure in Kachemak Bay, Alaska from 2012 to 2015	Kimberly Powell, James Schloemer, Kristine Holderied, Angela Doroff	R16 , P178
Gulf Watch Alaska: Taking the pulse of the northern Gulf of Alaska	Rob Suryan, Mandy Lindeberg, Donna Aderhold, Katrina Hoffman	R16 , P180
State of Alaska’s Salmon and People-Emerging insights from a large interdisciplinary synthesis project	Peter Westley, Ian Dutton	R16 , P182

Optical assessment of the Gulf of Alaska benthos east of Kodiak Island, AK	Victoria Batter, T. Scott Smeltz, Gregg Rosenkranz, Bradley Harris	R16 , P188
The interactive effects of CO ₂ exposure and prey quality on growth and lipid composition of Pacific cod larvae	Thomas Hurst, Louise Copeman, Scott Haines, Summer Meredith, Kaylin Hubbard	R17 , P191
Trophic relationships among juvenile salmon during cool and warm periods in Southeast Alaska	Emily Fergusson, Haila Schultz, Todd Miller	R17 , P193
Identifying key piscine predators of Pacific herring (<i>Clupea pallasii</i>) and walleye pollock (<i>Gadus chalcogrammus</i>) during winter months in bays of Prince William Sound, Alaska through multivariate analysis of stomach contents	Ben Gray, Mary Anne Bishop, Sean Powers	R17 , P195
Spatial scales for foraging juvenile Pacific herring inferred from fatty acid analysis	Ron Heintz, Fletcher Sewall, Lawrence Schaufler, Corey Fugate	R17 , P197
Diet profiling Alaskan octopuses: Applying stable isotope analysis to Alaskan populations of the giant Pacific octopus, <i>Enteroctopus dofleini</i>	Ben Jevons, Nathan Wolf, David Scheel, Richard Hocking, Bradley Harris, Sarah Webster	R17 , P199
Too hot, too cold, or just right? Temperature dependent growth and consumption of YOY Sablefish (<i>Anoplopoma fimbria</i>)	Joseph Krieger, Ashwin Sreenivasan, Anne Beaudreau, Ron Heintz	R18 , P201
Exploring the use of mucus to assess stress hormones in Pacific halibut (<i>Hippoglossus stenolepis</i>)	Anita Kroska, Nathan Wolf, Joseph Planas, Matthew Baker, Bradley Harris	R18 , P203
Title: Spatiotemporal assessment of Pacific halibut (<i>Hippoglossus stenolepis</i>) growth performance in IPHC Area 3A	Brian Ritchie, Nathan Wolf, Ian Stewart, Sarah Webster, Bradley Harris	R18 , P205
Surf or Turf? A determination of amino acid isotopic discrimination factors in Chinook salmon raised on fish meal versus terrestrially-derived protein diets	Matthew Rogers, Andrew Gray, Ryan Bare, Ron Heintz	R18 , P207
Developing a camera chute to assess halibut bycatch of Alaska's trawl fisheries	Craig Rose, Farron Wallace, Jenq-Neng Hwang, Tsung-Wei Huang, Suzanne Romain, Jason Sagmiller	R18 , P209
Using habitat characteristics and prey abundance to predict distribution and abundance of groundfish in the Gulf of Alaska	Kirsten Simonsen, Patrick Ressler, Chris Rooper	R18 , P211
Effects of the parasite <i>Ichthyophonus</i> (spp.) on Pacific halibut (<i>Hippoglossus stenolepis</i>) growth and condition	Sioned Sitikewicz, Paul Hershberger, Nathan Wolf, Bradley Harris	R19 , P213
Growth, consumption, and energy allocation strategies of YOY sablefish (<i>Anoplopoma fimbria</i>) cultured at five different temperatures	Ashwin Sreenivasan, Ron Heintz	R19 , P215
Tier 5 rockfish management	Todd TenBrink, Thomas Helser	R19 , P219
Morphometrics of forage fish sampled by puffins in Alaska: Describing the data	Sarah Ann Thompson, William Sydeman, Mayumi Arimitsu, John Piatt, Heather Renner, Scott Hatch	R19 , P221
Involving stakeholders in investigating and addressing multiple causes of historical Klawock Lake sockeye salmon declines	Christine Woll, Cathy Needham, Aaron Prussian	R19 , P224
Alaskan bathymetry for fisheries and oceanography research	Mark Zimmermann, Megan Prescott	R20 , P226
Impact of anomalous ocean conditions on the vertical distributions of groundfish in the Gulf of Alaska	Qiong Yang	R20 , P228

A Decade of Vital Rate Telemetry: Summarizing Results, Challenges and Opportunities

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The Life History Transmitter (LHX tag) is an implantable satellite-linked archival transmitter developed with Wildlife Computers, Inc. LHX tags are surgically implanted into homeotherm hosts and record data throughout their life. Summarized data are transmitted via the Argos satellite system postmortem after tags are extruded from decomposing, dismembered or digested carcasses. LHX tags provide known-fate data on the location and causes of mortality. For traumatic deaths with dismemberment, novel sensors including accelerometers and low-pH exposure may allow the distinction of predator species. For non-traumatic mortalities, measured cooling rates allow estimating body mass at time of death. LHX tags can be programmed to detect reproductive events that may yield age at primiparity and lifetime births in females. Two tags were used per animal to increase and quantify data return probability. Since 2004, 122 LHX tags have been deployed in 4 rehabilitated subadult California sea lions (California), 45 juvenile Steller sea lions (Gulf of Alaska), 4 rehabilitated harbor seal pups (Salish Sea), and 10 subadult and adult harbor seals (Western Aleutian Islands), and 2 rehabilitated sea otters (California). Twenty LHX tags were tested via 10 carcass deployments (Oregon and California), and LHX tags were tested on four captive sea otters and deployed in two rehabilitated otters released in California. Thirty-seven data returns were received from 42 tags deployed in 21 mortalities detected in sea lions and harbor seals. Data were received from 18 of 20 tags deployed in carcasses. From these 55 returns, data return probability for dual tag deployments was estimated at > 98%. Eighteen of 20 mortalities detected in Steller sea lions were classified as predation events. Five of these were attributed to Pacific sleeper sharks; the predator in the remaining events could not be determined. Vital rates are likely biased towards individuals with lower survival rates. Opportunistic data recovery from live animals via shore-based automated data relay systems is being developed and may reduce this bias and provide electronic mark re-sight data. The unique combination of postmortem known-fate data, opportunistic resights, and reproductive data allows novel experimental designs.

Endangered Species Act Status Change for Humpback Whales: So What Does This Mean for Alaska?

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On September 8, 2016, the National Marine Fisheries Service (NMFS) changed the status of humpback whales under the Endangered Species Act (ESA). Previously, humpback whales were listed under the ESA as an endangered species worldwide. In the 2016 decision, NMFS recognized the existence of 14 Distinct Population Segments (DPSs), classifying four as endangered, one as threatened, and the remaining nine as not warranting ESA protection. Three DPSs occur in Alaska waters: Western North Pacific (endangered), Mexico (threatened), and Hawaii (not listed). The recovered Hawaii DPS comprises the majority of humpback whales occurring throughout Alaska, representing 94% of the whales in Southeast Alaska and 89% elsewhere. NMFS has developed management approaches in Alaska to reflect the different conservation status of each population. First, NMFS Alaska Region issued guidance that federal actions which may affect humpback whales anywhere in Alaska should undergo ESA Section 7 consultation to consider potential effects to listed DPSs, given that the three DPSs overlap on Alaskan feeding grounds. When proposed actions are expected to “take” humpback whales off Alaska via harassment, injury, or mortality, NMFS uses probability of occurrence models developed by Wade et al. (2016) to provide the structure for apportioning takes to the Western North Pacific, Mexico, and Hawaii DPSs. Second, NMFS issued recommendations that research projects and stranding response activities which may involve humpback whales in Alaska be authorized under the ESA to account for the possibility that affected whales could belong to listed DPSs. Third, NMFS re-issued the 2001 Humpback Whale Approach Regulations to ensure that all humpback whales in Alaska, regardless of their ESA status, continue to benefit from protections against vessel strikes and harassment. Finally, NMFS and collaborators are actively implementing a monitoring plan in Southeast Alaska to ensure that the Hawaii DPS continues its recovery. The successful recovery of Hawaii DPS humpback whales is a story to celebrate, reflecting the efficacy of the ESA and other conservation measures. Meanwhile, conservation concerns remain for the other two breeding humpback whale

populations that migrate to Alaska, and NMFS continues its management of these still-listed DPSs to meet recovery goals.

Susceptibility of Alaska Marine Mammals to Acute RNA Viruses

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Marine mammals play important roles in top trophic levels of the Alaska marine ecosystem. Within the past 20 years there have been several unusual marine mammal mortality events along the Alaska coast, including sea otters (2006), pinnipeds (2011), and large whales (2015). Investigation of the cause of these and other strandings have been largely inconclusive. It is imperative to evaluate the extent pathogens, environmental toxins, climate change and anthropogenic factors have on marine mammal populations. Pathogenic RNA virus infections have been detected in significant marine mammal strandings in the North Atlantic. However, understanding of RNA virus reservoirs and host species susceptibility remains elusive. We have begun to study the impact of acute RNA viruses on marine mammal populations. In Alaska, preliminary studies have found phocine distemper virus (PDV) in sea otters (*Enhydra lutris*), and a potential case in Steller sea lions (*Eumetopias jubatus*). To confirm emergence of RNA viruses, we are improving PCR diagnostic assays by redesigning primers and specific fluorescent probes using recent virus sequence data. Experiments focus on respiratory and gastrointestinal infections including PDV, seal influenza A virus, cetacean morbillivirus, and marine mammal coronaviruses. A recent sampling (n = 7) of healthy harbor seals (*Phoca vitulina*) hunted for subsistence in Alaska (2014), and samples from strandings, are under investigation. To better understand virus evolution and pathogenesis, we are adapting virus full genome next-generation and nanopore (MinION) sequencing protocols developed for avian influenza A virus (AIV), avian paramyxoviruses, and bat coronaviruses, for study of marine mammal RNA viruses. Virus genome sequencing is crucial for mapping the spread of infection and host susceptibility on environmental interfaces between marine mammals and other species (such as birds). Ultimately, this data can be integrated into evaluation of how ecological and physiological factors impact health of marine mammal populations in Alaska.

Sea Otter (*Enhydra lutris*) Foraging Behavior Across a Density Gradient in Southeast Alaska

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Foraging studies have shown that sea otters (*Enhydra lutris*) will reduce invertebrate prey biomass while recolonizing an area. Until translocation efforts in the 1960s, sea otters were absent from Southeast Alaska due to extirpation from the fur trade in the 18th and 19th centuries. 413 sea otters were reintroduced to six Southeast Alaska locations including two sites near Prince of Wales Island in southern Southeast Alaska. This study will examine how diet changes according to sea otter density, age, sex, and substrate type around Prince of Wales Island. Aerial surveys conducted from 1987-2011 inform historical distribution and density of sea otters. We surveyed sea otter density throughout Prince of Wales Island via boat-based observational counts in 2017 to inform study site selection for our ecological studies. Sea otter activity was measured by quantifying the number of sea otter pits in soft-sediment habitats. Preliminary data on sea otter foraging were collected at sites that vary by sea otter density and substrate (soft vs. rocky bottom). In 142 individual dives across 15 foraging bouts of unique sea otters, prey type and size were recorded. Preliminary results show a diet of crabs (*Cancer productus*, *Metacarcinus magister*, *Pugettia* spp., and *Telmessus cheiragonus*) clams (*Saxidomus gigantea*, *Clinocardium* spp., *Macoma* spp., and *Mya* spp.), chitons (*Chrytochitron stelleri*), sea cucumbers (*Parastichopus californicus*), sea urchins (*Stronglyocentrotus droebachiensis*), sea stars (*Pisaster ochraceus*), and mussels (*Modiolus modiolus*). Foraging data collection will continue in Summer 2018 in both rocky and soft sediment communities, with emphasis on soft sediment (i.e., sea grass) ecosystems which have been under-studied relative to rocky bottom ecosystems (e.g., kelp forests). Foraging data collected will quantify sea otter diets and foraging strategies around Prince of Wales; this information will aid in future management of shellfisheries and subsistence hunting. This work is a part of a large-scale project examining how

returning apex predators structure nearshore marine ecosystems, provide ecosystem services, and affect community sustainability.

Oxidative Stress Indicators for Assessing Adverse Effects of Mercury Exposure in Steller Sea Lions: Baseline Values From Relatively Low Mercury Exposure

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Neurotoxicity of monomethyl mercury (MeHg⁺), likely caused by oxidative stress, may be countered by selenium (Se) via numerous antioxidant mechanisms. Increased oxidative stress is associated with a wide range of degenerative diseases, increased morbidity and decreased longevity. In the Steller sea lions (*Eumetopias jubatus*, SSL), one-third of the sampled pups in the central and western Aleutian Islands have total Hg concentrations ([THg]) hair values above levels of concern (> 20 µg/g) to increased risk of fetal neurological effects. The marine diet of pinnipeds supports high levels of systemic Se, and relatively high levels of antioxidants as an adaptation to reperfusion injury subsequent to long term dives (hypoxia). However, relatively low molar ratios of TSe:THg are documented for some SSL pups with relatively high [THg] (possible Hg dependent Se deficiency), leading to a possible overall antioxidant deficiency. Pinnipeds may experience similar oxygen and oxidative dependent physiological challenges during capture and anesthesia as occurs during diving, including oxidative stress. We captured and anesthetized newborn SSL pups at Chiswell Island, Alaska, to assess the interactions between [THg] and [TSe] status and the oxidative stress response in this population of SSL with a documented relatively low [THg]. The animals were captured as part of ongoing population monitoring research. All animals were anesthetized with isoflurane and 100% oxygen via a facial mask. Mixed arterial-venous blood gases were collected from the caudal gluteal plexus (n = 17), and blood gases (PO₂, PCO₂, SaO₂, pH, and lactate) were analyzed immediately with an i-STAT[®] blood gas analyzer, confirming normoxic, but slight hypercapnic, values. EDTA whole blood was processed on the rookery and plasma frozen immediately in a dry shipper. Biomarkers for lipid (4-HNE)

and protein (protein carbonyl content) peroxidation, [THg], [TSe] and the TSe:THg molar ratio were determined in the Wildlife Toxicology Laboratory. These baseline (reference) values in an anesthetized SSL population with relatively low [THg] will allow us to investigate our recently sampled animals from the central and western Aleutian Islands (higher Hg exposure).

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 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 season of digitally capturing and reporting sightings, we'll present lessons learned and a path forward for continued conservation.

Southern Alaska Resident Killer Whales May Be Dependent on More than Alaska Salmon: Some Initial Stream of Origin Genetic Data From Prey Samples

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There has been recent concern over declining Chinook salmon returns in Alaska waters including portions of the Alaska north gulf coast where a primary prey of southern Alaska resident killer whales is Chinook salmon. For over 20 years, we have collected fish scale and tissue samples from killer whale predation sites to determine prey species, but recently we have also determined rivers of origin for these fish. Initial results from samples taken in 2015 and 2016 indicate that the natal streams of fish consumed by killer whales are often far distant from predation sites; for example, one king salmon consumed by a killer whale in Prince William Sound, Alaska, was reared in a tributary of the Columbia River. Fifteen of the Chinook prey samples analyzed were collected from the Kenai Fjords, Alaska region, in May and June and two from Prince William Sound in August. All of the nine samples from Kenai Fjords that originated in Alaska spawning grounds were from the Situk River near Yakutat. Of the remaining seven, four were from central British Columbia spawning sites, three from northern British Columbia rivers, and one from a Columbia River tributary. In addition, four chum salmon prey were genotyped and although there was less certainty in determining river of origin, it appears that two were from Nootka Sound, British Columbia, on Vancouver Island, one from northern British Columbia, and one was from the Dipac Hatchery in Juneau, Alaska. Even in these nearshore areas, southern Alaska resident killer whales are feeding on fish of broad geographic origin, not necessarily on local stocks. For the annual spring aggregations of killer whales in Kenai Fjords, Chinook salmon from the Situk River, approximately 350 miles to the east, appear to be an important component of the prey base. Additional sampling and analysis are needed to determine salmon stocks currently important to southern Alaska resident killer whales.

Spatial Distribution of Humpback (*Megaptera noveangeliae*) and Fin Whales (*Balaenoptera physalus*) in Relation to Acoustically-Sensed Prey Distribution and Environment

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Visual cetacean surveys and simultaneous acoustic-trawl surveys of their potential prey were conducted in two canyons off Kodiak Island in 2004 and 2006. A combination of univariate and multivariate statistical modeling are used to examine the associations between sightings of fin and humpback whales and measures of their potential prey and environment. Together, these observations and models indicate that fin whales were disproportionately abundant in areas with the highest observed euphausiid concentrations, while humpback whales were abundant at lower euphausiid concentrations and also in areas where juvenile pollock were abundant. Fin whales were disproportionately abundant in the deepest areas surveyed (> 150 m depth), while humpback whales were primarily found in shallower areas. The different depth and prey affinities of fin and humpback whales suggest niche and habitat partitioning between these two co-occurring species. Abundance models built using these acoustically sensed data are a useful tool for further understanding the distribution, abundance, and behavior of these animals, and may be useful for future conservation efforts.

Summary of Spatial, Temporal, Demographic, and Behavioral Characteristics of Groups of Cook Inlet Beluga Whales *Delphinapterus leucas* Encountered During Photo-ID Surveys Conducted 2005-2016

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More information is needed to understand and reverse the unexplained lack of recovery of Alaska's endangered Cook Inlet beluga whale (CIBW) population (*Delphinapterus leucas*). Here we summarize 12 years of sighting information (month, location, size, color/sex/age-class composition, and observations of feeding behavior) for 551 groups encountered during 421 photo-ID surveys. Results are presented as maps to assist managers in evaluating seasonal/area restrictions for mitigation, monitoring, and permitting purposes of human activities with the potential to affect CIBW or their habitat. Data were collected during vessel- and shore-based surveys April through October 2005-2016 in Cook Inlet. Most of the effort was concentrated in the Susitna River Delta, Knik Arm, and Turnagain Arm, with fewer surveys in the Kenai River Delta and Chickaloon Bay/Fire Island. In each of the field seasons, the largest group encountered annually occurred in the Susitna River Delta during a 2.5-week period between mid-July and early August. Maximum group size has been increasing in recent years; groups of 200 or more individuals were first seen in 2012 and the maximum group of 313 whales was seen in 2015. Most groups encountered consisted of white belugas, gray belugas, and calves/neonates, although the relative percentage of each varied by year, month, and area. Data from known-sex individuals showed little difference between the sexes in terms of the groups and areas in which they were sighted. Calves were seen in all areas, months, and years surveyed. The first neonate sighting each year was in the Susitna River Delta between early July and early August. Neonates were seen as late as mid-October, and in all areas surveyed. Feeding behavior was observed in most of the areas in which groups were encountered and in all months surveyed except April. Beluga groups were not distributed uniformly throughout the study area, but were instead associated with river mouths and water channels connecting them, with strong tidal and seasonal patterns to their distribution and movements. The distinct areas where belugas are found seasonally, corridors connecting them, and "hotspots" of special biological significance (e.g., feeding, calving/calf rearing) should warrant concerted management and protection.

Reproductive Endocrine Profiles in Blue Whales From the Eastern North Pacific

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The goal of this project is to define progesterone and testosterone profiles for different reproductive states in blue whales (*Balaenoptera musculus*) from the eastern North Pacific and determine how samples stored in different ways alter these concentrations. While extensive work has been conducted using photo-identification and tagging to estimate population abundance and movements, physiological parameters regarding reproduction are fundamental for describing population dynamics and defining growth. In this study, blubber progesterone concentrations were combined with sighting history as a tool to determine pregnancy status in blue whales. Results of progesterone and testosterone in 89 blubber biopsies and in three stranded individuals support the hypothesis that hormones concentrations vary across reproductive state. Specifically, observational data confirmed pregnancy status for three out of seven adult biopsied whales with high progesterone, as they were seen with calves the following year and for one stranded individuals, as it was carrying a fetus at the time of necropsy. Furthermore, very low concentrations of progesterone were found in immature (i.e., less than 10 years old) and lactating females. Testosterone concentrations were higher in samples from the summer grounds as animals prepare to breed. Additionally, to determine the feasibility for hormone analysis of archived samples stored in dimethyl sulfoxide (DMSO) a pilot experiment was designed and carried out: pieces of blubber were placed in DMSO and analyzed after 2, 4 and, 8 weeks. Results indicate that blubber stored for at least 8 weeks in DMSO showed no significant difference in progesterone concentration compared to blubber stored frozen (p -value > 0.05). Further steps include the use of these data for estimating reproductive parameters such as pregnancy and calving rates. Additional archived blubber samples stored in DMSO will be processed for further analysis, now that we have verified this storage method does not invalidate results.

Recent Declines in Humpback Whale Population Metrics in Glacier Bay and Icy Strait -- Is Their Heyday Over?

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Humpback whales that summer in Southeast Alaska exhibit strong maternally-directed site fidelity that has driven population growth over time. From 1985 to 2017, we used consistent methods to monitor humpback whales annually from June 1 to August 31 in Glacier Bay and Icy Strait (GB-IS) in one of the longest running photo-ID studies of humpback whales in the world. Beginning in 2014, along with declines in total whale abundance, we documented substantial declines in adult site fidelity, calving, and juvenile return rates. Numerous adult whales with a long-term history of site fidelity to GB-IS appeared to be missing. From 1985 to 2013, we observed a mean of 9.3 calves/year (range 2-21) and a crude birth rate (annual number of calves/annual total whale count) of 3.3%-18.2%. In 2014, an unprecedented number of mothers (n = 5) appeared to lose their calves and none of the remaining calves (n = 9) have been resighted in subsequent years. In 2015, we documented relatively few calves (n = 5) and none have been resighted. In 2016, we documented one mother/calf pair (both appeared to be abnormally thin), which led to the lowest crude birth rate (0.6%) since monitoring began. In 2017, we documented two mother-calf pairs; one of these mothers appeared to be abnormally thin and the other lost her calf by mid-July. Juvenile return rates have declined with no 1-2 year-old whales detected in 2016 and very few small whales in 2017. Out of 29 calves that we documented from 2013-2015, only two individuals are known to have survived to be juveniles. These trends appear to be occurring throughout northern Southeast Alaska, as indicated by observations during a 2016-2017 collaborative regional study of humpback whales. We hypothesize that these changes relate to recent shifts in whale prey availability and/or prey quality in the region that are affecting whale distribution, maternal body condition/reproductive success, and juvenile survival. Given the importance of local recruitment to this population's growth over the previous 30 years, sustained declines in site fidelity, calving, and/or recruitment will have long-term effects on the humpback whale population in this area.

Remote Sedation to Capture and Handle Large Otariids: Lessons Learned for Expanded Applications

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Advances in remote sedation have made the once nearly impossible task of safely capturing and handling subadult and adult Steller sea lions in the water now possible. Over the past 4 years, the Alaska Department of Fish and Game and National Marine Fisheries Service have collaborated to safely capture and disentangle nine subadult male Steller sea lions in Southeast Alaska. Using a combination of midazolam, butorphanol, and medetomidine, we were able to safely immobilize sea lions on land and in the water without respiratory compromise. With each entanglement response and capture, we learned many valuable lessons that could help other scientists who plan to embark upon this method. Many factors impact the success of a capture including the location, size, and position of the animal; communication among responders; experience of responding personnel; adaptive techniques when the unexpected occurs; weather, tidal, and other environmental conditions; capture equipment and satellite tag application; and response of the target sea lion and surrounding sea lions after darting. While this new but challenging method has been very effective for disentangling Steller sea lions, its application could be applied to other research questions about subadult and adult Steller sea lions.

Prevalence of Western Distinct Population Segment (DPS) Origin Steller Sea Lions in the Eastern DPS

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Steller sea lions in the Glacier Bay region are of greater mass, experience higher survival and have more rapid population growth than sea lions elsewhere in Southeast Alaska. Fifty-two percent ($n = 31$) of individuals captured here had maternal origins in the endangered western Distinct Population Segment (DPS) rather than the local, recovered eastern DPS, as determined by analysis of mitochondrial DNA (mtDNA) in skin samples. Using satellite telemetry and brand-resight observations, we tracked these wDPS-origin individuals as far as Sea Lion Island and Tenakee Inlet, 630 km south of the nearest sea lion haulout within the wDPS. The wDPS origin females captured here as immature juveniles also remained here to breed, years later, at the local Graves Rocks and White Sisters rookeries. This second generation of immigrant breeders corroborates earlier speculation that the population growth in this area, compared to elsewhere in the eDPS, is likely related to colonization of the thriving eDPS by individuals emigrating from the wDPS. Yet unknown is whether these wDPS origin individuals enjoy higher survival than their eDPS neighbors. Because we have observed other branded and satellite-tagged sea lions roaming throughout Southeast Alaska, and 10 years have elapsed since our previous genetic sampling effort, we are now prioritizing additional skin samples for analysis from our existing archive of sea lions tracked in the eDPS, and analyzing new skin samples collected from the Glacier Bay region to determine their stock origins. Use of tracking data will expand the ability of mtDNA samples, taken at a single location, to more fully describe the prevalence of wDPS origin sea lions within the eDPS, assisting our understanding of colonization of this delisted population by an endangered population and the implications for DPS-based management in Southeast Alaska.

Interactions of *Streptococcus infantarius* ss *coli* and *Streptococcus phocae* in Resurrection and Kachemak Bays, Alaska

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The U.S. Fish and Wildlife Service declared an unusual mortality event (UME) in 2002 when a high number of sea otters in Alaska were found dead. Necropsies conducted between 2002 and 2010 revealed the cause of death in 30% of examined cases to be a vegetative valvular endocarditis (VVE) colonized by gram-positive cocci, later determined to be primarily *Streptococcus infantarius* subsp. *coli* and *Streptococcus phocae*. While much work has been done to uncover the pathogenic agent responsible, the ecology of these bacteria in the environment remains poorly understood. This study investigated the persistence of *S. infantarius* subsp. *coli* and *S. phocae* in the marine environment by 1) developing a molecular method to detect *S. infantarius* subsp. *coli* 2) examining potential microbe-habitat associations and 3) determining the competency of otter prey species to act as reservoirs for these pathogens. A PCR assay was developed to detect *S. infantarius* subsp. *coli* in both environmental and clinical samples. Water and blue mussels were collected from 162 sites around the perimeters of Kachemak and Resurrection bays in the summer of 2016 and pathogen presence was determined using PCR to detect the *sodA* gene. Habitat attributes were recorded onsite and determined using ShoreZone. Prey competency was tested via a dosing experiment in the lab. Our primer set for *S. infantarius* subsp. *coli* *sodA* and a previously published primer set for the *S. phocae* *sodA* gene successfully identified our targets in clinical and environmental samples using PCR and quantified the *sodA* gene in dosed prey samples using qPCR. *S. infantarius* subsp. *coli* and/or *S. phocae* were present in water and mussels at 61 sites. Statistical analyses to determine bacterial correlations with habitat attributes revealed inconsistent weak correlations between habitat parameters selected and presence of our target bacteria in the environment. Prey competency experiments showed that bivalves were the most competent pathogen reservoirs. Results of this study will inform microbial ecologists and wildlife managers of the potential environmental risk factors for *S. infantarius* subsp. *coli* and *S. phocae* infection as well as provide information about pathogenic bacterial persistence in the marine environment.

Watching People Watch Whales in Juneau, AK: Assessing Passenger Attitudes Towards Regulations and How Vessel Presence Impacts Humpback Whale Behavior

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The whale watching industry in Juneau, Alaska has developed rapidly alongside a growing population of North Pacific humpback whales (*Megaptera novaeangliae*). As the number of whale watch vessels increases within whale feeding grounds, there is concern that negative short-term and long-term effects could jeopardize the health of the resource in which the industry relies. Alternatively, whale watching has the potential to increase passenger awareness and understanding of whales, which may encourage the conservation of whales. The first aim of this study is to determine potential costs of whale watching by measuring changes in humpback whale movement and behavior in response to whale watch vessel presence. The second aim is to assess the potential benefits of whale watching by analyzing whale watch passengers' conservation attitudes, and knowledge of whales and whale watching guidelines, using surveys before, after, and 6 months after their whale watch experience. From the summer of 2016, movement and behavior data were collected on 54 adult humpback whales through shore-based theodolite tracking and associated behavioral observations. For each whale observation (mean = 39.2 min; range = 15.8 min - 71.4 min), mean inter-breath interval, speed over course, and directionality were determined while traveling. Preliminary results indicate that boat presence did not have a significant effect on these variables. A total of 979 passenger surveys were completed in 2016. Survey results revealed that the percentage of passengers knowledgeable of guidelines and regulations doubled after a boat-based whale watch experience and was maintained six months later (before: 35%, after: 72%, 6 months after: 82%). Most passengers agreed that regulations are important for the protection of whales (before: 91%, after: 86%, 6 months after: 81%); however, passengers were more likely to disagree between the before (4%) and 6 month after (15%) survey periods (Wilcoxon rank sum test, $p = 0.038$). Additional data collected in summer 2017 will improve the sample size to increase statistical power. Further investigation on vessel impact will be necessary for maintaining a healthy humpback whale population. Developing whale watch experiences with conservation-minded educational messages may also be important for

influencing passenger support of existing and future changes in guidelines and regulations.

Premature Extrapolations? Preliminary Findings About Reproductive Status of Female Belugas From Cook Inlet, Alaska

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Belugas of Cook Inlet are a genetically unique and critically endangered population for which adequate life history data are lacking. In 2016, the abundance of this population was estimated to be 328 whales (95% CI = 279, 386). Since 2008 (when the population was listed as endangered), the range occupied by these whales in early summer has contracted farther into the upper reaches of the inlet. Whales now occupy about 29% of the summer range they occupied in the late 1970s. Hunted (pre-2006), live stranded, and beach-cast whales are reported to NMFS and photographed/sampled whenever possible. Unfavorable weather, extreme tides (to 12 m), strong tidal currents, and carcasses in remote locations often preclude acquisition of photographs, measurements, and tissue samples. Our sample includes 51 females necropsied between March and November 1995 to 2014. Age was determined on the basis of growth layer groups (GLGs) in tooth sections. Sexually mature females ranged from age 10 to 47. Seven whales were immature (< 3 GLGs) and 14 were too decomposed to determine reproductive status. Of 30 sexually mature females, 12 were non-gravid, 10 were pregnant, and 8 were recently postpartum. A pregnant 14 GLG whale was photographed 4 years earlier, at age 10, with a neonate. This is in agreement with age at first births in other populations. The 47 GLG whale had an enlarged uterus and was lactating. Ovary weights and internal ovarian structures were recorded on examination of 12 paired and 10 single ovaries. For paired ovaries, one appeared dominant: more so in near-term and recently post-partum animals. Of the 10 pregnant whales, 4 had small early-stage fetuses and 6 were near-term. We found no evidence of reproductive senility. Except for one ectopic pregnancy (ruptured uterus), no term fetuses were encountered after mid-June. Based on our small sample, some breeding may extend into May. Births begin in June when the whales are near and in rivers to take advantage of warm, shallow waters, and to feed on abundant, sequentially-available coastal and anadromous fishes.

Tipping Points in Marine Mammal Health: A Synthesis of Evidence from the Pacific Basin

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Presenter: Anne Southam

A synthesis of data from stranding events and Unusual Mortality Events (UMEs) across the Pacific Basin indicate a potential increase in the number and diversity of species stranding or entering rehabilitation programs as emaciated and independently failing to thrive. Certain species have shown a decline in pup girth over several decades. Recently, emaciation has been a contributing factor in these events. In 2015, a record 4,200 California sea lions (*Zalophus californianus*) stranded off California. From January - June 2016, the average number of stranded California sea lions (n = 2,043) was two times higher than the same 6-month period 2003 – 2012 (NOAA, 2016). Stranded pups were emaciated and dehydrated due to apparent malnutrition. San Miguel California sea lion female pup weight has been decreasing over the last 41 years, with the mean weight in 2015 of 11.8 kg, 31% lower than previous years. In 2015, the San Miguel stock of northern fur seal (*Callorhinus ursinus*) pups had the third lowest average weight in 41 years (Melin, 2015). Similarly, the decline of Hawaiian monk seals (*Monachus schauinslandi*) has been partially attributed to the loss of juveniles with low body weight (Parrish et al., 2012). Poor prey resources may have contributed to a UME of eastern North Pacific gray whales (*Eschrichtius robustus*) 1999 – 2001, with at least 651 whales confirmed dead (Gulland et al., 2005; Thomas et al., 2016). An overall increase in ocean temperature globally has been particularly notable in the North Pacific (Xue et al. 2014; Johnson et al. 2013). The marine heatwave in the eastern North Pacific Ocean has caused ecosystem-wide changes in species composition and resulting prey availability for marine mammals. The incidents of domoic acid toxicity due to harmful algal blooms combined with malnourishment and changes in prey may indicate marine mammals in the Pacific are reaching specific tipping points for survival. A comprehensive review of these occurrences raises questions about the stability of marine mammal habitats over a broad scale.

Morphometric and Physiological Links to Survival in Steller Sea Lions

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Morphometric and physiological measures are often used to assess the health of wildlife populations, but links between these measures and individual fate (growth, survival and reproduction) have less often been assessed, especially from wild populations. In this study we identify which morphological and physiological parameters are most strongly associated with survival (and therefore population trend) of Steller sea lions to inform monitoring programs of Alaskan marine mammal populations. We examined the effects on individual survival (to 1–1.5 years after the time of measurement, S) for 9 morphological variables, 8 basic blood measures, 23 serum chemistry measures, measures of fasting/feeding state, and mercury level in hair, using resighting data of 2,430 branded animals first captured at ages 2 week–3 year and resighted up to age 15 years. Based on a priori hypotheses and exploratory analysis, linear and quadratic trends and effects at the upper or lower portions of the ranges of observed values were assessed separately for each variable via mark recapture models. Preliminary results included a positive linear trend in annual survival with age/sex-specific mass, with effect size greatest for very young pups ($\Delta S / \Delta \text{kg} = 0.014$ for ages 0–2 months, 0.008 at ages 1+ year). A nearly identical pattern was observed for body volume. A positive trend in survival was observed only at age 1+ year (when some animals were potentially weaned) for two condition indices ($\Delta S / \Delta 1\% \text{ in condition} = 0.002$ for both indices). A significant quadratic relationship was observed between S and both age/sex-specific body length and axillary girth: S increased by $\sim 0.015/\text{cm}$ with these measures before leveling off at the mean length and at 10 cm > the mean girth, for a given age/sex. The expected pattern was observed concerning feeding/fasting state but was not statistically supported ($n = 343$): survival was -0.20 lower for pups in severe fasting state than pups that had more recently fed.

Assessing Potential Impacts of Whale Watching on Humpback Whale Respiration Rate in Juneau, AK

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Whale watching serves as an important industry in Juneau, Alaska, during the summer when humpback whales (*Megaptera novaeangliae*) arrive to prey on abundant food resources. This coincides with the arrival of cruise ships packed with tourists, one-quarter of whom embark on whale watching excursions that generate millions of dollars for Juneau's economy. However, because the sustainability of whale watching depends on the abundance and health of the whales, assessment of the costs is essential to creating a mutually beneficial industry for whales and humans. Costs of whale watching may include negative effects on whale behavior resulting from vessel presence. Energy is a significant factor in the determination of the fitness of an organism, and vessel presence may provoke a stress response in humpbacks, resulting in behavioral changes and greater energy expenditure. The objective of this study was to demonstrate the short-term effects of whale watching vessel presence or absence on whale respiration rates and dive times, which can serve as proxies for energy expenditure in cetaceans. Shore-based observations in conjunction with a larger theodolite study were used to record the behavior of whales with respect to whale watch vessels during summer 2017 in Juneau. Specifically, the effect of whale watch vessel presence and number on humpback whale respiration rate and dive time was analyzed. Preliminary results based on 80 sightings of humpback whales during June 2017 indicate that boat presence does not have a significant effect on whale respiration rate. However, analysis is on-going with the larger dataset to confirm or refute this preliminary finding. Continued research will help to determine if and how vessel presence influences whale behavior in Juneau. These assessments will aid in the development of conservation policy and help to promote the best practices for the whale watching industry.

Development of a Marine Mammal Disaster Response Plan for Cook Inlet and Kodiak

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Projected increases in oil and gas development 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 in Alaska's waters that could have consequences for marine mammals, such as mass stranding events. The National Marine Fisheries Service (NMFS) recognized the need for regional response plans in Alaska detailing protocols for marine mammal disaster response and communication with agency personnel, partners, communities, and other stakeholders to respond to these kinds of events. NMFS has nearly completed the Arctic Marine Mammal Disaster Response Guidelines, and is in the process of developing a similar plan for Cook Inlet and Kodiak. The concentration of oil and gas development and shipping in Cook Inlet, and multiple vessel groundings and a recent large whale unusual mortality event on Kodiak, led NMFS to select this area for the next regional marine mammal disaster response plan. The early stages in the development of this plan included visits to communities on the Kenai Peninsula and Kodiak Island in Spring 2017 to meet with people who would likely be involved or affected by a disaster response occurring in these areas. The plan will build upon existing communication pathways, facilities, and response processes; and will incorporate protocols for marine mammal de-oiling, tissue sampling, necropsies, and carcass collection. NMFS will also continue to meet with industry, oil spill response organizations, marine mammal co-management groups, and others in order to solicit further input for the plan. A draft of the Cook Inlet and Kodiak Marine Mammal Disaster Response Plan is expected in September 2018.

Foraging Ecology and Habitat Use of Cook Inlet Beluga Whales (*Delphinapterus leucas*)

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The Cook Inlet beluga (CIB) whale population underwent a ~50% decline associated with unsustainable subsistence harvests. In spite of a volunteer moratorium on subsistence harvests, listing under the U.S. Endangered Species Act, and designation of critical habitat the CIB population has not recovered. This project employs both field and laboratory methods to understand whether changes in prey availability are impeding recovery. The laboratory research builds upon our previous analyses of growth layer groups (GLGs) of teeth for isotope signatures ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values, and $87\text{Sr}/86\text{Sr}$ ratios) to assess habitat use and foraging over the lifetime of individuals. We present data indicating a reduction in the geographic range of belugas into the upper and more freshwater reaches of Cook Inlet, where their prey may have a greater freshwater influence. The $87\text{Sr}/86\text{Sr}$ ratios of multiple growth layer groups from 5 beluga teeth (3 male, 2 female) trend away from the global marine ratio (0.70918) over time toward more freshwater influenced ratios. These findings are consistent with aerial survey data showing a retraction of CIB into the upper Cook Inlet. The preliminary results for $87\text{Sr}/86\text{Sr}$ ratios also suggest the spatial foraging ecology may differ between female and male CIBs. A pilot study is underway to determine if GLG measurements can be used to assess changes in relative growth and body condition of CIBs over their lifetime, thereby providing a new method to track changes in these parameters in relation to prey and environmental factors from the 1960s to the present. Current spatial distribution of beluga feeding occurrence will be monitored with 11 acoustic moorings deployed in September 2017. Overwinter deployment locations are based on known beluga locations and fisheries information where potential prey concentrate in winter. In spring, the moorings will be moved to areas where belugas concentrate to feed during the open water season. Acoustic data from these locations will also be used to characterize anthropogenic noise to quantify and monitor potential disturbance (i.e.,

spatial displacement) in these feeding areas. This study will provide needed information on the current and historical foraging and habitat use of CIBs.

Diving Behavior of Juvenile Steller Sea Lions in Relation to Predation

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With most species juveniles constitute one of the most vulnerable life stages. Telemetry data has revealed that predation is the single greatest contemporary cause of mortality for juvenile Steller sea lions (SSL; *Eumetopias jubatus*) in the Kenai Fjords/Prince William Sound (KW/PWS) region, Alaska. Since the Western Distinct Population Segment of the SSL is endangered, understanding the linkages between behaviors and predation risk will therefore be critical for managing and promoting species recovery. We analyzed post-release dive behavior data (time-at depth, dive depth and dive duration) from external satellite tags deployed on juvenile SSLs captured in the KF/PWS region (n = 38). We compared juveniles that remain alive as of 2017 (n = 21) to juveniles with a known mortality event detected by implanted vital rate transmitters (n = 17) to examine potential differences in their diving behaviors. After accounting for other factors that may affect dive behavior (i.e., sex, mass, season) our results show that, on average, there is no significant difference between alive juvenile SSLs, and those that subsequently perished. Variability in diving behaviors between groups was also not significantly different. In a few cases, external tags were still transmitting up to the time of death (n = 3). Using these records, we also examined these individuals' behaviours 7 days ante-mortem relative to their normal behavioral repertoire and found variation across individuals. These preliminary results suggest that dive behavior alone does not seem to relate to predation risk, and that the majority of variation across individuals can be accounted for by seasonal differences. This highlights the need for further investigation into whether diving and local habitat/bathymetry interact to influence predation risk of juveniles. We anticipate our results will be incorporated into a larger multi-faceted predator prey dynamic study that would assist future management and conservation goals.

Research Strategy Analysis for Cook Inlet Beluga Whales

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Cook Inlet beluga whales (CIBW), a geographically isolated population of beluga whales in Cook Inlet, Alaska, are listed as endangered under the U.S. Endangered Species Act and were recently declared a NOAA Fisheries' Species in the Spotlight. CIBW suffered a precipitous decline in the mid-1990s due to unsustainable levels of subsistence harvest. Hunting has been extremely limited since 1999, but aerial surveys indicate that the population is still not increasing and the number of mature individuals probably remains well below 250. The reasons for this recovery failure are unknown. The CIBW Recovery Plan indicates that we need to continue monitoring the population's status, improve our understanding of basic CIBW biology and ecology, and identify the threats that are preventing the population's recovery. In particular, we need to ascertain the CIBW's population structure, reproductive and survival rates, and compare them to healthier stocks. We also need information on year-round distribution patterns as a basis for more in-depth studies of foraging ecology and to provide information for consultations to limit the impacts of anthropogenic disturbance. Research Strategy Analysis builds on the well-established frameworks of decision analysis and management strategy evaluation. It provides a structured process for decision-making about research design based on the recognition that decisions can be separated into objectives, alternative actions, predictions of the consequences, and evaluation of those consequences. The CIBW Research Strategy Analysis will have three key components: 1) articulate research objectives (e.g., population abundance and trends, population structure and vital rates, year-round distribution patterns and group/individual movement patterns) and measurable criteria, 2) identify alternative research designs (composed of various

intensities of aerial surveys, photo-identification, genetic studies, or passive acoustic monitoring), 3) predict how these alternatives will contribute to attaining research objectives. Following this analysis, managers and researchers will be better able to evaluate the potential contribution of research actions designed to monitor the population's status and improve our understanding of basic CIBW biology and ecology, and possible risks to this endangered population. In the future, research objectives can be evaluated within a formal value-of-information analysis to understand how learning can optimally contribute to desired management outcomes.

Risky Business: Developing a Habitat Use Model for With Inclusion of Predation Risk

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The spatial distribution and habitat utilization of upper trophic level predators is assumed to be primarily driven by foraging opportunities and predation avoidance, but the latter is rarely included in species distribution models for marine animals due to lack of data. Modern implanted telemetry devices; for example, Life History Tags (LHX tags), can assist in bridging this data-gap by detecting the occurrence and location of predation events from known age, free-living animals. In our case-study, we have geospatial tracking data from juvenile Steller sea lions (SSLs) tagged between 2000 and 2014 (n = 105) in the Prince William Sound (PWS) and Kenai Fjords (KF) regions in Alaska. LHX tags were implanted in a subset of these animals (n = 45), of which there have been 20 known mortalities to date. The data from the LHX tags suggests at least fifteen mortalities were classified as predation, in turn demonstrating that predation is the single greatest cause of mortality for juvenile Steller sea lions in the PWS/KF region. By integrating the geospatial satellite tracking information, environmental data, and a spatially explicit predation event probability layer, our habitat use models will be used to address several questions including: 1) Is predation pressure influencing juvenile SSL dive or movement behaviors?; 2) Is there evidence to support a specific species is the primary predator of juvenile SSLs?; and (3) Under various climate change scenarios, how might predation risk change, and therefore, how might juvenile SSL distributions shift? Here we will present our preliminary results, and provide opportunity to discuss various methods for addressing these questions. Juveniles constitute one of the most vulnerable life history stages for SSLs; therefore, understanding the preference and avoidance of specific environmental and predator related factors is vital to management, and for promoting the recovery of the species.

Precipitous Decline in Steller Sea Lion Pups in the Gulf of Alaska in 2017: Is It the “Blob”?

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Warm water anomalies have been occurring with increasing frequency and regularity in the North Pacific Ocean since 2013, earning the nickname the “Blob”. In 2015 in the Gulf of Alaska, dozens of large whales, tens of thousands of common murrelets, and sea stars washed up dead. In 2016, more than 200 emaciated tufted puffin carcasses were discovered in the fall and northern fur seal pup production reached an all-time low in 100 years in the Bering Sea. Also in 2016, thousands of starving California sea lion pups stranded along the coast of California related to the strong 2015/2016 El Niño. We can now add Steller sea lions to the list of species potentially affected by warm water anomalies. NOAA Fisheries conducts abundance surveys to collect counts of Steller sea lions in Alaska during the summer breeding season. Counts from the 2017 survey indicate live pups declined 33% and 18% since 2015 in the eastern and central Gulf of Alaska regions, respectively. This cannot be explained by emigration of adult and juvenile (non-pup) Steller sea lions; in fact, counts showed an atypical movement of ~ 1,000 non-pups to the central Gulf of Alaska. Preliminary counts from the western Gulf of Alaska indicates little to no change in pup production in 2017, while pup counts in southeast Alaska were down slightly. Large numbers of dead Steller sea lion pups were not observed during our survey nor during a 2-month field camp at the Marmot Island rookery (near Kodiak). This differs from the response of female California sea lions when prey resources may be limited, who give birth to underweight pups that they eventually may abandon. California sea lions experience less seasonal variability in their mid-latitude environment than sub-Arctic Steller sea lions, but are exposed to unpredictable food resources due to climate anomalies like El Niño. Despite the highly seasonal environment inhabited by Steller sea lions, they could be expected to have more predictable prey availability. However, with warm water anomalies reaching high-latitudes and possibly influencing food resources, could Steller sea lion pup production have been influenced by reduced prey availability?

Assessment of Public Perceptions on Pacific Razor Clam (*Siliqua patula*) Management Initiatives Following Recreational Closures

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Presenter: Kathleen O'Brien

Pacific razor clam (*Siliqua patula*) harvesting has been an important recreational and commercial activity in Cook Inlet, Southcentral Alaska, since 1919. For unknown reasons, the fishery has declined significantly in recent years, resulting in the entire east side of Cook Inlet being closed to Pacific razor clam harvesting in 2015. The west side of Cook Inlet remains open to commercial and recreational harvesting with no bag limit. The goals of this project were to assess community involvement in Pacific razor clam harvesting and public perceptions of recent Pacific razor clam management initiatives. In 2016, an online survey was conducted to address these goals. 111 people responded to the survey. Responses were analyzed to identify potential differences in the perception of recent Pacific razor clam management initiatives a) between respondents who primarily harvest clams on the east side of Cook Inlet and those who primarily harvest clams on the west side of Cook Inlet, and b) between respondents that indicated the Cook Inlet Pacific razor clam fishery to be an issue of personal importance and those who indicated that the fishery was not an issue of personal importance. Personal importance was defined by participants who responded that a) they wished their children would be able to harvest Pacific razor clams in the future, and b) they felt that Pacific razor clams were important to their family. Results indicated that individuals who harvest Pacific razor clams primarily on the east side of the Inlet view current management initiatives less favorably than individuals who primarily harvest clams on the Inlet's west side. Respondents that indicated Pacific razor clams in Cook Inlet is of personal importance view current management initiatives less favorably than respondents who view the population in a less personal manner. In addition, 55.5% of respondents in the former group want the east side of the Inlet to be closed to Pacific razor clam harvesting. Incorporating these results into management explores the disconnect between the public and management agencies. Learning where holes in communication are can inform managers on how to better educate members of the public on management objectives and initiatives.

Using Local and Traditional Knowledge of Fishers to Assess Long-Term Ecological Change in Coastal Alaska

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Local and traditional knowledge (LTK) is a valuable source of place-based information about long-term change in marine ecosystems. In this study, we documented LTK of recreational and subsistence harvesters who have fished in the same areas over many decades and target a diverse suite of species in nearshore habitats. Our primary objectives were to: 1) synthesize trends in relative abundance and body size of harvested species since the 1960s, and 2) assess differences in LTK between fishing sectors and regions. From 2014 to 2016, we conducted 98 interviews with subsistence harvesters and charter fishing captains in six communities of Southeast and Southcentral Alaska. Respondents were asked to classify the relative abundance and body size of each focal species for each decade in which they had fished from standardized qualitative categories (e.g., “very high” to “very low” abundance). Qualitative categories were converted to numerical indices of abundance and body size, which were summarized for Pacific halibut, lingcod, black rockfish, yelloweye rockfish, and Chinook salmon. Respondents in both regions reported stable or decreasing trends for most species; however, charter and subsistence fishers differed in the temporal extent of their observations. We identified several sources of variation in fishers’ perceptions of ecological change. This research is an important step towards the development of a framework for integrating LTK and scientific knowledge to inform resource management in Alaska, particularly for data-poor species.

Connecting Alaska School Systems to Alaska's Marine and Aquatic Ecosystems

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Beginning during the 2013-2014 school year, Alaska Sea Grant (ASG) implemented a new approach to K-12 environmental literacy, with the goal of increasing, improving, and sustaining marine and aquatic education in Alaska schools. ASG became a community partner to 10 of Alaska's 54 school districts by providing grant funds, professional development, and sustained support to revise school district science/STEM curriculum frameworks. The results have been 1) changes in teacher practice that increased time spent teaching place-based science/STEM concepts and skills using local coastal and watershed environments, 2) collaborative development of new lesson plans and units aligned with the Next Generation Science Standards (new national Science-Technology-Engineering-Math, or STEM, standards) and with district frameworks for meeting state cultural standards; and 3) more students engaged in experiential learning outdoors on field trips annually. This systemic approach to Alaska K-12 education has resulted in instructional changes that have been institutionalized at the school and school district level and are thus sustainable despite high rates of annual teacher turnover in rural Alaska school districts. It has also provided the means to have a significant impact on the Anchorage School District (ASD), one of the largest and most diverse in the United States, through collaborative development of a semester-long STEM kit focused on interdependent relationships in local watersheds with emphasis on salmon. This became the required curriculum for 150 4th-grade classrooms (approximately 3,750 students) beginning in spring semester, 2017. We also partnered with the ASD and six other community partners to develop a supplementary aquatic field trip kit that supports teacher-led field trips and a watershed education program provided annually to some 300 4th grade students in schools in Anchorage's Chester Creek Watershed. New K-8 lesson plans and units that were developed collaboratively will be posted on ASG's Alaska Seas and Watersheds website (www.alaskaseagrant.org/teachers) in early 2018.

Expanding the Understanding of Ocean Acidification Processes and Consequences Through the Alaska Ocean Acidification Network

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With Alaskans heavily reliant on the ocean for their lives and livelihoods, both direct and indirect effects of ocean acidification could have serious implications on species being harvested, and the food web that sustains our fisheries. Researchers are trying to better understand the chemical and ecological systems at play so we can anticipate and respond to future changes due to ocean acidification. Currently, the direct risks to Alaska's fisheries and shellfish industry are not well understood. An Alaska-focused study on public understanding and awareness of OA risk revealed that Alaskans are three times more aware of ocean acidification than Americans in general. However, despite the heavy reliance on fishing in Alaska's economy, Alaskans do not consider ocean acidification as an immediate risk and have a limited understanding of how Alaska will be impacted by ocean acidification. In response, the Alaska Ocean Observing System (AOOS) initiated an ocean acidification (OA) network for the state of Alaska. The Alaska OA Network is one of six in the Nation, with a primary mission to engage impacted communities to expand the understanding of OA processes and associated consequences in Alaska. The Alaska OA Network provides and receives relevant information from the fishing and aquaculture industries, policy makers, coastal communities and the general public, and works closely with both OA science experts and Alaska entities interested in participating in OA research and monitoring. Stakeholder communities are members and provide input to the knowledge gaps and information needs for their regions. The Network anticipates advising on priorities for monitoring, research & modeling and will share best practices for monitoring quality assurance. The network also promotes data sharing and acts as a resource hub for OA information in Alaska.

Demonstrating the Use of Local Knowledge to Inform Catch Accounting and Decision-Making in the Pacific Halibut (*Hippoglossus stenolepis*) Fishery off Southeast Alaska

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This research aims to develop new directions for incorporating local knowledge into fisheries management decisions. Catch accounting is challenging when catches are distributed across large numbers of small vessels, as they are in the fishery for Pacific halibut (*Hippoglossus stenolepis*) in Southeast Alaska. Although the International Pacific Halibut Commission (IPHC) longline survey uses gear similar to that used in the commercial fishery, there is concern that patterns of incidental catch observed in IPHC surveys may not be characteristic of patterns of incidental catch in the commercial fishery across seasons and areas. In 2013, the North Pacific Fishery Management Council extended the federal fisheries observer program to include vessels commercially fishing Pacific halibut. Fishermen in Southeast Alaska have voiced negative opinions about reforms to the observer program. We used interviews with commercial halibut fishermen to document experiences with incidental catch, as well as opinions about four alternative data collection methods (human observers, electronic monitoring, detailed logbooks, or pre-2013 status quo). Multivariate statistical techniques were used to measure concordance among the observations of fishermen and incidental catch observed in IPHC surveys. Multiple criteria decision analysis was used to document support for each data collection method. Results shed light on the potential for increased monitoring to contribute meaningful catch accounting data for the management of the halibut fishery, as well as which data collection methods might receive the strongest support from halibut fishermen in Southeast Alaska.

Implementation of Community Based PSP Testing for Subsistence and Recreational Shellfish Harvesting In Southwestern Alaska – Year 1 Update

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NPRB project #1616 addresses the risk of exposure to potentially high paralytic shellfish poisoning toxins (PSTs) by subsistence shellfish harvesters in southwest Alaska from consumption of untested shellfish. Due to a number of factors including budgetary limitations, the State of Alaska's extensive coastline per capita, and the remoteness of many subsistence communities, there is currently no routine testing of personally harvested shellfish. This project addresses the problem through continued development of community based monitoring and development of a new electrochemical field test (ECtest) that will utilize improved saxitoxin antibodies and provide numerical toxin results to strengthen test interpretation. The study leverages community networks from the 2012-2015 Alaska Department of Environmental Conservation (DEC) Recreational Shellfish Beach Monitoring Pilot program, the Aleutian Pribilof Islands Association, and NPRB-funded technologies (#118) to implement subsistence shellfish testing. Five communities including Old Harbor, Ouzinkie, Kodiak, Sand Point and King Cove participate with monthly collection of butter clam samples. Results from Year 1 of the study will be presented. Toxin testing by high performance liquid chromatography at the NOAA Beaufort Laboratory, was validated using previously tested DEC recreational shellfish homogenates. Project samples are primarily analyzed by Beaufort, with some comparative samples still being tested at DEC. Time series of the regional toxicity patterns will be presented. The comparison between regions will help in the understanding of statewide toxicity patterns. To address previous community concerns, this project explores the toxicity differences of edible and non-edible tissue types of the clam. Preliminary results from butter clams demonstrate that PSTs having the highest toxicity were generally most concentrated in the siphons of the clams (as reported in other studies), but with indication that seasonality may be a factor in anatomical distribution. This line of investigation is ongoing and will continue under the direction of local shellfish harvesters to determine common bivalve cleaning methods. Preliminary

testing of the ECtest components is progressing and on track for supervised field use by the end of Year 2.

The Alaska Harmful Algal Bloom Network (AHAB) – An Introduction

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Harmful algal blooms (HABs) are not new to Alaska and include both toxic and non-toxic phytoplankton. The most well-known and destructive HABs in Alaska include the toxic dinoflagellate *Alexandrium*, that produces paralytic shellfish toxins, and the toxic diatom *Pseudo-nitzschia*, that can produce amnesic shellfish toxins (or domoic acid) under certain environmental conditions. Non-toxic *Chaetoceros* has also been linked to fish kills and survival of hatchery reared salmon upon release to the marine environment. Paralytic shellfish toxins have been well documented in shellfish and have killed or sickened people in Alaska through consumption of untested contaminated shellfish; however there have been no documented human cases of amnesic shellfish poisoning in Alaska and shellfish have tested below the regulatory level for domoic acid. While long suspected to impact Alaska marine mammals and seabirds, both of these toxins have only recently been confirmed present in these upper trophic level species. Although the causes of harmful algal blooms are not well understood, climate change is likely to increase the threat of HABs in Alaska, resulting in increases in HAB duration, intensity and regional expansion. The Alaska Harmful Algal Bloom Network (AHAB) was formed in 2017 to provide a statewide approach to HAB awareness, research, monitoring and response in Alaska. AHAB coordinates a diverse group of coastal stakeholders to address human and wildlife health risks from toxic algal blooms. Objectives of the group include reducing health risks due to HABs and facilitating safe supply of seafood, improving effectiveness of HAB response and HAB education and outreach, expanding HAB monitoring and developing forecasting capabilities, and identifying needs and data gaps related to HABs. The network is a partnership of regional stakeholders dedicated to this mission. The group is co-sponsored by Alaska Sea Grant and the Alaska Ocean Observing System. The website <http://www.aos.org/alaska-hab-network> will be formally launched in January 2018 to share information statewide, describe current monitoring and research, provide real time results and provide access to statewide experts and resources. This poster shares the objectives of the network and introduces the content of the AHAB website.

Changes in Forage Fish During the Winter 2015-16 Seabird Die-off and the North Pacific Marine Heat Wave

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In the midst of an extended period of anomalously warm ocean temperatures in 2013–16 there was a widespread die-off of common murres in the northeast Pacific Ocean. Necropsies of beachcast birds from Prince William Sound and elsewhere in the Gulf of Alaska in the winter of 2015–16 revealed that birds were extremely emaciated, and evidence suggests that most deaths were due to the food supply, rather than disease, biotoxins or other factors. Concurrent with the die-off we observed several signs of declining quality and quantity of key forage fish species. Capelin had lower body condition in 2015 compared to 2012–14; these fish were longer but weighed less than they had in previous years. We also observed an absence of age-1 capelin during 2016 acoustic-trawl surveys in Prince William Sound, suggesting recruitment failure by the 2015 year class. Likewise for sand lance the 2015 year class exhibited low energy density as young-of-the year fish in 2015 and as age-1 fish in 2016. Evidence from sand lance otolith annual growth rings indicated extremely slow growth from 2015 to 2016. Additionally, acoustic indices of forage fish abundance in 2015 were lower than 2014 or 2016. This was largely driven by low abundance of age-0 walleye pollock, which were widespread and abundant in the system in other years, particularly in 2012. Changes in the forage fish community were also observed on Middleton Island in 2014–16, when preferred species like capelin and sand lance were largely replaced by sablefish, salmon, and herring in seabird diets. Together this evidence suggests that the 2015–16 winter seabird die-off in the Gulf of Alaska was triggered by changes in quality and quantity of the prey base resulting from the persistence of warm ocean conditions in the preceding years. Continuing efforts by the Gulf Watch Alaska long-term monitoring program will provide important information on predator-prey interactions and their response to changes in the marine environment over time.

Building a Foundation of Decision-Support Tools Integrating Existing Mapping and Monitoring Information for the Benefit of Long-Term Shellfish Sustainability and Management in Kachemak Bay and Cook Inlet, Alaska

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Shellfish have long been important subsistence, recreational, and commercial fisheries in the Kachemak Bay region of Alaska. Native clam populations in southcentral Alaska have declined significantly in recent decades to the point where fisheries on the north side of the bay are now closed and harvest opportunities are lost. In a study beginning in 2015, researchers, decision-makers and stakeholders partnered through the National Marine Fisheries Kachemak Bay Habitat Focus Area to align resources and prioritize long-term habitat science and conservation efforts for native bivalves. This project addresses native bivalve issues by establishing a framework upon which ecosystem-based management questions can be explored, and rehabilitation efforts can be built. By compiling and mapping available information, the Alaska Center for Conservation Science constructed a landscape-level synthesis of information as a reference of habitat conditions from which change can be measured. In addition to a suite of environmental monitoring variables, physical habitat maps of the Bay are included, incorporating a detailed intertidal zone mapping done by the Kachemak Bay National Estuarine Research Reserve over the past decade and high resolution subtidal characterizations from NOAA's recent bathymetric and benthic sampling efforts. Alutiiq Pride Shellfish Hatchery piloted methods for monitoring the environmental conditions and timing of

bivalve spawning and recruitment in Kachemak Bay in order to explore the feasibility of native clam rehabilitation techniques. These activities, along with additional stakeholder input helped develop a conceptual model of the stressors and needs of bivalves throughout their life stages. Additional web-based story maps, public education discovery labs, a decision-maker field demonstration day, and Alaska Sea Week curricula were created to increase access to the information. Collectively, these actions foster stewardship, harvest sustainability, and best management practices of native clams through stakeholder engagement and public education.

Sea Otter Impacts on Subsistence Resources of the Southeast Alaska Rocky Intertidal

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The Apex Predators, Ecosystems, and Community Sustainability (APECS) project (<http://apecs-ak.org>) is a large, interdisciplinary project investigating how sea otter (*Enhydra lutra*) reintroduction and subsequent expansion is impacting the marine ecosystem and subsistence resources of Southeast Alaska. Prior to their reintroduction 50 years ago, sea otters had been extirpated for nearly 100 years. As the sea otter population expands, these top predators may compete with subsistence harvesters from rural Alaskan communities for food. The presence of top predators, like sea otters, has also been shown in many ecosystems to increase species diversity and resilience. We are investigating changes in abundance and distribution and ecological effects along a gradient of sea otter recolonization and human harvest for two intertidal and subtidal marine invertebrates: the black Katy chiton (*Kathrina tunicata*) and pinto abalone (*Haliotis kamtschatkana*). This interdisciplinary study integrates socio-ecological analysis and rocky intertidal/subtidal ecosystem assessments. Historical subsistence harvest reports and interview data inform trends in abalone and chiton harvest and can be compared before and after sea otter recolonization. We are quantifying ecological community composition and potential trophic interactions along a gradient of sea otter colonization history and density. Our social and ecological project objectives aim to elucidate top-down ecosystem effects and impacts on subsistence harvest viability, along a gradient of sea otter recolonization in Southeast Alaska.

Using Small Unmanned Aircraft Systems (sUAS) to Map Intertidal Topography in Katmai National Park and Preserve, Alaska

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In 2017, the NPS, USGS, and Gulf Watch Alaska collaborated to collect aerial photography at two long-term intertidal monitoring sites along the coast of Katmai National Park and Preserve. We used a vertical take-off and landing (VTOL) small unmanned aircraft system (sUAS). This pilot project was the first time that a sUAS was used to map intertidal sites in a national park unit in Alaska. The purpose of the project was to demonstrate the capabilities of using a sUAS to generate precise digital elevation models (DEMs) and high-resolution aerial imagery, and to evaluate these products for assessing species presence and abundance within intertidal elevational zones. To accomplish these objectives, precise ground control was established using static GPS surveys of markers that were placed within the study sites prior to each flight. Each low-altitude (< 50 ft) flight was performed over small intensively sampled monitoring sites (~50 m by ~20 m). High-resolution orthophoto-mosaics and DEMs were produced for each site. The products will allow us to correlate elevation with species presence and abundance, and if produced annually, such data may facilitate detection of shifts in topography and beach elevations at the site level which result from physical disturbances (e.g., ice scour, earthquakes, storms, etc.). This data will also be valuable when interpreting annual variation in community structure within sites. Further, sUAS measurements over time can be used to perform future assessments of intertidal ecosystem changes due to sea-level rise or changing climatic conditions.

A Decade's Worth of Data: Key Metrics from a Large-Scale, Trophic Web-Based Long-Term Monitoring Program in the Northern Gulf of Alaska

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Nearshore marine habitats support distinct and valued ecosystem services, and are components of a long-term monitoring effort supported by Gulf Watch Alaska. For over a decade, this multi-agency endeavor has designed, tested and implemented a nearshore monitoring program that focuses on intertidal algae and sea grasses as primary producers, benthic invertebrates such as mussels, limpets, and clams as primary consumers, and sea stars, black oystercatchers and sea otters as apex consumers across several areas in the northern Gulf of Alaska, from Katmai National Park and Preserve to Prince William Sound. We monitor population trends, diet, and demographics of apex consumers, while simultaneously monitoring metrics such as density and size distributions associated with the primary producers and primary consumers, with the goal of identifying potential causes and spatial scales of change. Here, we compare spatial and temporal variability and trends in several metrics across the Gulf of Alaska. While some trends are relatively consistent among regions, others are unique to a specific region. These results provide evidence for the importance of long-term

monitoring across multiple trophic levels that can assist with and guide management activity.

Demographic and Environmental Influence on Steller Sea Lion Pup Condition Reflects Long-Term Changes at Marmot Island, Alaska

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Northern Gulf of Alaska ecosystems have been found to respond to high levels of ocean and climate variability. Responses to changes in local environmental conditions may be reflected by the growth rate and condition of Steller sea lion pups, because breeding occurs in dense rookeries and their mothers provision them by undertaking repeated foraging trips. We examined the condition of 4-6 week-old pups ($n = 784$) weighed and measured at Marmot Island, Alaska, in 1987, 1988, and in 7 years between 2000 and 2014 using two condition indices; a scaled mass index (MI) that scales mass by length, and a condition index (CI) as a ratio of observed to expected mass based on a linear regression with weighing date. The North Pacific Index anomaly (NPI) was used as an indicator of environmental conditions, and comparisons with pup counts from aerial and land-based surveys were used to test density-dependent effects. Male pups on average weighed more than female pups, grew at a slightly faster rate, and their masses scaled differently with length (3.08 vs. 2.75). The two condition indices were weakly correlated ($r = 0.33-0.40$), suggesting they reflect body condition or growth rate slightly differently. Condition indices were generally indifferent to changes in the NPI, though positive NPI anomalies were associated with increased CI. No density-dependency in pup condition was evident. During the 27-year sampling period pup abundance declined from about 3,000 pups in the late 1980s to about 500 pups in the late 2000s, yet condition indices between the years 1987-88 and 2000 were similar (ANOVA $p > 0.8$), consistent with a decline in carrying capacity over that period. During 2000-2004 relatively stable pup abundance combined with better pup condition may indicate improved carrying capacity, but MIs were significantly less in 2010 and 2014 (ANOVA $p < 0.01$). The magnitude of pup condition changes observed could be reflected in subsequent survival and age structure with consequences for subsequent population trends.

Living in a Watery World: Linking Environmental Variables to Pacific Herring (*Clupea pallasii*) Productivity

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Presenter: Jessica Gill

Pacific herring (*Clupea pallasii*) have proven to be extremely sensitive to environmental and human-induced disturbances. With pressures from both harvesters and predators, it is critical that we understand the linkages between environmental factors and herring productivity. I examine spatial trends in productivity using an analysis of covariation between 49 Pacific herring stocks in the northeast Pacific Ocean. Once trends in covariation have been identified, I examine hierarchical modelling to identify the strongest environmental drivers in herring productivity. I examine multiple environmental indices including the Pacific Decadal Oscillation, sea surface temperature, and chlorophyll-a concentrations. I anticipate finding a correlation between stocks spawning in similar locations and the strongest environmental linkage with small-scale drivers. I hypothesize these results because herring stocks spawning in similar locations will likely respond to the same small-scale driver, such as freshwater input and chlorophyll-a concentrations. Once these environmental linkages are identified, a possible mechanism for predicting herring spawning biomass could be included in modelling efforts.

The Northern Gulf of Alaska Long-term Ecological Research Program

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Bigger, better and more often. We describe the expansion of the Seward Line into one of NSF's new long-term monitoring and ecological research sites starting in 2018. Connection to other efforts in the Gulf of Alaska are highlighted.

Variability in Intertidal Prey Availability and Diet Preferences of *Enteroctopus dofleini* in Prince William Sound, Alaska

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Presenter: Caitlin Marsteller

Enteroctopus dofleini are important predators in intertidal communities throughout the Gulf of Alaska. As a predator, the foraging choices and density of *E. dofleini* may affect the relative population sizes, habitat distribution, and size distribution of its prey. Likewise, fluctuations in prey density and size may affect the foraging choice of this octopus. Therefore, the purpose of this project was to determine the population fluctuations from 2002 to 2017 of six species of small, intertidal, non-commercial crabs (*Lophopanopeus bellus*, *Cancer oregonensis*, *Cancer productus*, *Telmessus cheiragonus*, *Pugettia gracilis* and *Hapalogaster mertensii*) in relation to densities and diet preferences of *E. dofleini* in Prince William Sound, Alaska. Samples of crab population densities and sizes, along with habitat characteristics were obtained in transects at four study sites in northeastern and southwestern Prince William Sound from 2002 to 2017. Measures of *E. dofleini* density and predatory behavior, represented by midden remains, were also collected. Larger crabs and those with shorter handling times (pulled apart or bitten by the octopus) had higher selectivity indices (more preferred) than smaller crabs or crabs that were more commonly drilled by the octopus. Similarly, crabs with more mobile escape behavior had higher selectivity indices than crabs that more typically remained motionless. Among crab species with higher selectivity indices, population density was negatively correlated with octopus abundance but also influenced by recruitment events that may be climate driven. Octopuses have unusually diverse diets, and these findings suggest ways to better understand octopus diet breadth in the context of octopus preference, local dynamics of benthic populations and the regional effects of climate in intertidal communities.

Twenty-Eight Years of Intertidal Biological Variability Based on Volunteer Visits to Photo Sites in Western Prince William Sound

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Presenter: Alan Mearns

Understanding the range of natural biological variability is essential to understanding recovery from impacts such as oil spills or other catastrophic events. During the summer of 2017 volunteers re-visited six fixed intertidal photo-monitoring sites in western Prince William Sound, contributing to a 28th year of nearly continuous annual monitoring of sites impacted and not impacted in 1989 by the *Exxon Valdez* oil spill. The landscape-scale photos were again examined for percent cover of conspicuous biota including seaweeds, mussels and barnacles and the estimates added to data from the previous 27 years, revealing a wide range of their long-term inter-annual variability. In summer 2017 at most sites we observed a resurgence of rockweed (*Fucus*) cover that was low the previous 2-3 years, and a decline of barnacle cover which had peaked as a result of a major invasion in 2015-16. For rockweed, this appears to represent the fifth episode of increasing cover during the past 28 years, with such episodes occurring at 4-to 7-year intervals, each separated by several years of low percent cover. At several sites cover of mussels also increased in 2017, but at one site, curiously named Mussel Beach, a gravel-based mussel bed has not returned after its virtual disappearance in 1994-95. The images at another site, "Mearns Rock" in Snug Harbor, Knight Island, continue to be purveyed on the NOAA Office of Response and Restoration website offering the public a visual experience in seeing biological variability first-hand. This annual study has been carried on exclusively by local citizen and science volunteers since 2013 and attests to the role volunteers can play in documenting ecological change and variability and adding to other intensive monitoring studies, such as Gulf Watch Alaska.

Oceanographic Characteristics Associated with Spring Zooplankton Community Structure in Kachemak Bay, Alaska from 2012 to 2015

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Presenter: Kimberly Powell

Kachemak Bay, located in southcentral Alaska, is an oceanographically dynamic and biologically productive estuary with an 8.5 m tidal range. The bay supports a diverse zooplankton community, which directly contributes to the success of higher trophic level species such as commercially important salmon and halibut populations. As a part of the Gulf Watch Alaska program, funded by the *Exxon Valdez* Oil Spill Trustee Council, we monitor phytoplankton and zooplankton communities and environmental variables over time in Kachemak Bay and lower Cook Inlet. Here, we look at a subset of these data in spring months from 2012 to 2015 at two transects in Kachemak Bay to examine the potential environmental drivers of spatial and interannual variation in the zooplankton community. The sampling period included a transition from cooler to warmer conditions in late 2013 as part of the Pacific warm anomaly event. Oceanographic characteristics were sampled using a Seabird SBE 19plus SeaCAT Profiler CTD, and the zooplankton community was sampled with vertical tows of a 0.333 μm mesh bongo net. Zooplankton community composition and abundance were compared to oceanographic parameters including temperature, dissolved oxygen, photosynthetically active radiation (PAR), salinity, and chlorophyll-a (fluorescence). Zooplankton community structure varied over time, with six taxa dominating in all years: barnacle nauplii, egg, *Neocalanus* spp., *Pseudocalanus* spp., *Acartia* spp., and crab zoea. The most significant variability was in the dominant species over time and space, and in the oceanographic characteristics that most influenced community structure, including temperature, salinity, PAR, and chlorophyll-a. Future analysis will include examining the effects of oceanographic and zooplankton variability on higher trophic level species.

Gulf Watch Alaska: Taking the Pulse of the Northern Gulf of Alaska

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Presenter: Rob Suryan

Gulf Watch Alaska (GWA) is a long-term (20-year) ecosystem monitoring program in the Gulf of Alaska that began in 2012 and is funded by the *Exxon Valdez* Oil Spill Trustee Council. GWA has three main scientific components: 1) environmental drivers (physical and biological oceanography), 2) pelagic ecosystems (prey and upper trophic level species), 3) nearshore ecosystems (subtidal and intertidal). Over 25 researchers from various agencies and organizations comprise 11 field sampling projects within GWA. The geographic extent of GWA sampling includes coastal to oceanic regions of the Gulf of Alaska and spans across regions from Prince William Sound to the Alaska Peninsula, including Cook Inlet, the Kenai Peninsula, and Kachemak Bay. These projects include many biophysical time series spanning decades, with the longest over 40-years (e.g., hydrographic sampling at GAK-1 and in Prince William Sound). Primary objectives of GWA include assessing limitations to recovery of injured resources nearly 30-years after the 1989 *Exxon Valdez* oil spill and evaluating the effect of environmental variability on Gulf of Alaska ecosystems, and how this might limit recovery. Furthermore, with many long-term, legacy datasets and formation of GWA prior to the recent marine heat wave in the northeast Pacific, GWA is well poised to assess biological impacts of and recovery from this major event. Future efforts for GWA include improved integration with other Gulf of Alaska research and monitoring programs, such as the Gulf of Alaska Integrated Ecosystem Research Program synthesis, NOAA Gulf of Alaska Studies, and the newly established National Science Foundation Long-term Ecological Research site. GWA provides a unique opportunity for partnerships in sustained long-term study of this sub-arctic ecosystem.

State of Alaska's Salmon and People-Emerging Insights from a Large Interdisciplinary Synthesis Project

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Presenter: Peter Westley

State of Alaska's Salmon and People-Emerging Insights from a Large Interdisciplinary Synthesis Project This poster presents emerging key insights generated from the State of Alaska's Salmon and People (SASAP) project. With support from the National Center for Ecological Analysis and Synthesis at the University of California Santa Barbara, this interdisciplinary project includes work by over 100 researchers and region-based advisors, with work organized into eight simultaneously running working groups. Preliminary findings presented on the poster address the overall project goal to answer three core questions: what do we know, what do we not know, and how can we better integrate and share what we know about Alaska's salmon system for more informed and equitable decision making? SASAP Working Groups (see <https://alaskasalmonandpeople.org>) have been working over the past year to compile, analyze, and visualize available data to provide new insights into Alaska's salmon systems and their relationships with salmon people through a collaborative, science-based and adaptive assessment process. The Working Group synthesis process has emphasized collaboration between indigenous knowledge and western science perspectives to bridge the information gap between cultures. SASAP has a dual emphasis on multidisciplinary science synthesis and on building capacity in Alaska to undertake similar processes going forward. Products of the work are designed to be diverse in order to reach multiple audiences and include, but are not limited to academic papers and reports supported by an openly accessible web portal where users can explore synthesized data, archived models and analyses, education materials, and access the raw underlying data that have been assembled. These materials will be widely distributed and communicated to government, education, research, community and commercial interests to strengthen their understanding of salmon systems and prioritize future research, monitoring and management. There will be an initial public "rollout" of products at the 2018 Alaska Forum on the Environment and at a symposium at the 2018 joint Alaska Chapter and Western Division Annual Meeting of the American Fisheries Society.

Optical Assessment of the Gulf of Alaska Benthos East of Kodiak Island, AK

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Presenter: Victoria Batter

The continental shelf east of Kodiak Island is a diverse and productive region of the Gulf of Alaska which includes several submarine canyons and supports commercial harvests of weathervane scallops (*Patinopecten caurinus*). Despite abundant commercial fishing, the spatial distributions of fishery species and their habitats in this region are poorly understood. This paucity of information has constrained the assessment of the weathervane scallop abundance in this region to catch per unit effort information only. During the spring of 2014, the Alaska Department of Fish & Game collected more than one million high-resolution underwater photographs of the benthos in and around the Chiniak Gully (North and South), Christmas Tree, Barnabas, and Albatross scallop beds. I selected approximately 150,000 of the georeferenced images using systematic random sub-sampling, counted benthic macroinvertebrates (including weathervane scallops and sea whips), and identified benthic substrates (sand, mud, shell hash, shell debris, gravel, cobble, boulder, and bedrock). The resulting data will be used to estimate scallop density using a generalized linear model with a Poisson distribution, abundance of scallops using scallop bed densities and bed area, and generate the first maps of macroinvertebrates and substrates for the surveyed areas. Substrate analysis is important because certain substrates are believed to play a role in successful scallop recruitment events. Preliminary results indicate scallop densities are greatest in the Christmas Tree bed. Substrate interpolation analyses indicate sand presence across all scallop beds, while other substrate types vary among beds.

The Interactive Effects of CO² Exposure and Prey Quality on Growth and Lipid Composition of Pacific Cod Larvae

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High-latitude seas are predicted to be severely impacted by ongoing ocean acidification. However, the responses to these changes by most fishery species, including Pacific cod (*Gadus macrocephalus*), remain poorly studied. Elevated CO² levels are expected to have a range of impacts, categorized as either “direct” (physiological) and “indirect” (food web) in nature. We examined the effects of elevated CO² (ambient versus 1,700 μATM) on growth rates of larval Pacific cod over the first 9 weeks of life using two different feeding treatments (rotifers with high or low polyunsaturated fatty acid, PUFA, enrichments) for the first five weeks post-hatch. Larval growth and lipid levels were also monitored from weeks 5 through 9 when larvae were all fed the same enriched *Artemia* diet. Differential enrichment of rotifers used for early feeding larvae resulted in high quality (5% lipid per dry weight, 30% docosahexaenoic acid 22:6n-3) and low quality (3% lipid, 10% 22:6n-3) live-food. Across both dietary treatments, fish at elevated CO² levels (1,700 μATM) had lower growth rates and were smaller. Diet had a significant effect on both lipids and fatty acids per dry weight in larval fish after 2 and 5 weeks of feeding. Further, in both dietary treatments high CO² levels resulted in decreased total fatty acids, PUFA and monounsaturated fatty acids per dry weight compared to larvae reared at ambient CO² levels. The differences among CO² treatments in terms of growth, lipids and fatty acids per weight were not observed in fish older than 5 weeks of age. These results contrast with previous observations on co-occurring larval walleye pollock (*Gadus chalcogrammus*) and suggest a stage-specific sensitivity of Pacific cod to both the direct and interactive effects of ocean acidification. Further understanding of these effects will be required to predict the impacts of ocean acidification on fishery production.

Trophic Relationships Among Juvenile Salmon During Cool and Warm Periods in Southeast Alaska

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Marine growth and survival of juvenile Pacific salmon (*Oncorhynchus* spp.) has been linked to marine temperatures and feeding conditions during their first few months in the ocean. Evidence from the Bering Sea, Prince William Sound, and Southeast Alaska (SEAK) suggest that the juvenile salmon prey community is responsive to environmental change, and that these changes are reflected in their species richness, abundance, and nutritional quality. Therefore, understanding what salmon consume under varying environmental conditions is important to understanding how their growth and survival is affected by climate change. For over 20 years, the Alaska Fisheries Science Center has been monitoring seawater temperatures, zooplankton abundance, and the diets of juvenile salmon in Icy Strait, AK, a major fish migration corridor in northern SEAK. Here, we used multivariate statistical methods to examine how the diets of juvenile pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon in Icy Strait responded to shifts in seawater temperature and zooplankton abundance during the summer months of 2013-2017. During this five-year period, water temperatures shifted from a cool phase in 2013 to a warm phase in 2014-2016, then back to a cool phase in 2017. Overall, the diet composition and prey diversity varied within and between zooplanktivorous (pink, chum, sockeye) and piscivorous (coho) salmon species, with the exception of 2015 which showed euphausiids as the overwhelmingly dominant prey in all four species. The dominance of euphausiids in 2015 was also observed in zooplankton samples, showing their overall presence in the system at that time. In other years, pink, chum, and sockeye salmon consumed more gastropods, hyperiids, and gelatinous-bodied prey while coho consumed mainly decapod and fish larvae. The results of this study underscore the importance of incorporating trophic measures into long-term monitoring of pelagic ecosystems.

Identifying Key Piscine Predators of Pacific Herring (*Clupea pallasii*) and Walleye Pollock (*Gadus chalcogrammus*) During Winter Months in Bays of Prince William Sound, Alaska, Through Multivariate Analysis of Stomach Contents

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Presenter: Ben Gray

Predation by groundfish during winter months has been suggested as a primary source of mortality for both juvenile Pacific herring (*Clupea pallasii*) and walleye pollock (*Gadus chalcogrammus*) in Prince William Sound, Alaska (PWS), however, winter-specific groundfish diet information is scarce. To address this knowledge gap, we analyzed the diets of groundfish from 11 PWS bays over November and March surveys (2009–2012). The diets of 16 fish species, collected throughout all bays, were included in a feeding guild analysis based on presence-absence data of 25 prey groups. Four feeding guilds and three outlier species were determined using a group-average cluster analysis. Guilds primarily clustered through differing occurrences of unidentified fishes, pollock, herring, shrimps, and other fishes and invertebrates in diets. From the guild analysis, Pacific cod (*G. macrocephalus*), walleye pollock, and big skate (*Raja binoculata*) diets were analyzed individually as guild-representatives using PERMANOVA. Each species' diet varied significantly across five "core" bays (Whale, Lower Herring, Eaglek, Zaikof, and Simpson Bays), sampling periods, and lengths-at-ages, but did not differ across bays at similar lengths, indicating similar prey use by similar-sized fish. As body size increased, Pacific cod, walleye pollock, and big skate each consumed greater amounts of larger pollock while size of herring consumed remained similar. Spatio-temporal variability in diet was also significant, but trends were not as evident. To our knowledge, this is the first analysis of fish diet compositions in PWS with an emphasis on winter herring and pollock predation. By identifying key predation avenues, we gain insight into herring recovery efforts and a better understanding of the importance of both species in regions of the PWS food web.

Spatial Scales for Foraging Juvenile Pacific Herring Inferred from Fatty Acid Analysis

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Sampling strategies for monitoring juvenile fish populations depend on resolving the spatial scales over which they forage. This can be difficult for species like Pacific herring (*Clupea pallasii*) that rear in heterogeneous nearshore habitats. We addressed this question by examining the fatty acid compositions of young-of-the-year herring from different locations and seasons in Prince William Sound, Alaska. We combined laboratory studies and field sampling to test the idea that the fatty acid compositions of herring at the end of the growing season reflect the prey fields they foraged on and used measures of similarity between compositions to identify the spatial range of foraging. We also hypothesized that winter energy deficits would conserve the fatty acid compositions observed between foraging groups and facilitate monitoring of winter movement. Laboratory manipulations included monitoring the fatty acid composition of fasting fish, fish on low rations and fish fed low rations of an alternative diet. Field sampling included collection of age-0 herring from a variety of bays in fall and spring over two winters. Sampling locations provided the opportunity to compare fatty acid compositions over several spatial scales, while sampling across seasons allowed us to examine how well compositions were conserved. Laboratory results largely supported our assumption that the fatty acid composition of fasting fish reflects their diet in fall and is unaffected by foraging at low levels. Field sampling in late fall revealed significant variation in fatty acid composition among fish collected from different bays indicating that prey fields vary across bays. Fatty acid compositions also varied within bays indicating little movement of fish over spatial scales of a few kilometers. Similar results were observed in spring but there tended to be a greater diversity of fatty acid “types” in spring. Variability in fatty acid composition was much greater across seasons than within season indicating fish foraged over winter. We conclude that fatty acids are useful for identifying the spatial scale of foraging by juvenile fish within season and that age-0 herring forage over spatial scales on the order of a few kilometers.

Diet Profiling Alaska Octopuses: Applying Stable Isotope Analysis to Alaska Populations of the Giant Pacific Octopus, *Enteroctopus dofleini*

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Eight species of octopus are known to inhabit Alaska waters, and are often identified in the incidental catch of federal and state fisheries. The largest of these species, giant Pacific octopus (GPO; *Enteroctopus dofleini*), dominates octopus bycatch in the state – accounting for 200-500 tons annually. Management of GPO stocks in Alaska is hindered by the data-poor status of the species. Limited information exists on important elements of GPO life-history and ecology, such as diet. Much of what is currently known about GPO diets has been determined using midden analysis in inter and sub-tidal zones. While a potentially valuable source of information, midden analyses do not account for entirely soft-bodied prey, midden use by multiple individuals, and potential effects of tide and currents on midden retention. Furthermore, significant logistical challenges hamper the use of midden analysis to investigate the diet composition of GPO inhabiting benthic areas. Carbon and nitrogen ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$, respectively) stable isotope analysis offers an alternative approach to study diets of individual GPOs without the logistical difficulties and potential biases associated with midden analysis. In addition, stable isotope analysis can provide temporally-linked, individual-specific diet information. We use $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analysis to investigate GPO diets in Alaska by: a) conducting a controlled diet-switch experiment to determine incorporation rates and diet-to-tissue discrimination values for ^{13}C and ^{15}N in GPO muscle, dermis, and beak tissues; b) collecting samples of the three tissues from free-living individual GPOs caught incidentally in commercial, recreational, and subsistence fisheries; and c) compiling a library of the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of potential prey items collected during survey trawls and intertidal surveys. Diet compositions of individual free-living GPOs for the three time-frames represented by the sample tissues will be determined using MixSIAR, a Bayesian implementation of a stable isotope mixing model using discrimination values derived from our captive experiments. Diet profiling in this way will provide essential information on a widely-

encountered octopus species in commercial fisheries, and will provide management with foundational life-history information on octopus predator-prey interactions.

Too Hot, Too Cold, or Just Right? Temperature-Dependent Growth and Consumption of YOY Sablefish (*Anoplopoma fimbria*)

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We are conducting a series of experiments to better understand how variable temperature and ration affect growth and energy allocation patterns of young-of-year (YOY) sablefish (*Anoplopoma fimbria*) in the Gulf of Alaska (GOA). Our goal is to assess how fall physiological condition of YOY sablefish translates to overwinter survival and subsequent year-class success. To meet this goal we are conducting a series of controlled growth studies to understand how ration size, food quality and temperature influence growth and lipid energy allocation during feeding and energy loss rates during fasting. We began this work in 2016 when we fed YOY sablefish ad lib rations at 5, 8, 12, 16 and 20° C for 3 weeks followed by one week of fasting to assess how growth and metabolism relate to temperature. We found that growth was maximized at 15.3° C and metabolic rates were maximized at 12.0° C. However, fish fed ad lib rations probably do not represent trophic conditions of wild fish and may not fully capture the physiological response of sablefish to varying environmental conditions. An experiment underway is subjecting YOY sablefish to four temperature (7, 14, 18, 22° C) and three ration treatments (high, medium, low) for a growth period of 12 weeks. Physiological data (calorimetry, proximate composition, RNA/DNA ratios, length, mass) is being collected to determine how energy is allocated and prioritized (somatic growth vs. lipid storage) among tank treatments. Following this initial growth period, all fish will be starved for 12 weeks to mimic overwinter fasting. Information on growth, consumption rate, and respiration (derived from energy loss through fasting) will be used to outfit a Wisconsin type bioenergetics model. In addition, growth and physiological data obtained from the lab experiment will be used to generate a Dynamic Energy Budget (DEB) model capable of capturing the influence of variable environmental conditions on YOY sablefish physiology and survivorship. This DEB model will help inform managers by providing context to field observations of YOY sablefish, and provide a platform from which future population-level models may be integrated into existing fisheries management efforts in the GOA.

Exploring the Use of Mucus to Assess Stress Hormones in Pacific Halibut (*Hippoglossus stenolepis*)

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The endocrine responses of non-target fishes captured by commercial fishing gear can provide insight into their post-release survival. During the capture process, a suite of physical and sensory interactions between the gear, the environment, and the fish can result in increased levels of circulating cortisol, a stress hormone. Currently, the probability of a non-retained fish surviving after handling is determined by visual assessments. While efficient, this approach may lack in its ability to detect and assess internal damage and physiological disturbances resulting from the capture process or the potential effects of prior experiences on the potential for post-release survival. This research aims to use cortisol measurements to investigate the stress response in Pacific halibut with the eventual goal of developing tools to augment the visual assessments used to estimate post-release survival. Previous work employing cortisol analysis in fish has predominately used plasma as a sampling tissue. Given the logistical challenges associated with sampling and storing blood plasma onboard marine vessels, as well as the potential increases in circulating cortisol caused by the blood sampling procedure itself, we will investigate the use of a relatively novel sampling tissue—mucus. Unlike blood plasma, external mucus can be sampled in a relatively non-invasive fashion and does not require centrifugation. Initial objectives focus on external mucus sampling methods and include determining the most effective tools and protocols for sample collection and storage and investigating sampling locations on the halibut body to minimize potential sample contamination from contact with other fishes during capture or holding. These sampling methods will then be employed in a controlled experiment to determine the magnitude and rate of cortisol absorption and elimination in blood plasma and external mucus by stimulating cortisol release in captive Pacific halibut using adrenocorticotrophic hormone (ACTH) injections. Preliminary results from live and postmortem sampling efforts indicate that standard glass microscope slides inserted into centrifuge tubes may provide an effective and efficient solution for external mucus sampling.

Spatiotemporal Assessment of Pacific halibut (*Hippoglossus stenolepis*) Growth Performance in IPHC Area 3A

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Decreases in individual size-at-age of Pacific halibut have resulted in declines of observed stock biomass. This low observed biomass, and the associated low female spawning biomass, have resulted in decreases in the harvest allocations of target and non-target fisheries. Current and previous efforts to identify and explore the mechanisms driving these decreases in size-at-age have been somewhat limited by an incomplete understanding of the spatiotemporal distributions of the decreases. This project will use International Pacific Halibut Commission (IPHC) setline survey data to address these topics by 1) describing the current spatiotemporal distribution of halibut size-at-age in IPHC Area 3A, 2) modelling the current and historic spatial structure of halibut growth performance (length-at-age) using geo-statistics and determining the presence/absence of persistent spatiotemporal anomalies in growth performance relative to Area 3A intra-cohort, year-over-year mean size-at-age values, and 3) investigating potential spatial variability in Pacific halibut diet that may be contributing to decreases in size-at-age using $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analysis. Preliminary results indicate that anomalies in size-at-age do cluster spatially, and that temporal persistence in those spatial structures does exist.

Surf or Turf? A Determination of Amino Acid Isotopic Discrimination Factors in Chinook Salmon Raised on Fish Meal versus Terrestrially-Derived Protein Diets

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Stable isotope analysis has gained wide acceptance as a tool for evaluating trophic interactions between species. More recently, the ability to evaluate the isotopic ratios in specific compounds has significantly improved our ability to resolve trophic interactions. This is because essential compounds, such as amino acids that are acquired only in the diet, contain information about nutrient sources at the base of the food web, removing the need to make assumptions about or collect data from the appropriate isotopic end members. However, the application of compound-specific isotopic analyses towards aquatic ecosystems is currently constrained by a lack of information on trophic discrimination factors (TDFs). Experimental determination of stable isotope TDFs through controlled feeding trials are needed for interpreting data from wild fish. Here we investigated the effects of two diets, one a traditional fish meal feed (BioVita, BioOregon, WA, USA) and the other a terrestrially-derived protein feed (BioClark's, BioOregon, WA, USA), on compound-specific amino acid ^{13}C TDFs for hatchery-raised Chinook salmon. Tissue-specific (whole body, muscle, and liver) amino acid TDFs were determined for both dietary treatments. Three essential amino acids (Phe, Ile, Leu) showed no ^{13}C discrimination from diet to tissue for either feed, indicating that these amino acids can be used to determine dietary carbon sources and environmental baseline isotopic information in Chinook salmon. There were some differences in amino acid ^{13}C TDFs between the two diet treatments and across tissues, indicating that diet quality may influence amino acid ^{13}C discrimination factors and that tissue-specific TDFs are necessary. This experimental study is the first measurement of amino acid ^{13}C TDFs in a salmonid, the new data of which will contribute to interpreting and understanding amino acid isotopic biogeochemistry and diet carbon source dynamics and modeling in these species.

Developing a Camera Chute to Assess Halibut Bycatch of Alaska's Trawl Fisheries

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Limits on bycatch of Pacific halibut (*Hippoglossus stenolepis*) impose significant constraints on Alaska bottom trawl fisheries. Exceeding fixed bycatch caps, either by fishery or vessel depending on fishery, stops fishing. All halibut from trawl catches must be returned to the sea as soon as possible. Bycatch is currently assessed by onboard observers taking samples from catches. More accurate accounting of halibut bycatch could be achieved by electronic monitoring of all halibut as they are released. A combined effort, involving the Alaska Fisheries Science Center, the University of Washington Electronic Engineering Department, the Pacific States Marine Fisheries Commission, and FishNext Research have developed and tested a camera chute that detects passing halibut, takes their picture, and analyzes the image to determine individual fish size. Image analysis includes multiple options for separating halibut from chute background (segmentation), calibration, and length measurement. Chutes have been deployed on trawl vessels in the Bering Sea and Gulf of Alaska to test their effectiveness and to identify improvements needed to maintain consistent use and acceptance on a range of vessels and fisheries. Designing and implementing such improvements have provided increasingly more consistent operation and performance. Key issues addressed included chute size, onboard image processing, consistent lighting, camera triggering, clearing water splash from camera ports, and durability. This presentation will detail the development and improvement process and describe the resulting device, including validation of measurements and overall performance. Applications in different Alaska fisheries will be outlined, including facilitating deck-sorting and vessel quota tracking. Future applications including species identification and coordination to improve mortality estimation will be discussed.

Using Habitat Characteristics and Prey Abundance to Predict Distribution and Abundance of Groundfish in the Gulf of Alaska

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Distribution and abundance of finfish may be influenced by numerous factors, including prey abundance, habitat features, and environmental conditions, depending on the species life histories. We sought to determine which of these factors had the greatest effect on the abundance of commercially and ecologically important finfish in the Gulf of Alaska (GOA). Abundance data for walleye pollock, Pacific ocean perch (POP), arrowtooth flounder, capelin, and eulachon are available from concurrent summer acoustic-trawl and bottom trawl surveys in 2003, 2005, 2011, 2013, and 2015. Generalized additive models (GAM) were used to predict the abundance of these fishes in the GOA as a function of acoustically-estimated euphausiid ('krill') prey abundance, habitat features including depth, bathymetry, and presence of habitat complexity indicated by structure forming invertebrates (deep-sea corals and sponges), and environmental conditions such as temperature and chlorophyll-a concentration. Preliminary results indicate that there are species-specific effects of each of these variables on the distribution of key finfish species in the GOA. Acoustically derived krill abundance was a significant, though weak, predictor of both pollock and Pacific ocean perch abundance. Both pollock and arrowtooth flounder exhibited strong relationships with depth. Habitat complexity was a significant predictor for arrowtooth flounder and rockfish, including POP, with a strong negative relationship with arrowtooth flounder and a strong positive relationship for rockfish. Further analysis of these data will help to elucidate these patterns, and help us gain insight on community structure in the GOA.

Effects of the Parasite *Ichthyophonus* spp. on Pacific Halibut (*Hippoglossus stenolepis*) Growth and Condition

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Ichthyophonus is a globally distributed, largely undescribed genus of fish parasites inhabiting fresh and saltwater aquatic systems. Documented in 145 fish species, including economically important stocks (e.g., Pacific halibut, salmon, and herring), it can result in reduced growth, stamina, and overall health; decreased market value; and has triggered large-scale mortality events. As changing ocean temperatures increase the potential for presence and spread of pathogens, it is important to monitor *Ichthyophonus* prevalence and its current and potential effects on Alaska fisheries. Preliminary studies conducted at Alaska Pacific University in 2012 and 2013 found *Ichthyophonus* in 26% (n = 563) of Pacific halibut (*Hippoglossus stenolepis*) sampled in the port of Homer, AK. The parasite infected heart tissues but not liver, kidney, or spleen, and was more prevalent in older fish. My research expanded on this work by adding additional surveys for 2016 and 2017 that used a length-based sampling design, and included bioelectric impedance analysis and Fulton's Condition Factor to assess *Ichthyophonus* impacts on fish condition. Also evaluated were size-at-age, host immune response to infection, parasite load within the heart, and parasite-induced changes in heart mass. 2016 and 2017 field objectives were accomplished while sampling cooperatively with the Alaska Department of Fish and Game port sampling program and charter fleets. Overall *Ichthyophonus* prevalence in Pacific halibut in 2016 was 57% (n = 335), and prevalence in 2017 was 58% (n = 143). Sample and data analyses for all other objectives are currently underway, and are expected to be completed before January 2018.

Growth, Consumption, and Energy Allocation Strategies of YOY Sablefish (*Anoplopoma fimbria*) Cultured at Five Different Temperatures

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Presenter: Ashwin Sreenivasan

We conducted a pilot growth study on young-of-the-year (YOY) sablefish in order to understand temperature-dependent growth, consumption, and metabolic responses, including RNA/DNA (cellular growth) and proximate composition (energy allocation strategies). Individually tagged YOY sablefish were cultured at five temperature treatments (5°, 8°, 12°, 16°, and 20° C) and fed ad libitum rations (C_{max}) for 3 weeks. As expected, growth rates increased with increasing temperature. The highest growth was observed in fish at 16° C, with reduced growth at 20° C. Applying a second order polynomial growth curve to temperature-dependent growth responses showed a peak growth at 15.3° C. However, corresponding RNA/DNA ratios failed to mirror growth trends, with highest values at 12° C and reducing at 16° C. The growth responses in conjunction with RNA/DNA ratios indicated the presence of a narrow “growth efficiency window” between 12° C and 16° C due to reduced metabolic costs, in turn maximizing the scope for growth. Thermal stress effects were present on either side of this temperature range. Regardless of growth and RNA/DNA responses, fish maintained ~8% total-body lipid across all temperature treatments, suggesting a baseline lipid level under optimal conditions. Conversely, total-body protein content had a positive relationship with temperature treatment, peaking at 20° C. The increased protein synthesis in conjunction with lower growth in fish at 20° C suggested an increased decoupling of protein synthesis and somatic growth, possibly due to a temperature-stress response. The increased metabolic costs due to this heightened protein synthesis would be expected to negatively affect growth efficiency, as was observed with reduced growth at 20° C. The “growth efficiency window” closely matched water temperatures where field-caught fish were obtained during surveys in the Gulf of Alaska. This highlights the importance of somatic growth for YOY sablefish that actively inhabit temperature zones where they have reduced metabolic costs while maximizing growth. These temperature-dependent growth/consumption responses will be utilized with data from an ongoing YOY sablefish growth study to bioenergetically model the effects of environmental conditions on YOY sablefish growth.

Tier 5 Rockfish Management

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Presenter: Todd TenBrink

Rockfish are valuable components in the groundfish fisheries of Alaska. These stocks are managed by the North Pacific Fishery Management Council (NPMFC) in the Bering Sea-Aleutians Islands (BSAI) and Gulf of Alaska (GOA) management areas. In order to fill critical gaps in their life histories, four commercially important but data-limited rockfish species were targeted for research to support upward mobility from their current management tier: shortspine thornyhead (*Sebastolobus alascanus*), shortraker rockfish (*Sebastes borealis*), harlequin rockfish (*S. variegatus*), and redstripe rockfish (*S. proriger*). In an effort to support this upward movement in these species, three major components were investigated: 1) maturity and other aspects of reproduction; 2) ageing techniques, including age validation through bomb-produced ^{14}C analysis; and 3) modeling for ageing error observations and how this could be incorporated into an integrated modeling framework for use in stock assessments. Each of the rockfish species exhibited a group synchronous mode of reproduction that preceded either a live bearing (*Sebastes*) or oviparous (*Sebastolobus*) strategy. Maturity ogives were generated for the following stocks: AI shortspine thornyhead, GOA harlequin rockfish, and BSAI and GOA shortraker rockfish. New maximum ages were estimated for two of the four rockfish species. In harlequin rockfish the maximum age was approximately 76 years, and in redstripe rockfish the maximum age was 46 years. Based on bomb-produced ^{14}C analysis, redstripe rockfish age estimates were the most accurate; the probability of under- or over-ageing by two or more years was less than 5%. Harlequin rockfish age estimates were less accurate showing a 90% and 50% probability of under-ageing by 2 and 4 years, respectively. The degree to which ageing bias affects estimates of growth, maturity, and F_{spr} reference points depends not only on the degree of accuracy of the age readings, but also on the age range for which empirical estimates of bias are available.

Morphometrics of Forage Fish Sampled by Puffins in Alaska: Describing the Data

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Puffins are ideal samplers of forage fish because they are generalist predators that carry whole fish to their chicks on breeding colonies, which can then be identified and measured by field biologists. Puffin diet samples have been collected regularly in conjunction with seabird monitoring since the late 1970s and provide some of the best time series data on forage fish in the North Pacific. These fish include small coastal pelagic species, such as capelin and sand lance, as well as a suite of age-0 and to a lesser extent age-1 age classes of commercially valuable species such as pollock and Pacific cod. These data may be used to better understand 1) food web characteristics and how prey quality and availability may influence populations of marine predators in Alaska, and 2) variation in young-of-the-year characteristics and how this may affect fisheries recruitment and populations. Our study utilizes the extensive time series of forage fish measurements produced during diet sampling of three puffin species from 42 breeding sites in southeast Alaska and across the Aleutian Islands. These data are stored in the Alaska Puffin Diet Database (APDD), which contains length and mass data of forage fish based on diet collections from puffins. To examine forage fish morphometrics, we extracted ~70,000 records from the database for length of individual fish, and from these records, we calculated the condition index for ~48,000 fish collected from 1978 to 2015. Initial summaries of the data focus on Pacific sand lance, capelin, and age-0 gadids, which are preferred prey species of rhinoceros auklets and tufted puffins and therefore have a large amount of data (~6,000–15,000 records each). Here we present metadata and summaries of the sample sizes to be used in future analyses, as well as trends and covariability of sampling aspects of this data set.

Involving Stakeholders in Investigating and Addressing Multiple Causes of Historical Klawock Lake Sockeye Salmon Declines

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Sockeye salmon from Klawock Lake have been important to people on Prince of Wales Island for thousands of years. It is evident that current abundance of sockeye salmon is significantly less than historical values, and this has been a concern of local residents for some time. Because of these declines, there have been many previous efforts to address declines through research and management. We completed a retrospective analysis of this system to serve as a single source of information regarding the many research, management, and watershed restoration projects that concern this stock and to synthesize the factors that may influence their productivity. Review of this previous research reveals that multiple factors likely conspire to influence the sockeye decline, and that while various research efforts have been completed over the years, significant gaps still exist. These factors include climatic influences on sockeye salmon in both the freshwater and marine environment, which are likely complex and difficult to predict; historical timber harvest, which altered the majority of available spawning habitats above the lake; predation impacts from both hatchery-reared coho salmon and other predators, as well as historical and current harvest of the stock by both commercial and subsistence users. In addition to this retrospective analysis, we have worked to further assess the habitat condition for sockeye spawning on the lake. Field and imagery analysis-based assessments of spawning distribution and past and present river habitat suggest that habitat condition in areas likely to be historically productive have declined. Through the course of this study, significant outreach to stakeholders, including community members, private and public land owners, fish and wildlife managers, subsistence fishers, state and federal agencies, local tribes and municipalities, academic interests, and environmental non-governmental organizations in order to understand stakeholder concerns and provide results from analyses. Community meetings and stakeholder meetings have resulted in a suite of actions, including potential management changes, research projects, and restoration and enhancement options for stakeholders to work together on to address declines. For these efforts to be effective, future work will require a collaborative approach between multiple stakeholders to ensure lasting results in this important and complex system.

Alaskan Bathymetry for Fisheries and Oceanography Research

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Presenter: Mark Zimmermann

Detailed and accurate bathymetry provides the basis for describing fish habitats, understanding land and sea interfaces, and determining how biological and physical processes integrate over a range of geospatial scales. As funding and time permit, we have been publishing accurate bathymetry and sea floor features by combining data from hydrographic smooth sheets, multibeam bathymetry, and other data sources, but detailed bathymetry is still lacking for many areas of Alaska. Our previously published maps for the Aleutian Islands, Cook Inlet, Norton Sound and the central Gulf of Alaska have been used for a wide range of projects including coral and sponge distribution modeling, Essential Fish Habitat maps, and NPRB's Gulf of Alaska - Integrated Ecosystem Research Program. Three new bathymetry maps are in progress. Our compilation of the eastern Bering Sea slope provides significant details on the canyons and features associated with this narrow and extremely steep area. Cross-sections of Shelikof Strait, taken from our western Gulf of Alaska compilation, show the largest and smallest openings of this complicated body of water. This more detailed map of Shelikof might help improve the understanding of water flow, which is probably a critical component of the success or failure of the large stock of walleye pollock (*Gadus chalcogrammus*) that spawns here. The eastern GOA compilation has provided new details on the numerous bays, rocky reefs and troughs of this area, and it aligns very well with a new topographic map of the area's islands. We have just started a NPRB-funded revision of our first compilation from the Aleutian Islands, originally published in 2013. These bathymetries have resulted in numerous additional collaborations with tsunami, tide simulation and storm surge modelers, as well as geologists studying faults and uplift.

Impact of Anomalous Ocean Conditions on the Vertical Distributions of Groundfish in the Gulf of Alaska

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We investigated changes in the vertical distributions of groundfish in the Gulf of Alaska (GOA) in response to the anomalous warm ocean conditions during the recent “blob” event (2015). A 10-year dataset of fish abundance, bottom temperature and depth from Alaska Fisheries Science Center bottom trawl surveys during the period of 1996 – 2015 was analyzed. Among the 10 survey years, 2015 is the warmest year. Seven fish species including Pacific ocean perch, arrowtooth flounder, northern rock sole, southern rock sole, Pacific cod, sablefish and walleye pollock, were considered. Fish were binned by size to account for ontogenetic differences. We applied a joint probability density distribution (PDF) of bottom temperature and depth to represent the distribution of fish abundance. The distributional changes of fish in the blob year of 2015 were then derived as the difference between the joint PDF for the year 2015 and the 10-year mean PDF. The impact of habitat on the joint PDF was removed. Our results suggest that groundfish exhibit complex distributional response to changes in ocean temperatures. No noticeable vertical movements were found for northern or southern rock sole. Ontogenetic differences were found for Pacific cod and pollock. Young fish were resilient to changes in ocean temperature while older fish were more responsive. In the central GOA, Pacific cod and walleye pollock moved deeper in warm years and shallower in cold years. The downward movement in response to warm temperature was most pronounced in 2015.

MONDAY, JANUARY 22

WAVE 2

(7:45 PM TO 9:00 PM)

Wave 2
Monday, January 22nd (7:45 pm to 9:00 pm)

W. E. Eagan Civic and Convention Center

Title	Authors	Location (Row, Poster)
Update on 2017 Steller sea lion population abundance in the Commander Islands, Russia: A slight increase	Natasha Laskina, Vladimir Burkanov, Thomas Gelatt	R1 , P3
Assessment of an un-manned quadrocopter for collecting observations of marked Steller sea lions on Tuleny Island, Russia	Ivan Usatov, Anna Kirillova, Vladimir Burkanov	R1 , P6
Brief results of Inchoun walrus haulout survey using traditional methods and drone Phantom 4 PRO aerial photography	Natalia Kryukova, Ivan Krupin, Vladimir Burkanov	R1 , P9
Associations between Steller sea lion survival and reproduction and local commercial fishery activity	Alexey Altukhov, Russel Andrews, Thomas Gelatt, Burkanov Vladimir	R1 , P12
Stomach content analysis of dead stranded marine mammals in Alaskan waters	Louise Biderman, Anna Bryan, Lori Quakenbush	R2 , P15
Acoustic foraging behavior of beluga whales via combined technology: Satellite telemetry, passive acoustics, accelerometry, and stomach temperature sensing	Manuel Castellote, Aran Mooney, Russ Andrews, Stacy Deruiter, Lori Quakenbush, Caroline Goertz, Rod Hobbs, Eric Gaglione	R2 , P18
Assessing abundance of beluga whales in Bristol Bay using genetic mark-recapture methods	John Citta, Gregory O'Corry-Crowe, Lori Quakenbush, Anna Bryan, Tatiana Ferrer, Myra Olson, Roderick Hobbs	R2 , P21
POWERful cruise results: Finding the world's rarest whale	Jessica L. Crance, Koji Matsuoka, Jessica K.D. Taylor	R2 , P24
Assessment of effects from life history tags surgically implanted in wild harbor seals	Shawn Dahle, Markus Horning, Paul Conn, Josh London, Peter Boveng	R3 , P27
Estimated abundance and distribution of eastern Bering Sea belugas from aerial surveys in 2017	Megan Ferguson, Kathy Frost, Amelia Brower, Amy Willoughby, Christy Sims, Robert Suydam	R3 , P33
Geographic segregation among resident and transient killer whales in the western North Pacific	Olga Filatova, Ivan Fedutin, Olga Shpak, Alexandr Burdin, Erich Hoyt	R3 , P36
Humpback whale entanglements and interactions with Bering Sea and Aleutian Islands fisheries	Melissa Good	R4 , P39
A plan for all seasons: Year-round cetacean surveys in the North Pacific by the USSR	Yulia Ivashchenko	R4 , P42
Tracking reproductive histories in Steller sea lion and northern fur seal whiskers	Mandy Keogh, Patrick Charapata, Shawna Karpovich, Brian Fadely, Renae Sattler, Russel Andrews, Jason Waite, Vladimir Burkanov, Lori Polasek	R4 , P45
Pregnant or pretending? Comparing known reproductive states of walruses with endocrine profiles	Jenell Larsen, Shannon Atkinson	R4 , P47
Habitat use of harbor seals in the Aleutian Islands	Josh London, Shawn Dahle, Kenady Wilson, Peter Boveng	R5 , P51
Foraging Trip Duration: an index of prey availability & reproductive success in a depleted marine mammal - northern fur seals (<i>Callorhinus ursinus</i>)	Greg Merrill	R5 , P54
The NIST Marine Environmental Specimen Bank's projects in Alaska	Amanda Moors, Debra Ellisor, Jennifer Ness, Jared Ragland, Jennifer Trevillian, Stacy (Vander Pol) Schuur, Teresa Rowles, David Roseneau, Rebecca Pugh	R5 , P57
The efficacy of fecal hormones to detect nutritional changes in northern fur seals	David Rosen	R5 , P60
What's in a Whisker? Comparisons of Pacific harbor seal (<i>Phoca vitulina richardii</i>) spatial habitat use and foraging ecology in two regions of the North Pacific	Sheanna Steingass, Lorrie Rea, Heather Ziel, Markus Horning	R6 , P63
Steller Sea Lions: Why Did They Decline?	Andrew Trites, David Rosen	R6 , P66
Relationships among blubber depth, body condition, and morphometric measurements in Alaska phocids	Heather Ziel, Brett McClintock, Peter Boveng	R6 , P71

Connecting individual pre-breeding behavior and physiology to egg laying failure in the red-legged kittiwake	Rachael Orben, Abram Fleishman, Alexis Will, Marc Romano, Rosana Paredes, Alexander Kitaysky	R7 , P82
Status of Aleutian and Arctic Terns breeding in the Kodiak Archipelago, 2016-2017	Robin Corcoran, Jill Tengeres, Donald Lyons	R7 , P83
Alaskan breeding colonies of Northern Fulmars exhibit extensive gene flow and limited population structure	Diana Baetscher, Jessie Beck, Eric Anderson, Kristen Ruegg, Andrew Ramey, Scott Hatch, John Carlos Garza	R8 , P85
Non-breeding marine bird response to forage fish schools in Prince William Sound, Alaska	Anne Schaefer, Mary Anne Bishop, Richard Thorne	R8 , P86
Algal toxin assessments in seabird and forage fish tissues during the 2015-2016 seabird die-off	Caroline Van Hemert, Sarah Schoen, William Holland, John Piatt, Mayumi Arimitsu, John Pearce, Matthew Smith, Rance Hardison, Steve Kibler	R8 , P88
Marine bird diversity in Alaska marine ecosystems: Spatial patterns and temporal trends	Gary Drew, John Piatt	R8 , P89
A sea of murre: A novel technique for tracking individual nest sites when using time-lapse cameras	Sarah Tanedo, Tuula Hollmén	R8 , P90
Winter distribution of red-legged kittiwakes from Buldir Island, Alaska	Brie Drummond, Aaron Christ, Nora Rojek, Heather Renner	R8 , P92
Aleutian Tern monitoring in the Kodiak Archipelago	Jill Tengeres, Robin Corcoran, Donald Lyons	R9 , P93
Algae on acid: high-latitude corallines and low pH water	Lauren Bell, Diana Steller, Emily Donham, Kristy Kroeker	R9 , P94
Subsistence, biodiversity & change along Southeast Alaska's rocky coast	Lauren Bell	R9 , P95
A flow cytometry based assay for measuring the growth rate of Walleye Pollock (<i>Gadus chalcogrammus</i>) larvae	Steven Porter, Annette Dougherty	R9 , P97
Species of " <i>Hedophyllum</i> " in the Aleutian Islands, Alaska	Sandra Lindstrom, Sam Starko, Ga Hun Boo, Mandy Lindeberg	R9 , P98
Investigating aging techniques for the giant Pacific octopus in the Gulf of Alaska	Paul Bennetts	R9 , P99
Defining population genetic management units of kelps in Alaska	Erica L. Chenoweth, Wei Cheng, William D. Templin, Christopher Habicht, Cynthia Pring-Ham, W. Stewart Grant	R9 , P100
Microbial community structure in Prince William Sound	Eric Collins	R9 , P102
Freezing in a warming climate?	Katrin Iken, Brenda Konar	R10 , P103
Trends in intertidal sea star abundance and diversity across the Gulf of Alaska: effects of sea star wasting	Brenda Konar, Katrin Iken, Heather Coletti, Tom Dean, Dan Esler, Kim Kloecker, Mandy Lindeberg, Benjamin Pister, Benjamin Weitzman	R10 , P104
Regional and local drivers combine to structure mussel growth and mortality	Suresh Sethi, Katrin Iken, Brenda Konar, Heather Coletti	R11 , P105
Distribution and bloom conditions of the toxic alga <i>Alexandrium catanella</i> in Kachemak Bay and Lower Cook Inlet, Alaska	Dominic Hondolero, Mark Vandersea, Patricia Tester, Kristine Holderied, Steve Kibler, Kimberly Powell, Steve Baird, Angela Doroff, Wayne Litaker	R9 , P106
Mechanisms leading to the increase of the coarse spongy cushion <i>Codium ritteri</i> within urchin barrens	Scott Gabara, Ben Weitzman, Doug Rasher, Matt Edwards	R9 , P108
The physiological ecology of the calanid copepod, <i>Neocalanus flemingeri</i> in the northern Gulf of Alaska	Petra Lenz, Vittoria Roncalli, Daniel Hartline, Martina Germano, Matthew Cieslak, Suzanne Strom, Russell Hopcroft	R10 , P110
Pink Salmon induce a trophic cascade in plankton populations around the Aleutian Islands.	Sonia Batten, Greg Ruggerone, Ivonne Ortiz	R10 , P111
Using stable isotopes to study the trophic relationships of groundfish, squid, and spermwhales in the Gulf of Alaska	Kristina Long	R10 , P112
Zooplankton community structure and seasonal abundance in Prince William Sound	Caitlin McKinstry, Rob Campbell	R10 , P114
How to recognize the frilled giant Pacific octopus, an increasingly common large octopus in Prince William Sound, AK	David Scheel, Nathan Hollenbeck	R10 , P116
Zooplankton and forage fish spatial distributions under varying environmental conditions in the northern Bering Sea	Kelly Kearney, Kerim Aydin, Al Hermann, Ivonne Ortiz	R11 , P118

Nearshore food web structure in two contrasting regions of Cook Inlet	Danielle Siegert, Katrin Iken, Brenda Konar, Susan Saupe, Mandy Lindeberg	R11 , P119
Pteropod shell status and ocean acidification in the Marine National Park of Glacier Bay, AK	Faith Stemmler, Russell Hopcroft	R11 , P121
How many krill are there in the Bering Sea and Gulf of Alaska? Field observations and acoustic calibration of krill and their composition in 2016 and 2017	Joseph Warren, Brandyn Lucca, Patrick Ressler, Rodger Harvey, Georgina Gibson	R11 , P123
Spatiotemporal variation in relative composition of suspended particulate matter in Arctic nearshore habitats	Katrina Abel, Mark Barton, Kevin Boswell, Brenda Norcross, Ron Heintz, Chunyan Li, Johanna Vollenweider, Leandra Sousa	R11 , P125
Pilot investigation into the age structure of market squid, <i>Doryteuthis opalescens</i> , in the Gulf of Alaska	Dawn Wehde	R11 , P126
Fine-scale trophic ecology and bioenergetics of euphausiids in Prince William Sound, Alaska	Courtney Weiss, John Moran, Todd Miller	R11 , P128
How people of the Yukon River value of salmon	Catherine Moncrieff	R12 , P129
Implications of halibut bycatch management in the North Pacific: A prospective model of fleet behavior in the groundfish trawl fisheries	Matt Reimer, Joshua Abbott, Alan Haynie	R12 , P132
Characterizing cross-fishery permitting patterns using network analysis	Matthew Reimer, James Sanchirico, Daniel Lew, Justine Huetteman, Ethan Addicott, Kailin Kroetz	R12 , P133
How do we prepare Bering Sea Fisheries Management for Success in a Changing Environment?	Alan Haynie, Amanda Faig, Kirstin Holsman, Stephen Kaspersi, Anne Hollowed	R12 , P137
Developing culturally relevant environmental stem education: Challenges, opportunities, and considerations	Jennifer Renee, David Armstrong, Janet Armstrong, Kirstin Holsman, William Christopher Long, P. Sean McDonald, Jonathan Reum	R12 , P140
Oceanographic warming along the coast of the Gulf of Alaska evidenced and tracked by a persistent range expansion of market squid, <i>Doryteuthis opalescens</i>	Michael Navarro	R20 , P230
Enhanced OA observing by citizen science initiatives and land-based measurement strategies in coastal Alaska	Carrie Weekes, Wiley Evans, Jacqueline Ramsay, Jeff Hetrick, Deborah Kurtz, Jeremy Mathis, Burke Hales	R20 , P236
Congruence of intertidal and pelagic water and air temperatures during an anomalously warm period in the northern Gulf of Alaska; the "Blob" washes ashore	Daniel Monson, Kris Holderied, Robert Campbell, Seth Danielson, Russell Hopcroft, Brenda Ballachey, James Bodkin, Heather Coletti, Tom Dean, Katrin Iken, Kimberly Kloecker, Brenda Konar, Mandy Lindeberg, Brian Robinson, Ben Weitzman, Robert Suryan	R21 , P241
Ocean Acidification Observations along the Seward Line: 2008-2017	Natalie Monacci, Jessica Cross, Jeremy Mathis	R21 , P243
The Seward Line - 2017	Russell Hopcroft	R21 , P246
Calcium carbonate variability in near shore waters	Lily Hood, Muriel Reid	R22 , P249
Variability in estuarine salinity and stratification in Kachemak Bay, Alaska from 2012-2017	Kristine Holderied, Kimberly Powell, Steve Baird, James Schloemer	R22 , P253
Building out an Ocean Acidification detection array for southeast Alaska	Wiley Evans, Allison Bidlack, Jeremy Mathis, Katie Pocock, Geoff Lebon, Esther Kennedy, Burke Hales	R22 , P257

Update on 2017 Steller Sea Lion Population Abundance in the Commander Islands, Russia: A Slight Increase

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Yugo-Vostochny rookery is the major breeding site of the Steller sea lion (SSL) in the Commander Islands (CI) located on the southern tip of Medny Island, Russia. Regular breeding season observations have occurred there since 1991. Surveys are conducted with binoculars and include regular counts of pup births, sex/age groups of non-pups, and mortalities. In general, count methods have remained unchanged throughout the 26 years of observation. In 2015-2017, observations were conducted daily from mid-May to mid-August by four researchers. In addition to traditional visual observations during 2017, an unmanned quadcopter (Phantom 4) was used to collect aerial images. We recorded a significant decline in abundance of all age/sex groups between May 30 to July 10, 2015, compared to the same period in 2014, and the lowest pup count in recent decades. In 2017, during same period, a median of 254 (range 142 - 316; n = 11) non-pup individuals were present on the rookery, of which 171 (range 45 - 212; n = 11) were females; 59 (range 52 - 64; n = 11) were mature males; and 11 (range 6 - 14; n = 11) were juveniles. In 2017, we counted 183 pup births, including 3% pup mortality. Overall abundance increased in 2017 compared to 2015: the number of 1+ year-old animals increased by 45%, adult females by 49%, mature males by 23%, juveniles by 83%, and pups by 20%. However, the pup production remained below the annual averages prior to 2009, when the number of pups did not fall below 210 individuals. The maximum number of pups born on Medny Island was recorded in 1998. Over the past 19 years pup abundance declined by 34%. The non-pup abundance decreased by 56%, while the number of females decreased by 49%. Declines are caused by low survival rates, reduced birth rates, and dispersal of young mature females to other breeding locations. SSL abundance continues to be at low level in the CI relative to historic levels, but we report on positive changes in abundance for all age and sex groups in 2017, an encouraging bit of news for the SSL population in the CI.

Assessment of an Unmanned Quadcopter for Collecting Observations of Marked Steller Sea Lions on Tuleny Island, Russia

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Brand re-sight data collection is critical for Steller sea lion (SSL) demographic studies. Traditionally, this has been collected by researchers on land or boat visually searching rookeries and haulouts. We tested the feasibility of using a quadcopter (QC) (Phantom 4) to collect photographic images of SSL on Tuleny Island during summer 2017. Two researchers surveyed the rookery regularly between June 27 and August 11. Visual searches were performed for 21 days (222 hours; 10.6 hr/day) and QC flights were performed for 39 days (143 flights; 3.7 flights/day). Visual observers used binoculars and digital cameras to record individual brands on sea lions. QC flights were conducted manually at an altitude of 4-10 m and an average speed of 2-4 m/s. Despite the low altitude there was no discernible disturbance due to the elevated level of natural noise created by thousands of northern fur seals and hundreds of thousands of birds. We only observed four instances of apparent disturbance caused by the QC when for one or another reason QC speed increased to > 4 m/s. The camera was programmed to shoot photos at a rate of 30 images/min. The 35-mm equivalent lens was turned 20-50 degrees towards the horizon. We flew over all SSL-occupied sites, first clockwise around the island and then counterclockwise to collect images of both sides of the animals. We obtained 67,7142 images from QC during the study (1,742 images/day). Images were searched using an existing module in MS Access. The average processing time from one flight was ~75 min. Visual observers found a total of 235 branded SSL during the study while using QC images revealed 253 or 7.7% more. Using QC for locating marked SSL's substantially increased the efficiency and productivity of SSL demographic research at Tuleny Island. The work was funded the Fishing Industry and Communities Promotion Organization (Japan), a non-profit organization, and the Hokkaido National Fisheries Research Institute of Fishery Agency of Japan.

Brief Results of Inchoun Walrus Haulout Survey Using Traditional Methods and Drone Phantom 4 PRO Aerial Photography

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Observations on a coastal walrus haulout (HO) located 6 km southeast of Inchoun village were conducted from August 31 to October 3, 2017. The HO consists of a small rocky cape and two short narrow beaches beneath the cliff and nearshore rocks. A visual observation point was located on a shore cliff 165 m above sea level above the HO. During the season, we surveyed the HO for 20 days conducting nine traditional direct visual counts and 12 aerial photography surveys using quadcopter Phantom 4 PRO (22 flights). Walrus were present on the HO 11 days and counts ranged from 80 to 2,500 individuals. During maximum walrus abundance, visual counts were 93% lower compared to the drone aerial imagery counts due to access limitation, and because a large part of the HO was not visible from the observation point or any other onshore locations. We were able to conduct a survey of entire HO using only the drone. Drone flights were limited by wind speed (~8 m/s) and strong swirling winds near the cliff made drone flights very unstable. Flights lasted on average 15 min (range 5-25 min), and maximum flight distance was about 700 m. Minimum drone flight altitude over hauled-out walrus was 70 m, and 40 m above animals swimming in water. The walrus did not appear to react to drone noise. We found the Phantom 4 PRO quadcopter very useful and an important instrument to monitor walrus coastal HO near Inchoun village and highly recommend it for future work. The project was funded by U.S. Geological Survey.

Associations Between Steller Sea Lion Survival and Reproduction and Local Commercial Fishery Activity

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Steller sea lion abundance in the Commander Islands (Russia) has been declining for decades. Longitudinal mark-resight research is the best approach for measuring vital rates in such long-lived animals and also facilitates evaluation of the time-varying effects of environmental and anthropogenic factors, including commercial fishing. The Commander Islands Steller sea lion population has been under observation since 1996, and the data from these islands, which lie less than 200 miles from the western-most U. S. Steller sea lion rookery, provide a unique opportunity to test various hypotheses about Steller sea lion demography and possible associations with local commercial fisheries. We evaluated resight histories of sea lions branded on the Medny Island rookery in the Commander Islands between 1996 and 2010, and resighted from 1997-2016. The only changes in survival over time were for males > 3 years old. Survival rates of females remained the same. Changes in birth rates over time for females from Medny Island were mostly associated with changes in the probability of skipping a year between pupping. Most sea lions from Medny Island travelled away from the Commander Islands and spent the first few years of their life along Eastern Kamchatka, and adult females tended to return to Eastern Kamchatka after the summer reproductive season on Medny Island. We compared our estimates of vital rates with pollock fishery data from the Eastern Kamchatka region for the same period. High male survival coincided with years when the fishery was very active, possibly because of a high abundance of fish that could support both the fishery and sea lions. In contrast, inter-birth intervals were longer, and therefore birth rates were lower, when the commercial pollock catch was high. Males were likely more actively depredating on commercial fish catch, obtaining easy fish, leading to increased survival, with the benefits of depredation outweighing bycatch mortality. Further research is necessary because birth performance may not be directly related to the removal of fish by fisheries but rather might be due to increased competition between males and females.

Stomach Content Analysis of Dead Stranded Marine Mammals in Alaska Waters

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Since 2001, the Alaska Department of Fish and Game (ADF&G) has processed more than 200 stomachs collected from cetaceans and pinnipeds found dead on Alaska beaches. Whole stomachs or stomach contents are shipped to the ADF&G laboratory in Fairbanks, rinsed, sorted, and prey items are identified to the lowest possible taxonomic level. Diet reports are then submitted to the National Marine Fisheries Service, Alaska Region who funds the analyses. Identifying prey found in stomachs is an important tool for understanding the feeding habits of stranded marine mammals and provides valuable diet information for marine mammal species that are otherwise difficult to study, such as killer whales (*Orcinus orca*) and Stejneger's (*Mesoplodon stejnegeri*) and Cuvier's (*Ziphius cavirostris*) beaked whales. Diet information provides clues about foraging behaviors (e.g., prey found in a Steller sea lion (*Eumetopias jubatus*) stomach indicated it followed a fishing vessel and ate discarded exotic bait). Fish otoliths and cephalopod beaks can be used to estimate the size of prey consumed. Prey items can indicate if the animal was feeding pelagically or benthically. Although empty stomachs do not provide diet information, they can provide information about the animal's overall health (e.g., ulcers and parasite load). These data have been used in a variety of research projects and papers, including comparing the diet of Cook Inlet beluga whales (*Delphinapterus leucas*) to other stocks of belugas in Alaska, documenting sea otters (*Enhydra lutris*) and birds as prey for killer whales, and documenting sizes and species of squid eaten by Stejneger's beaked whales.

Acoustic Foraging Behavior of Beluga Whales Via Combined Technology: Satellite Telemetry, Passive Acoustics, Accelerometry, and Stomach Temperature Sensing

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In Nushagak Bay, within Bristol Bay, Alaska, seven temporarily restrained wild belugas were instrumented with a short-term multi-sensor tag (DTAG3), a long-term satellite tag (SPLASH 10) and a stomach temperature pill (STP3) in August 2014 and May 2016. DTAG deployments provided 20 to 40 hours of dive depth, 3D acceleration, and recordings of echolocation and vocalizations of tagged and nearby belugas. For all belugas, data consisted of a long period of silence (i.e., transit), until a beluga group was joined, followed by alternating periods of vocalizations (i.e., social interaction), quiet (i.e., resting at the surface), and episodes of intense echolocation activity related to feeding behavior, confirmed by sudden decreases in stomach temperature. Foraging periods occurred in the company of multiple individuals engaged in episodes of intense buzzing, which may indicate cooperative or competitive interaction, followed by long resting periods in deeper waters nearby. Satellite tag data showed these feeding periods occurred in both shallow mud flats and river channels during the flooding tide. Feeding behavior was not always associated with sudden changes in acceleration (jerks) as described in other odontocetes, but the whales often rolled their body sideways during capture attempts. Turning sideways is likely related to the need to maintain enough fluking amplitude to generate thrust while swimming in very shallow waters or near the seafloor, but could also be related to prey capture strategies involving dorsoventral head movements and mouth suction. Results also confirmed that belugas buzzes directed to prey show acoustic characteristics typical of other odontocete feeding buzzes. However, they buzzed longer and more often than other odontocetes, suggesting an avid prey scanning and selection before engaging in capture attempts.

This combination of multiple instruments provided a comprehensive approach to study beluga whale foraging ecology, including behavior, feeding effort and feeding success.

Assessing Abundance of Beluga whales in Bristol Bay using Genetic Mark-Recapture methods

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The Bristol Bay stock of beluga whales (*Delphinapterus leucas*) is genetically distinct and resides in Bristol Bay year-round. We estimated the abundance of this population using genetic mark-recapture, whereby genetic markers from skin biopsies, collected between 2002 and 2011, were used to identify individuals. We identified 516 individual belugas in two inner bays, 468 from Kvichak Bay and 48 from Nushagak Bay, and recaptured 75 belugas in separate years. Using a POPAN Jolly-Seber model, abundance was estimated at 1,928 belugas (95% CI = 1,611 to 2,337), not including calves, which were not sampled. Most belugas were sampled in Kvichak Bay at a time when belugas are also known to occur in Nushagak Bay. The pattern of genetic recaptures and data from belugas with satellite transmitters suggested that belugas in the two bays regularly mix. Hence, the estimate of abundance likely applies to all belugas within Bristol Bay. Simulations suggested that POPAN estimates of abundance are robust to most forms of emigration, but that emigration causes negative bias in both capture and survival probabilities. Because it is likely that some belugas do not enter the sampling area during sampling, our estimate of abundance is best considered a minimum population size.

POWERful Cruise Results: Finding the World's Rarest Whale

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The IWC-POWER (International Whaling Commission 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. The 2017 POWER cruise occurred between 3 July and 25 September in the eastern Bering Sea. Though primarily a visual line-transect survey, passive acoustics (via sonobuoys) was included for the first time to acoustically monitor for marine mammals, especially eastern North Pacific right whales (*Eubalaena japonica*, hereafter NPRW). The vessel surveyed along pre-determined tracklines, from Bering Strait south to the Aleutian Islands. Results presented here focus on the passive acoustic component, and NPRW visual results. A total of 240 sonobuoys were deployed, for over 841 monitoring hours. Species detected include fin whales (46.7% of sonobuoys), followed by killer (20.4%), sperm (18.3%), right (15.8%), humpback (9.6%), and gray whales (1.7%), fish grunts (2.5%), seismic airguns (0.8%), and Cuvier's beaked whale clicks (0.4%). A total of 9 schools of 18 individual NPRW were sighted, including 2 schools of 3 individuals that were duplicates and 3 unphotographed individuals. Of the 9 sightings, 5 were the result of acoustic localization. In total, 12 unique individual NPRW were photographed, and three biopsy samples collected, including one from a possible juvenile. 7 of the 12 photographed NPRW were sighted 50 nautical miles east of the critical habitat in Bristol Bay, and five were sighted in the habitat. To date, 8 of the 12 have been matched to the Marine Mammal Laboratory catalog. The remaining four individuals are not yet matched, though this may be a result of poor photo quality and not indicative of new individuals. All three biopsy samples were collected from whales of unknown sex. Such high sighting numbers, especially given the short amount of time in the area, have not been documented for NPRW since the large aggregation seen in 2004 (n = 17). The information obtained during this survey, in particular the biopsy samples and potential new individuals, will greatly contribute to our knowledge of this critically endangered population.

Assessment of Effects from Life History Tags Surgically Implanted in Wild Harbor Seals

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Harbor seals (*Phoca vitulina*) in the Aleutian Islands 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 Argos-linked dive recorders on 35 seals at five locations in the central and western Aleutian Islands during September 2016. Ten of these seals also received pairs of life history transmitter (LHX) tags surgically implanted in their abdominal cavities. These tags are designed to transmit data on survival, birth events in females, and location and potential causes of mortality after the seals have died. Because this study was the first deployment of LHX tags at sea and in wild harbor seals, our first objective was to determine whether there were any acute or chronic effects on the seals from the surgical procedures or tags. We present a treatment-versus-control comparison for a suite of movement and foraging performance parameters obtained from the Argos-linked dive recorders. Preliminary graphical comparisons revealed no substantial differences between LHX (treatment) and non-LHX (control) seals in three measures of diving performance or a component of the foraging activity budget. If confirmed by statistical analyses, these results suggest that LHX tags can continue to be safely deployed to collect valuable demographic data on this at-risk population.

Estimated Abundance and Distribution of Eastern Bering Sea Belugas from Aerial Surveys in 2017

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The eastern Bering Sea (EBS) beluga (*Delphinapterus leucas*) stock is found in the vicinity of Norton Sound and the Yukon River Delta, Alaska, during the ice-free period from spring breakup to autumn freeze up. During June and July, belugas aggregate near the Yukon River Delta, where they feed on seasonally abundant salmon (*Oncorhynchus* spp.). EBS belugas are an important nutritional and cultural resource to Alaska Natives, and are harvested by more than 20 communities in Norton Sound and the Yukon. Like all beluga stocks in Alaska except Cook Inlet, EBS belugas are co-managed by the Alaska Beluga Whale Committee (ABWC) and NOAA Fisheries. Estimates of abundance and trends in abundance are critical input to conservation and management decisions for marine mammal stocks. The existing abundance estimate for EBS belugas is based on data collected during aerial surveys in the Norton Sound region in 2000. To collect data for an updated abundance estimate, line-transect aerial surveys for belugas were conducted in Norton Sound and off the Yukon River Delta from June 16 to 29, 2017. During the 14-day survey period, 16 survey flights were conducted on 12 days, covering over 8,500 km on transect. Throughout the study area, 741 beluga groups totaling 1,897 belugas were sighted. Similar to previous surveys, the highest densities overall extended approximately 25 km offshore along the Yukon River Delta to the west of Pastol Bay, broadening to approximately 100 km offshore northward to Unalakleet. The resulting abundance estimate for the EBS beluga stock, based on stratified distance sampling methods without correcting for animals below the water's surface and unable to be detected, was 4,621 belugas (CV = 0.12, 95% CI ranged from 3,635-5,873 belugas). Using the same availability bias correction factor of 2.0 that was used to analyze the data from the 2000 survey, the corrected abundance estimate for 2017 is 9,242 belugas. This 2017 stratified abundance estimate is approximately 30% larger, and the associated CV is 30% smaller, than the analogous estimate from 2000. This research was conducted under

collaboration between NOAA Fisheries' Alaska Fisheries Science Center, the ABWC, and the North Slope Borough.

Geographic Segregation Among Resident and Transient Killer Whales in the Western North Pacific

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The killer whale (*Orcinus orca*) has a world-wide distribution, but specific forms or ecotypes occur in particular regions. In the eastern North Pacific, three distinct reproductively isolated ecotypes have been described: fish-eating “residents”, mammal-eating “transients” (also called “Bigg’s killer whales”) and offshore killer whales that likely specialize on hunting sharks. Offshore killer whales typically occur far from the shore, while residents and transients share overlapping habitat in the coastal waters. In the western North Pacific, fish-eating and mammal-eating ecotypes have been described, resembling and related to the eastern North Pacific residents and transients, respectively. Here we report the differences in geographical distribution of fish-eating and mammal-eating killer whales revealed through surveys and opportunistic observations in different areas of the western North Pacific from the Okhotsk Sea to Chukotka in 2000-2017. Fish-eating killer whales prevailed in areas where relatively deep waters occurred close to shore: eastern Kamchatka and the Kuril and Commander islands. By contrast, in the areas with extensive coastal shallows (coastal northern and western Okhotsk Sea, western Kamchatka, eastern Chukotka) only mammal-eating killer whales were observed. In Anadyr Gulf both ecotypes were registered, but encounters with mammal-eating killer whales were more common. Large-scale differences in ecotype distribution have not been described previously for the well-studied killer whale populations in the eastern North Pacific. There is some local habitat segregation: transient killer whales use small shallow bays more often than residents, but no major region of the eastern North Pacific has been reported to be exclusively visited by the whales of only one ecotype. We suggest several hypotheses to explain these differences, including ice distribution and cultural traditions among the local killer whale pods.

Humpback Whale Entanglements and Interactions with Bering Sea and Aleutian Islands Fisheries

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During the fall of 2015, Unalaska's saw the first of four entangled North Pacific humpback whales (*Megaptera novaeangliae*) in a 2-year period in Unalaska Bay. As it turns out, humpback whales are the most commonly entangled whale species on the West Coast with the number of documented entanglements increasing. According to the International Whaling Commission (IWC), the number of whale entanglements is growing worldwide. While it is hard to assess the full extent of this issue, a recent IWC report estimated that 308,000 whales and dolphins die annually due to entanglement in fishing gear. Humpback whales were once plentiful worldwide before commercial whaling at the start of the 20th century depleted the global population. Humpback whales, with a population of 6-8,000 in the North Pacific, are common in the Bering Sea and Aleutian Islands where they migrate from temperate low-latitude breeding grounds to high-latitude feeding grounds each summer to feed on reliable and abundant food sources. Unalaska has seen an increase in whale activity in recent years, with high numbers of whales remaining in Unalaska Bay throughout the summer. With the observed increase in whales in the area, there has also been increase in documented entanglements in fishing gear. Responding to entanglements in this remote area is difficult, as was evident during the 2015 response when responders were unable to effectively free a humpback whale entangled in commercial pot-fishing gear leading to subsequent mortality of the whale. With increases in local fishing activity and a growing humpback population, fishery interactions could increase, a problem that we will soon need to seek solutions.

A Plan for All Seasons: Year-round Cetacean Surveys in the North Pacific by the USSR

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Pelagic whaling in the mid-20th century represents a source of extensive information on the distribution and density of many large whale species around the North Pacific. However, one of the major limitations of this large dataset is that all data were collected during the whaling season (May-October), with little information available from other times of year. Nonetheless, the 1950s and 1960s were a period of intensive scientific exploration of different areas of the North Pacific by the USSR, in the fields of oceanography, ichthyology, and marine mammals; the intention was to survey a wide geographic range across different seasons. Marine mammal surveys covered mid-latitudes of both western and eastern pelagic areas, as well as the Bering Sea and some tropical waters. While these surveys were not systematic, they provide information on the occurrence of cetaceans over many areas and all months, including late fall and winter. Given the extremely limited nature of information on whales in offshore waters outside the summer, the Soviet surveys represent a unique dataset for understanding cetacean distribution year-round. In this North Pacific Research Board project, data from unpublished reports from Soviet whaling and scientific expeditions are being recovered, translated, and entered into a standardized database that will be made freely available to researchers. Examples of available data relating to marine mammals and concurrent environmental sampling are provided.

Tracking Reproductive Histories in Steller Sea Lion and Northern Fur Seal Whiskers

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Several populations of North Pacific pinnipeds are currently listed as depleted, endangered, or with unknown status, highlighting the need for new methods to assess the reproductive rates of these populations. Keratinized tissues including whiskers have proven ideal for acquiring a record of physiological parameters, such as dietary stable isotope signatures. Unlike tissues currently used to determine reproductive status (e.g., serum, feces), whiskers do not require special storage or handling. More importantly, current sampling methods provide a snapshot of reproductive status whereas whiskers allow for repeated sampling of hormone concentrations longitudinally over multiple years for otariids. Whiskers were obtained from Steller sea lions (*Eumetopias jubatus*, SSLs) and northern fur seals (*Callorhinus ursinus*, NFSs) from three sources: animals live-captured and released during field research, bio-sampled carcasses, and animals housed in aquaria. Whiskers were serially sectioned with a hand chisel, pulverized, and steroid hormones extracted with methanol at room temperature and slow rotation for 24 hours. Standard methods including recovery of added mass, parallelism, and dilution linearity were used to validate progesterone and 17 β -estradiol enzyme immunoassay kits (Arbor Assay). Progesterone and 17 β -estradiol were detectable in serial sections of SSL and NFS whiskers and multiple hormones could be measured from the same methanol extract. Progesterone detection required less whisker tissue compared to 17 β -estradiol. Therefore, whiskers were sectioned and hormones extracted based on the mass requirement for progesterone and the methanol extract from multiple sections were combined to measure 17 β -estradiol. Whiskers collected from females

with known reproductive histories were used to compare hormone concentrations during reproductive events including full-term pregnancy and estrous without pregnancy. Whiskers showed cyclical patterns in progesterone concentrations (SSL: 3.3-136.9 pg/mg whisker; NFS: 48.6-1193 pg/mg whisker) along the length of the whisker which appears to signify previous pregnancies or luteal phases. However, estradiol concentrations (SSL: 0.25-0.77 pg/mg whisker; NFS: 7.5- 47.1 pg/mg whisker) did not show the expected patterns and may not be as informative as progesterone. These results indicate otariid whiskers retain reproductive hormones throughout the length of the whisker providing insights into multi-year reproductive histories of SSLs and NFSs.

Pregnant or Pretending? Comparing Known Reproductive States of Walruses with Endocrine Profiles

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Presenter: Jenell Larsen

The reproductive cycle of female Pacific walrus (*Odobenus rosmarus divergens*) is characterized by breeding in winter, an embryonic diapause from conception until summer and parturition the following spring. Like other pinnipeds, female walruses likely undergo a postpartum estrus, but the function for this is unknown as males are thought to be infertile outside of the breeding window. Reproductive parameters, such as behaviors indicative of estrus and endocrine profiles, are difficult to obtain for this species due to logistical difficulties of sampling. The goal of this study was to determine progesterone concentrations in ovarian tissues, including corpora lutea (CL), of females in differing reproductive states, to further understand the reproductive cycle of this species. Ovarian tissues and reproductive statuses of females were provided by Alaska Native hunters from animals harvested in May of 2011, 2015 and 2016. Progesterone was measured using enzyme immunoassays and profiles were compared with known reproductive states. CL of postpartum females (n = 11) had the lowest progesterone concentrations (77.31 +/- 58.21 ng/g) whereas CL from unbred females (not pregnant or postpartum) (n = 3) had the highest progesterone concentrations (2170.01 +/- 246.29 ng/g). One CL was present from a female known to be near full-term pregnancy (62.92 ng/g), as well as one CL from a female known to be in embryonic diapause (108.48 ng/g). To our knowledge, this is the first time that progesterone has been assessed in ovarian tissues for this species. Further steps include measurement of total estrogens in the ovarian tissue as an indicator of ongoing estrus.

Habitat Use of Harbor Seals in the Aleutian Islands

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Harbor seals (*Phoca vitulina*) are found throughout much of Alaska's coastal marine habitat and have long been a significant subsistence and cultural resource for Alaska Native communities. The Aleutian Islands stock declined by about 67% in the 1980s and 1990s. The strongest declines—up to 86%—occurred in the western region with progressively lower declines toward the east. The current abundance is estimated at 6,431 seals. To investigate potential foraging-related causes for the decline and failure to recover, we deployed satellite-telemetry tags on 75 harbor seals at 11 sites throughout the Aleutian Islands in 2014-2016. Of these, 42 were female and 33 were male with a total of 36 adults. The tags provided locations as well as dive and haul-out behavior. Results from the study indicate spatial use of harbor seals in the Aleutians is mostly nearshore with the vast majority of time spent within the Aleutian shelf and upper continental slope. Dive behavior was fairly consistent with median dive depths around 50 m (most less than 100 m with a few dives greater than 350 m). Median dive durations were around 4 minutes with most less than 10 minutes. Harbor seals declined in a similar geographic pattern to sea otters, northern fur seals, and Steller sea lions in this region. A recent study of Steller sea lion telemetry data in the Aleutians relied on a novel analytical approach (continuous-time Markov chain) for predicting utilization distributions from movement and habitat covariates (bathymetry, distance from haul-out site, distance to shelf). Here, we apply the same method to the harbor seal telemetry and compare overlap in spatial use between these upper trophic level predators. Such a multi-species approach provides greater insight into the ecosystem of the Aleutian shelf environment.

Foraging Trip Duration: An Index of Prey Availability and Reproductive Success in a Depleted Marine Mammal - Northern Fur Seals (*Callorhinus ursinus*)

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Lactating northern fur seal (*Callorhinus ursinus*-NFS) females make repeated trips from Pribilof Island colonies to predictable regions of the eastern Bering Sea to forage in support of milk production. Because volume and timing of milk delivery influences pup growth and survival, we postulate that the duration of maternal foraging trips (MFTD) may influence NFS demographic parameters. We aimed to examine metrics of prey availability and reproductive success in the context of individual breeding colonies and foraging domains. In doing so, we hope to establish the integrity of MFTD as a monitoring/management index for NFS population stability. Specifically, we postulate that (1) MFTD varies by rookery within and among seasons, and (2) that MFTD is spatially and temporally correlated with mean pup mass at the rookery level. To address these hypotheses, we measured pup mass at 3 rookeries and MFTD of 142 females at 6 rookeries between July and December 2016 using VHF flipper tags. Proximal rookeries shared statistically similar trip durations (North and East, 7.1 and 6.6 days; South and Zapadni 5.9 and 5.4 days). However, the pairs of rookeries (North/East vs. South/Zapadni), exhibited statistically distinct MFTDs from each other ($p < 0.0005$) suggesting foraging domains and prey availability differ for colonies on the northern and southern sides of St. George Island. A pilot study conducted at Polovina Cliffs (PC) demonstrated both inter- and intraannual variation in MFTD; increase from ~4.5 days to ~7 days in 2015 but from ~4.5 days to ~8 days in 2016 between 7/6 and 12/5. Average pup mass at PC and South (10.0, 11.2kg) were lower than those at Zapadni (11.7 kg) (se 0.1, 0.1, 0.1). General trends of lower average pup mass and longer average MFTDs at PC during the unusually warm 2016 season suggests MFTD may be a good index of local prey availability and NFS reproductive success.

The National Institute of Standards and Technology Marine Environmental Specimen Bank's Projects in Alaska

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The National Institute of Standards and Technology (NIST) began banking specimens for contaminant monitoring in 1979. Based on these initial projects, NIST protocols for collection, processing, and banking were primarily developed for environmental contaminant analysis. In 1989, the National Marine Fisheries Service, Office of Protected Resources (NMFS/OPR), in collaboration with NIST began the National Marine Mammal Tissue Bank (NMMTB) for long-term cryogenic archival of marine mammal tissues. The NMMTB is part of NMFS's Marine Mammal Health and Stranding Response Program and is maintained by NIST as part of its Marine Environmental Specimen Bank's (Marine ESB) projects. Marine mammal specimens from Alaska are provided to the NMMTB through the Alaska Marine Mammal Tissue Archival Project (AMMTAP), which was established in 1987. In 2010, NIST consolidated all banking operations to the Marine ESB located at the Hollings Marine Laboratory in Charleston, SC. In addition to marine mammal tissues, NIST has collaborated with the U.S. Geological Survey Biological Resources Division (USGS-BRD), U.S. Fish and Wildlife Service (USFWS), and the Bureau of Indian Affairs (BIA), to collect and bank seabird tissues for the Seabird Tissue Archival and Monitoring Project (STAMP) since 1999. STAMP was designed and implemented to serve as a systematic, long-term program to identify and track anthropogenic contaminants in Alaskan seabirds over multiple decades. Protocols for collecting and banking marine samples were designed to: (1) provide sufficient material for multiple analyses, (2) minimize the possibility of sample change and/or loss during storage, (3) ensure sample integrity by minimizing potential contamination during collecting and processing, (4)

protect long-term sample stability by using cryogenic techniques, and (5) keep and maintain records of sample histories. Through their respective tissue access policies, samples from NIST's Alaska banking projects are available to request for analysis. NIST is working with collaborating partners, and potential new partners, to expand the scope of the specimen bank and develop it as a resource for animal health research. This expansion will emphasize the banking of specimens for wildlife disease studies, exposure to biotoxins, and development of health biomarkers.

The Efficacy of Fecal Hormones to Detect Nutritional Changes in Northern Fur Seals

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Changes in prey resources have been identified as a potential contributing factor to the continued decline in northern fur seals on the Pribilof Islands. Episodes of inadequate food intake – due to either changes in the type or level of prey consumed - can lead to specific physiological changes, including increases in stress hormones and decreases in metabolic hormones circulating in the blood. In theory, blood hormone levels should be reflected by the concentration of these same hormones in an individual's feces, which can be collected from animals in the wild with minimal disturbance. However, while diet can affect hormone levels from the direct physiological effects of changes in nutritional status, it can also theoretically alter apparent fecal hormone levels due to varying digestibility of different prey items. This project tested the effectiveness of using combinations of hormones recovered from feces to identify nutritional status within wild populations of northern fur seals and other otariids. We compared fecal and blood hormone levels in northern fur seals maintained on five different diets, as well as a period of induced nutritional stress. We also examined the degree to which changes in hormone levels were associated with other physiological variables (metabolism, mass change), and how these relationships differed with season. Overall, circulating blood hormone levels were strongly related to relevant physiological variables. While fecal hormone levels loosely reflected blood hormone levels, there was a higher level of variability in the former. Part of this variability could be directly attributed to differences in diet digestibility rather than nutritional status per se. The results suggest that fecal hormones can be a useful indicator of physiological status in wild northern fur seals, providing a valuable tool in species conservation research and management, but that care must be taken in interpreting the results.

What's in a Whisker? Comparisons of Pacific Harbor Seal (*Phoca vitulina richardii*) Spatial Habitat Use and Foraging Ecology in Two Regions of the North Pacific

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Between September 2014 and September 2015, we captured 24 adult male Pacific harbor seals (*Phoca vitulina richardii*) at two locations on the Oregon coast, and released them with Wildlife Computers SPOT5[®] satellite tags attached to each animal. We collected one whisker (vibrissa) per animal at the time of tagging for stable isotope analysis. We analyzed $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ ratios in the vibrissae to examine whether diet can be used as a predictive variable of *P. vitulina* spatial foraging behavior, and if this predictive capacity holds true between two habitats in the North Pacific Ocean: the central Oregon Coast and the Aleutian Islands. Simultaneously, vibrissae and satellite-tracking data from Pacific harbor seals in multiple locations in the Aleutian Islands, AK, were collected in 2014-15 by the Alaska Fisheries Science Center's Marine Mammal Laboratory and University of Alaska. As part of a collaborative study, we will prepare and analyze samples from the Aleutian Islands with the same laboratory standards as Oregon samples in a comparison of ecological differences between Pacific harbor seals in these geographically-distinct regions. Oregon vibrissae were processed and analyzed at the University of Fairbanks in collaboration with the Marine Ecotoxicology and Trophic Assessment Laboratory. Tags individually transmitted between 20 and 324 days, with a total time period of 606 days. Hierarchical cluster analysis (Ward's method; R package 'cluster') identified two statistically-distinct groups (long-ranging vs. localized foragers) based on time spent in rivers/bays, latitudinal range, mean distance from shore and home range. For these two groups, mean $\delta^{13}\text{C}$ also differed significantly, suggesting that carbon may be an indicator for spatial habitat use. We will ultimately compare the Oregon data with upcoming Aleutian data to determine if these foraging strategies and correlations are upheld cross-regionally. These methods will be used to examine whether satellite telemetry and isotope values can be combined to create a comparative picture of spatial habitat use and ecological niche of a common generalist marine predator in two distinct ecosystems of the North Pacific.

Steller Sea Lions: Why Did They Decline?

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Presenter: Andrew Trites

A number of theories have been put forward to explain the decline of Steller sea lions in the Aleutian Islands and Gulf of Alaska. They have been difficult to test — and have resulted in a variety of field studies, mathematical models, and experiments with captive animals to gain insight into this perplexing mystery. Combining individual energy requirements with information about the changes that occurred in the Bering Sea food web points to the population decline of Steller sea lions being caused by young animals having difficulty acquiring sufficient energy to meet their daily needs from the high abundance of low-quality prey that became available to them following the 1976-77 regime shift (i.e., pollock, cod, and Atka mackerel). Reduced prey-quality rather than reduced prey-quantity underlies the sea lion decline, as there is no indication of there being a shortage of low-quality prey available to Steller sea lions. Energetic modelling and captive feeding studies indicate that it is difficult for young Steller sea lions to consume sufficient low-energy prey alone to meet their energetic requirements. A lower nutritional plane can stunt growth, cause reproductive failure (i.e., abortions), increase susceptibility to disease, and increase the risk of being removed by predators. Mathematical modeling suggests that killer whales could have been a significant contributing factor in the decline of Steller sea lions, and may now be impeding population recovery. Our findings indicate that energy density of prey can have a greater impact on the population dynamics of marine species than prey biomass, and should be given greater consideration in ecosystem models and ecological studies. Our findings also highlight the importance of combining field studies with captive research and mathematical models to fully understand the ecological changes that are underway in the North Pacific Ocean.

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 source of energy 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 phocid seals, but measures of body condition based on blubber content in Alaska phocids are limited and primarily from harvested rather than 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 2014-2017. Using linear regression, we modeled body condition (mass/standard length) and morphometric measurements as a function of blubber depth. Across species, body condition was well explained by sex, age class, and blubber depth ($F_{8,147} = 158.6, p < .001$; adjusted $R^2 = 0.89$), and the best blubber depth predictor for body condition was at the right lateral hip. Body condition was generally highest for adult males and lowest for pups. Axillary girth (cm) was also well explained by sex, age class, and blubber depth ($F_{5,150} = 254.2, p < .001$; adjusted $R^2 = 0.89$). Blubber depth at the dorsal axillary was the best predictor for axillary girth, with adult males and female pups exhibiting the largest and smallest girths, respectively. We found similar results for hip girth ($F_{7,148} = 119.1, p < .001$; adjusted $R^2 = 0.84$), with blubber depth at the right lateral hip as the best predictor, but spotted seals had significantly larger hip girths than ribbon or harbor seals. As expected, we found blubber depth was positively related to both body condition and morphometric measurements. These analyses demonstrate that blubber depth can be a useful predictor of body condition and girth among species, age classes, and sexes for ribbon, spotted, and harbor seals. Blubber depth can therefore be used to provide an indication of condition, which will be valuable in assessing potential effects of changing environmental conditions for these species.

Connecting Individual Pre-Breeding Behavior and Physiology to Egg Laying Failure in the Red-Legged Kittiwake

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Long-lived migratory seabirds are expected to skip reproduction when environmental conditions are sub-optimal, yet proximate mechanisms underlying an individual's reproductive decisions are not well known. To address this, we studied mechanistic links between individual condition and behavior and egg-laying success in red-legged kittiwakes nesting on St. George Island in the Bering Sea. During three of our study years laying success was uncharacteristically low (37 year mean = $70 \pm 21\%$, 2015 = 48%, 2016 = 42%, 2017 = 8%), resulting in the majority of birds skipping reproduction. To examine carry-over effects of nutritional stress incurred by birds at the end of the winter migration, we measured concentrations of the hormone corticosterone deposited in feathers grown during the pre-nuptial molt. We quantified colony attendance and conversely foraging trip durations through data derived from leg attached loggers with wet-dry-light sensors ($n = 74$). For kittiwakes, colony attendance is required for nest defense and pair bonding, while foraging is necessary to maintain/improve condition. To assess effects of immediate nutritional limitations, we characterized feeding areas and foraging patterns of pre-laying birds using GPS loggers ($n = 33$), and measured their body condition and concentrations of corticosterone in blood plasma. We then use a logistic modelling framework to identify if any of these components predicts egg laying. Our multi-dimensional approach will serve to identify potential drivers of reproductive initiation in an endemic specialist seabird that has experienced population declines in the recent past.

Status of Aleutian and Arctic Terns Breeding in the Kodiak Archipelago, 2016-2017

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Aleutian terns (*Onychoprion aleutica*) are colonial nesting seabirds that breed in coastal Alaska and the Russian far east, often in association with Arctic terns (*Sterna paradisaea*). Both species forage in near-shore marine waters, although Aleutian terns may also forage over a substantial portion of the continental shelf. Recent trend analysis of numbers of Aleutian terns at colonies in Alaska indicates that this poorly known seabird has declined by almost 93% over the past three decades. The much more abundant and widely distributed Arctic tern also appears to have declined by more than 90% regionally in coastal locations in the Gulf of Alaska (GOA). There is, however, a high degree of uncertainty in breeding population status of both species in Alaska due to their scattered and remote nesting locations, and variable site fidelity and colony attendance patterns. Tern colonies in the Kodiak Archipelago have been the focus of monitoring and research periodically since the 1970s, providing valuable information on the status and ecology of both species in the GOA. Seabird colony records from the 1970s-2017 identify 53 sights with a history of tern activity in the Archipelago; Aleutian and Arctic terns nested together at 24 of the 53 known sites, and the remaining 29 locations were single species Arctic tern colonies. During the 2016-2017 breeding seasons we surveyed for terns at 41 of the 53 colony sights and searched for new colonies. Arctic terns were active at 28 colonies, and Aleutian terns were observed at 11 colonies. We confirmed nesting at seven Aleutian tern colonies, and colonies varied in the maximum number of individuals from 2 to 212. We confirmed nesting at 18 Arctic tern colonies, and colonies varied in the maximum number of individuals from 5 to 120. Due to high depredation rates, variable nest initiation dates and re-nesting propensity, and frequent colony abandonment it was challenging to confirm nesting or determine nest success despite multiple visits to most colonies each season. Tern monitoring efforts on Kodiak highlight the difficulty that intra-annual variability in colony occupancy and size has on determining population size.

Alaska Breeding Colonies of Northern Fulmars Exhibit Extensive Gene Flow and Limited Population Structure

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With a North Pacific population in Alaska estimated at 1.4 million birds, the northern fulmar (*Fulmarus glacialis rodgersii*) is frequently encountered by U.S. North Pacific groundfish fisheries, resulting in thousands of birds taken annually as bycatch. Most fulmars breed at one of four major colonies on islands in the Bering Sea and Gulf of Alaska/Aleutian Islands. Behavioral and physical characteristics suggest potential differentiation among colonies, yet genetic population structure in Pacific fulmars has not been previously examined. Our project is evaluating whether Pacific fulmars exhibit genetic population structure using samples collected at breeding colonies (n = 636), with the aim of understanding relative impacts of bycatch on individual colonies. We used reduced-representation genome sequencing to sequence DNA from 96 birds, 24 from each of the four major colonies. After filtering data for quality, minimum read depth, and presence of sequence for at least 80% of samples, we performed preliminary analyses using 105,000 single nucleotide polymorphisms (SNPs). These data indicate the presence of weak population structure among colonies, with F_{st} values ranging from 0.002 to 0.008. We will use these data to design molecular markers for a smaller number of SNPs with which we will genotype hundreds of colony and bycatch samples. This targeted sequencing of a smaller number of SNPs is a cost-effective method for validating preliminary population structure results and will provide a valuable genetic resource for research and management of northern fulmars.

Non-breeding Marine Bird Response to Forage Fish Schools in Prince William Sound, Alaska

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Pacific herring (*Clupea pallasii*) has been identified as a resource injured by the 1989 *Exxon Valdez* Oil Spill in Prince William Sound (PWS). Concurrent with the decline in Pacific herring abundance, several marine birds wintering in PWS have demonstrated a reduced capacity to recover post-oil spill, a phenomena that may be related to decreased forage fish availability. Despite the dynamic association between marine birds and forage fish, few studies have addressed specific marine bird-herring relationships during winter months and the potential for effects on population recovery. For this study, we conducted marine bird observations concurrent with hydroacoustic herring surveys in juvenile herring nursery bays in PWS. Surveys were performed during early and late winter over five years. Our goals for the analyses were three-fold: 1) characterize abundance and distribution of marine bird predators in relation to prey abundance and distribution and habitat characteristics, 2) identify key habitats and characteristics of marine bird-associated and marine bird-non-associated fish schools, and 3) evaluate key habitats and fish-school characteristics influencing the abundance of marine birds present at fish schools. Preliminary results indicate environmental and temporal factors, as well as fish school characteristics, such as school depth, influence the presence and abundance of piscivorous marine birds near fish schools. Examining the spatial relationship between seabirds and prey during winter could help inform fisheries management and research, in which knowledge of seabird responses to environmental variability could be used to predict changes in forage fish.

Algal Toxin Assessments in Seabird and Forage Fish Tissues During the 2015-2016 Seabird Die-Off

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Harmful algal blooms (HABs) pose a growing threat to marine ecosystems worldwide. The HAB neurotoxins domoic acid (DA) and saxitoxin (STX) have recently been documented in marine mammal species throughout Alaska, indicating that exposure to these toxins occurs across a broad geographic area and spans multiple trophic levels. In 2015 and 2016, an unprecedented mortality event of common murres in Alaska was observed in association with a mass of anomalously warm ocean water (“The Blob”). Previous studies have documented morbidity and mortality in seabirds resulting from exposure to DA and STX, raising concerns about the potential role of algal toxins as a factor in the common murre die-off. We tested for DA and STX in a suite of seabird tissues from beach-cast common murre specimens associated with the 2015-16 winter mortality event as well as from apparently healthy birds and samples of their forage fish prey that were collected during the following summer. DA occurred rarely and only at trace concentrations in both bird and forage fish samples. In contrast, we detected STX across multiple tissue types in both healthy and beach-cast birds as well as in forage fish. No reference values currently exist for seabirds, but concentrations of STX in most individuals were relatively low and we found no evidence that acute exposure to algal toxins was a direct cause of common murre mortalities. Nevertheless, our results demonstrate the widespread occurrence of STX in seabirds and forage fish in Alaska and suggest that HABs should be considered in future assessments of seabird health, especially given the potential for greater occurrence of HABs in the future.

Marine Bird Diversity in Alaska Marine Ecosystems: Spatial Patterns and Temporal Trends

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Presenter: Gary Drew

Little is known about spatial and temporal variability in the diversity of marine bird communities across large marine ecosystems, in part because long-term data at large spatial scales were not available for analysis. The North Pacific Pelagic Seabird Database (NPPSD) is a compilation of at-sea survey data collected in 1973-2012 from across the North Pacific and published for use by the U.S. Geological Survey. We used data from the NPPSD to develop maps identifying spatial gradients and long-term trends in diversity of marine birds. To map diversity we calculated a series of diversity indices for 25 km × 25 km cells in marine areas surrounding Alaska. Although there were differences depending on the diversity index used, there was a general agreement on biodiversity hotspots, for example, the Aleutian Islands. To examine long-term trends in diversity, we used repeated measure data from the NPPSD and tested for differences in biodiversity among four 10-year time periods. Although the sample area has experienced a decrease in marine bird density over the last 40 years, we noted a significant increase in biodiversity. The scale of the data encompassed in the NPPSD was necessary to identify marine bird diversity patterns in the North Pacific and illustrates the value of consolidating these datasets.

A Sea of Murres: a Novel Technique for Tracking Individual Nest sites When Using Time-Lapse Cameras

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Presenter: Sarah Tanedo

Remote camera methods of monitoring wildlife are becoming more prevalent in studies ranging from camera trapping for endangered species to time-lapse photography to track reproductive phenology of colonial species, such as many species of seabirds. With such a wide range of applications and study subjects, techniques to review collected data can be just as diverse. For colonial seabird species, this can be particularly challenging, as breeding colonies can range from cliff sides with relatively easy reference points to flat areas with little way of tracking target individuals. We present here a novel technique for reviewing time-lapse images for a colony of common murres (*Uria aalge*) on Barwell Island, a location that is flat and lacking in reference points to facilitate review. Trail cameras were mounted in areas around the island that captured the largest number of nesting murres and thousands of images were collected from May-August during the breeding season. To track individual murres in a group of up to 300 other breeding birds throughout the breeding season, we used the free software program, ImageJ. Sets of three images twice a day were stitched together in sequences so that images could be reviewed using the ImageJ program. Individual murres were stamped with identification numbers that carried over into the rest of the images in the sequence, facilitating site-based tracking of each individual. We used the technique to observe 60 nest sites per year in a dense colony.

Winter Distribution of Red-Legged Kittiwakes From Buldir Island, Alaska

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Red-legged kittiwake (*Rissa brevirostris*), a Bering Sea endemic that breeds at just a few colonies in Alaska and Russia, may be particularly sensitive to environmental change due to a small population size, limited range, and specialized diet. However, our ability to explain population demography across Alaska remains limited by a lack of understanding of conditions away from the breeding colonies. Data on wintering locations exist from red-legged kittiwake colonies in the Pribilof Islands but are lacking for any other colonies. We used geolocation dataloggers to track winter distributions of red-legged kittiwakes from the breeding colony on Buldir Island, in the western Aleutian Islands. We deployed 10 loggers during the 2016 breeding season and were able to retrieve two the following year. Analysis of light level data from loggers showed both birds had similar patterns of distribution during the 2016-2017 winter. Both birds left the breeding colony in September and traveled southwest to the region around the Kurile Islands by October, made forays into the Sea of Okhotsk in November and December, and spent January and February east of the Kurile Islands. By February, both birds began moving east towards the Aleutian Islands and were back in the area of Buldir Island by April. Conclusions from these preliminary results are limited by our low sample size but we hope to recapture remaining loggers, as well as 12 additional devices deployed during the 2017 breeding season, in 2018.

Aleutian Tern Monitoring in the Kodiak Archipelago

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The Alaska population of Aleutian terns (*Onychoprion aleuticus*) has declined by more than 80% at known colonies over the past three decades, and the reasons for this decline are unknown. During the 2017 breeding season, we monitored Aleutian tern colonies in the Kodiak Archipelago to collect behavioral and ecological data to assist in identifying potential threats and conservation actions. Trail cameras were placed on the nests of Aleutian terns and neighboring nesting seabird species to determine nest survival rates, causes of nest failure, and information on prey types being provided to chicks. A total of 19 cameras were set, including cameras at 15 active Aleutian tern nests, one abandoned Aleutian tern nest, two Arctic tern (*Sterna paradisaea*) nests, and one mew gull (*Larus canus*) nest. Two camera nests out of 18 survived to hatching, though we were unable to determine the fate of the chicks. Three nests were abandoned after camera placement and one camera failed within minutes of being set. The remaining 12 nests failed due to various predators including domestic sheep (*Ovis aries*), mew gulls, egg harvesting by local people, northwestern crows (*Corvus caurinus*), black-billed magpies (*Pica hudsonia*), and red foxes (*Vulpes vulpes*). The cameras also captured images of 132 chick provisioning events at one Aleutian tern nest with Pacific sand lance (*Ammodytes personatus*), greenling (*Hexagrammos* spp.), and other fish species present in the diet. In addition to monitoring nest status, we collected nest-site specific and surrounding habitat data at every camera nest and used MANOVA to compare the vegetation characteristics of Aleutian tern, Arctic tern and mew gull nests to the surrounding available habitat. We found significant differences between species nesting microhabitat for various measures of vegetation height, distance between nests and the nearest vegetation, and the composition and extent of ground cover. Our data suggests that high predation rates may be an important influence on Aleutian tern productivity, however we do not know what effects prey availability, nesting habitat suitability, and interactions with associated nesting species may also be having on Aleutian tern populations in the Kodiak Archipelago.

Algae on Acid: High-Latitude Corallines and Low pH Water

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Coralline algae (CA) occupy an important ecological role in Alaska's nearshore marine habitats, providing chemical settlement cues for invertebrate larvae and complex calcified habitat for juvenile and adult organisms. As calcium-carbonate containing plants, CA are considered highly vulnerable to dissolution under anticipated increases in carbon dioxide concentrations in the North Pacific. This is in contrast to fleshy macroalgae, which are projected to experience enhanced photosynthetic and growth rates from elevated CO² concentrations. Fleshy macroalgae grow in close association with CA, often as epiphytes, raising the question of whether non-calcified algae could mitigate deleterious impacts of ocean acidification on CA by altering the carbonate chemistry microclimate between the two algal types. To explore the impact of future ocean acidification on CA in Alaska waters we conducted a 4-week experiment in August – Sept. 2017 in Sitka, AK. An indoor mesocosm with flow-through seawater from Sitka Sound was manipulated with CO² gas and artificial lighting to simulate three pH levels (current summer, current winter, future winter) under two seasonal light regimes (summer vs. winter). Within each pH level and light regime, individual pieces of a crustose coralline algae (sp. undetermined) and an articulated coralline algae (*Calliarthron* sp.) were either set alone or paired in close contact with the fleshy red alga *Cryptopleura ruprechtiana* for the duration of the experiment. Treatment effects were explored using a fluorescent stain to quantify CA growth, buoyant weight to define loss or gain of calcified mass, and photosynthesis-irradiance curves and total alkalinity incubations to investigate physiological impacts to the algal replicates. Here, we present results from this pilot experiment and discuss the implications for future research efforts exploring the impacts of ocean acidification and macroalgal species interactions on high-latitude calcifying algae.

Subsistence, Biodiversity and Change Along Southeast Alaska's Rocky Coast

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Southeast Alaska is an archipelago characterized by an abundant and diverse marine ecosystem that provides cultural and economic sustenance to many Alaskan communities deeply connected to the ocean. Impacts to the biodiversity and thus the resilience of this coastal system directly affect the human population that lives in geographically isolated locations throughout the island chain. It was therefore of notable concern when sea star wasting disease arrived in Sitka Sound, on the productive gulf coast of Southeast Alaska, in summer 2014. The cascading effect of this disease on predatory sea star populations and their associated marine communities has been well documented in other affected regions, and local divers soon recognized similar impacts within the subtidal systems of Sitka Sound. Considered within the context of extensive subsistence harvest of nearshore resources in Sitka, including pinto abalone and herring roe-on-kelp, the potential impacts of a major disease event such as sea star wasting in Sitka could very well extend to human activity. To explore the broader impacts of this type of disturbance in our local waters, quantitative assessments of conspicuous members of the nearshore community were combined with qualitative interviews of historical resource users to identify biodiversity risk and resilience in coastal Southeast Alaska. Community surveys along pre-existing permanent subtidal transects were conducted to document sea star die-off and recovery, as well as explore seasonal and depth-related patterns in population structure and density of select grazers and macroalgae. Informal semi-structured interviews with local experts were used to document traditional and local ecological knowledge about historic changes in the nearshore systems and highlight important areas of productivity and subsistence harvest. Many of these local experts are aged and the time allowing an opportunity to benefit from this knowledge is limited. Our intent is that the diverse data resulting from this project will provide essential supporting information that can be used to anticipate and account for the broader impacts of future disturbance events in this ecosystem.

A Flow Cytometry Based Assay for Measuring the Growth Rate of Walleye Pollock (*Gadus chalcogrammus*) Larvae

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Presenter: Steven Porter

The larval stage of marine fish is a time of high mortality, and small changes in growth or mortality rates during early life may affect year-class strength. Growth rate plays an important role in determining the survival of marine fish larvae, so accurately measuring their growth is crucial. Results of a method for measuring the growth rate of walleye pollock (*Gadus chalcogrammus*) larvae using cell-cycle analysis of muscle tissue measured with flow cytometry are presented here. A generalized additive model to predict growth rate (growth in length, mm/d) during the period of time from first feeding to when a larva was sampled was formulated using larvae reared in the laboratory at 1.6°, 3°, 6°, and 8° C ($r^2 = 0.79$). Covariates were temperature, larval length (standard length, SL), fraction of cells in the S phase of the cell cycle, fraction of cells in the G2 and mitosis phases, and the ratio of the number of S phase nuclei to the number G1 phase nuclei with high nuclear RNA content. Model accuracy was tested using an independent set of larvae from all rearing temperatures. Predicted growth rates correlated well with laboratory growth rates (calculated from known age and SL; $r = 0.83$). Mean predicted growth rate for larvae reared at 6° and 8° C ($0.13 \text{ mm/d} \pm 0.03$) was significantly less than corresponding otolith derived growth rate (calculated from the number of increments from the day of first feeding to the otolith edge and SL; $0.18 \text{ mm/d} \pm 0.03$), and predicted rates were highly correlated with the distance from the first feeding increment on the otolith to the otolith edge (a relative measure of somatic growth; $r = 0.92$) indicating that the model tracked growth well. Predicted growth rates of larvae collected from the Gulf of Alaska in 2013 were also highly correlated with the distance from the first feeding increment to the otolith edge ($r = 0.98$). Additionally, mean predicted growth rate ($0.21 \text{ mm/d} \pm 0.11$) was within the range of published growth rates for Walleye Pollock larvae in the Gulf of Alaska (0.14 to 0.24 mm/d).

Species of *Hedophyllum* in the Aleutian Islands, Alaska

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Presenter: Sandra Lindstrom

A previously unknown species of the kelp genus *Saccharina* was recently recognized to occur in the Queen Charlotte Islands (Haida Gwaii), British Columbia, Canada. *Saccharina druehlii* is morphologically indistinguishable from *Saccharina sessilis* (formerly *Hedophyllum sessile*) although it is said to be more consistently bullate than *S. sessilis* (possibly due to occurrence at more protected sites). This discovery prompted us to examine specimens resembling *S. sessilis* from the Aleutian Islands. Sequences of the mitochondrial CO1 gene and the nuclear ribosomal ITS region indicated that none of our Aleutian specimens belonged in *Saccharina sessilis* sensu stricto. Specimens collected from Akutan Harbor in the eastern Aleutian Islands and Little Tanaga Island in the central Aleutians were genetically identical to *S. druehlii* from Haida Gwaii for the CO1 gene whereas those from Hawadax Island (formerly Rat Island) in the western Aleutians differed by 0.2%. Young specimens from Attu Island, the westernmost Aleutian Island, resembled *S. druehlii* and *S. sessilis*, but as they matured, the base of the blade became stipe-like and canaliculate, and the blade split down the middle and also became twisted, resulting in a very distinctive morphology. The distinctiveness of this morphology was supported by molecular data. We resurrect *Hedophyllum subsessile* (Areschoug) Setchell (type locality: Bering Island, Commander Islands, Russia) and create a new combination for it in *Saccharina*, the genus to which it clearly belongs.

Investigating Ageing Techniques for the Giant Pacific Octopus in the Gulf of Alaska

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Much of the life history of octopuses is still unknown. This is especially true of octopuses in Alaska waters. One area where information is lacking is age data. Octopuses lack most hard structures like bones or teeth that are appropriate for direct aging. Without the ability to accurately estimate age it is impossible to gather information needed for management like recruitment and mortality. New techniques have recently been developed, and validated, for aging octopus directly. However, these techniques are still early in development and species-specific validation is required. One species that these new techniques need to be validated on is the giant Pacific octopus *Enteroctopus dofleini*. In Alaska, *E. dofleini* is the major contributor to octopus bycatch in many fisheries, but primarily in the cod pot fishery. *E. dofleini* age is currently estimated using growth models based on results from tagging and aquarium studies. While the results of these studies largely concur with each other *E. dofleini* still have highly variable growth between individuals, dependent on individual genetics, water temperature, food availability and food quality. This variability in conjunction with a semelparous life history and spawning across multiple seasons makes fitting *E. dofleini* into age cohorts based on size difficult. The lack of information on *E. dofleini* forces fisheries managers in the Northeast Pacific to manage them as an extremely data poor species. This study will validate three new octopus aging techniques for *E. dofleini*. These techniques work by looking at the buildup of non-metabolic tissues through the life of individual *E. dofleini*. The techniques I will look at include Stylet (vestigial shell) increment analysis, beak increment analysis and lipofuscin (florescent biomolecule) concentration.

Defining Population Genetic Management Units of Kelps in Alaska

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Alaska has a diverse flora of seaweeds along its coast that can potentially support a substantial seaweed farming industry. Worldwide, seaweeds represent a more than \$10 billion dollar industry that is expected to double by 2024. Kelps (brown seaweeds: Phaeophyta), in particular, are used in numerous products, ranging from food (including the foam on beer) to the paper, textiles, and biofuels, and have been used in wastewater management and efforts to mitigate the effects of climate change on marine ecosystems. The Alaska Mariculture Initiative has stimulated numerous pilot projects to test the feasibility of farming seaweeds. Permitting of these farming activities by the State of Alaska is designed to prevent the loss of genetic diversity and to avoid introductions of maladaptive genes into wild populations. The goal of this project is to describe the genetic population structure of two species of interest to the seaweed industry: sugar kelp (*Saccharina latissima*) and the winged kelp (*Alaria marginata*), which inhabit lower intertidal and subtidal zones of rocky and gravel shores. We are using nuclear and organellar DNA markers to define the genetic population structures of these kelps along Alaska's shoreline. The results will help to develop permitting practices that will lead to maintenance of wild populations while allowing for development of Alaska's seaweed resources.

Microbial Community Structure in Prince William Sound

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Prince William Sound is a deep estuarine bay that encompasses a productive ecosystem with important gradients between marine and terrestrial environments, ranging from freshwater input via glaciers to deep subsurface water from the Gulf of Alaska. Each of these aquatic habitats hosts a distinct microbial community that influences primary productivity and organic matter transformations. During the September 2016 Seward Line cruise, we conducted the first molecular genetic survey of the bacteria, archaea, and microbial eukaryotes in Prince William Sound using 16S and 18S ribosomal RNA metabarcoding. The fall phytoplankton community was dominated by *Synechococcus* in the smaller size class and diatoms (*Corethron* and *Thalassiosira*) and dinoflagellates (*Gonyaulax*) in the larger. A hierarchical clustering analysis of combined patterns of OTU abundance from both the 16S rRNA and 18S rRNA amplicon sequencing datasets showed strong community stratification by depth. Three primary clusters of samples were delineated: surface, deep, and pycnocline (mixed layer). Three pairs of primary OTU clusters were delineated, reflecting a combination of depth of sampling, relative abundance, and level of endemicity, with an additional cluster composed mainly of rare metazoans. Three clusters were found predominantly in deep waters and three in surface waters. Two clusters contained abundant OTUs that were almost exclusively found in either deep or surface waters, respectively. Two clusters contained abundant OTUs that were widespread in the water column, with maximal relative abundances in deep/pycnocline and surface waters, respectively. Two clusters were found at low relative abundances throughout the water column, with maximal relative abundances in deep and surface waters, respectively. One cluster, composed primarily of metazoan sequences, was found throughout the water column at low abundances.

Freezing in a Warming Climate?

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Presenter: Katrin Iken

The Gulf of Alaska (GOA) has experienced anomalously warm water conditions for several years, spurring concerns about consequences in marine environments such as rocky intertidal communities. Here, we provide evidence that suggests that although coastal climate warming is occurring, freezing weather events can still be a prominent driver in structuring high latitude rocky intertidal communities. Low spring tide events that coincided with freezing air temperatures in winter 2016/17 caused massive mortality that changed the structure of the rocky intertidal community across multiple locations in Kachemak Bay, Alaska. Specifically, lower than normal abundance of fleshy macroalgae and higher than normal cover of barnacles and open rock were observed in spring 2017. This suggests that local factors can override these long-term trends and can have equally drastic, or even more dramatic, effects on the organisms and community structure as the much-observed and reported warming trends. Specifically, freezing events can add a unique weather stress contributing to the community mosaics in a generally warming climate. Continued long-term monitoring such as through the Gulf Watch Alaska program is necessary to track changes in ecological communities alongside changes and events in key environmental variables, measured at scales relevant to organisms. This is essential to recognize important signature events such as extreme freezes that could leave their marks on assemblages for decades.

Trends in Intertidal Sea Star Abundance and Diversity Across the Gulf of Alaska: Effects of Sea Star Wasting

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Sea stars are ecologically important in intertidal systems. They can be predators, grazers and/or scavengers and thus play a key role in trophic cascades. In 2014, sea star wasting expanded north from California and reached the Gulf of Alaska, where numerous sea stars were found exhibiting symptoms of this disease in Kachemak Bay and Prince William Sound. Gulf Watch Alaska, in collaboration with similar long-term monitoring programs, have been surveying sea stars for approximately ten years in Kachemak Bay, Katmai National Park and Preserve, Kenai Fjords National Park, and Prince William Sound. These four regions comprise an area that spans a large portion of the northern Gulf of Alaska (approx. 500 km). Sea star data from these regions were examined to determine spatial and temporal trends in sea star abundance and diversity and to determine if effects of sea star wasting could be detected. Our analyses demonstrated high spatial and temporal variability in sea star densities in all surveyed regions. In addition to high temporal variability in abundance, the diversity and dominance of individual species varied greatly among regions. A dramatic decline in sea star numbers, most likely attributable to sea star wasting, has been seen across all regions in recent years. Gulf Watch Alaska will continue monitoring these important species in the future. Continued monitoring will also provide insights into the impacts that sea star wasting is having on intertidal communities over time.

Regional and Local Drivers Combine to Structure Mussel Growth and Mortality

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Mussels (*Mytilus trossulus*) are an important link between primary production and upper trophic level predators in nearshore marine ecosystems. As climate changes manifest, nearshore systems in the Gulf of Alaska may be undergoing increased variability in water and weather conditions, along with long-term warming. Identifying drivers of mussel dynamics is important for forecasting changes in these prey resources associated with changing climate. Here, we utilize 6 years of mussel survey data from the Kachemak Bay region of the northern Gulf of Alaska to infer growth and mortality across six sites with different physical and community-biological characteristics. We implement a novel combination of demographic and finite mixture modeling in a Bayesian framework to translate length frequency data into estimates of growth and an index of annual mortality. Results indicate consistent site-specific differences in mussel growth and mortality across the study region, suggesting different drivers combine to structure mussel populations. Recruitment across sites varied systematically, however, all sites appear to have high frequencies of annual settlement. Post-settlement, different forces appear to influence mussel dynamics whereby some sites have higher initial growth coupled with high mortality consistent with physical stress, whereas other sites appear to support strong growth and low mortality but may be space limited. Methods herein provide a tool to link physical and biological site characteristics to fundamental demographic processes in mussel populations utilizing length-frequency data.

Distribution and Bloom Conditions of the Toxic Alga *Alexandrium catanella* in Kachemak Bay and Lower Cook Inlet, Alaska

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Due to the remote locations and reliance of many rural populations on shellfish resources harmful algal blooms can present a significant risk to Alaska residents. Despite the long history of paralytic shellfish poisoning events in Alaska, little is known about *Alexandrium* distribution and abundance or factors that control *Alexandrium* bloom development. As part of the Gulf Watch Alaska monitoring program, we have been sampling phytoplankton in Kachemak Bay and lower Cook Inlet, Alaska, to determine how the distribution and abundance of *A. catanella*, the dominant *Alexandrium* species, was influenced by prevailing temperature, salinity, and nutrient conditions. *A. catanella* cell concentrations from 572 surface water samples were estimated using quantitative PCR. High frequency sampling revealed a cyclic pattern of *A. catanella* cell growth that was positively correlated with water temperatures. Prevailing salinity conditions however did not significantly affect abundance, nor was nutrient limitation a direct factor. Bloom concentrations were detected in 35 samples (8%) from Kachemak Bay and ranged from 100 to 3,050 cells L⁻¹. The highest cell concentration detected in 127 samples from lower Cook Inlet was 67 cells L⁻¹. These data confirmed *A. catanella* blooms originated in Kachemak Bay and were not transported from Cook Inlet. Average water temperatures increased approximately 2° C over the course of the study and were accompanied by an increase in highest annual cell abundances and an increase in saxitoxin concentrations in shellfish. We also observed differences in *A. catanella* concentrations among Kachemak Bay sub-bays with both higher cell concentrations and shellfish toxicity observed in Tutka Bay and Sadie Cove. The role of temperature in

regulating *A. catanella* is further supported by a comparison to continuous temperature data from the Kachemak Bay Research Reserve System-Wide Monitoring Program (SWMP), which showed that *A. catanella* cell concentrations and shellfish toxicity were higher following anomalously high winter sea surface temperatures in 2015 and 2016. As a result, temperature monitoring data from the SWMP program are being used as an early warning signal for development of shellfish toxicity in Kachemak Bay.

Mechanisms Leading to the Increase of the Coarse Cushion *Codium ritteri* Within Urchin Barrens

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The loss of sea otters across the Aleutian Islands has led to the formation of urchin barrens that are characterized by high urchin densities, low abundances of fleshy macroalgae, and high cover of crustose coralline algae. The resulting reduced competition for light and space may facilitate an increase of flora and/or fauna with defenses that enable survival under intense grazing pressure by urchins. Although crustose coralline algae is common within barrens across the island chain, high bottom cover of fleshy macroalgae such as the green alga *Codium ritteri* is observed and may provide a new habitat type increasing benthic heterogeneity. To elucidate the mechanisms driving the increase in *Codium* within some urchin barrens, we 1) conducted a field caging experiment to determine if urchins consume *Codium*, 2) manipulated light in the laboratory to test if *Codium* becomes less palatable under higher light in urchin barrens, and 3) estimated spatial variation in the rate of *Codium* consumption by urchins among islands. The difference in the amount of *Codium* within caging treatments indicates that urchins consume *Codium* tissue at a greater rate than its growth. Increasing light appears to have little effect on the rate of *Codium* growth or the amount consumed by urchins. Overall, rates of *Codium* consumption differed among islands, suggesting palatability may be geographically variable. Future work will determine whether chemical defenses play a role in the spatial variation of algae palatability by habitat and island and the potential consequences for urchins.

The Physiological Ecology of the Calanid Copepod, *Neocalanus flemingeri* in the Northern Gulf of Alaska

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The copepod *Neocalanus flemingeri* is a key copepod species in the subarctic North Pacific. In the spring, this species is abundant in the upper 100 m, building prodigious lipid stores while progressing through five copepodid life-stages to prepare for its next phase, dormancy, and to store sufficient energy to fuel reproduction in the following year. Food supply during this period is highly variable, in both time and space. To determine the effect of this patchy food environment on the physiology and development of *N. flemingeri*, stage CV individuals were collected in May 2015 from six stations that provided a spatially heterogeneous distribution of food (inshore and offshore Gulf of Alaska and Prince William Sound). These were 1) assessed for respiration rates; and 2) preserved for gene expression profiling. Respiration rates were variable, but in general higher in individuals collected in Prince William Sound than those from the Gulf of Alaska. Furthermore, gene expression analysis identified large differences among individuals collected from different stations. Oceanic offshore CV individuals were developmentally less advanced than the individuals collected in Prince William Sound. Upregulation of genes involved in lipid catabolism suggested food stress in offshore individuals compared with the inshore individuals where lipid biosynthesis genes were upregulated. The physiological data correlate with station differences in environmental factors including in situ fluorescence used as a measure of phytoplankton abundance.

Pink Salmon Induce a Trophic Cascade in Plankton Populations Around the Aleutian Islands

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A 15-year time series (2000-2014) of summer observations of plankton populations sampled by Continuous Plankton Recorders reveals opposing biennial patterns in abundances of both large phytoplankton and copepod populations in waters around the Aleutian Islands. This is likely caused by the predation pressure on copepods from East Kamchatka pink salmon causing a trophic cascade effect by reducing copepod grazing pressure on large diatoms in high-abundance, odd years. In addition to influencing the abundance of diatoms and large copepods, we also report an effect on phytoplankton taxonomic composition. We find regional differences in the expression of these effects with alternating odd/even year patterns being strongest in the central and eastern Aleutians and reduced, or absent, in the western Aleutians. When the abundance of 2013 pink salmon was unexpectedly low, there were consequent changes in the plankton populations, with highest recorded numbers in the time series of large copepods and microzooplankton (hard-shelled ciliates). These findings emphasize the importance of predators and the effects on the ecosystem of variability in their abundance, which in this case were greater than physical oceanographic variability.

Using Stable Isotopes to Study the Trophic Relationships of Groundfish, Squid, and Sperm Whales in the Gulf of Alaska

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Over 150,000 sperm whales (*Physeter macrocephalus*) were removed from the Gulf of Alaska (GOA) during 20th century whaling. Removal of this top predator may have caused significant changes to population dynamics of the GOA ecosystem. Biologists onboard whaling ships examined stomach contents and found a diet of 68% groundfish and 32% squid for GOA sperm whales. The goal of this study was to compute current trophic level calculations of historic sperm whale prey in the GOA. This study is part of a broader study using stable isotope analysis to establish trophic relationships and determine the current sperm whale diet in the GOA. Nitrogen stable isotopes ($^{15}\text{N}/^{14}\text{N}$; $\delta^{15}\text{N}$) can be an indicator of the trophic level at which animals forage because they are fractionated as they move through the food web becoming more enriched in the heavy isotope, ^{15}N , with each trophic level. Isotopic analysis was conducted on seven species of groundfish ($n = 158$) and two species of pelagic squid ($n = 14$), all known to be historical prey of sperm whales. Groundfish were collected between July and August of 2016 from the annual GOA NMFS longline survey, consisting of skates (*Rajidae* sp.), shortraker rockfish (*Sebastes borealis*), sablefish (*Anoplopoma fimbria*), grenadier (*Macrouridae* sp.), and spiny dogfish (*Squalus acanthias*). Magister squid (*Berryteuthis magister*) and robust clubhook squid (*Onykia robusta*) were caught on commercial longline fishing gear from March to May of 2014-2017 ($n = 11$ for 2016, $n = 1$ for 2014, 2015 and 2017). Calanoid copepods (*Neocalanus* sp.) were used as indicators of ecosystem baseline, collected in July of 2016 ($n = 30$) for trophic level calculations. Trophic level results ranged from highs for clubhook squid and skates, 4.2 and 3.9, respectively, followed by shortraker rockfish at 3.8, sablefish at 3.6, grenadier at 3.5, spiny dogfish at 3.3, and magister squid the lowest at 3.2. These results indicate that clubhook squid and skates are the top predators analyzed. This study provides insight into diet and trophic connections for these species. Future studies should continue to use stable isotope analysis to compare trophic levels of these species as an indicator of changes within groundfish communities that may affect commercially important species.

Zooplankton Community Structure and Seasonal Abundance in Prince William Sound

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Presenter: Caitlin McKinstry

Large calanoid copepods and other zooplankton comprise the prey field for ecologically and economically important predators including juvenile pink salmon, herring, and seabirds in Prince William Sound (PWS). From 2009 to 2016, the Gulf Watch Alaska program collected zooplankton 5-10 times each year at 12 stations in PWS to establish annual patterns. Surveys collected 188 species of zooplankton with *Oithona similis*, *Limacina helicina*, *Pseudocalanus* spp., and *Acartia longiremis* as the most common species present in 519 samples. Generalized additive models assessed seasonal abundance and showed peak abundance in July (mean: 9826 no. m⁻³ [95% CI: 7990 to 12084]) and lowest abundance in January (503 no. m⁻³ [373 to 678]). Significantly higher zooplankton abundance occurred in 2010 (542 no. m⁻³ ± 55 SE) and lowest in 2013 (149 no. m⁻³ ± 13). The species composition of communities, determined via hierarchical cluster analysis and indicator species analysis, produced six distinct communities based on season and location. The winter community, characterized by warm-water indicator species including *Mesocalanus tenuicornis*, *Calanus pacificus*, and *Corycaeus anglicus*, diverged into four communities throughout the spring and summer. The first spring community, characterized by copepods with affinities for lower salinities, occurred sound-wide. The second spring community, comprised of planktonic larvae, appeared sporadically in PWS bays in 2011-2013. Spring and summer open water stations were defined by the presence of large calanoid copepods. A summer community including the most abundant taxa was common in 2010 and 2011, absent in 2013, then sporadically appeared in 2014 and 2015 suggesting interannual variability of zooplankton assemblages. The zooplankton community shifted to a uniform assemblage characterized by cnidarians in the early autumn. Community assemblages showed significant correlations to a set of environmental variables including SST, mixed layer depth, location, depth of chlorophyll-a max, mixed layer average salinity, chlorophyll-a maximum, and bottom depth ($\rho = 0.24$, $p < 0.05$). The disappearance of the summer community coincided with the appearance of the Gulf of Alaska warm water anomaly known as “The Blob”. A shift in zooplankton community composition during critical grazing periods for predators such as juvenile Pacific herring (*Clupea pallasii*) could have energetic consequences for overwintering success.

How to Recognize the Frilled Giant Pacific Octopus, an Increasingly Common Large Octopus in Prince William Sound, AK

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Presenter: David Scheel

We used body patterns and genetics to distinguish two types of large octopus in Prince William Sound Alaska. The first type is the giant Pacific octopus, *Enteroctopus dofleini* (Wulker 1910). The second type is a likely congener, the frilled giant Pacific octopus, which is a previously unnoticed octopus species of a novel morphotype. The novel morphotype octopuses were distinguished from GPO morphotype octopuses by the presence of a lateral mantle frill and the absence of longitudinal mantle folds, ventral mantle texture below the lateral frill, and patch and groove patterning. Additional traits could be used in combination to reliably characterize the novel morphotype. The GPO morphotype was identified with *E. dofleini* based on the match of body pattern traits to published descriptions of that species and the match of its genetic haplotype to published sequences of *E. dofleini*. Novel morphotype body patterns did not match descriptions of any species from the eastern north Pacific, while its genetic haplotype matched that of a recently sequenced undescribed octopus. The GPO and novel morphotypes are sister clades. We used the body pattern traits for field identification of live octopuses to estimate the relative frequency of each type in the bycatch of the Alaska Department of Fish & Game shrimp test fishery in western Prince William Sound. At the start of our sampling in 2012-2013, 67% of octopuses caught in shrimp pots were *E. dofleini*. Samples in subsequent years have not exceeded 30% *E. dofleini*, with the remainder of the catch comprised of the frilled giant Pacific octopus.

Zooplankton and Forage Fish Spatial Distributions Under Varying Environmental Conditions in the Northern Bering Sea

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Declines in Yukon and Kuskokwim Chinook salmon returns over the last decade have been hypothesized to be linked to decreased survival of these salmon during their early marine period, when unfavorable ocean conditions can lead to decreased fitness and growth rates. Recently, the Bering 10K ROMS model, a regional ocean model with coupled nutrient, lower trophic, and upper trophic level biological components, has been overhauled to better capture conditions throughout the Bering Sea, including the northern Norton Sound region that serves as habitat for juvenile Chinook salmon. We will present results from the most recent simulations of this model, with a focus on the distributions of the large zooplankton and small forage fish species that are key prey items for first-year Chinook salmon.

Nearshore Food Web Structure in Two Contrasting Regions of Cook Inlet

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Nearshore benthic ecosystems in Alaska are critical habitats for many marine species, and are utilized by humans for harvest and commerce, including oil and gas extraction. These nearshore communities are also impacted by increased glacial melt and river discharge due to climate warming, but how these ecosystems respond to such stressors is still unclear. Here we use Cook Inlet as a case study to compare food web and community composition between two regions (Kachemak Bay and Kamishak Bay) exposed to differing physical environments and potential climate and human exploitation stressors. Key taxa, including benthic invertebrates and macroalgae, were analyzed for stable isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) to determine food web structure. We present preliminary comparisons of food webs linked to quantitative measures of community structure between the two regions. Quantitative measures will include the percent cover of taxa, mean trophic level of consumers, and the relative abundance of trophic levels in each region. These data will help us assess food web complexity, which has been linked to increased ecosystem stability. Building on current monitoring projects, we aim to improve understanding of the community structure in these regions to better inform management of these vulnerable nearshore habitats.

Pteropod Shell Status and Ocean Acidification in the Marine National Park of Glacier Bay, AK

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Presenter: Faith Stemmler

Pteropods can be important components of marine ecosystems and are one of the zooplankton species considered most at risk from ocean acidification because of their calcareous shells. We studied distribution and seasonality of pteropods in Glacier Bay, Alaska in conjunction with measurement of inorganic carbon saturation states during 2016-2017. Aragonite was consistently undersaturated ($\Omega < 1$) during the winter (January), summer (July), and fall (September and October) months, but not during springs. The highest pteropod abundances were found in samples from the July and September cruises, especially nearest the glaciers. It is notable that May abundance of 25-40 individuals/m³ in Glacier Bay are lower than the Gulf of Alaska mean of 200 individuals/m³, although fall numbers in Glacier Bay 75-90 individuals/m³ are higher than Gulf of Alaska mean of 25 individuals/m³. This may indicate a seasonal shift in pteropod distributions between the Gulf of Alaska open ocean and more sheltered waters of the inner passage. Given the low saturation states found in many months, we also examined their shells for indication of damage due to undersaturation of aragonite. Interestingly, pteropod shell conditions from the most undersaturated cruises revealed little to no visible damages, suggesting these species may be less at risk than currently believed.

How Many Krill are There in the Bering Sea and Gulf of Alaska? Field Observations and Acoustic Calibration of Krill and their Composition in 2016 and 2017

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Acoustic echosounder surveys and trawl sampling are conducted by ASFC-NMFS-NOAA in the Bering Sea and Gulf of Alaska to estimate the biomass of walleye pollock (*Gadus chalcogrammus*). Aggregations of zooplankton, especially euphausiids (krill), can often be detected and quantified from the data collected during the pollock surveys, yet current acoustic and net estimates of krill abundance show poor agreement in both regions. This leaves a gap in estimates of krill biomass which could greatly benefit ecosystem models to address management questions. Accurate estimates of krill biomass are dependent on validated Target Strength (TS) models that predict how individual krill scatter sound and incorporate the effects of animal morphology, material properties, and orientation. Measurements were made on ecologically important krill species from the Bering Sea (*Thysanoessa inermis*, *T. raschii*, and *T. spinifera*) and Gulf of Alaska (*T. spinifera* and *E. pacifica*) during the summers of 2016 and 2017, respectively. A stereo drop camera system was used to measure the orientation of individual krill in situ. Krill exhibited a wide range of orientations with certain directions more common. Methot net tows equipped with strobe lights were used to: collect live animals for shipboard experiments and laboratory measurements of lipid composition, groundtruth acoustic estimates of krill numerical density, and determine the effect of strobe lights on krill catch abundance. Tows with active strobe lights caught more krill (than unstrobed tows) during both the day (4×) and night (2×). Krill shape and size were measured using digital photography and varied between taxa. Individual krill density varied within and among the different taxa, however the relationship between krill density and detailed lipid class distribution and content was more complex. The TS of individual krill was measured in a shipboard aquaria over a wide range of frequencies (50 to 455 kHz) using both narrow- and broad-band transducers. These data were used to refine and validate a more accurate scattering model for krill, which in turn, reduces the uncertainty in krill abundance estimates from net and echosounder data.

Spatiotemporal Variation in Relative Composition of Suspended Particulate Matter in Arctic Nearshore Habitats

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Climate change in the Arctic is causing sea-ice to rapidly melt, changing ecosystems and food webs, and presenting new opportunities for exploitation from commercial and tourist industries. Research has focused on understanding how these changes may affect Arctic marine ecosystems, but estuaries and nearshore habitats have been largely excluded from these efforts. Arctic estuaries are assumed to be important nurseries and foraging grounds for a multitude of fish, seabirds and marine mammal species, but little is known about the dynamics of resources at the base of the food web. Investigating phytoplankton and other Suspended Particulate Matter (SPM) composition will aid in identifying important environmental drivers of basal resource composition, and will establish baseline information to assess future impacts on these ecosystems. These low trophic level resources such as detritus and phytoplankton are likely to be affected most rapidly in the event of a disturbance, thus their responses may be crucial indicators of how the rest of the food web can be affected. SPM samples ($n = 76$) were collected by filtration from July 15 to August 14 of 2014-2015 near Point Barrow, AK, at 12 stations in three different nearshore habitats: narrow shelf coast (Chukchi Sea), broad shelf coast (Beaufort Sea), and shallow protected lagoon (Elson Lagoon). Samples were processed using Fluid Imaging FlowCAM, and sorted into functional groups. Multivariate analysis indicated that temperature, wind direction and speed, explained a substantial amount of variance in SPM composition (53%). The Chukchi Sea is generally more productive than the Beaufort Sea, but Elson Lagoon is the most productive of the three habitats based on high relative abundance of phytoplankton during summer months. The Chukchi had a gradual increase in relative phytoplankton abundance throughout the sampling period which may be attributed to upwelling of nutrient rich waters associated

with more easterly winds. These results indicate that low trophic levels respond to climatic and meteorological conditions, and understanding the dynamic effects that changing conditions have on low trophic level resources will allow for better predictions of how entire food webs will respond as the arctic nearshore continues to be changed.

Pilot Investigation into the Age Structure of Market Squid, *Doryteuthis opalescens*, in the Gulf of Alaska

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Market squid, *Doryteuthis opalescens*, have been observed continuously in Southeast Alaska since 2015. Prior, only transient populations were documented. To better understand their persistence, in this ongoing pilot study squid were collected from the 2017 Alaska Fisheries Science Center Ecosystem Monitoring and Assessment GOA benthic trawl survey on 5 and 10-11 July 2017 and opportunistically collected from Sitka Sound on 8 May 2017. Analysis of samples will include mantle length, gonadosomatic index, and statolith microstructure to estimate the sexual maturity, hatch time, age, and growth rate of the squid. In California, market squid tend to feed offshore and migrate inshore to reproduce. Because of this, we anticipate that the squid collected offshore will be younger and further from sexual maturity than those caught inshore at Sitka Sound. Our findings will aid in the understanding of the market squid population in Southeast Alaska.

Fine-scale Trophic Ecology and Bioenergetics of Euphausiids in Prince William Sound, Alaska

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Presenter: Courtney Weiss

Euphausiids are important prey to a wide range of higher trophic level consumers; however, there are considerable unknowns in how individual species vary trophically and energetically. For example, we have observed a 9 kJ/g dry mass range in the energy densities of *Thysanoessa raschii* depending on the season in which they were sampled, underscoring the variation in nutritional value within a single species. This is important because euphausiids are often considered as a single group within ecosystem models that are linked to commercially important species. Here we relate the relative trophic position and carbon source to the nutritional value of *Euphausia pacifica* and *Thysanoessa spinifera*, collected within Prince William Sound (PWS) in September of 2017. Nutritional value was measured as energy density and determined from bomb calorimetry. Stable isotopes of carbon and nitrogen were measured in the euphausiids and baseline samples (particulate organic matter and small copepods < 200 μ m), to assess source carbon (δ 13C) and relative trophic level (δ 15N). Both energy density and stable isotope values were assessed by species, size (dry weight and orbital-telson length), and habitat (water temperature and salinity at depth) from glacially and marine-influenced sites. This analysis is ongoing, however previous data indicate that we will observe considerable variability in the quality of these prey items and that the quality will relate to the carbon sources they consume and their trophic position. The results from this study will address critical unknowns in our understanding of the life history of these euphausiids. Species-specific isotope and nutritional condition values will also help better delineate trophic and prey quality contributions to higher trophic level predators such as herring and whales, leading to more accurate depictions of euphausiids in ecosystem models.

How People of the Yukon River Value of Salmon

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People along the Yukon River rely on salmon for food, culture, and income. It is well known that salmon has a high value to the subsistence users along the Yukon River but the details of this value are not well described, nor are management decisions in times of shortage currently guided by knowledge of these values. A greater understanding of the values of salmon is needed. Through this project, case studies were developed for three Yukon River communities and Yukon River fishing families had the opportunity to share how they value salmon, why they value salmon, and the ways in which it is most important to them. This talk will present objectives, methods, and results.

Implications of Halibut Bycatch Management in the North Pacific: A Prospective Model of Fleet Behavior in the Groundfish Trawl Fisheries

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There is a pressing need for conducting prospective analyses of fishing effort changes in response to management changes, including those designed to reduce bycatch. In June 2015, the North Pacific Fishery Management Council (NPFMC) took action to reduce the prohibited species catch (PSC) limits for halibut in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries, and is currently exploring ways for tying future PSC limits to measures of halibut abundance. Understanding the behavior of the groundfish fleet in response to such limits is a key ingredient for measuring potential socioeconomic and biological impacts, and yet current models are insufficient for predicting the behavioral response of the fishing industry under the current quota-based management structure of most BSAI groundfish fisheries. We are developing an empirical modeling approach for predicting the economic and ecological consequences of alternative halibut PSC management policies. Our model focuses on the dynamic decision making of vessels as they manage tradable quotas for target and bycatch species within a fishing season, and provides predictions of changes in the spatial and temporal distribution of fishing effort in response to management changes, including changes in catch limits and time/area closures. These predictions are then combined with estimated space/time distributions of species to predict the cumulative consequences for catch and quota balances, gross and net revenues, and the ecosystem resulting from alternative halibut PSC management measures. Preliminary results suggest that the groundfish fleet is flexible in adjusting their fishing practices to reduce halibut bycatch; however, halibut bycatch reductions are costly, in terms of foregone groundfish revenue and operating costs, particularly at low levels of halibut PSC limits. Moreover, our results highlight behavioral margins that would not otherwise be predicted using models that do not account for the within-season dynamics of quota-based fisheries. While the application we pursue is specific to halibut PSC management in the BSAI groundfish fisheries, our methodological approach is capable of being applied to policy impacts in other quota-based multispecies fisheries.

Characterizing Cross-Fishery Permitting Patterns Using Network Analysis

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Many fishermen hold a portfolio of permits across multiple fisheries, providing them with the opportunity to substitute effort between fisheries, and potentially enabling impacts from a policy change in one fishery to spill over into non-targeted fisheries. In regions with a large and diverse number of permits and fisheries, joint permitting can result in a complex system, making it difficult to understand the potential for cross-fishery substitution. Network theory offers a means to understanding such complex systems. We construct a network representation of permit ownership to characterize the degree of interconnectedness between Alaska commercial fisheries due to cross-fishery permitting. Overall, the Alaska fisheries network is very dense, with approximately one-third of all potential fishery pairs sharing at least one permit holder. Furthermore, significant heterogeneity in interconnectedness exists across fisheries, suggesting there is likely to be variability in fisheries' likelihood of generating and being susceptible to network shocks, such as changes to policies or fish stocks. Fisheries that are federally managed and/or have a statewide geographic scope tend to be larger, share permit holders with more fisheries in the network, share a greater number of permit holders with other fisheries, and have a higher closeness centrality, on average. We find that fisheries that share similar geography—and to a lesser extent fishing gear—are more likely to be a part of a highly connected cluster of jointly-permitted fisheries. Altogether, our results show the value in applying network theory to complex permitting patterns in commercial fisheries to provide a more complete characterization of cross-fishery permitting and the potential for spillover effects across connected fisheries.

How Do We Prepare Bering Sea Fisheries Management for Success in a Changing Environment?

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The Alaska Climate Integrated Modeling (ACLIM) project is a multidisciplinary effort to examine how different climate scenarios are likely to impact the Bering Sea ecosystem – and to ensure that our management system is ready for these potential changes. ACLIM integrates climate scenarios with a suite of biological models which include different levels of ecosystem complexity and sources of uncertainty. This talk focuses on coupling the project’s bio-physical models with models of fisher behavior and management. The complexity of the economic models varies to match the scale of the biological models with which they are coupled. We identify the economic and management factors that are the core drivers of fisher behavior. For management, there are many possible future policy choices, such as changes in target and bycatch species allocations or expanded spatial protective measures. Building on common socioeconomic pathways, we define the primary measures that have been shown to impact past fisher behavior and define a range of future economic changes and policy interactions under which we predict future integrated modeling outcomes. We demonstrate how different policy tools can have a large impact on our ability to adapt to environmental change.

Developing Culturally Relevant Environmental STEM Education: Challenges, Opportunities, and Considerations

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A growing body of educational research has demonstrated the value of culturally responsive or culturally-sustaining practices to support the success of underrepresented students. Yet culturally responsive teaching methods tend to be particularly uncommon within science, technology, engineering, and mathematics (STEM) topic areas. Engaging students in place-based, culturally relevant, learning provides a localized framework that can contextualize learning through their cultural character, experiences, and perspectives. In the present example, we developed place-based lesson plans for 3rd-5th grade students of the Pribilof Islands, as part of funded research on blue king crab (*Paralithodes platypus*). To do so, we conducted interviews with educators on St. Paul Island and created materials in collaboration with scientists and local experts. Moreover, we participated in a week-long immersive educational experience (Bering Sea Days) to receive feedback from educators and students. The educational kit focuses on the complex life history of blue king crabs, the importance of habitat preference in juveniles, and the impacts of climate change, both locally and globally. Our experience supports existing work indicating that place-based examples with local cultural-relevance are effective for solidifying student understanding and facilitating student engagement with a topic. We suggest that community involvement and local cultural knowledge are invaluable for creating impactful lesson plans. Moreover, we contend that culturally relevant lessons are most effective when created in collaboration with communities, and when guided, but not dominated by, state and federal standards.

Oceanographic Warming Along the Coast of the Gulf of Alaska Evidenced and Tracked by a Persistent Range Expansion of Market Squid, *Doryteuthis opalescens*

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Recent reports in the Gulf of Alaska (GOA) have shown anomalous sea surface warming with the onset of the “warm blob” in 2013 and continuing with the onset of the 2014 El Niño. Historically, market squid (*Doryteuthis opalescens*) have tracked oceanographic change in the GOA well. In 2015, market squid arrived in Southeast Alaska likely through waters advected by El Niño as has occurred during temporary range extensions in the past. However, their current persistent distribution in the GOA is exceptional not only regarding its duration but also in its spatial extent. Their spawning distribution (e.g., inferred by eggs) track warm hydrographic conditions for nearshore ecosystems of the GOA especially well. Spawning events have been reported continuously in the Southeast Alaska since 2015 and have extended far into the GOA reaching Kodiak Island in late 2016. This extension is a key step towards their permanent residence in the GOA and highlights the effects of environmental forcing on the composition of forage species within the GOA coastal ecosystem.

Enhanced Ocean Acidification Observing by Citizen Science Initiatives and Land-Based Measurement Strategies in Coastal Alaska

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Data describing ocean acidification (OA) in Alaska coastal waters is dominated by measurements made from periodic research vessel surveys and oceanographic moorings. While the data attained from these platforms are extremely valuable, the information may be limited in space and time solely due to the dynamic nature of coastal settings. The addition of citizen science initiatives, including data collection by non-oceanographic agencies, and land-based instrumentation may help to expand our understanding of OA patterns where traditional oceanographic resources are limited. Here we present two case studies to evaluate the effectiveness of these added OA observing capacities. Case Study 1 is an analysis of discrete OA samples collected by both citizen scientists from native villages on Kenai Peninsula and around Prince William Sound and a partnering non-oceanographic agency (i.e., National Park Service). Discrete surface seawater measurements are compared between sites and against corresponding monthly interpolated surface maps of OA parameters (i.e., seawater pH and carbonate mineral saturation states) in order to determine regional differences across sampling locations and against large-scale oceanographic data (SOCAT V5). Case Study 2 details the linkages between two CO₂ measurement systems operating within Resurrection Bay on the Kenai Peninsula: Alutiiq Pride Shellfish Hatchery's "Burke-o-Lator" (BoL) that analyzes incoming seawater drawn from 75 m adjacent to shore and the National Oceanic and Atmospheric Administration/University of Alaska Fairbanks Ocean Acidification Research Center's surface OA buoy positioned at the mouth of the bay. Seasonally resolved CTD profiles and discrete OA data collected proximal to these platforms are used to evaluate coherent structure between the two high-resolution datasets, and determine the effectiveness of utilizing the hatchery-based BoL record as a diagnostic for in-water conditions within Resurrection Bay. Together, these case

studies provide sound evidence of the benefits of adding citizen science and land-based initiatives to our collective portfolio of OA observing strategies.

Congruence of Intertidal and Pelagic Water and Air Temperatures During an Anomalously Warm Period in the Northern Gulf of Alaska; the “Blob” Washes Ashore

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The nearshore component of the Gulf Watch Alaska Program monitors the status and dynamics of shallow-water communities across the northern Gulf of Alaska. Both water and air temperature can be important drivers of community dynamics within intertidal communities that exist at the interface of terrestrial and oceanic realms. The influence of oceanic conditions on intertidal temperatures are poorly understood because satellite-derived sea surface temperatures can be inaccurate nearshore, and the concordance between offshore and shore-based readings have not been established. Gulf Watch Alaska monitors intertidal air and water temperature at the 0.5 m tidal

elevation of 20 study sites spread between Prince William Sound and the Katmai coast on the eastern Alaska Peninsula. Here we examine temporal patterns in intertidal water temperatures and their congruence with pelagic temperature monitoring platforms including vessels, buoys, and satellites. Notably, the anomalously warm water mass (the “Blob”) that developed in the eastern north Pacific during the winter/spring of 2013-2014 and persisted into the 2016 El Niño, was evident in intertidal water temperature records, with water temperature patterns similar among our Gulf Watch areas. We seek a better understanding of the differences in magnitude and timing between this pelagic warming and intertidal water and air temperature patterns, which in turn may influence intertidal community dynamics. Findings will provide insight into future nearshore community changes that may develop due to global climate change.

Ocean Acidification Observations Along the Seward Line: 2008-2017

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The long-term time hydrographic time series along the Seward Line has documented seasonal, interannual, and multidecadal variability of the northern Gulf of Alaska (GOA). The GOA has seen short and long-term climate changes, particularly in the Alaska Coastal Current (ACC), due to rising temperatures, freshening, and changes in atmospheric circulation. In conjunction with these rapid and ongoing changes, anthropogenic carbon dioxide (CO²) emissions are also changing biologically important ocean chemistry through a reduction in pH known as ocean acidification (OA). OA is a major climate risk for marine ecosystems and has the potential to negatively affect calcifying and non-calcifying organisms at the species level (e.g., survival, reproduction) and the food web (e.g., size, quality). Biannual OA observations began on Seward Line research cruises in 2008, with the first decade of results available in 2017. These observations show the intrusion of anthropogenic CO² has caused a decrease in pH and other biologically important parameters in this ecologically and economically productive region. However, other changing variables like stratification, temperature, and freshwater inputs are simultaneously driving changes in the regional carbon cycle. Here we present preliminary decadal analyses highlighting each of these changes. Taken together, it is possible that the long-term warming observed through this and other studies may provide some resilience to the negative effects of OA. In order to support the regional subsistence and commercial fisheries that rely on this environment, it will be critical to translate these multiple stressors to modeled biological responses in order to better understand future trends and promote sustainable management.

The Seward Line - 2017

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During 2017, average temperatures along the upper Seward Line returned to normal. Anomalously warm temperatures at mid-depths represented remnants of the Blob/El Niño. By September, this anomaly was absent across the shelf, with anomalously cold and shallow midwater temperatures occurring offshore. Despite return to more normal temperatures, the zooplankton community composition remained abnormal. Although some warmwater species remained, there was a shift in the dominance of several large-bodied copepods, especially *Neocalanus flemingeri* and *Calanus marshallae*. We propose that poor condition and lipid storage of *Neocalanus* resulted in reduced winter fecundity of this species and subsequently low recruitment during 2017 to the advantage of *Calanus marshallae*.

Calcium Carbonate Variability in Near Shore Waters

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Presenter: Lily Hood

In Alaska, where our economy and subsistence lifestyles are tied to the marine world, ocean acidification could dramatically impact our way of life. Shelled zooplankton form the base of the marine food chain and rely on the amount of calcium carbonate in the water. However, under more acidic ocean conditions it has and will become more difficult for shells to form. Additionally, because the study of ocean acidification is fairly new, there is little data regarding the natural carbonate chemistry variability at nearshore locations in Alaska. As part of a summer science mentorship through the Sitka Sound Science Center and in partnership with the Sitka Tribe of Alaska, high school students from Sitka, AK, set up a water sampling regime to analyze nearshore waters for pH, aragonite saturation state (Ω), salinity, and temperature. Water samples were taken from two different sites at two different depths every Sunday for 6 weeks using a Niskin Bottle. The water samples were then put into a tinted bottle and poisoned with mercuric chloride which killed off any living organisms, allowing the sample to be tested at anytime. The study showed differences in carbonate chemistry with time and depth. Results show that weather can have a substantial effect on pH of shallower waters. The results also suggest that the ocean's pH changes within one season, and depending on the proximity to freshwater. Being that Alaskans rely on the fishing industry as a major economic driver and as a significant influence on Alaska culture, the variability of carbonate chemistry and the impacts of such variability on marine ecology are some of the most important areas for further research.

Variability in Estuarine Salinity and Stratification in Kachemak Bay, Alaska, From 2012 to 2017

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Oceanographic conditions in Gulf of Alaska estuaries are influenced by seasonal and interannual changes in freshwater input from rain, snowpack, and glacier melt, exchange with shelf waters, and mixing from tides and winds. Climate variations in the North Pacific Ocean can directly and indirectly affect these conditions through processes that act at both basin-wide and local (watershed) scales. Plankton, fish and shellfish species are affected by changes in water temperature, freshwater input, salinity and water column stratification and spatial variability in these conditions may influence estuarine productivity. In order to better understand the influence of changing freshwater inputs on sub-arctic estuarine conditions, we used oceanographic and meteorological time series data in Kachemak Bay, Alaska, to examine temporal and spatial variability in water column salinities and stratification. 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 mid-bay conditions from 2012 to 2017. Salinity anomalies indicated differences in interannual patterns between surface and deeper waters, with freshening observed in deeper waters after a 2014 transition to warmer conditions associated with the Pacific Warm Anomaly event. Stratification indexes were calculated for both nearshore and mid-bay locations, with seasonal stratification increasing consistently in spring, but exhibiting more interannual variability in fall months. Similarly, a freshwater content index calculated for a cross-bay section from CTD data indicated increased variability in late summer and early fall months. Spatial, seasonal and interannual changes in estuarine conditions are being used, as part of the Gulf Watch Alaska long-term ecosystem monitoring program, to help understand how climate variations may drive bottom-up changes in marine food webs, paralytic shellfish poisoning events, and outbreaks of sea star wasting disease.

Building Out an Ocean Acidification Detection Array for Southeast Alaska

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Southeast Alaska spans a complex range of seascapes including open shelves, a broad network of connected inland waterways, and glaciated fjords. The oceanic dynamics operating over the region are forced by strong tides, high rainfall from storms associated with the Aleutian Low, topographic steering of surface winds by large coastal mountains, and runoff from pluvial and glacial sources. Given the complexity of environmental drivers, highly variable patterns of coastal acidification are expected and would be influenced by changing climate. However, significant information gaps have impeded our understanding of the time and space acidification patterns across the region. Until recently, our perception of acidification in this area was attained only from data collected during infrequent research vessel operations, measurements made from a now inactive NOAA surface buoy, or by regional or large-scale climate model projections. Now, through a multi-agency effort, much improved temporally and spatially resolved information is being generated by a collection of CO² observing assets in operation across the region, including two “Burke-o-Lator” (BoL) pCO²/TCO² analyzers and a new underway CO² system aboard the Alaska Marine Highway Ferry MV *Columbia*. Data collection by the ferry platform links observations made by each land-based BoL and are further supplemented with discrete measurements collected by citizen scientists. In this presentation, we will highlight results from this detection array of surface high-resolution and nearshore acidification observing assets that are documenting the time and space patterns across southeast Alaska.

TUESDAY, JANUARY 22

WAVE 1

(6:30 PM TO 7:45 PM)

Wave 1
Tuesday, January 23rd (6:30 pm to 7:45 pm)
W. E. Eagan Civic and Convention Center

Title	Authors	Location (Row, Poster)
Following least auklets (<i>Aethia pusilla</i>) into the winter	Alexis Will, Jean-Baptiste Thiebot, Akinori Takahashi, Alexander Kitaysky	R7 , P81
Microplastic debris and contaminants in Alaskan marine and shoreline environments	Veronica Padula, Jannelle Trowbridge, Monica Ketchum, Douglas Causey	R7 , P84
Estimating diet composition of Steller's eiders using DNA present in scat	Katrina Counihan, Tuula Hollmen	R8 , P87
Dynamics of remigial molt of captive Steller's eiders (<i>Polysticta stelleri</i>)	Sadie Ulman, Tuula Hollmen, Dan Esler	R8 , P91
Observations of a changing ice environment in northern Alaska	Karen Brewster	R12 , P131
Integrating shared knowledge through the Alaska Arctic observatory and knowledge hub	Olivia Lee, Donna Hauser	R12 , P135
Coastal resilience research needs and highlights	Amy Holman, John Pearce, Simon Stephenson, Carolina Behe	R12 , P139
Balancing Science and Culture on the Arctic Coast	Kaare Siikuaq Erickson, Nagruk Harcharek	R13 , P142
A comparison of different UASs for applications in the Arctic	Justin Blank, Sheyna Wisdom, Jamie Cunningham	R13 , P145
Fishing as a way of life: evaluating community responses to federal subsistence fishing regulations in Southeast Alaska	Willem Klajbor, Maggie Chan, Anne Beaudreau	R13 , P146
Putting some spring in our swim: June catch composition of fishes in the Chukchi Sea	Caitlin Forster, Brenda Norcross	R13 , P147
Macrofaunal respiration rates across the northern Bering and southern Chukchi Sea shelf	Brittany Jones, Sarah Hardy	R13 , P148
Characterizing gene functions of particle-associated microbes and their role in the carbon cycle of the Bering and Chukchi seas	Rachel Lekanoff, Eric Collins, Andrew McDonnell	R13 , P149
Field studies to investigate the fate of juvenile arctic cod in the U.S. continental shelf region of the Chukchi Sea	Christopher Wilson, Robert Levine, Alex De Robertis, Ed Farley	R13 , P150
Arctic IERP: Chukchi Sea benthic fish and invertebrate catch and distribution during Arctic IES 2017	Libby Logerwell, Dan Cooper	R13 , P151
Seasonal distribution of picophytoplankton in the Bering and Chukchi seas.	Michael Lomas, Steven Baer, Lisa Eisner	R13 , P152
Transport and nutrients in the Eastern Chukchi Sea	Calvin Mordy, Phyllis Stabeno, Carol Ladd	R14 , P153
Determining particle abundance, size, and composition in the North Bering and South Chukchi seas during an earlier spring melt	Stephanie O'Daly, Andrew McDonnell	R14 , P154
Growth of calanoid copepods on an Arctic shelf	Alexandra Poje, Caitlin Smoot, Russ Hopcroft	R14 , P155
Innovative Technologies to Advance Ocean Observation	Heather Tabisola, Jessica Cross, Chris Meinig, Calvin Mordy	R14 , P156
Physical and biological drivers of variability in epibenthic communities along the Aleutian Archipelago	Aaron Bland, Brenda Konar	R14 , P157
Stable isotope fingerprinting of benthic organisms from the Hanna Shoal region to determine the proportional contribution of primary production sources	Morgan Siebka, Kenneth Dunton, Arny Blanchard, Katrin Iken, Diane O'Brien, Audrey Rowe, Ann-Christine Zinkann, Mathew Wooller	R14 , P159
A multi-faceted approach to understanding salmon bycatch in the North Pacific Ocean	Jordan Watson, Curry J. Cunningham, Andrew K. Gray, Jeffrey R. Guyon, James N. Ianelli, Christine Kondzela, Charles M. Guthrie III, Ellen M. Yasumiishi, Jackie Whittle	R14 , P161
Does canopy matter? Characterizing patterns of net community production across the Aleutian Archipelago	Matthew Edwards, Brenda Konar, Scott Gabara, Pike Spector, Genoa Sullaway, Ju-Hyoung Kim, Tristin McHugh, Sadie Small	R15 , P165
Documenting Alaska's marine invertebrate diversity: Perspectives and prospects from the University of Alaska Museum's research collections	Angela Gastaldi, J. Andres Lopez, Sarah Hardy, Bodil Bluhm, Alyx Hoover	R15 , P167

Regional differences and potential future shifts in mercury biomagnification in arctic marine food webs	Austin Fox, John Trefry, Robert Trocine, Kenneth Dunton, Brenda Lasorsa, Brenda Konar, Carin Ashjian, Lee Cooper	R14 , P169
The Argos Alliance: Working towards keeping the critical Argos wildlife tracking system viable	Markus Horning, Bruce Mate, Melinda Holland, Kim Holland, Andrew Seitz	R15 , P170
Bridging the gap between mechanistic understanding and climate projections: An example based on the Alaska Climate Integrated Modeling Project	Anne Hollowed	R15 , P172
Large zooplankton abundance as an indicator of walleye pollock recruitment in the southeastern Bering Sea	Lisa Eisner, Ellen Yasumiishi, Alex Andrews	R15 , P174
Using conceptual modeling and participatory science to investigate Pribilof Islands blue king crab	P. Sean McDonald, David Armstrong, Janet Armstrong, Kirstin Holsman, William Christopher Long, Jonathan Reum, Matt Sedlacek	R15 , P175
Developing stable isotope fingerprinting of bivalve shells to detect long-term changes in organic matter sources into the Arctic marine ecosystem	Audrey Rowe, Arny Blanchard, Katrin Iken, Diane O'Brien, Matthew Wooller	R16 , P177
The Cold Pool Refuge: What an atypical warm stanza and recent cooling reveal about ecosystem structure and walleye pollock in the Eastern Bering Sea	Janet Duffy-Anderson, Alex Andrews, Kristin Cieciel, Lisa Eisner, Edward Farley, Nissa Ferm, Ronald Heintz, David Kimmel, Jesse Lamb, Jim Murphy, Elizabeth Siddon, Adam Spear, Phyllis Stabeno, Johanna Vollenweider, Eric Wisegarver	R16 , P179
Issues with the co-existence of commercial fisheries and Steller sea lions in the western Bering Sea and the waters surrounding East Kamchatka	Vladimir Burkanov, Alexey Altukhov, Olga Belonovich, Ivan Usatov, Sergey Fomin	R16 , P181
The relative importance of bottom-up and top-down drivers explains recruitment variability of walleye pollock in the eastern Bering Sea	Elizabeth Siddon, Alex Andrews, Tayler Jarvis, Kirstin Holsman	R16 , P183
Spatial and temporal variability in growth of age-0 walleye pollock in the eastern Bering Sea: A hindcast analysis across contrasting climate stanzas	Elizabeth Siddon, Alex Andrews, Kirstin Holsman, Ron Heintz, Tayler Jarvis	R16 , P184
Biological drivers of total mercury and monomethyl mercury concentrations in subsistence fish from Kotzebue Sound	Andrew Cyr, Alex Whiting, Robert Gerlach, Todd O'Hara, Juan Andres Lopez	R16 , P185
Fine scale patchiness of Steller sea lion prey items in the Aleutian Islands and its influence on diet and foraging efficiency	David Bryan, Susanne Mcdermott, Chris Rooper, Mike Levine, Tom Gelatt, Brian Fadely	R16 , P186
Seasonal distribution and relative abundance of Steller Sea lion groundfish prey in the Aleutian Islands	Susanne McDermott, Kimberly Rand, Mike Levine, David Bryan, Todd Loomis	R16 , P187
Fish surveys and culvert assessments on Adak Island	Jeanette Alas, Mark Eisenman	R17 , P189
A seascape scale fishing impacts model to assess tradeoffs between spatial closures and gear modifications	T. Scott Smeltz, Suresh Sethi, Brad Harris	R17 , P190
Genetic analysis of mating dynamics of snow crab in the eastern Bering Sea	Laura M. Slater, W. Stewart Grant, Gordon H. Kruse, Tyler M. Jackson, Chris Habicht, Joel B. Webb	R17 , P192
Environmental drivers of spatio-temporal variation in Arctic nearshore fish community composition	Mark Barton, Kevin Boswell, Ron Heintz, Johanna Vollenweider, Brenda Norcross, Chunyan Li, Leandra Sousa	R17 , P194
Juvenile Chinook salmon growth from the Yukon River to the Bering Sea	Fletcher Sewall, Katharine Miller, Ashwin Sreenivasan	R17 , P196
Reexamining an assumption about marine mortality of Chinook salmon	Andrew Seitz, Andrew Seitz, Michael Courtney, Kaitlyn Manishin, Curry Cunningham, Peter Westley	R17 , P198
Counting on stomachs: Evaluation of thin sections from potential age structures for commercially important crabs in Alaska	April Rebert	R17 , P200
Sampling strategy evaluation in fish populations with spatially structured traits	Patricia Puerta, Bethany Johnson, Alix Gitelman, Grant Thompson, Lorenzo Ciannelli	R18 , P202
Effects of ocean acidification on young of the year golden king crab (<i>Lithodes aequispinus</i>) survival, growth, and morphology	W. Christopher Long, Katherine Swiney, Robert Foy	R18 , P204
Genetic stock structure of golden king crabs in Alaska	Stewart Grant, Wei Cheng, Zac Grauvogel, Erica Chenoweth, Heather Liller, Chris Siddon	R18 , P206

How low can you go - thiamine levels and survival of Yukon River Chinook salmon	Corey Fugate, Sean Larson	R18 , P208
Impacts of climate change on red king crab larval advection in Bristol Bay: Implications for recruitment variability	Benjamin Daly, Carolina Parada, Albert Hermann, Sarah Hinckley, Timothy Loher, David Armstrong	R18 , P210
Comparing numerical integration method for constructing size-transition matrix with other construction methods	Lee Cronin-Fine, Andrè Punt	R18 , P212
Nature vs Nurture: Disentangling cohort and year effects on Pacific cod size at age in the eastern Bering Sea	Lorenzo Ciannelli, Irina Tolkova, Thomas Helser, Patricia Puerta	R19 , P214
Investigating life history of Pacific sleeper sharks (<i>Somniosus pacificus</i>) and salmon sharks (<i>Lamna ditropis</i>) in the Bering Sea and Gulf of Alaska	Erica Aus, Julie Ayres, Bruce Wright, Ron Heintz, Matthew Rogers, Julius Nielsen	R19 , P216
Early life history and benthic settlement of crabs in Pribilof Islands nearshore habitat and investigation of bottlenecks in recruitment for blue king crab (<i>Paralithodes platypus</i>)	Jared Weems, Ginny Eckert, W. Christopher Long	R19 , P218
Remotely-operated towed acoustic system for observation of fish behavior in front of trawls	Stan Kotwicki, Liz Dawson, Alex De Robertis, Kresimir Williams	R19 , P220
Genetic distinctiveness of skate nursery sites in the Eastern Bering Sea	Ingrid Spies, Pam Goddard, Gerald Hoff, Jay Orr, Chris Rooper, Duane Stevenson	R19 , P222
Fishery interactions with skate nursery areas in the eastern Bering Sea	Duane Stevenson, Gerald Hoff, James Orr, Ingrid Spies, Chris Rooper	R19 , P223
Does fishing disturbance explain the spatiotemporal distribution of structure-forming benthic features important for red king crabs in the eastern Bering Sea?	Kelsey Bockelman, Bradley Harris	R20 , P225
Characterization of benthic habitats and contaminant assessment in arctic lagoons and estuaries	Ian Hartwell, Terri Lomax, Doug Dasher, Army Blanchard, Stephen Jewett	R20 , P227
Underway ship system time series of physical and biological measurement from the Gulf of Alaska, and the Bering and Chukchi seas	R. John Nelson, Svein Vagle, Di Wan, Curtis Martin, Diana Varela, Philippe Benoit, Francis Wiese, Ian Wrohan	R20 , P233
Zooplankton in Bering Canyon: Transport, community composition, and basin-shelf connectivity	Colleen Harpold, Carol Ladd, Wei Cheng, Janet Duffy-Anderson, Calvin Mordy, Phyllis Stabeno	R21 , P239
The North – South Transition zone of the eastern Bering Sea shelf: Oculus Coastal Glider observations at high spatial resolution	Carol Ladd, Shaun Bell, Calvin Mordy, Phyllis Stabeno	R22 , P251
High resolution (2-km) physical hindcasts and forecasts of the southeastern Bering Sea	Albert Hermann, Kelly Kearney, Benjamin Daly	R22 , P255
Declining surface nitrogen concentrations in the eastern Bering Sea during summer	Jeanette Gann, Lisa Eisner	R22 , P259

Following Least Auklets (*Aethia pusilla*) Into the Winter

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Presenter: Alexis Will

Throughout its range the small planktivorous least auklet (*Aethia pusilla*) has been shown to respond negatively to warm breeding season conditions. These negative responses have been traced back to changes in the availability of lipid-rich copepods. Whether warm conditions also negatively affect least auklets during the winter is not known. This is largely because we do not know where least auklets go or how much stress they incur while there. Previous work has identified core-use wintering areas for planktivorous bowhead whales (*Balaena mysticetus*) in the Gulf of Anadyr and along coastal areas in the Northern Chukchi Sea. It is not clear whether food in these areas would also be easily accessible to least auklets which must feed frequently and cannot dive as deeply as bowheads. To determine whether these core-use areas provide foraging habitat for seabirds we deployed geolocators on least auklets breeding on St. Lawrence Island in 2016 and recovered the loggers in 2017. Here we present our preliminary findings on the overwinter distribution of least auklets and the relative levels of stress they experienced during the winter compared to the summer. We discuss what these data may indicate about the presence of critical habitats for planktivores wintering in the region.

Microplastic Debris and Contaminants in Alaska Marine and Shoreline Environments

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Plastic debris, in general, is one of the most abundant and persistent contaminants in the marine environment. The plastic debris that enters the Pacific Ocean eventually reaches the marine coastal communities of Alaska. Plastic ingestion is particularly prevalent among seabirds, and has even been implicated in large-scale population declines. Today, plastic fragments are found in all terrestrial, freshwater, and marine ecosystems, extending from the Arctic to Antarctica. A variety of animals including fish, seabirds, turtles, and marine mammals get entangled in plastics or ingest them. In the case of seabirds, they mistake plastic for prey items, or as food to give to their chicks. Ingestion can result in ulcerations, starvation, or death. The large plastic debris is unsightly, but the most problematic is what we cannot see: the "microplastics." Plastics degrade through exposure to sunlight and the ocean, and quickly become microscopic. Although unseen by us, the microplastics act as sponges and absorb numerous chemical contaminants, particularly endocrine-disrupting compounds like phthalates, PCBs, and other persistent organic pollutants (POPs). Microplastics can pass through a bird's stomach and intestine, where chemicals leach off these particles and get incorporated into the animal's tissue. These effects may be exacerbated in humans through personal and subsistence harvest of these marine organisms, particularly of top-level members of the coastal foodweb -- such as salmon and egg harvests. The majority of studies that have examined microplastics and nanoplastics have identified them visually, either by eye or under a microscope. The problem with identifying microplastics only visually is multifold. Many microplastics, especially in sediment, are covered in a biofilm and resemble biotic material, and can thus be underestimated when being visually sorted. We report here the utility of using UV autofluorescence to characterize the composition and abundance of microplastics in stomach samples and body tissues. We also test the significance of the type of plastics and their association with detectable presence of phthalates and other POP contaminants.

Estimating Diet Composition of Steller's Eiders using DNA Present in Scat

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Presenter: Katrina Counihan

The Alaska breeding population of Steller's eiders (*Polysticta stelleri*) was listed as threatened under the Endangered Species Act in 1997 due to reductions in their population and nesting habitat. Food availability may be a factor in the decline of Steller's eiders, but their diet is poorly understood. Determining the prey base of eiders will help identify foraging habitat and evaluate how it may be affected by anthropogenic and environmental changes. Quantitative PCR (qPCR) is a sensitive, non-invasive method that has been used to detect prey DNA in scat from other species. To complement other available diet tracking techniques such as stable isotope and fatty acid signature analysis, we developed qPCR assays to estimate diet from fecal samples of Steller's eiders that were fed a known diet. Fifteen eiders were included in the study and were fed Mazuri duckling starter pellets, Mazuri supplemented with surf clam (*Spisula solidissima*), silversides (*Menidia menidia*) and Antarctic krill (*Euphasia superba*) or Mazuri supplemented with bloodworms (*Glycera dibranchiata*), glassworms (*Chaoborus* sp.) and mysis (*Mysis* sp.). Fecal samples were collected when the eiders were eating each diet type and the DNA extracted. Primers that targeted arthropods, crustaceans, plants, fish, bivalves and dipterans were used in qPCR assays. Plant primers were included because the primary ingredients in Mazuri are corn, wheat and fish meal. Prey DNA was accurately identified in eider scat using qPCR. The primer sets were able to detect diet items in the fecal samples in the same proportions they were fed. DNA from prey could be identified in scat within 24 hours of consumption. This method was useful for estimating the diet of captive eiders fed a known diet and could be applied to wild eiders after additional primer development to target their suspected prey items.

Dynamics of Remigial Molt of Captive Steller's Eiders (*Polysticta stelleri*)

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Remigial molt in waterfowl is an energetically costly and critical time in the annual life cycle. The Alaska SeaLife Center's captive Steller's eiders were studied to provide data on the dynamics of this physiologically demanding period. Data on captive birds will provide beneficial information for interpretation of data collected on this federally threatened species of eiders in the wild. During the 2017 remigial molt, we looked at the pre-emergence interval, timing of molt initiation, primary growth rate, and duration of flightlessness of captive Steller's eiders. Body mass and 9th primary feather measurements were taken on 41 birds at 1-2 week intervals from end of July through mid-October in 2017. To characterize energetic costs of the remigial molt in Steller's eiders, we monitored body weight change and measured the rate of oxygen consumption throughout the molt period.

Observations of a Changing Ice Environment in Northern Alaska

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In this final phase of the Northern Alaska Sea-ice Project Jukebox (www.jukebox.uaf.edu/seaice), eight new oral history interviews were conducted with residents of Utqiagvik, Point Hope, Wainwright, and Kotzebue discussing their observations of changing coastal ice conditions. By providing access to historical and current oral history recordings about sea-ice, this website creates a retrospective database of traditional knowledge and long-term observations. These 2017 recordings add important new perspectives to this record of changing nearshore sea-ice conditions in northern Alaska. In addition to documenting traditional knowledge, the Sea-ice Project Jukebox also addresses how changes in the sea-ice are impacting subsistence and marine resources, and how climate change is affecting the ecosystems and the local people. Using the people's own words, this project demonstrates how the nearshore sea-ice has changed over the past 40 years and how the Inupiat are adapting to these changes. The presentation will highlight some of the themes discussed in the interviews and demonstrate the benefits of collaboration between scientists and local experts. Also, featured in this presentation will be the photo gallery of sea-ice features and the videos of sea-ice related topics, such as the Utqiagvik sea-ice webcam, scientific fieldwork being conducted, elders speaking about ice conditions, animated radar imagery, and videos of seasonal ice conditions shot by local residents, that were added to the website during this phase of the project. This phase of the Northern Alaska Sea-ice Project Jukebox has been funded by the University of Alaska Coastal Marine Institute which receives funding from the Bureau of Ocean Energy Management (BOEM). This presentation fulfills the funder's requirement of presenting final results at a scientific conference.

Integrating Shared Knowledge through the Alaska Arctic Observatory and Knowledge Hub

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Presenter: Olivia Lee

The Alaska Arctic Observatory and Knowledge Hub (AAOKH) builds collaborative observing efforts with community observers in arctic coastal Alaska. The focus of observing effort is on changes to the cryosphere and corresponding effects to the seasonal cycle of subsistence hunting activities. Changes in coastal sea-ice conditions are shared in an online database that builds on previous collaborative research, that now includes over a decade of observations providing a unique perspective of how changing sea-ice affects coastal communities. The timing of spring break-up and fall freeze-up along the coast can be assessed from the perspective of spring and fall subsistence hunting activities, and linked to the migratory behavior of key subsistence harvest species. Flexibility in the AAOKH framework allows us to build on the current observing protocols and include new instrument deployments to further enhance the value of the observing efforts. The project relies on the expertise and involvement of community observers for developing baseline environmental change data at study sites in areas of community interest. The knowledge hub component of AAOKH emphasizes the need to develop tools to communicate results and share data with communities and the broader research community. The knowledge hub is continuing its development, but a map-based interface with a story-telling component is explored as a way to integrate shared knowledge.

Coastal Resilience Research Needs and Highlights

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Presenter: Amy Holman

The Interagency Arctic Research Policy Committee's Coastal Resilience Collaboration Team is a mechanism to engage coastal communities in discussions with researchers regarding Arctic research and advance knowledge on cultural, safety, and infrastructure issues. This poster provides an overview of recent accomplishments towards the team's goals of: 1) engaging coastal communities in research and advance knowledge on cultural, safety, and infrastructure issues for coastal communities, 2) advancing knowledge of ecosystems and environmental health in coastal areas by monitoring trends and modeling biological processes, 3) advancing knowledge on the physical coastal processes impacting natural and built environments, and 4) improving observations, mapping, and charting to support research across the coastal interface. Come learn what is going on related to your work and opportunities where you may be able to contribute your expertise. Copies of the FY2017 accomplishments will be available as well as announcements of related funding opportunities.

Balancing Science and Culture on the Arctic Coast

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Presenter: Kaare Siikuaq Erickson

At the frontlines of climate change, Utqiagvik is an important hub for marine science in the Arctic. With growing interest in the Beaufort and Chukchi seas, local residents of the Arctic coast have experienced an influx of international commercial, private, and research vessels. The presence of marine traffic always has the potential to impact sensitive subsistence practices and resources, primarily the bowhead whale and the traditional practice of harvesting the whale. In some cases this sensitivity has historically been overlooked, causing local Iñupiat communities to take a strong stance against marine traffic, including research vessels. American scientists and government entities who conduct research in the Arctic Ocean have taken steps to engage with communities to avoid conflict regarding subsistence. These efforts have made headway. In addition to working around sensitive subsistence activities and resources, marine scientists are usually faced with difficult circumstances such as: more variable weather conditions on the ocean as opposed to terrestrial research; higher costs for conducting research, especially on large vessels; negative blowback from Arctic communities due to extensive marine traffic that does not consult with locals, resulting in communities venting frustrations at researchers; lack of ship-to-shore capabilities; and due to high costs and variable weather, marine scientists are forced to follow strict schedules that change on a moment's notice, making it difficult to plan community meetings and activities while in the Arctic. Based out of Utqiagvik, UIC Science, LLC is an Iñupiat-owned and operated company that provides logistics to roughly 80 research projects per year. UIC Science, LLC acts as community liaison between hundreds of researchers and the communities and entities on the North Slope. This poster explores the complicated dynamics of conducting meaningful science outreach in Arctic communities and highlights success stories and lessons learned during these interactions. Learn about outreach activities such as public presentations, classroom visits, the BARC Science Fair 2017, and successful meetings between marine researchers and local entities. Learn about how and why certain marine research projects draw interest and concerns from local residents, while other research projects elicit less interaction.

A Comparison of Different UAS for Applications in the Arctic

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Presenter: Justin Blank

Unmanned aerial systems (UAS) have become increasingly popular across all industries for their ability to reduce risk to human safety, as well as cost, when compared to manned aircraft. Here we compare different UAS in a variety of applications so that others may benefit from our experience. Between 2013 and 2017 five different types of unmanned aircraft were deployed (InSitu ScanEagle, DJI Phantom, AeroVel Flexrotor, DJI Inspire, and DJI M600) for different uses in the Arctic. UAS launch, retrieval, and overflight occurred at both terrestrial and offshore locations. In total, four Visual Line of Sight (VLOS) and three Beyond Visual Line of Sight (BVLOS) programs were conducted. We present details and the intended purpose of each, then evaluate the UAS' performance for that particular use. Metrics evaluated include endurance, weather tolerance, payload performance, and logistics footprint in the various Arctic environments. Also analyzed is quality of sensor data and ease of sensor integration. Each project is qualitatively evaluated on total cost compared to the amount and quality of data that were collected.

Fishing as a Way of Life: Evaluating Community Responses to Federal Subsistence Fishing Regulations in Southeast Alaska

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Presenter: Willem Klajbor

In Alaska, many people rely on noncommercial, customary and traditional uses of wild resources for food, fuel, or clothing. Harvesting and use of these resources is known as subsistence, and the Alaska Department of Fish and Game estimates that 95% of Alaskans in rural areas rely on some sort of subsistence activity. In 2003, the regulations for subsistence fishers targeting Pacific halibut (*Hippoglossus stenolepis*) were updated, allowing the use of more hooks and more efficient gear types. Though these new rules aimed to make subsistence halibut fishing more efficient and accessible to Alaskans, both annual harvest and participation in the program have decreased since their implementation. We conducted semi-structured interviews with 45 subsistence halibut harvesters in three Southeast Alaska communities, seeking to learn about how these regulations have impacted their fishing habits. Interview recordings were analyzed to identify cultural, demographic, and regulatory factors that have affected people's fishing practices. Using information from the interviews and U.S. Census data, we found that demographic differences among study communities align with differences in sharing habits and reactions to the regulations. We also found that respondents' definitions and views of subsistence fishing varied according to their place of residence, age, and cultural traditions. Through this interdisciplinary project, we gain a better understanding of the social, cultural, and regulatory factors that can impact the subsistence lifestyle.

Putting Some Spring in Our Swim: June Catch Composition of Fishes in the Chukchi Sea

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Presenter: Caitlin Forster

Seasonal retreat of sea-ice in the Chukchi Sea drives springtime patterns of biological productivity. Despite the biological importance of the ice melt in the Arctic ecosystem, logistical challenges have limited sampling efforts during this season. Additionally, there have been significant changes in the timing of the spring-melt season; over the past several decades, the duration of the melt process has decreased by nearly 30 days. To investigate the dynamics of the spring season in the northeastern Chukchi Sea, we conducted trawl surveys in June 2017 to explore fish abundance and life history parameters. Demersal fishes were targeted with a 3 m plumb staff beam trawl, while pelagic fishes were targeted using an Isaacs-Kidd midwater trawl. A total of 24 demersal trawls were conducted, catching 417 individual fishes. The pelagic trawl successfully captured 301 individuals in 21 trawls. Among both pelagic and demersal trawls, nine families and over 30 species were represented in the catches. Abundance of demersal individuals was dominated by the sculpins (Cottidae) and pricklebacks (Stichaeidae). Patterns in demersal biomass were dominated by sculpins, and to a lesser extent, pricklebacks. Notably, Arctic cod, an important forage fish species and a critical trophic link in Arctic ecosystems, was encountered in small numbers in only four demersal trawls. Pelagic catches were primarily comprised of larval sculpins, cods (Gadidae), and snailfishes (Liparidae). Abundance estimates of fish species represent some of the earliest spring sampling season efforts in the U.S. Arctic. The results of this study will be compared with a similar survey conducted later in the same season in the Chukchi Sea to investigate seasonality of fish abundance patterns. In addition, estimates of Arctic cod distribution and abundance will be incorporated into a multi-year study comparing the seasonal and spatial patterns of Arctic cod distribution in the U.S. Arctic.

Macrofaunal Respiration Rates Across the Northern Bering and Southern Chukchi Sea Shelf

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Presenter: Brittany Jones

Benthic production in the northern Bering and southern Chukchi seas is a substantial portion of the total food web production in the region. Quantifications of benthic production and energy transfer through the food web are needed to better constrain and evaluate ecosystem models, particularly in the Arctic where future climate change is expected to have a dramatic effect on marine ecosystems. Oxygen consumption rates are often used to represent energy flow through the food web as a proxy for organic matter consumption. We selected four dominant infaunal taxa (*Macoma* sp., *Serripes* sp., *Neries* sp., and *Ampelisca* sp.) that were characteristic of different habitat types (ranging from fine mud to coarse sandy mud) to measure oxygen uptake rates at ambient temperature (0°C). Closed-system respirometry was conducted using non-invasive oxygen optodes on board the R/V *Sikuliaq* in June 2017 as part of the Arctic Shelf Growth, Advection, Respiration, and Deposition (ASGARD) project. Total oxygen consumption rates for *Macoma* sp. ranged from 0.03 to 0.89 $\mu\text{mol O}_2 \text{ h}^{-1}$, and mass-specific oxygen consumption rates ranged from 0.39 to 8.54 $\mu\text{mol O}_2 \text{ h}^{-1} \text{ g}^{-1}$ ash-free dry mass (AFDM). Additional experiments are planned for spring 2018 to include incubations at 5°C in order to evaluate the potential influence of increasing temperatures on vital ecosystem process rates.

Characterizing Gene Functions of Particle-associated Microbes and Their Role in the Carbon Cycle of the Bering and Chukchi Seas

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Particles play an essential role in the marine carbon cycle, especially in export and sequestration. Microbes (bacteria and archaea) associated with these particles are instrumental to cycling as they are responsible for solubilizing and metabolizing particulate carbon into its inorganic forms. If not for microbes, this pool of carbon would remain untapped, unavailable for use to primary producers and higher trophic levels. Despite this importance, few studies have investigated particle-associated microbes in Alaska polar waters. Our study endeavors to provide a much needed overview on the diversity of particle-attached and free-living microbes in the Bering and Chukchi seas. Field research has successfully been conducted at dozens of sites where microbe and particle samples were collected. Hundreds of microbe samples were collected with in-line filtration of seawater onto different filters (20 μm , 3 μm , and 0.2 μm). Suspended particulate matter (SPM) measurements and particulate organic carbon (POC) samples were also collected at the same sites at which microbes were filtered. These SPM and POC samples will be used to better constrain particle concentration and composition. Particle-associated microbes will be distinguished from their free-living counterparts based on presence in the larger filter mesh (20 μm and 3 μm) and absence from the smallest (0.2 μm). After extraction, genetics of the microbes were obtained using next-generation sequencing techniques and analyzed using bioinformatics tools to study gene function and microbe community composition. We expect particle-associated microbes will be the dominant microbe in areas of high particle concentration; those microbes will have a variety of genes associated with carbon cycling. There are thousands of known carbon cycling genes associated with marine microbes. Through our analyses, we hope to discuss the relationship between spatial patterns of particle abundance and composition and the patterns in community structure in free-living and particle-associated microbes. We also hope to explore the partitioning of gene functions such as carbon fixation, cellulose, lignin, and chitin degradation between the free-living and particle-associated microbial guilds. These results will better define the microbial communities of Alaskan polar waters, and help understand the shifts these communities might undergo in the coming years due to climate change.

Field Studies to Investigate the Fate of Juvenile Arctic Cod in the U.S. Continental Shelf Region of the Chukchi Sea

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To investigate the role of the Chukchi Sea as a nursery area for juvenile Arctic cod, an acoustic-trawl (AT) survey was conducted in the Chukchi Sea during August to September 2017 as part of the Arctic Integrated Ecosystem Research Project. Previous (2012, 2013) summer AT surveys in the area determined that pelagic fishes were dominated by large numbers of age-0 Arctic cod (*Boreogadus saida*). These and other surveys suggested that survivorship of age-0 is either very low or that these juvenile Arctic cod emigrate to other areas as they grow. Thus, an objective for the 2017 fieldwork was to use the AT survey data to determine whether the relatively large age-0 abundances observed in summer 2012 and 2013 is a characteristic feature of the Chukchi Sea. Another objective was to deploy three echosounder moorings, which will continuously make acoustic measurements of fish over two years (2017-2019). These moorings will be used to describe seasonal changes in abundance and track the movement patterns of individual Arctic cod to understand the role of the Chukchi as a nursery area for this species. The 2017 summer AT survey was conducted along transects from latitudes 67° N to 72.5° N across the U.S. continental shelf. Midwater trawls were conducted to estimate the size and species composition of the fishes, which is then used to convert the backscatter measurements to fish abundance. The 2017 catch data indicated that sound-scattering organisms were dominated by age-0 Arctic cod, with greatest densities between 70° N and 72° N. Very few age-1+ Arctic cod were captured. The 2017 backscatter attributed to age-0 Arctic cod was greater than in 2012 to 2013 and exhibited a more widespread geographic distribution. This AT survey will be repeated in summer 2019.

Arctic IERP: Chukchi Sea Benthic Fish and Invertebrate Catch and Distribution During Arctic IES 2017

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Presenter: Libby Logerwell

The goal of NPRB's Arctic Integrated Ecosystem Research Program (IERP) is to better understand the mechanisms and processes that structure the Arctic marine ecosystem and influence the distribution, life history, and interactions of biological communities in the Chukchi Sea. The Arctic Integrated Ecosystem Survey (IES), one of two IERP surveys, was a multi-disciplinary survey covering the U.S. Chukchi Shelf in August – September 2017. A second survey is planned for 2019. Benthic fish and invertebrates were sampled with a 3-m plumb staff beam trawl at 60 grid stations from the Chukchi slope south to Bering Strait. Epibenthic invertebrates dominated the catches, comprising over 90% of the total catch by weight. Invertebrate diversity was also high - at least 199 individual taxa were identified. In contrast, 36 individual taxa of fish were caught. The top 10 fish species caught (by number) were Arctic cod, eelblennies and pricklebacks, sculpins, eelpouts, alligatorfishes, and snailfishes. Walleye pollock were also caught in small numbers, at around lat. 72° 30' N, but they were not likely mature age classes. The top 10 invertebrate taxa caught (by biomass) were brittlestars, *Psolus* sp. (Holothuroidea), snow crab, starfishes, clams, sponges, and tube worms. The snow crab were also relatively small, although ovigerous females were caught at two stations at around lat. 71° 30' N. Arctic cod, pollock, and snow crab distribution are mapped to hypothesize relationships between their distribution and physical and biological oceanographic variables derived from data collected by other Arctic IES investigators. Further work will entail statistical and/or habitat modeling in an effort to confirm relationships; and identify mechanisms and processes that structure Arctic benthic ecosystems.

Seasonal Distribution of Picophytoplankton in the Bering and Chukchi Seas

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Presenter: Michael Lomas

Phytoplankton size-structure is an important parameter for understanding ecosystem trophic structure. In cold, nutrient-rich highly productive systems large diatoms dominate the autotrophic biomass resulting in efficient transfer of organic carbon to higher trophic levels. In contrast, when temperatures warm and nutrients are depleted diatom biomass declines revealing the background pico- and nanophytoplankton autotrophic carbon biomass. Due to tight grazer control of the pico- and nanophytoplankton, newly fixed organic carbon is largely recycled with relatively little left for transfer to higher trophic levels. During a relatively warm year in the Chukchi Sea, 2017, we quantified the spatial distribution of pico- and nanophytoplankton abundance and carbon content from the northern Bering Sea into the Chukchi Sea using flow cytometry. The absolute abundance of pico- and nanophytoplankton was higher in the eastern stations, and lower in those stations impacted by the nutrient-rich Anadyr Current in the west. Furthermore, cell abundances, increased from south to north through the sampling grid. At those stations where pico- and nanophytoplankton abundance exceeded $\sim 1,000$ cells/ml, and $< 5\mu\text{m}$ chlorophyll concentrations were low ($< 1\text{ }\mu\text{g/L}$) these phytoplankton groups contributed $> 50\%$ of the total phytoplankton carbon. At thirteen stations throughout the northern Bering Sea and Southern Chukchi Sea, microzooplankton grazing rates and phytoplankton physiological growth rates were measured and found to be always be tightly coupled. These observations support the notion that pico- and nanophytoplankton can dominate the phytoplankton biomass in these sub-polar seas, but that their biomass remains tightly controlled by microzooplankton grazing. These data highlight the importance of pico- and nanophytoplankton at the base of the sub-Arctic foodwebs and give a glimpse of what ecosystems may look like in a future, warmer ocean.

Transport and Nutrients in the Eastern Chukchi Sea

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We have deployed biophysical moorings in the Chukchi Sea since 2010. The moorings at Icy Cape provide estimates of total transport and concentrations of nitrate. The mean northward transport through Bering Strait is $\sim 1 \times 10^6 \text{ m}^3/\text{s}(\text{Sv})$ and $\sim 40\%$ of this transport flows northward through Central Channel and along the Alaska coast, exiting the shelf through Barrow Canyon. Transport varies on multiple time scales. Annual northward transports at Icy Cape range from 0.24 Sv in 2011 to 2012 to 0.55 Sv in 2014 to 2015. In addition, the magnitude of transport is seasonal, with the strongest monthly mean flows in June – August ($\sim 0.6 \text{ Sv}$) and the weakest in December – March ($\sim 0.1 \text{ Sv}$). Satellite-tracked drifter trajectories indicate a transit time during May – September of ~ 90 days from Bering Strait to exit the shelf via Barrow Canyon. Transit times during the winter months are longer with estimates of >150 days. Concentrations of nitrate are lowest in the late summer and increase over the winter and early spring. The sources of nitrate on the Chukchi Shelf are two-fold – advection and local regeneration of nutrients. Using time series of currents and nitrate, estimates of nitrate transport are made. Ammonium concentrations in winter are sufficient to support nitrification and to supply significant nitrate to the shelf. During the winter months, interannual variability in nitrate concentrations was correlated with transport along the Icy Cape line. The balance between advection and regeneration supports a robust ecosystem in Chukchi Sea.

Determining Particle Abundance, Size, and Composition in the North Bering and South Chukchi Seas During an Earlier Spring Melt

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Presenter: Stephanie O'Daly

The Northern Bering and Southern Chukchi seas are estimated to be the most important sink of carbon in the Arctic. This area is also experiencing a longer ice-free season, which is predicted to get even longer with the poles warming twice as fast as the rest of the planet. It is critical to understand how earlier spring melting affects primary productivity, particle abundance, and carbon flux to the seafloor. Changes in these parameters could have widespread consequences in the global carbon cycle. In June 2017, as a part of the Arctic Shelf Growth Advection Respiration and Deposition (ASGARD) project I used a combination of two in situ optical imaging instruments to enumerate particles in the water column. The underwater vision profiler (UVP) images in situ particles in a slice of seawater. Data on particle size (60 μm through several cm), depth, and particle density within the water column is recorded and can be used to determine particle type (detrital aggregate, fecal pellet, zooplankton, or phytoplankton). The laser in situ scattering and transmissometry (LISST) instrument measures percent transmittance of light through 5 cm of water and the angles at which this light is scattered in the forward direction. This information can be used to estimate particle size ranging from 2.5 to 500 μm . Together, these instruments allowed for the construction of the particle size distribution over a wide range of sizes. I also filtered water from various depths through 0.7 μm Whatman glass fiber filters and 0.3 nucleopore filters for Carbon, Hydrogen, and Nitrogen (CHN) and suspended particulate matter (SPM) analysis. Higher levels of SPM were observed in the south Chukchi Sea compared to the north Bering Sea and higher levels further from the coastline. I also found higher levels of SPM deeper in the water column. This supports the hypothesis that the area is an important location of carbon deposition on the sediments. These results help shed light into the impacts of an earlier spring ice melt on particle flux this region of high benthic productivity.

Growth of Calanoid Copepods on an Arctic Shelf

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Copepods are a key component of secondary production in the marine pelagic ecosystem, and therefore estimating their potential growth aids in our understanding of the dynamics of this system. Experiments were conducted during June 2017 in the northern Bering and southern Chukchi Seas to determine growth rates of the populous copepod species using the artificial cohort method. Samples collected from nine sites were incubated for 10 days, then processed to determine changes in size and copepodite stage. The copepod communities consisted primarily of *Neocalanus flemingeri*, *Calanus marshallae*, *Pseudocalanus* spp., and *Metridia pacifica*. *Calanus* and *Pseudocalanus* were numerous enough for all copepodite stages to determine growth rates. In experiments averaging 4° C with a wide range of chlorophyll concentrations weight-specific growth rates for *Calanus marshallae* were estimated to be between 4% and 17% /day, and were typically half of that for *Pseudocalanus* spp.. These estimates compare favorably to estimates made for the Gulf of Alaska, but differ notably from those predicted using the Hirst equations. Clearly, direct rate measurements are still essential to understand production dynamics in high latitudes.

Innovative Technologies to Advance Ocean Observation

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In a region where ice rules, monitoring ecosystem change as it occurs is a challenge. Traditional ship, satellite, and mooring based data collection techniques are the backbone of oceanographic research. However, in this new frontier, autonomous vehicles and novel sensors are being developed to supplement traditional observation infrastructures. Growing interest in conducting such challenging U.S. Arctic research led NOAA's Pacific Marine Environmental Laboratory (PMEL) to establish a collaborative science and engineering program, Innovative Technology for Arctic Exploration (ITAE) to design instrumentation specific to the big, remote, and harsh region. The mission of the ITAE program is to conceptualize and build effective research equipment for the assessment of the Arctic environment and ecosystem with the operation of high-resolution sensors on autonomous platforms. Since 2015, we have collaboratively tested ~15 technologies and platforms in support of advancing ocean observation in the U.S. Arctic. Platforms used for testing include autonomous sailing vehicles, moorings, floats and gliders. Here, we provide an overview of the technologies used, their evolution, and successes (and failures), throughout 2017.

Physical and Biological Drivers of Variability in Epibenthic Communities Along the Aleutian Archipelago

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Presenter: Aaron Bland

Physical and biological drivers can influence the structure of coastal epibenthic communities. These communities contribute to the functioning of their ecosystems by receiving carbon that sinks to the bottom and in turn feeding higher trophic levels. Here, we examine the spatial variability of offshore epibenthic communities along the Aleutian Archipelago and their potential relationships to the local physical environment, onshore invertebrate abundance, and drift algal subsidies. Onshore and offshore communities at an island share physical characteristics of the island, such as water mass characteristics, which may be more important in influencing the distribution of certain taxa than onshore-offshore differences, such as differing depths or substrate types. Additionally, relative abundance of certain taxa within offshore communities may be related to their relative abundance within onshore communities. Furthermore, onshore kelp forests may provide an important food resource to offshore communities in the form of drift algae. It is unclear whether specific physical and biological onshore features affect offshore epibenthic community structure. We assessed epibenthic communities (biomass and abundance) at 39 offshore sites across 12 islands throughout the Aleutian Archipelago using a plumb staff beam trawl. Sediment grabs at trawl locations provided information on bottom sediment characteristics, and a geographic information system provided local physical habitat conditions such as distance to shore and continental shelf width. Dive surveys provided information on onshore invertebrate abundance and kelp density with respect to these sites. We matched the offshore and onshore community data to examine how the local physical environment, onshore invertebrate abundance, and drift algal subsidies may explain the variable nature of Aleutian offshore epibenthic communities.

A Multi-Faceted Approach to Understanding Salmon Bycatch in the North Pacific Ocean

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Salmon bycatch is a controversial and difficult problem in North Pacific trawl fisheries, with large potential ecological and economic consequences. Hundreds of stocks of Chinook (*Oncorhynchus tshawytscha*) and chum (*Oncorhynchus keta*) salmon are incidentally caught throughout the fishing seasons in the eastern Bering Sea and Gulf of Alaska. Developing a more coherent understanding of the factors influencing stock-specific bycatch risk is necessary. However, the complexity of this multi-stock, multi-age class problem requires a similarly multi-faceted approach to understand how environmental or other factors may influence which salmon are caught when and where, and how these catches may impact their respective adult returns to freshwater. Researchers at NOAA's Alaska Fisheries Science Center are integrating multiple types of data and expertise to build models that lead to a better understanding of the impacts of salmon bycatch on different regional stock groupings and cohorts. By combining data from genetic stock compositions, scale-based ages, trawl fishery observers, coded-wire tags (CWT) (stock and age), fleet movements (from observers and vessel monitoring systems), and environmental information, we are working towards a next generation of spatiotemporal models that will provide 1) finer-scale resolution for adult equivalency models that estimate the impacts of bycatch on specific cohorts of salmon populations that would have returned to rivers along the Pacific rim, and 2) an exploration of the feasibility to predict bycatch compositions within fishing seasons. We illustrate here the types and potential utility of available datasets to emphasize the value of this large collaboration for combining a suite of genetic, age, CWT, and fleet experts, and next

generation statistical modeling. Together, this body of effort moves us towards applied solutions for a multitude of management topics of concern to the North Pacific Fishery Management Council, and to subsistence and commercial fisheries.

Does Canopy Matter? Characterizing Patterns of Net Community Production Across the Aleutian Archipelago

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Fluctuations in the abundance of species that serve as ecosystem engineers can have dramatic impacts on primary production, biodiversity and nutrient cycling across a range of habitats. An example of this in the Aleutian Archipelago, where the loss of the annual canopy forming kelp, *Eularia fistulosa*, and the transition to urchin barren grounds has been linked to shifts in marine and terrestrial ecosystem functioning, biodiversity and carbon cycling. Over the course of two summers, we quantified differences in net community production (NCP) and benthic diversity across 12 islands spanning the Aleutian Archipelago. We used experimental collapsible benthic incubation tents (CBITs) to quantify in situ fluctuations of dissolved oxygen in fixed volumes of water across three habitat types; kelp forests, urchin barren grounds, and the transition zones between the two. CBIT deployments were coupled with habitat sampling in each habitat in order to quantify differences in benthic diversity. Linkages between NCP and benthic diversity across several degrees of longitude are presented here. While the presence or absence of macroalgae affects seawater dissolved oxygen (DO), abiotic factors such as available sunlight and temperate may have a disproportionate impact over the contribution from benthic macrophytes. Further, biogeographic breaks in productivity may also indicate differences in NCP; islands in distinct bioregions may group more closely together than the prediction of habitat type alone. Working under the assumption that the presence or absence of canopy forming kelp can be a sole predictor of ecosystem function and health may prove inaccurate. However, understanding large-scale changes species distributions and abundances is paramount to their proper management and conservation, which the results from this study can directly inform.

Documenting Alaska's Marine Invertebrate Diversity: Perspectives and Prospects From the University of Alaska Museum's Research Collections

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The University of Alaska Museum of the North (UAMN) is home to tens of thousands of marine invertebrate specimens collected from the waters around Alaska and beyond over the past century. Collection holdings include specimens collected off Point Barrow in the 1940s, samples collected after the Exxon Valdez oil spill, and significantly, all the specimens that were previously part of the Auke Bay Laboratories research collections. We have a large quantity of samples derived from various field sampling efforts, a substantial proportion of which can be linked to records such as cruise reports and field datasheets. Specimen records for all UAMN holdings are created, curated and maintained in Arctos (<https://arctos.database.museum>), a web-based relational database that hosts catalogs from over 130 natural history collections. Arctos databases can be explored and obtained by the public using a feature-rich search interface with geography, taxonomy and time filters. Efforts are currently being made to digitize all legacy specimen records. There are currently approximately 18,000 records online, with more being added daily. Well-sampled regions include the Gulf of Alaska (~5,000 records), Southeast Alaska (~4,000 records), the Bering Sea (~4,000 records) and the Arctic Ocean (~2,500 records). Major taxa represented in our collection include molluscs (~9,000 records), arthropods (~4,000 records), echinoderms (~1,500 records), and polychaetes (~1,000 records). These specimens are available for loan for research purposes. Most specimens have been previously fixed in formalin and are valuable for taxonomic and ecological studies that rely on well-preserved morphology. Recent refinements in DNA molecule capture technology suggests all or most of these specimens will also be useful in genetic research. The UAMN Marine Invertebrates collection is also a growing repository of voucher specimens and frozen tissues samples available for genetic analyses.

Regional Differences and Potential Future Shifts in Mercury Biomagnification in Arctic Marine Food Webs

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Predictive tools and a large new dataset were used to help identify regional differences and potential future shifts in the magnitude of Hg biomagnification in Arctic marine food webs. Data for both total mercury (THg) and monomethylmercury (MMHg) in muscle tissue and whole organisms were obtained for phytoplankton, zooplankton, 9 species of invertebrates plus Arctic cod from the northeastern Chukchi Sea (NECS). Concentrations and % MMHg increased by > 150-fold and from < 10 to > 85%, respectively, from phytoplankton (< 1.5 ng/g) to muscle in the whelk *Plicifusus kroeyeri* (279 ng/g, TL 4.5). The trophic magnification slope (TMS) for MMHg ($\log_{10}[\text{MMHg}] = \text{TMS}(\delta^{15}\text{N}) + b$) was 0.23 ± 0.02 for biota from this study. No significant differences in TMS were found for the NECS and other studies from the eastern Canadian Arctic; however, regional differences in MMHg concentrations were identified based on results from an ANCOVA that showed statistically different ($p = 0.001$) intercept values and lower concentrations of MMHg in biota from the NECS relative to the same species from the eastern Canadian Arctic. Future changes that affect bioaccumulation of MMHg in the Arctic may impact the biomagnification equation by changing the TMS, intercept or both. The intercept is more likely to respond to future changes in productivity and concentrations of dissolved Hg whereas the TMS may respond to growth rates that change in response to fluctuations in productivity and food availability. Therefore, small changes in the intercept or TMS can yield predictably large increases or decreases in MMHg concentrations in apex predators.

The Argos Alliance: Working Towards Keeping the Critical Argos Wildlife Tracking System Viable

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The continued viability of Argos, one of the most important global wildlife tracking systems used since 1978, is in extreme jeopardy. The Argos Alliance of users and manufacturers was formed to address this challenge and to provide a voice to the scientific community in ensuring support for an essential tool for ecological studies. The Argos satellite telemetry system locates and collects data from mobile transmitters, and is dedicated to scientific, environmental and human safety applications. Argos platform transmissions are received by satellites in polar Low Earth Orbits (LEO). These features make the Argos system uniquely suited for wildlife telemetry studies: (1) global coverage, (2) low power required to reach LEO satellites, (3) burst transmissions as short as 1/8 second without a handshake requirement can yield data and locations even under difficult circumstances, such as infrequent short surfacing in aquatic species, (4) ultra-miniaturized transmitters under 3 grams are available. Argos currently uses receivers aboard six LEO satellites: four are operating many years past their design life, two satellites have a design life into early 2018. Only two replacement missions are currently scheduled to fill a potential complete gap in coverage in 2018. These new satellites would become operational in mid-2018 and early 2019. A U.S. launch carrying an Argos 4 receiver has been delayed due to funding cuts. If a funded launch schedule for the Argos 4 receiver is not established, as the existing overaged satellites fail coverage could drop to just two of three minimally required orbits, resulting in increased latency and reduced data recovery opportunities. This may critically limit functionality of a telemetry system key to essential ecological studies. The Argos Alliance seeks the input, participation and support from the Scientific Tagging Community towards keeping Argos viable!

Bridging the Gap Between Mechanistic Understanding and Climate Projections: An Example Based on the Alaska Climate Integrated Modeling Project

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As the international scientific community strives to provide policy relevant scientific advice with respect to the implications of climate change on marine ecosystems, the need for mechanistic understanding of physical-biological couplings is critically important. This presentation will illustrate how results from a large interdisciplinary interagency partnership are being used to inform climate change projections for the southeastern Bering Sea ecosystem. In 2007, the North Pacific Research Board, the National Science Foundation and the National Marine Fisheries Service partnered to conduct an integrated study of the Bering Sea ecosystem. The results of this multi-million dollar research effort provided several new insights into the processes governing recruitment, growth, and predator prey interactions. This talk will describe the evidence for these mechanistic linkages and discuss how the mechanisms are formulated to drive the Alaska Climate Integrated Modeling (ACLIM) projections of climate change impacts on the Bering Sea. The structure of the ACLIM project is designed to quantify scenario, parameter, and structural uncertainty through a multi-model projection suite across a range of ecosystem complexity. This talk focuses on parameter uncertainty and model complexity. The paper serves as a starting point for the discussion of how best to quantify and communicate the full range of uncertainty associated with projected impacts of climate change impacts on marine fish and fisheries.

Large Zooplankton Abundance as an Indicator of Walleye Pollock Recruitment in the Southeastern Bering Sea

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Interannual variations in large zooplankton abundance (sum of the most abundant large taxa, typically important in age-0 pollock diets) were compared to age-1 and age-3 walleye pollock (*Gadus chalcogrammus*) abundance for year classes 2002-2012 and 2014 on the southeastern Bering Sea shelf. Data were collected on BASIS fishery oceanography surveys during mid-August to late September for warm (low sea-ice) and cold (high sea-ice) climate stanzas. A positive significant linear relationship was found between mean abundance of large zooplankton during the age-0 stage of pollock and estimated abundance of age-1 and age-3 pollock. Increases in sea-ice extent and duration were associated with increases in large zooplankton abundances, increases in large copepods and euphausiids in pollock diets, and increases in age-0 pollock lipid content. Our results suggest that increases in the availability of large zooplankton prey during the first year at sea were favorable for age-0 pollock overwinter survival to age-1 and recruitment into the fishery at age-3. If the relationship between large zooplankton and age-1 (age-3) pollock remains significant, the index may be used to predict future recruitment success of pollock one (age-1) to three (age-3) years in advance. This provides support for the revised oscillating control hypothesis that suggests as the climate warms, reductions in sea-ice (and reduced availability of ice-associated algae, an early spring food source) could be detrimental to large crustacean zooplankton and subsequently to the pollock fishery in this region.

Using Conceptual Modeling and Participatory Science to Investigate Pribilof Islands Blue King Crab

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Fisheries management can be both complex and contentious, particularly for data-poor stocks. A conceptual modeling approach can be applied where quantitative data are scarce and/or interdisciplinary questions require input from disparate information sources. Moreover, conceptual models are well suited for collaborative science because expert opinion and local and traditional ecological knowledge can be integrated and visualized. In the present study, we use stakeholder meetings to create conceptual models to explore issues in a coupled human-marine ecosystem involving Pribilof Islands blue king crab (PIBKC). In the Pribilof Islands, protections for the depleted PIBKC stock impact management of other fisheries and consequently human use of the nearshore environment. We asked meeting participants to construct conceptual models of the PIBKC human-ecological system to understand how key ecological, human, and environmental variables could explain the lack of PIBKC stock recovery. Additionally, we conducted pre- and post-meeting surveys of the participants. Our results show some similarities in the way stakeholders perceive the ecosystem but the number of linkages differs widely among individuals. Surveys indicate that stakeholders responded positively when contributing toward group dynamics and felt a stronger personal connection to the issue. Overall, the integration of participatory science in the PIBKC discussion can provide benefits to management, empower stakeholders, and help guide future research to support recovery of the species.

Developing Stable Isotope Fingerprinting of Bivalve Shells to Detect Long-Term Changes in Organic Matter Sources into the Arctic Marine Ecosystem

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Benthic invertebrates are a crucial link in trophic energy transfer in the Arctic Ocean. However, the organic matter sources sustaining these organisms are not well understood. As filter feeders, they could theoretically feed on sinking particulate organic matter from sea-ice algae, phytoplankton, terrestrial organic matter eroded from the coastal environment, or microbially reworked organic matter. The proportional contribution of each of these sources to Arctic benthic organisms is currently not clearly known, and might additionally undergo significant shifts as the Arctic environment changes in the future. We are applying stable carbon isotope fingerprinting of essential amino acids preserved in bivalve shells as an archive to identify temporal variation in the proportional input of organic matter sources in benthic invertebrate species. We have analyzed *Serripes* spp. and *Macoma* spp. shell and muscle samples collected from 2004 to 2015 in the Chukchi and Beaufort seas. A comparison of the isotopic signatures preserved in these species revealed that they obtained their essential amino acids from very different primary sources. We also found that the signatures from muscle samples were similar to those from the shells, implying that shells from the fossil or archaeological records could be used to examine long-term changes in organic matter sources into the Arctic marine ecosystem. Future directions will include analyses of archaeological bivalve samples from Barrow, Alaska, to establish a pre-industrial baseline. Identifying how organic matter pathways have changed both over long timescales and in recent years will yield a better understanding of how current changes are altering the Arctic ecosystem.

The Cold Pool Refuge: What an Atypical Warm Stanza and Recent Cooling Reveal About Ecosystem Structure and Walleye Pollock in the Eastern Bering Sea

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The southeastern Bering Sea shelf experienced unprecedented warming from 2014 to 2016. Ecosystem observations from this most recent warm stanza included sea surface temperatures as high as 15°C, the presence of coccolithophore blooms, reduced abundances of lipid-rich copepods, and an eastward shifted distribution of young-of-the-year (YOY) walleye pollock (*Gadus chalcogrammus*) with moderately low energetic content. These observations indicated that YOY walleye pollock would experience increased susceptibility to over-winter mortality. Despite these warning signs, significant declines in the pollock population did not occur. Evidence from ecosystem surveys indicated that warming in 2015, the second year of the 3-year stanza, was atypical relative to 2001-2005, 2014, and 2016. Specifically, an intense cold pool north of the

Pribilof Islands was found to harbor Arctic ice algae, a population of large, lipid-rich copepods, and age-0 and age-1 pollock. Accordingly, YOY pollock were able to sufficiently provision to buffer the strong over-winter mortality predicted from a warm-stanza trophic cascade. In 2016, Bering Sea warming conditions returned to typical patterns but a residual euphausiid standing stock from 2015 provided a modest prey base to foraging YOY pollock. Presently, the Bering Sea is entering a cooler period, with spring 2017 sea-ice covering much of the southern shelf and into Bristol Bay. Latent heat from the previous warm stanza precluded further cooling to cold year levels. We present integrated ecosystem data (e.g., oceanography, chlorophyll-a, rapid zooplankton analysis, and fish condition), from limited sampling in 2017. We evaluated the condition of the 2017 walleye pollock cohort in the context of new, emerging cooling over the Bering Sea shelf with implications for survival and recruitment success.

Issues with the Co-Existence of Commercial Fisheries and Steller Sea Lions in the Western Bering Sea and the Waters Surrounding East Kamchatka

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The western Bering Sea (WBS) and East Kamchatka (EK) waters represent important Steller sea lion (SSL) habitat as well as globally important fishing grounds for commercial fisheries that target one of the sea lion's primary food sources. We analyzed the fishing activity of six of the most important commercial groundfish species in the region (FAO zones 6101, 6102 and 6701) for a 10-year period (2004-2013) using a dataset of 396,591 mandatory daily catch reports (DCR) sent by 689 fishing vessels to the state electronic database. Each report contained data on catch volume by species, gear type, and vessel position at the time the report was transmitted. We accepted this position as a reported catch position. The fishing fleet was diverse with boats of different size and capacity. The number of vessels involved in the groundfish fishery ranged from 293 to 378. The total time worked in the fishing ground was ~175,000 vessel days or 15,000-22,000 thousand vessel days per year. The cumulative catch of six groundfish species for 10-year period was > 6 million t, of which 83% was pollock, 7% Pacific cod, 3% each of herring, Atka mackerel, and flounders, and ~1% halibut. Almost 73% of combined catch and 82% of pollock removal occurred in WBS (FAO zone 6101). A total of 235 types of fishing gear were used, but about 76% of total catch was made by mid-water trawls and 15% by snurrevad. About 50% of all fishing effort occurred in zone 6101, while 18% occurred in sub-zone 6102.1 and 32% in subzone 6102.2. Approximately 41% of fish was removed from coastal waters within 30 nautical miles (nmi) from shore (Steller sea lion (SSL) habitat) and about 31% within 30 nmi of SSL terrestrial sites. Fishery intensity varied widely (e.g., in FAO zone 6102.2 between 92% and 99% of total catch volume of each commercial groundfish species was removed from the SSL habitat). Besides intensive food competition between SSLs and commercial fisheries, sea lions are also killed in fishing gear as bycatch, or found in ghost nets. Collectively, these threats continue to hamper the recovery of Steller sea lions in Russia.

The Relative Importance of Bottom-Up and Top-Down Drivers Explains Recruitment Variability of Walleye Pollock in the Eastern Bering Sea

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Understanding drivers of recruitment variability in marine fishes increases our ability to project cohort strength under future climate conditions. In the eastern Bering Sea, bottom-up processes shape foraging landscapes that ultimately determine the energetic condition and overwinter survival of juvenile fish (e.g., walleye pollock, *Gadus chalcogrammus*) while top-down pressures through predation and cannibalism act differentially to structure recruitment success. We utilize empirical observations between 2003 and 2014 and retrospectively develop indices of spatial overlap between juvenile pollock and (i) foraging landscapes and (ii) predator abundances to help explain recruitment variability across thermal stanzas in the eastern Bering Sea. The indices of spatial overlap highlight differential contribution of bottom-up and top-down pressures in warm and cold stanzas, respectively. This work is complementary to bioenergetic modeling efforts presented by Jarvis et al. that examines spatially-explicit growth potential of juvenile pollock that can inform how discrete spawning populations may contribute disproportionately to the adult population of pollock on the eastern Bering Sea shelf.

Spatial and Temporal Variability in Growth of Age-0 Walleye Pollock in the Eastern Bering Sea: a Hindcast Analysis Across Contrasting Climate Stanzas

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Understanding drivers of recruitment variability in marine fish increases our ability to project cohort strength under future climate conditions. For walleye pollock (*Gadus chalcogrammus*), variability in recruitment relates to juvenile growth and survival, which is driven in part through bottom-up processes. These processes, such as temperature, prey availability and quality, mediate growth which can be a proxy of survival. The eastern Bering Sea (EBS) experiences multiple-year climate stanzas of above (warm) and below (cold) average thermal conditions. In warm conditions, age-0 pollock consume lower quality prey and therefore experience reduced energetic condition and subsequent reduced overwinter survival success, while cold conditions result in higher quality prey for pollock and increased energy densities, leading to increased growth and survival. Here, we used a spatially explicit bioenergetic modeling approach, including local predator and prey energy densities, to estimate potential growth ($g \cdot g^{-1} \cdot d^{-1}$) of age-0 pollock in the EBS across years (2003-2014). This period includes a cold stanza bracketed by two warm stanzas. Results show that in warmer conditions, age-0 pollock experienced lower growth rates compared to conspecifics in colder conditions. Also evident were growth 'hot spots' indicating differential growth conditions across the EBS shelf; discrete spawning populations may therefore contribute disproportionately to the adult population of pollock in the EBS. This work is complementary to modeling efforts presented by Siddon et al. that describe the relative contribution of bottom-up and top-down mechanisms of age-0 pollock survival over the time series.

Biological Drivers of Total Mercury and Methyl Mercury Concentrations in Subsistence Fish from Kotzebue Sound

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The community of Kotzebue relies heavily on subsistence foods from the marine environment, including several species of fish. Due to the concern surrounding mercury (Hg) levels in their fish, the Native Village of Kotzebue (AW) requested continued Hg monitoring of important subsistence fish resources commonly caught and consumed from Kotzebue Sound. We address total Hg concentrations ([THg]) and the neurotoxic monomethyl Hg concentrations ([MeHg⁺]) that accumulate in fish reaching concentrations of concern in some higher trophic feeding individuals. We examined a total of 241 fish representing eight species, donated by subsistence fishers from Kotzebue. We measured [THg] as well as stable isotopes of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) in muscle samples to help assess the role of feeding ecology on [THg]. We also measured [MeHg⁺] in muscle from a subset of fish ($n = 101$, representing five species) to test the assumption that the majority of Hg in fish fillets is in the MeHg⁺ form. Across all samples, unadjusted [THg] ranged from 3 to 235 ng/g of wet weight (ww). As expected, sheefish (*Stenodus leucichthys*), a large and widely-consumed fish, contained the highest mean [THg] (85 ng/g ww), while Pacific herring (*Clupea pallasii*) contained the lowest mean [THg]. The [THg] positively and significantly increased with fork length (~proxy for age) in sheefish, Bering cisco (*Coregonus laurettae*), starry flounder (*Platichthys stellatus*), Pacific herring, and tom cod (*Microgadus proximus*). Similarly, [THg] positively and significantly increased with increasing $\delta^{15}\text{N}$ values (~trophic position) in sheefish, Bering cisco, starry flounder, Pacific herring, but also in whitefishes (*Coregonus* spp.). In agreement with expectations, MeHg⁺ represented an average of ~90% of Hg present in fish muscle tissue regardless of trophic position. These data demonstrate that fish from Kotzebue Sound are accumulating Hg, it appears to be magnifying with increasing trophic position of the fish, and that regardless of trophic position of the fish, the majority of Hg found in the fish is found in the form of MeHg⁺. These data have been provided to the State of Alaska Veterinarian for inclusion in the state's fish monitoring project for future inclusion in exposure and risk assessments.

Fine-Scale Patchiness of Steller Sea Lion Prey Items in the Aleutian Islands and Its Influence on Diet and Foraging Efficiency

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The spatial distribution and density of prey items helps define the foraging efficiency of Steller sea lions (*Eumetopias jubatus*). From the perspective of a Steller sea lion, the availability of prey items can generally be regarded at two spatial scales: 1) a coarse scale (1-10 km²), which dictates how far and where an individual needs to travel to find abundant prey items and 2) a fine-scale (1-100 m²), which influences the success of an individual dive. Most research has focused on the distribution and density of prey at a coarse scale as this represents the scale at which most fish data has historically been collected. In this study, we use data from 280 towed stereo camera hauls to provide fine scale information on fish densities in the Aleutian Islands during summer months. Several methods are explored to quantify the patchiness of Steller sea lion prey items from towed camera data. Preliminary results suggest that fish that are more commonly observed in SSL diets such as Atka mackerel (*Pleurogrammus monopterygius*) and rockfish species (*Sebastes* sp.) are those with higher patchiness values (i.e., less likely to be randomly distributed). We examined patchiness values with respect to depth, bottom type, and distances from shore, rookeries, and passes. This will lay the groundwork towards creating a predictive model of fine-scale fish patchiness and associated biomass of Steller sea lion prey items.

Seasonal Distribution and Relative Abundance of Steller Sea Lion Groundfish Prey in the Aleutian Islands

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Groundfish stocks in Alaska are managed at large scales (i.e., hundreds of km); however, important ecological interactions, such as predation, spawning and habitat selection occur on local scales (i.e., tens of km). Furthermore, commercial fishing is an activity with potential for localized effects. In 1997, the Aleutian Island's western stock of the Steller sea lion (*Eumetopias jubatus*) population was declared endangered. One of the hypotheses for their decline was competition between the commercial groundfish fishery and Steller sea lions for prey. In order to better understand the effects of fishing on a local scale we assessed Steller sea lion prey distribution around rookeries and haulouts in the western and eastern Aleutian Islands during the fall and winter. The focus was primarily the dominant prey, Atka mackerel (*Pleurogrammus monopterygius*); we conducted a large-scale tagging study to estimate local abundances and movement and exploitation rates of Atka mackerel near Steller sea lion rookeries and haulouts in areas of commercial fishing activities at scales relevant to sea lion foraging (i.e., tens of km). We also examined prey distribution patterns and relative abundance of northern rockfish (*Sebastes polyspinis*), Pacific cod (*Gadus macrocephalus*), Pacific ocean perch (*Sebastes alutus*) and walleye pollock (*Gadus chalcogrammus*). We related fish distribution and relative abundance to several metrics such as distance to rookeries and haulouts and environmental variables such as depth and temperature. We compared results from the western Aleutian Islands, where sea lion populations continue to decline, to a location in the eastern Aleutian Islands, where sea lion populations have been stable. Results for example showed that Atka mackerel showed some movement at smaller scales but no significant movement between management areas. Total abundance, average size, and catch per unit effort (CPUE) of Atka mackerel was lower in the western Aleutians, whereas relative abundance of northern rockfish was higher. The results of these studies contribute to an improved understanding of interactions between sea lions and groundfish and the commercial fishery.

Fish Surveys and Culvert Assessments on Adak Island

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Presenter: Jeanette Alas

Streams and culverts along the road system on Adak Island, Alaska, were sampled for freshwater and anadromous fish species and to assess stream crossings for fish passage. Fish sampling included 30 minnow trap events, 19 backpack electrofishing events with a SmithRoot LR 24, and on the ground visual observations. Seventy-six stream crossings were assessed, which included documenting the culvert type or crossing structure; measuring the culvert inlet or outlet and any perched culverts; documenting any potential velocity or other barriers to fish passage; and photo documentation of the inlet and outlet, inside the culvert, and habitat upstream and downstream of the culvert. A Garmin 64 handheld GPS was used to record the position of all fish sampling events, culvert locations, and to mark currently cataloged stream mouths and upstream extents of anadromy ending with a natural or man-made barrier. Fish survey data will be used to update the Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes and its associated Atlas and the Alaska Freshwater Fish Inventory Database. Culvert survey data will be used to update the Fish Passage Inventory Database. All database updates will include the online Fish Resource Monitor. A prioritized list of recommended culvert improvements will be developed in order to maximize the benefit of increased habitat for salmonids.

A Seascape Scale Fishing Impacts Model to Assess Tradeoffs Between Spatial Closures and Gear Modifications

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Managing fishing impacts to benthic habitats is a necessary component of sustainable fisheries management. Spatial closures and technological solutions such as gear modifications are two tools fisheries managers employ to minimize habitat impacts. Forecasting the effectiveness of these policies among complex multigear fisheries and habitats requires a quantitative framework to evaluate habitat impacts. We developed a model specifically to meet the needs of fisheries managers that incorporates high resolution information on fishing locations and habitat characteristics to produce spatially and temporally explicit estimates of habitat impacts. We implemented the model in the North Pacific using historic fishing data and habitat distribution maps to assess the current state and recent trends of habitat impacts. Finally, we used the model to simulate scenarios to evaluate the tradeoffs between spatial closures and gear modifications for habitat management. We found that the reallocation of fishing effort, the degree to which fishing events overlap, and relative habitat sensitivities are all integral components for evaluating tradeoffs between spatial closures and gear modifications for habitat management.

Genetic Analysis of Mating Dynamics of Snow Crab in the Eastern Bering Sea

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Snow crab (*Chionoecetes opilio*) in the eastern Bering Sea (EBS) support the largest and most valuable crab fishery in Alaska. This fishery is managed with large male-only harvest policies, yet little is known about the influence of male-only harvest on female reproductive output. Indicators of female reproductive potential that integrate information on mating success are needed to improve upon the proxy for stock productivity, mature male biomass, currently used in management. Female sperm reserves are a direct indicator of mating success between the harvested portion of the stock and female contribution to population renewal processes. Evaluating spatiotemporal trends in female sperm reserves has provided critical insight into functional relationships among female reproductive potential, maternal characteristics, and mating success. However, interpretation is hampered by a lack of empirical information on contributing male mates, including the extent to which interspecies mating occur, as evidenced by the presence of viable snow-Tanner hybrid crab in the EBS. Our research approach is to determine the extent of snow crab polyandry, multiple paternity, and interbreeding between species using genetic methods. We will develop and validate genetic markers and determine the number and species of males contributing to sperm reserves of primiparous and multiparous snow crab in the EBS and the paternity of the embryos brooded by those females. These data will allow for better understanding of spatiotemporal trends in sperm reserves and fecundity in relation to the relative abundance and distribution of males by species and size-shell-maturity classes. That improved understanding is essential for development of measures or indices of effective spawning biomass or fertilized egg production for EBS snow crab, which would bring greater clarity to annual stock assessments and fishery management. This is the first year of our project, so we will present conceptual information on our goals and approach and summarize our progress and next steps.

Environmental Drivers of Spatio-temporal Variation in Arctic Nearshore Fish Community Composition

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The Arctic is facing imminent threats from climate change and the anthropogenic activities that accompany it. It is important that a thorough understanding of the functionality of Arctic marine ecosystems is established before these threats are realized so that future impacts or ecosystem injuries can be properly identified. Much work has been done in offshore regions of the Arctic Ocean, but the understanding of the role of nearshore habitats is lacking in comparison. Spatio-temporal changes in community composition may be the best indicator of ecosystem changes. However, in order to identify impacts and ecosystem injuries an understanding of the current community structure and variability associated with seasonal patterns and physicochemical factors must come first. Using catch data collected with beach seines (n = 178 hauls) during three consecutive summers (2013-15) at weekly intervals at 12 sampling stations around Point Barrow, AK, we identified distinct differences in the communities found in narrow shelf coastal beaches (Beaufort Sea), broad shelf coastal beaches (Chukchi Sea), and sheltered shallow lagoons (Elson Lagoon). We identified 7 major environmental, spatial and temporal factors responsible for approximately 40% of variability in community composition. Additionally, we investigate the influence of prey resources, such as phytoplankton, detritus, and zooplankton, as a driver in fish community structure. This information will help streamline future monitoring efforts and aid in identifying impacts of climate change or anthropogenic activities.

Juvenile Chinook Salmon Growth From the Yukon River to the Bering Sea

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Adult Chinook salmon (*Oncorhynchus tshawytscha*) returns to the Yukon River have declined since the mid-2000s, though they have rebounded slightly since 2014. The causes of such changes in abundance are unclear. Variation in adult returns is largely set by their fall abundance as juveniles in the northeastern Bering Sea, indicating adult stock size is strongly influenced by early marine and freshwater survival. While coping with the fresh-marine water transition, emigrating juveniles may increase survival through rapid growth. Growth is in turn likely influenced by emigration timing and environmental factors. Our objective was to describe differences in size and condition of juvenile Chinook in the lower Yukon River and the northeastern Bering Sea, and potential influences of diet and temperature. Juvenile Chinook were collected in 2014 – 2016 in summer from the lower Yukon River and fall from the northern Bering Sea, and measured for size, diet composition, and energy density. A lab study was conducted to independently estimate growth rates under a range of temperatures and feeding to satiation. Emigrating fish from the lower Yukon showed relatively consistent size ranges and energy densities through summer, with mean sizes differing slightly across years – largest in 2014 and smallest in 2015. Autumn fish in the Bering Sea showed a nearly 10-fold increase in average mass, also largest in 2014, and size-dependent increases in energy density. Relative abundances of Yukon and Bering fish were lowest in 2014, suggesting density-dependent effects on growth. The highest growth rates under lab conditions were insufficient to achieve the observed large sizes of Bering Sea fish, possibly due to the use of a non-Yukon stock, or a limited daily feeding time. Diets showed no clear causes of growth differences across years: Yukon diets were of similar mass with inconsistent monthly patterns in piscivory, while Bering Sea diets were similar across years. Northern Bering Sea temperatures were above average in all years, slightly higher in 2014 and 2016 than in 2015. Following the end of the cooler period from 2006 – 2012, juvenile abundances have increased, preceding the rebound in adult returns, suggesting warmer years favor juvenile survival.

Reexamining an Assumption About Marine Mortality of Chinook Salmon

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It has become dogma that processes in the nearshore environment during the early marine phase of Pacific salmon life history largely govern adult population dynamics. As a corollary, it is widely assumed that the risk of mortality decreases dramatically after the first winter in the ocean, the marine environment is relatively safe thereafter, and that effects in this 'late' marine stage have minimal impacts on population characteristics, including dynamics and life history traits. However, recent evidence of concurrent declines in size-at-age and age-at-maturity, as well as lower-than-predicted returns of older adults suggest that late-stage, potentially selective, marine mortality may be more frequent than currently assumed. To examine this 'late-stage' selective mortality hypothesis, we examined evidence of predation on large Chinook salmon from recent satellite tagging research. Diagnostic evidence of predation was revealed from depth, temperature and light records collected by the satellite tags. Taken as a whole, these data suggest that predation on relatively large adult Chinook salmon by "warm-blooded" and "cold-blooded" predators may be relatively common. These results indicate the need to further investigate late-stage marine mortality of Chinook salmon and its possible effects on the population dynamics and life history characteristics of this species, and Pacific salmon more generally.

Counting on Stomachs: Evaluation of Thin Sections from Potential Age Structures for Commercially Important Crabs in Alaska

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Age data can drastically improve stock assessments, estimates of biological reference points, and specification of sustainable harvest limits. While standard methods are available to produce age data for many fish and invertebrate species, none have been established for commercially important crustaceans. Recent research evokes age determination methods for decapod crustaceans based on banding in the endocuticle layer of the exoskeleton. Banding, potentially indicative of age, has been observed in the gastric mill ossicles and eyestalks of red king crab (*Paralithodes camtschaticus*) and southern Tanner crab (*Chionoecetes bairdi*). However, the exact structures to target for age determination, as well as efficient, cost-effective processing methods have yet to be established. Our goal is to describe optimal species-specific methods for producing and evaluating band counts for red king and Tanner crab. To do this, eyestalks and gastric mill ossicles (mesocardiac, zygo-cardiac, and pterocardiac) were removed, cleaned, embedded in resin, and comprehensively thin-sectioned across both structures and with different orientations. Sections were evaluated for readability to suggest the preferred structure(s), location(s) within structure, and section orientation and thickness for presence and clarity of bands. To do this, we used a mixture of linear and additive models to describe patterns across structures and species to find the area within each structure with the highest probability of readable sections. We found that both the mesocardiac and zygo-cardiac contained the highest proportion of readable sections, and the zygo-cardiac had the most sections with the best readability. Further analysis across structures suggested that most readable sections are located within 20-40% of the total length of the structure away from the proximal edge. Further work will evaluate whether band counts are related to crab size and terminal molt shell condition, which are indicators of chronological age.

Sampling Strategy Evaluation in Fish Populations with Spatially Structured Traits

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The stock assessment of commercially exploited fish populations relies on the estimates of abundance and life history traits, such as size and age. These data are mainly obtained from scientific surveys, posing the problem of which sampling strategy collects better information about the fish populations. We elaborated a sampling strategy evaluation (SSE) to compare two commonly used but contrasting sampling strategies in the collection of age data for fish populations: the random (RS) and the length-stratified (LSS) samplings. We applied the method on a fish population with spatially structured traits, namely the eastern Bering Sea (EBS) Pacific cod, which presents considerable size variability from the inner to outer shelf in the EBS. We started the SSE creating a virtual population by resampling survey historical data, which has the same statistical characteristics than the EBS Pacific cod in terms of spatial distribution, length frequency, age structure and spatial auto-correlation. Then, LSS and RS were simulated 500 times over the virtual population, following the same protocol used in the surveys and recreating the otolith reading error. Finally, the SSE compared the estimates of population age structure, mean and modal size-at-age and the ability to incorporate the spatial patterns of the population's traits. RS provided more accurate estimates when considering the spatial structure in EBS Pacific cod's size. We extended the SSE to different scenarios to test the effects of: 1) otolith reading error, 2) sample size, 3) temperature in the population structure, and 4) spatial patterns in size. Results showed that divergence in estimates might be partially derived from the otolith reading error. Temperature has a strong influence in the recruitment and growth of Pacific cod, with colder years showing stronger recruitment and well-defined year classes. Thus, the relative year-class strength also influenced the size frequency and size-at-age estimates, enhancing the divergence in the estimates between the two sampling strategies. Similar divergences were observed when differences in size due to spatial patterns are larger. RS captured more accurately the geographical patterns in spatially structured populations, and thus provided more accurate estimates.

Effects of Ocean Acidification on Young of the Year Golden King Crab (*Lithodes aequispinus*) Survival, Growth, and Morphology

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Ocean acidification, a reduction in the pH of the oceans caused by increasing carbon dioxide (CO₂), can have negative physiological effects on marine species. In this study we examine how CO₂ driven acidification affected juvenile golden king crab (*Lithodes aequispinus*), an important fishery species in Alaska. Juveniles were reared from larvae in ambient seawater at the Kodiak Laboratory. Newly molted first stage crabs were randomly assigned to one of three pH treatments: 1) Ambient (pH ~8.2), 2) pH 7.8, and 3) pH 7.5. Thirty crabs were held in individual cells in each treatment for 127 days and checked daily for molting or death. Molts and dead crabs were photographed under a microscope and measured using image analysis. Mortality was primarily associated with molting in all treatments, differed among all treatments, and was highest at pH 7.5 and lowest at ambient pH. Crabs at pH 7.5 were smaller at the end of the experiment, both in terms of carapace length and wet mass, had a smaller growth increment after molting, and had a longer intermolt period. Carapace morphology was not affected by pH treatment. Decreased growth and increased mortality suggest that lower pH could affect golden king crab stocks and fisheries. This result is puzzling, however, as golden king crab are a deep water species that are likely living at a pH that is significantly less than ambient surface pH. We hypothesize that the larval rearing conditions selected for individuals that were better adapted for high pH conditions. This would lead to juveniles that survived and grew best at high pH. Future work will examine if larval rearing conditions affect the juvenile response to low pH.

Genetic Stock Structure of Golden King Crabs in Alaska

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Golden king crabs (*Lithodes aequispinus*) inhabit deep waters along the Aleutian Archipelago and in the fjords of southeastern Alaska and support a substantial baited pot fishery. The goal of this study was to use genetic markers to define genetic stock structure that could potentially be used to improve stock assessments. The delineation of population boundaries is a crucial component of the harvest management of wild populations so that small vulnerable populations are not overharvested. Mitochondrial DNA ND5 sequence (643 bp) variability among 517 crabs from 13 sites showed a moderate level of haplotype diversity of $h = 0.670$ without any geographic trend. Significant haplotype-frequency differences appeared among populations ($F_{ST} = 0.344$, $P < 0.0001$), which were due to differences between populations on a scale of tens to hundreds of kilometers within regions ($F_{sc} = 0.314$, $P < 0.0001$). The analysis of 14 microsatellite loci in 1044 crabs from 19 sites revealed only moderate levels of heterozygosity ($HO = 0.605$ to 0.692) compared to other crustaceans. Significant allele-frequency differentiation appeared among samples ($F_{st} = 0.002$, $P = 0.003$) and was due to differences between Aleutian Island and southeastern Alaska populations ($F_{st} = 0.003$, $P = 0.0001$). No significant differentiation was detected between populations within the two regions. These genetic results support the present practice of managing regional Aleutian Island and southeastern Alaska populations separately, but do not support separate management units within the two regions. Nevertheless, harvest management should account for apparent structure among golden king crab populations on small geographical scales.

How Low Can You Go - Thiamine Levels and Survival of Yukon River Chinook Salmon

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Since 2007, Yukon River Chinook salmon (*Oncorhynchus tshawytscha*) returns have faced significant declines. The driving force behind this decline is still poorly understood; however, one possible explanation may involve thiamine deficiency. Thiamine is required for numerous body functions, including muscle and nervous system function, digestion, and the metabolism of carbohydrates, fats, and proteins. Thiamine deficiency has been demonstrated to be responsible for brood year failure in numerous salmonid populations and is often a result of shifting feeding habits. Total egg thiamine concentrations were measured for Chinook salmon returning to the Yukon River in 2014 and 2015 by fluorescence spectroscopy coupled with high performance liquid chromatography. The mean total thiamine concentration at most sites was less than 8 nmol/g of egg tissue during both years, a level well below minimal values for development. Potential impacts below these levels include reduced growth, poor feeding, diminished predator avoidance, and impaired immune function. From this study, it is clear that thiamine deficiency was present in Yukon River Chinook salmon from the 2014 and 2015 brood years. It is unclear how common thiamine deficiencies are among Chinook broods, but, if these data represent a transitory event then returns from the 2014 and 2015 broods may be depressed.

Impacts of Climate Change on Red King Crab Larval Advection in Bristol Bay: Implications for Recruitment Variability

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Mechanisms driving recruitment variability are poorly understood for Bering Sea crab stocks, including Bristol Bay red king crab (*Paralithodes camtschaticus*). Because red king crab larvae spend months in the water column and have specific habitat requirements upon settlement, the location of larval release relative to oceanographic processes and suitable juvenile habitat are likely important for determining recruitment success or failure in any given year. The nearshore area between Unimak Island and Port Moller in southwest Bristol Bay has been hypothesized as the population's most important spawning ground because post-larvae are thought to be most likely to reach favorable settlement habitat when hatched from this area. To test this hypothesis, we evaluated the importance of climate variability, oceanographic conditions, and mature female spatial distribution for larval advection trajectories by coupling a biophysical and oceanographic circulation model. Results suggest inter-annual variability of spawning location and hatch timing impact post-larval settlement success through changes in larval pelagic duration and oceanographic circulation patterns. Larvae were transported shorter distances when exposed to warmer conditions, which caused higher rates of local retention. Further, post-larvae reached optimal settlement habitat when hatched outside the southwest Bristol Bay region, suggesting that contemporary spatial distributions of ovigerous females are adequate for supplying early benthic phase recruits to the population. In the face of a changing environment, it is important to consider how other factors such as physiological tolerances to fluctuating abiotic conditions and large-scale ecosystem reorganization will interact to affect larval advection trajectories and impact future recruitment success for Bristol Bay red king crab and other Bering Sea crab stocks.

Comparing Numerical Integration Method for Constructing Size-Transition Matrix with Other Construction Methods

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Stock assessment methods for many invertebrate stocks, include stocks of crabs in the Bering Sea and Aleutian Islands region of Alaska, are based on size-structured population dynamics models. A key component of these models is the size-transition matrix, which specifies the probability of growing from one size-class to another after a certain period of time. Size-transition matrices can be defined using three parameters, the growth rate (k), the asymptotic height (L_{∞}), and the variability in the size increment. Most assessments use mark-recapture data to estimate the parameters and assume that all individuals follow the same growth curve. However, not accounting for individual variation in growth can result in biased estimators of growth parameters and it is unrealistic to assume that every individual has the same k or L_{∞} . Unfortunately, to date, the only way to compute the size-transition matrix when allowance is made for individual variation in growth is using simulation, which is both computationally very intensive and the resulting likelihood function is non-differentiable with respect to the estimated parameters. We outline an approach that uses a numerical integration technique that allows k and L_{∞} to vary among individuals. This numerical integration technique is compared to two other methods for creating size-transition matrices each with separate assumptions about individual variation in growth. The first assumes all individuals follow the same growth curve. The second assumes individuals follow one of three growth curves through the “platoon” method. This method divides the population into separate platoons, each with their own growth curve and size transition matrix. The three construction methods are compared through a simulation study that evaluates how each method performs when the simulated population either has or does not have individual variation in growth.

Nature Versus Nurture: Disentangling Cohort and Year Effects on Pacific Cod Size at Age in the Eastern Bering Sea

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Fish life history traits, including growth rate and size at age, change spatially and temporally. Characterizing and determining the source of this variability is important for monitoring and managing fish species that are commercially harvested. In the Bering Sea, stock assessments of Pacific cod – an economically and ecologically important groundfish – draw on the size at age relationship of the population. In previous analyses we have found that the size-at-age function of Pacific cod differ among individuals due to the effects of environmental and geographic variables (such as temperature and depth-related factors) on fish growth. We additionally found residual variation of size at age related to the year of birth (cohort effect) and the year of capture (year effect) of the individuals. Using mixed-effects models, we analyzed survey records of Pacific cod size at age spanning from 1994 to 2016 and characterized the year versus cohort-related sources of variability in their growth. Both of these effects cause interannual variations of cod size-at-age but their origins and implications are different. A year effect implies strong phenotypic plasticity, whereas a cohort effect implies either a genetic difference of individuals' life history traits, or a long-lasting plastic response on fish performance. We found that there is a consistent significant year effect, resulting in fish with 2-4 cm smaller size at age during the warm stanza of 2000-2005. We also found a similarly consistent and significant effect of year of birth (cohort) which was correlated with both the temperature and the geographic location experienced by the cohort during the first year of life. These results have implications for how Pacific cod respond and adapt to climate forcing and are instrumental to inform assessment and sampling strategies in the eastern Bering Sea.

Investigating Life History of Pacific Sleeper Sharks (*Somniosus pacificus*) and Salmon Sharks (*Lamna ditropis*) in the Bering Sea and Gulf of Alaska

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The Alaska Shark Research Group (ASRG) is investigating Alaska sharks' ecology and other life history information including diet, reproduction parameters, genetics, age, and morphometrics. This study will focus on Pacific sleeper sharks (*Somniosus pacificus*) and salmon sharks (*Lamna ditropis*) caught as bycatch in the Bering Sea and Aleutian Islands (BSAI) walleye pollock (*Gadus chalcogrammus*) trawl fishery. The BSAI walleye pollock trawl fishery is the largest fishery in the United States by weight. Historically, Pacific sleeper sharks are the primary elasmobranch bycatch species in the BSAI, followed by salmon sharks. Most of the Pacific sleeper sharks caught in the BSAI are immature; it is currently unknown how the fishery affects their recruitment. Overall, there is a considerable lack of data for shark species in the BSAI, making effective management of sharks very difficult. Ten Pacific sleeper sharks and one salmon shark were sampled from August through September 2017, in Dutch Harbor, Alaska. Morphometric data were collected on all specimens. Stomach contents were examined, white muscle tissue, liver, and fin clips were obtained for stable isotopes and fatty acid analyses for genetic and diet studies. Eye lenses and vertebrae were collected for age structure. The reproductive organs were dissected to evaluate maturity. Plans in 2018 are to continue sampling bycatch sharks from the BSAI walleye pollock trawl fishery landed in Dutch Harbor, Alaska, possibly expanding into the long-line groundfish fisheries, as well as, at-sea sampling on catcher-processor vessels to obtain a greater size range of sharks. Results from this study will help fill in large data gaps and could have fishery management implications.

Early Life History and Benthic Settlement of Crabs in Pribilof Islands Nearshore Habitat and Investigation of Bottlenecks in Recruitment for Blue King Crab (*Paralithodes platypus*)

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Pribilof Islands blue king crab (*Paralithodes platypus*) is the only overfished federally-managed commercial fishery stock in the North Pacific, and recruitment limitation could be a contributing factor to failed rebuilding efforts. We are studying blue king crab early life history to identify potential bottlenecks in larval settlement and early juvenile phase recruitment to the benthos. Field sampling in 2017 quantified larval supply and juvenile abundance with diver surveys and larval collectors located at new and historically sampled sites surrounding Saint Paul Island. Preliminary analysis suggests low abundance of blue and red king crab, while a variety of non-commercial crab species were abundant and ubiquitous in distribution including: family Paguridae, *Hapalogaster* sp., *Dermaturus mandtii*, *Oregonia gracilis*, and *Cancer oregonensis*. Divers conducted benthic habitat surveys at shallow (< 18 m) sites and video camera surveys at deeper (< 60 m) historically sampled sites to assess habitat structure, benthic community composition, and changes in substrate. Predation potential on juvenile crab was assessed with diver surveys for predatory benthic invertebrates and demersal fish while collection of Pacific halibut stomach samples (n = 85) from local, volunteer commercial fishermen was accomplished for a direct measure of crab consumption. Throughout the summer, oceanographic measurements (CTD) and zooplankton samples were taken by conducting oblique Bongo net tows (333 μ m mesh) to assess larval crab presence seasonally, stage development, distribution and abundance. Sample processing is currently underway. Early evidence suggests 1) supply of larval blue king crab is lower than previous estimates, 2) juvenile blue king crab shell hash habitat is available at the same sites that were surveyed in the 1980s and historically had high abundances of juvenile crab (Armstrong et al. 1987), and 3) predatory fish are present, though degree of predation on crabs is still to be determined. In 2018, we will continue to sample for blue king crab, assess historical sites for habitat change, and conduct experiments to infer predation pressure. This multifaceted approach will elucidate the mechanisms controlling the abundance and survival of young-of-year blue king crabs and evaluate whether lack of juvenile recruitment is occurring and limiting recovery of the Pribilof Islands blue king crab stock.

Remotely-Operated Towed Acoustic System for Observation of Fish Behavior in Front of Trawls

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Understanding fish behavioral response to approaching bottom trawls is important for research and commercial fishing. In commercial fishing, knowledge of fish behavior is used to improve trawling efficiency for desirable species while avoiding bycatch. Fisheries surveys need this knowledge to understand sampling efficiency, selectivity, and availability of different species to the trawl. However, fish behavior in front of the trawl is difficult to observe. In the past, trawl-mounted acoustic equipment and video cameras were used to make these observations. Video cameras have limited viewing range and fish likely react to the trawl outside of the range of cameras. Additionally, video cameras require artificial lighting which can affect fish behavior. Acoustic equipment has a much larger range, does not require artificial lighting, and is perceived as having no effect on fish behavior. The use of vessel-mounted acoustics to observe fish in front of the trawl is difficult because the trawl is usually located several hundreds of meters away from the fishing vessel, a distance that vessel-mounted acoustics can't readily capture. Other acoustic methods such as acoustic buoys have been used; however, these observations are temporally limited to a few minutes at most as the vessel and net pass the buoy. Because of these shortcomings of existing systems, we designed a new acoustic observation system which can be towed behind a trawling vessel and remotely steered to access all the locations between the vessel and trawl net. The remotely operated catamaran (ROC) is built on a catamaran platform and can be steered using a towing winch and an electric motor, which can change the tow angle. Thus, the ROC can be towed behind the vessel and moved to observe fish abundance, distribution and behavior in relation to the trawl. The ROC is equipped with acoustic instruments similar to the equipment currently used on the fishing and acoustic survey vessels to allow comparison of fish vertical distribution under the fishing vessel and the under the ROC. The ROC is also equipped with GPS and radio equipment for easy geolocation and communications with the operator on the fishing vessel.

Genetic Distinctiveness of Skate Nursery Sites in the Eastern Bering Sea

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Skate nursery sites have recently been designated as Habitat Areas of Particular Concern (HAPC) in the eastern Bering Sea. A research priority established by the North Pacific Fisheries Management Council in light of this designation is to examine the genetic connectivity of nursery sites for the Alaska skate. The goals of this approach are to determine the contribution of individual skate nursery sites to the genetic diversity of the entire population, and to determine if population structure exists among skate nursery sites in the eastern Bering Sea. We constructed Restriction-site Associated DNA (RAD) sequencing libraries for Alaska skate (*Bathyraja parmifera*) embryos from five sites in the Bering Sea and for Aleutian skate (*Bathyraja aleutica*) embryos from two sites in the Bering Sea. The sites are located in Pervenets Canyon, between Zhemchug and Pribilof canyons (Inter-Prib-Zhemchug-1 and Inter-Prib-Zhemchug-2), Pribilof Canyon, and Bering Canyon. Embryos were sampled from a range of years from 2006 to 2017, as well as a range of developmental stages (spanning 4 years). Experiments were designed to answer additional research questions, including whether temporal differentiation exists at nursery sites, whether relatedness differs among samples from the same and different nursery areas, and whether patterns of genetic structure differ among species. Comparisons of genetic distinctions between each nursery site and across broad regions of the eastern Bering Sea will provide guidance for developing conservation plans that strive to maintain genetic diversity and healthy skate populations.

Fishery Interactions with Skate Nursery Areas in the Eastern Bering Sea

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Fishery observers in the North Pacific Observer Program have been receiving training in the identification and sampling of skate egg cases since 2015. The goal of this training has been to support a North Pacific Research Board project examining the unique properties of skate nursery sites established as habitat areas of particular concern (HAPC) in the eastern Bering Sea and the interactions of fisheries with skate egg cases. During this 3-year project, over 500 observers received training in egg case identification and sampling, and recorded data on over 3,000 skate egg cases. A total of 10 skate taxa were identified from egg cases, and over half (64%) of the egg cases were identified as Alaska skate (*Bathyraja parmifera*). Observers scored each egg case as either “viable”, meaning it contained a developing embryo, or “non-viable”, meaning it was either empty or full of mud. Approximately 39% of the egg cases sampled by observers were classified as viable. During the three project years, over 200,000 skate egg cases were reported by observers in the eastern Bering Sea. The majority of those egg cases (65%) were encountered in bottom-trawl fisheries, primarily targeting arrowtooth flounder and Greenland turbot (*Reinhardtius hippoglossoides*). However, a large proportion of the egg cases (32%) were reported in longline fisheries, almost exclusively on vessels targeting Pacific cod. Egg case encounters were concentrated on the outer shelf of the eastern Bering Sea, particularly in the canyons. Over half of all egg cases reported were within 14 km of one of the six HAPC-designated nursery areas.

Does Fishing Disturbance Explain the Spatiotemporal Distribution of Structure-Forming Benthic Features Important for Red King Crabs in the Eastern Bering Sea?

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Many marine fishes and invertebrates use structure-forming seabed features during their benthic and demersal life stages. Local rugosity due to stationary biological, biogenic or geological seabed elements can serve as refuge from disturbance and predation leading to increased survival of prey and increased foraging opportunities for predators. For example, Pirtle et al. (2012) found that when exposed to predation, juvenile red king crab had higher survival rates in areas of high structure than in comparable areas with less structure. Structure-forming features can be disturbed or removed by bottom-tending fishing gears. Risk to exposure from fishing disturbance increases because of features' (1) inherent traits, and (2) when features reside in areas with high frequency of fishing events. In 1996, both the Red King Crab Savings Area (RKCSA) and Near Shore Trawl Closure Area (NSTCA) were implemented to help protect red king crab from non-target fishery induced mortality. A recent application for an exempted fishing permit drew attention to lack of information on complex habitats in the North Pacific, in particular to the efficacy of RKCSA and NSTCA in protecting benthic habitats. This project aims to examine the spatiotemporal distribution of structure-forming benthic features in the RKCSA, NSTCA, and adjacent open areas relative to exposure to fishing disturbances. The presence and absence of features will be determined using National Marine Fisheries Service trawl survey data. Exposure to fishing disturbances will be assessed by area status (open vs. closed to fishing), fishing effort distribution, and frequency of fishing events using outputs from the North Pacific Fishing Effects Model. A binomial generalized linear mixed model (GLMM) will be used to evaluate presence as a function of closures, disturbance, and frequency of events. Analyses are currently underway examining presence of benthic features relative to area status (open vs. closed fishing).

Characterization of Benthic Habitats and Contaminant Assessment in Arctic Lagoons and Estuaries

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Characterization of six lagoons and estuaries in the Chukchi and Beaufort seas were conducted with water quality, sediment chemistry, benthic community structure, and fish body burdens. Concentrations of 194 organic and elemental contaminants were analyzed, plus stable isotopes of carbon and nitrogen. Additional sites were established in the offshore zone in the path of proposed oil infrastructure development. Arsenic and nickel were naturally elevated throughout the region. Concentrations of PAHs were relatively high. Characteristics of the PAH compounds present indicate large contributions of terrestrial organic matter in the form of peat and/or coal. Petroleum hydrocarbons were not evident. Concentrations of chlorinated pesticides and PCBs were uniformly low in fish tissue. Hexachlorobenzene was detected in all fish samples. Arsenic in fish tissue was elevated reflecting the general elevated background concentrations. With the exception of Peard Bay, the sampled estuaries were shallow and subject to landfast ice in winter, stressing animals in or on sediments. Most animals were juveniles, suggesting they moved into estuaries after ice breakup. Species abundance varied by two orders of magnitude between sites. Peard Bay and Elson Lagoon were the most diverse systems. Based on dual cluster analysis and nonmetric multidimensional scaling techniques, all the estuaries separate from each other based on species composition. Benthic samples were sieved through nested 1.0 and 0.5 mm sieves. Sieving through 0.5mm improves estimates of diversity and abundance. There were twice the number of taxa on average in the 0.5 mm than in the 1.0 mm collections. There was an order of magnitude difference in abundance. Diversity was usually higher in the smaller mesh size. The difference in biomass was only 15%. Multivariate statistical techniques illustrate that the smaller sieve size produces a clearer distinction between community traits and the physical habitat drivers that influence them. With the exception of Peard Bay, all the estuaries reflected a strong influence of terrestrial plant input, with very low $\delta\text{o}/\text{o}$ values for carbon and nitrogen. Peard Bay has a very limited watershed and is strongly influenced by tidal exchange with marine waters. Stable isotope values for Peard Bay were bracketed by the offshore sites.

Underway Ship System Time Series of Physical and Biological Measurement from the Gulf of Alaska and the Bering and Chukchi Seas

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Presenter: R. John Nelson

Long-term, large scale multi-trophic data sets are needed to gain quantitative understanding of the relationship between local, regional and global drivers and productivity in the ocean. Such data sets are provided by the annual U.S.-Canada research program run from the Canadian Coast Guard icebreaker *Sir Wilfrid Laurier* during her annual voyages from Victoria, B.C., to Barrow, Alaska. Between 2007 and 2017, measurements of salinity, temperature, chlorophyll-a, dissolved oxygen and gas tension in surface waters were made with an underway system along the Laurier's 5,000 km annual cruise. Physical, chemical and biological measurements were also made at defined stations to validate the underway measurements. Here we describe the use of underway dissolved gas data as a proxy for net community production, along with the geographical variation in ocean properties for 2 out of 11 years of data. We also examine how dissolved gas-based productivity estimates correspond to MODIS and isotope-based productivity measurements. The ultimate aim of this work is to describe the spatio-temporal variability in sea surface physical and biological parameters and how well these explain distribution and abundance of other ecosystem components such as zooplankton, benthic taxa, and seabirds.

Zooplankton in Bering Canyon: Transport, Community Composition, and Basin-Shelf Connectivity

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Presenter: Colleen Harpold

Transport of basin-origin zooplankton onto the Bering Sea shelf has been shown to be an important process that provides prey for fish, birds and marine mammals. Basin copepod species tend to be larger and more lipid rich than those originating from the continental shelf, and available evidence suggests basin-origin taxa form an essential part of the prey base. Oceanographic exchange between the basin and the shelf is facilitated through submarine canyons along the Bering Sea slope, providing an advective conduit for zooplankton. Bering Canyon, in the southeast corner of the eastern Bering Sea shelf-break, is thought to be one such conduit. Depth-discrete and whole water column plankton sampling occurred across transects spanning Bering Canyon and the Unimak Pass region spring and fall of 2014 to better describe zooplankton species composition, vertical distribution, and transport. Cluster analyses were used to describe plankton assemblages and show how dominant zooplankton species groups varied seasonally (spring and fall). Key copepod species (*Neocalanus* spp. and *Calanus marshallae/glacialis*) were investigated further, as they are important prey for juvenile walleye pollock (*Gadus chalcogrammus*) entering their first winter. Preliminary results evaluated patterns of zooplankton occurrence with respect to water mass layers and flow patterns to help resolve mechanisms of transport through Bering Canyon and investigate basin-shelf connectivity.

The North – South Transition Zone of the Eastern Bering Sea Shelf: Oculus Coastal Glider Observations at High Spatial Resolution

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Presenter: Carol Ladd

The eastern Bering Sea shelf is characterized by high biological productivity, seasonal sea-ice, and commercially important fisheries. Characterizing the spatial and temporal variability of the system is essential to understand the controlling mechanisms and potential influence of climate change. This region has been studied intensively over recent years and traditional shipboard sampling has provided a wealth of understanding of this important ecosystem. An important biogeographical transition at lat. $\sim 60^{\circ}\text{N}$ divides the ecosystems of the northern and southern Bering Sea shelf [Stabeno et al., DSR II, 2012]. The transition region (lat. $\sim 59 - 60^{\circ}\text{N}$) south of St. Matthew Island comprises complex currents with along-shelf flow along the 100 m isobath interacting with on-shelf flow via Zhemchug Canyon. This region exhibits complex submesoscale features that cannot be adequately sampled by the temporal and spatial limitations of shipboard sampling. Autonomous gliders are becoming widespread with their ability to economically sample at ecologically relevant spatial and temporal scales. A new glider, the Oculus Coastal Glider, has been specifically designed for shallow water operation (< 200 m). Rapid buoyancy change allows the vehicle to approach close to the bottom and to minimize time spent at the surface. Higher speeds (> 1 knot) allow work in energetic, highly stratified coastal environments. The Oculus glider was deployed along the 70 m isobath transect in August/September 2017, sampling ~ 3 dives per hour with a horizontal distance of ~ 500 m per dive. A long history of shipboard observations along this transect provides context for the Oculus observations. This presentation will focus on scales of variability in the complex North – South Transition zone and glider observations of active submesoscale mixing events. These events may have important ripple effects through the ecosystem. Incorporating higher resolution sampling with the Oculus into the Bering Sea observing network will improve our understanding of the ecosystem response to patchiness in the system.

High-Resolution (2 km) Physical Hindcasts and Forecasts of the Southeastern Bering Sea

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Presenter: Albert Hermann

Motivated by a need to anticipate the impacts of climate change on red king crab (*Paralithodes camtschaticus*) recruitment in the southeastern Bering Sea, a 2 km resolution model of Bristol Bay was implemented for a warm hindcast year (2005), a cold hindcast year (1999), and a projected/forecast year (2037). Model dynamics include tides and ice; results were stored as hourly averages. Initial and boundary conditions were derived from previously completed simulations with a 10 km resolution model of the full Bering Sea. Atmospheric forcing for past years was obtained through the NOAA Climate Forecast System Reanalysis (CFSR). Future atmospheric forcing was derived from a CMIP5 global model (MIROC) under presumed IPCC emissions scenario rcp8.5. Coastal runoff forcing was derived from USGS data. In hindcasts, the model performed well at capturing the observed evolution of the mixed layer at a mid-shelf mooring. Ten-day averages of temperature, salinity and currents exhibit substantial differences among the three simulated years. For March 15-25, warming in excess of 2° C is observed under the predicted future, relative to present conditions. Alongshore transport toward Bristol Bay appears to be enhanced as well under this future scenario. Here we summarize the results of these simulations (and their biases) by season, and quantify the sources of greatest uncertainty in our projected futures.

Declining Surface Nitrogen Concentrations in the Eastern Bering Sea During Summer

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Presenter: Jeanette Gann

The eastern Bering Sea is one of the most productive ecosystems in the world for a variety of fisheries, most notably walleye pollock (*Gadus chalcogrammus*). All of these fisheries depend on a significant amount of primary production that occurs within the upper water column of the eastern Bering Sea shelf. Surface nutrient concentrations over the shelf during late summer/early fall are what remain after the large spring bloom (mostly large diatoms) and summer grazing (generally smaller phytoplankton) have used up nutrients for growth and reproduction during summer. The nutrient concentrations below the pycnocline represent the potential nutrient stores available for a fall phytoplankton bloom after wind-mixing begins and more intense storms turn over the water column, bringing those nutrients to the surface for use by phytoplankton. With the goal of understanding how nutrient concentrations change throughout the water column over time, we investigate a variety of nutrients (dissolved inorganic nitrogen (DIN), phosphate, and silicic acid), over time (late summer/early fall, 2003-2016) in the eastern Bering Sea, both above and below the pycnocline. Preliminary results show surface DIN significantly decreasing over time ($P < 0.05$). A decrease in surface DIN could potentially impact phytoplankton community structure, and food availability for higher trophic levels during summer. Further investigations will analyze individual nutrient species concentrations, as well as satellite chlorophyll-a concentrations during summer months to look for any further trends and correlations.

TUESDAY, JANUARY 22

WAVE 2

(7:45 PM TO 9:00 PM)

Wave 2
Tuesday, January 23rd (7:45 pm to 9:00 pm)
W. E. Eagan Civic and Convention Center

Title	Authors	Location (Row, Poster)
Observations of subarctic wildlife species in the Arctic Waters of Alaska, 2016-2017	Megan Bles, Gregory Green, Forrest Ahkiviana, Jonah Leavitt, Layne Olson, Amanda Stafford, Kristina Woolston	R1 , P1
Solving the greatest difficulty with diet estimation using fatty acid data	Jeffrey Bromaghin, Suzanne Budge, Gregory Thiemann, Karyn Rode	R1 , P4
Polar bear occurrence on the western Beaufort Sea coast, summer and fall 2017	Amelia Brower, Amy Willoughby, Janet Clarke, Megan Ferguson, Corey Accardo, Lisa Barry, Vicki Beaver, Laura Ganley, Suzie Hanlan, Kate Pagan	R1 , P7
Characterization of the genetic variability in the full coding regions of genes of the Major Histocompatibility Complex in Alaskan populations of beluga: What can Next Generation Sequencing tell us on the risk of infectious disease on Arctic marine populations	Jeremie Brusini, Tatiana Ferrer, Jorge Monroy, Laura Pescitelli, Heidi Pagan, Alex Whiting, Glenn Seaman, Kathy Burek Huntington, Carrie Goertz, Robert Suydam	R1 , P10
Spotted seal productivity in Alaska using harvest-based monitoring; 1960s, 1970s, and 2000s	Anna Bryan, Lori Quakenbush, Justin Crawford, Louise Biderman, Ryan Adam	R2 , P13
Detecting wildlife in the eastern Chukchi Sea and coastal zone using thermal imagery from aerial surveys	Cynthia Christman, Erin Richmond, Erin Moreland, Peter Boveng	R2 , P16
The kids are alright – bowhead whale calves in the western Beaufort Sea, 2012-2017	Janet Clarke, Megan Ferguson, Amelia Brower, Amy Willoughby, Christy Sims, Corey Accardo, Lisa Barry, Vicki Beaver, Marjorie Foster, Laura Ganley, Jennifer Gatzke, Suzie Hanlan, Kate Pagan, Karen Vale-Vasilev	R2 , P19
Movements and dive behavior of young bearded seals as related to sea ice in the Pacific Arctic	Justin Crawford, Mark Nelson, Lori Quakenbush, Anna Bryan, Andrew Von Duyke, Merlin Henry, Alexander Niksik, John Goodwin, Alex Whiting, Matthew Druckenmiller	R2 , P22
Marker development for a polar bear genetic mark-recapture study	Tatiana Ferrer, Andrew Von Duyke, Raphaela Stimmelmayer, Robert Suydam, Jorge Monroy, Todd Sformo, Billy Adams, Greg O'Corry-Crowe	R3 , P25
Shipping in the western Canadian Arctic: Potential impacts on marine mammals in marine protected areas and possible management solutions	William Halliday, Stephen Insley, Lauren McWhinnie, Matthew Pine, Casey Hilliard, Tylerde Jong, Rosaline Canessa	R3 , P28
Seasonal patterns in ocean ambient noise near Sachs Harbour, Northwest Territories	Stephen Insley, William Halliday, Tylerde Jong	R3 , P29
Assessing the Impact of Vessel Noise as a Function of Active Listening Space in the Western Canadian Arctic	Matthew Pine, David Hannay, Stephen Insley, William Halliday, Francis Juanes	R3 , P30
Entangled bowheads – injury rates from fishing/crab gear via aerial photo-recapture	John C. George, Barbara Tudor, Geof Givens, Julie Mocklin, Linda Vate Brattström	R3 , P32
Movements and behavior of ringed seals tracked from Utqiagvik, AK during the 2011 Unusual Mortality Event	Donna Hauser, Andrew Von Duyke, David Douglas, Jason Herreman, Kristin Laidre, Harry Stern	R3 , P34
Polar Bear (<i>Ursus maritimus</i>) behavioral response to vessel presence in the Chukchi and Beaufort Seas	Sheyna Wisdom, Maile Branson, Cara Hesselbach	R4 , P37

Validation of a novel method using claws to create a temporal map of reproductive and stress-related hormones for bearded and ringed seals	Shawna Karpovich, Mandy Keogh, Lara Horstmann	R4 , P40
Using molecular techniques to assign sex to archaeological walrus remains	Rebekah Lyon, Kyndall Hildebrandt, Nicole Misarti, Lara Horstmann	R4 , P43
Testing a new method for measuring nutritional stress in an ice seal: Linking hair cortisol to body condition	Concepcion Melovidov, Amy Kirkham, Jennifer Burns	R4 , P46
Summer movements of western Arctic bowhead whales outside of the Canadian Beaufort Sea	Lori Quakenbush, John Citta, John C. George, Lois Harwood, Ellen Lea, Mads Peter Heide-jorgensen	R5 , P49
Seal-borne satellite transmitters provide ocean conditions in the Pacific Arctic	Lori Quakenbush, Stephen Okkonen, John Citta, Justin Crawford, Mar kNelson, Anna Bryan, Ryan Adam, Andrew Von Duyke	R5 , P50
Instrument-based aerial surveys to detect ice-associated seals and polar bears: Preliminary results from the eastern Chukchi Sea	Erin Richmond, Cynthia Christman, Erin Moreland, Eric Regehr, Paul Conn, Michael Cameron, Peter Boveng	R5 , P52
Omega-3 fatty acid levels in the RBCs of wild Alaskan belugas (<i>Delphinapterus leucas</i>) with seasonally varying dietary habits and managed belugas fed a herring (<i>Clupea harengus</i>) And capelin (<i>Mallotus villosus</i>) diet	Todd Schmitt, Carrie Goertz, Rod Hobbs, Bill Harris	R5 , P55
Results of application of oil and dispersed oil on drag on bowhead whale baleen	Todd Sformo, Gary Shigenaka, John George, Teri Rowles, Geof Givens, Michael Moore, Tom Lanagan, Alexander Werth	R5 , P58
Walrus whiskers as a tool to explore seasonal diet and migration	Hannah Starbuck, Casey Clark, Lara Horstmann, Nicole Misarti	R6 , P61
Forensic evidence of shark predation on northern pinnipeds: Preliminary case material from the Bering Strait and the North Slope, Alaska	Gay Sheffield, Brandon Ahmasuk, Vicky Beaver, Raphaela Stimmelmayer	R6 , P64
Umbilical hernia in a free-ranging male Polar bear (<i>Ursus Maritimus</i>), Barrow, Alaska	Raphaela Stimmelmayer, Billy Adams, Mike Pederson	R6 , P67
Crassicauda sp. infection in Bering-Chukchi Beaufort Sea bowhead whales (<i>Balaena mysticetus</i>)	Raphaela Stimmelmayer, David Rotstein, Guilherme Verocai, Amy Baird	R6 , P68
Liver Fluke Disease: Prevalence and distribution of associated pancreatic and hepatobiliary pathological findings in subsistence harvested bearded seals (<i>Erignathus barbatus</i>) and ringed seals (<i>Phoca hispida</i>) from the North Slope and Bering Strait, AK	Raphaela Stimmelmayer, David Rotstein, Gay Sheffield	R6 , P69
Ice Seal Energetics: Measuring seasonal changes in metabolism for ringed, bearded, and spotted seals	Colleen Reichmuth, Nicole Thometz, David Rosen	R7 , P73
Time matters: Lessons learned from three large-scale surveys of ice-associated seals	Irina Trukhanova, Vladimir Burkanov, Aleksandr Vasiliev, Vladimir Chernook, Peter Boveng	R7 , P77
Photo-identification of gray whales in the eastern Chukchi Sea, summer and fall 2017	Amy Willoughby, Megan Ferguson, Amelia Brower, Janet Clarke, Lisa Barry, Vicki Beaver, Karen Vale-Vasilev, Suzie Hanlan, Marjorie Foster, Corey Accardo, Kate Pagan, Christy Sims	R7 , P79

Contribution of microbially-derived carbon to benthic invertebrates across the Chukchi Sea shelf using amino acid specific stable isotope analyses	Ann-Christine Zinkann, Katrin Iken, Diane O'Brien, Matthew Wooller	R9 , P96
Physical and biological factors affecting distribution of crab larvae in the northeastern Bering Sea and southern Chukchi Sea in 2012	Jared Weems, Franz Mueter, Alexei Pinchuk	R9 , P101
Identifying environmental drivers of microbial community composition in the Arctic benthos	Alexis Walker	R10 , P107
A comparison in functional diversity of two Alaskan arctic shelf systems	Lauren Sutton, Katrin Iken, Bodil Bluhm	R10 , P109
Tracing the presence of sea ice algae in Arctic benthic consumers using the biomarker IP25	Tanja Schollmeier, Katrin Iken, Matthew Wooller, Simon Belt	R10 , P113
Hidden ocean 2016: Diversity and vertical structure of zooplankton communities from the Chukchi borderlands	Caitlin Smoot, Russell Hopcroft	R10 , P115
Abiotic factors affecting zooplankton in Arctic nearshore habitats	Andrea Nodal, Mark Barton, Kevin Boswell, Alexei Pinchuk, Brenda Norcross, Ron Heinz, Johanna Vollenweider, Chunyan Li, Leandra Sousa	R10 , P117
Resolving the <i>Harmothoe imbricata</i> species complex	Angela Gastaldi, J. Andres Lopez, Sarah Hardy	R11 , P120
Linking organic carbon sources and cycling with microbenthic abundance and diversity across the coastal shelf of the Mackenzie Delta	Pamela Neubert, Rodger Harvey, Rachel McMahon, Francis Wiese	R11 , P122
The role of sea ice decline on Arctic Ocean and sea ice ecosystems	Georgina Gibson, Wilbert Weijer, Nicole Jeffery, Shanlin Wang	R11 , P124
Benthic habitat associations in the Arctic Chukchi Borderland	Katrin Iken, Irina Zhulay, Bodil Bluhm	R11 , P127
Particulate bioactive trace metal cycling in Arctic sea ice	Channing Bolt, Ana Aguilar-Islas	R20 , P229
Development of an ice condition index for the Great Lakes	Seth Campbell	R20 , P231
Arctic Saildrone measurements in 2017	Edward Cokelet, Calvin Mordy, Jessica Cross, Heather Tabisola, Carey Kuhn, Alex De Robertis, Eugene Burger, Richard Jenkins, Noah Lawrence-Slavis, Christian Meinig	R20 , P232
Ocean acidification in the Pacific Arctic and the distributed biological observatory	Jessica Cross, Robert Pickart, Nicholas Bates, Jaqueline Grebmeier	R20 , P234
Water column distributions of particulate organic matter in western Arctic Ocean during late summer and fall	Miguel Goni, Laurie Juranek, Burke Hales, Rachel Sipler, Deborah Bronk	R20 , P235
Coastal erosion modeling in Elson Lagoon, Alaska, with a one-line model adapted for Arctic conditions	Leif Hammes	R21 , P237
BOEM geospatial databases: Understanding the physical environment and building a legacy database for the Alaska OCS region	Warren Horwitz, Rich Wawrzonek	R21 , P238
Nutrients, trace metals, and radium isotopes in the Mackenzie River estuary	Lauren Kipp, Matthew Charette, Paul Henderson	R21 , P240

Characteristics and Dynamics of wind-driven upwelling in the Alaskan Beaufort Sea	Peigen Lin	R21 , P242
Impacts of Baroclinic Instabilities Derived from Bering Sea Inflow on Chukchi Shelf Sea Ice	Kofan Lu, Seth Danielson, Thomas Weingartner	R21 , P244
Forecasting for the Arctic: Methods of downscaling environmental data for coastal modelling	Euan-Angus MacLeod, Thomas Ravens	R21 , P245
Hydromedusae and ctenophores of the northeastern Chukchi Sea during 2017	Heidi Mendoza-Islas, Russell Hopcroft	R21 , P247
Spectral analysis of sea ice draft and drift from sonars	Todd Mudge, Keath Borg, Alex Slonimer	R21 , P248
Transport of volume, freshwater, heat, and ice from an arctic ice-ocean circulation model	Dave Musgrave, Seth Danielson, Kath Hedstrom, Thomas Weingartner, Enrique Curshitsler	R22 , P250
Oil spill arctic trajectory analysis planner	Dylan Righi, Erika Ammann, Glen Watabayashi	R22 , P252
Vertical structure and temporal variability of currents over the Chukchi Sea continental slope	Phyllis Stabeno, Carol Ladd, Ryan McCabe	R22 , P254
Development of Arctic Xbeach	Michael Ulmgren, Tom Ravens, Michelle Wilber, Getu Hailu	R22 , P256
Marine ARctic Ecosystem Study (MARES): New measurements on the eastern Beaufort Sea shelf	Francis Wiese, Ed Ross, Donglai Gong, Robert Pickart, Michael Fabijan, Dave Fissel, Rowenna Gryba	R22 , P258
The influence of arctic storms on surface climate in the Chukchi-Beaufort seas	Yang Yang	R22 , P260

Observations of Subarctic Wildlife Species in the Arctic Waters of Alaska, 2016-2017

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Climate trends indicate warmer temperatures and less sea-ice occurring throughout the Pacific Arctic, shifting away from the “old normal” benthic-dominated marine ecosystem, to the “new normal” ecosystem dominated by pelagic wildlife species. This ecosystem shift has ostensibly increased the food supply for Arctic and subarctic planktivores resulting in a distributional shift northward of plankton-feeding marine mammal and seabird species. In 2016, Alaska temperatures along the west coast were the second warmest on record and sea-ice extent was the second lowest on record. Similarly, air temperatures were above average in 2017 and sea-ice extent was the eighth lowest on record. Quintillion laid undersea fiber-optic cable in the northern Bering, Chukchi, and Beaufort seas during summer and fall 2016 and 2017. Protected species observers aboard project vessels recorded sightings of various Arctic and subarctic marine mammals and seabirds in Pacific Arctic waters consistent with the “new normal” ecosystem. We will present species sighting data collected in comparison to climate trends. We also report on new regional bird records.

Solving the Greatest Difficulty with Diet Estimation Using Fatty Acid Data

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Presenter: Jeffrey Bromaghin

Knowledge of predator diets provides essential insights into their life history and ecology. Quantitative fatty acid signature analysis (QFASA) is one of the most common methods of estimating the diets of marine species. QFASA is based on fatty acid signatures, which are vectors of proportions that describe the composition of fatty acids in lipids. Data inputs consist of a sample of predator signatures, samples of signatures from potential prey, and constants called calibration coefficients that adjust for fatty acid metabolism and make predator and prey signatures comparable. A key assumption of QFASA is that the calibration coefficients are known, but in practice they have been estimated in feeding trials with captive animals of a limited number of model species. However, the assumption that feeding-trial calibration coefficients are accurate for free-ranging predators is impossible to verify, which has caused many to question the value of the method. We present a new model that simultaneously estimates both diet composition and calibration coefficients, based only on signature samples from predators and potential prey. Our model performed almost flawlessly in tests with constructed test cases for which diet composition and calibration coefficients were known. We also applied the model to Chukchi Sea polar bear data. The resulting diet estimates were similar to, but more diverse than, estimates conditioned on calibration coefficients from a mink feeding trial. Our new model offers several profound benefits; it frees QFASA from an unverifiable assumption, avoids bias from using inaccurate calibration coefficients, eliminates the need to conduct feeding trials, and nullifies the primary criticism of QFASA. This breakthrough substantially increases the value of QFASA as a tool to study aspects of predator ecology linked to their diets.

Polar Bear Occurrence on the Western Beaufort Sea Coast, Summer and Fall 2017

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The Aerial Surveys of Arctic Marine Mammals project (ASAMM) conducted line-transect surveys from July through October in the western Beaufort Sea (140°-157°W and shore-72°N) in 2012 to 2017. Polar bears along the western Beaufort Sea coast tend to congregate at bowhead whale carcasses resulting from subsistence whaling at Cross and Barter islands. The majority of polar bears documented by ASAMM were sighted at these two locations, but polar bear occurrence extended to nearly the entire coastline. In 2017, ASAMM documented polar bears on shore in the western Beaufort Sea in greater numbers and earlier in summer than in previous years, and higher numbers of polar bears were documented on Cross Island than in previous years. Increased polar bear sightings in 2017 could be related to summer sea-ice extent; by early September 2017, sea-ice in parts of the Beaufort Sea had retreated farther north than in any other year since sea-ice satellite records began in 1979. Increased sightings may also be related to survey effort. Several factors can affect numbers of polar bears sighted during ASAMM surveys, including amount of coastal survey effort per month and year, weather conditions at known congregation areas during ASAMM surveys of those areas, survey constraints such as time aloft and fuel reserves, and whether photographs of the congregation areas were taken. ASAMM surveys in the western Beaufort Sea are flown at 1,500 ft altitude and polar bears are quite small from that altitude. When possible, photographs of congregation areas are taken and analyzed post-flight, which can

substantially increase the numbers of polar bears documented. Although ASAMM's primary objective is to survey for cetaceans, our polar bear data can help supplement surveys conducted specifically for polar bears. ASAMM is funded by the Bureau of Ocean Energy Management and conducted by NOAA's Alaska Fisheries Science Center.

Spotted Seal Productivity in Alaska Using Harvest-based Monitoring; 1960s, 1970s, and 2000s

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Presenter: Anna Bryan

Spotted seals (*Phoca largha*) are an ice-associated pinniped that forage on pelagic fish and use sea-ice to rest, give birth, nurse, and molt. Arctic sea-ice is declining in extent, thickness, and duration. These declines are predicted to continue and may affect the distribution, availability, or nutritional quality of fish important to spotted seals. If prey availability or quality decline, spotted seal productivity could be affected, thus monitoring productivity is important. Currently there are no estimates of spotted seal abundance or trend in Alaska that can be used to track productivity. However, the Alaska Department of Fish and Game has worked with Alaska Native hunters since the 1960s to collect data from subsistence harvested spotted seals that can be used as an index to population health and status. In a report to the National Marine Fisheries Service in 2009, we provided the age at maturity and pregnancy rates for spotted seals collected between the 1960s and 2008. At that time, data for the 2000s were limited by incomplete age analysis and few mature female reproductive tracts. In that report, we found that although the average age at maturity was younger in the 1960s (3.7 yr) than the 1970s (4.1 yr), the average percent pregnancy for mature females was lower in the 1960s (80%) than the 1970s (89.3%). Here we update results for 2000 to 2016 with reproductive tracts from more than 400 spotted seals, including more than 80 mature females.

Detecting Wildlife in the Eastern Chukchi Sea and Coastal Zone Using Thermal Imagery from Aerial Surveys

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Presenter: Cynthia Christman

Thermal imaging science is paving a new road in wildlife ecology studies. One application of this technology is the use of thermal cameras to detect animals in remote environments where visual surveys would be prohibitive or ineffective. Coupling thermal cameras with high-resolution color imagery further enables identification of animals to species in multispecies environments where distributions of animals overlap. In April and May of 2016, we conducted aerial surveys as part of the Chukchi and East Siberian Surveys (ChESS) project to derive comprehensive abundance estimates for ice-associated seals and polar bears in the Chukchi Sea. To locate and identify animals, we used a six-camera array of paired thermal and color imagers to collect over 2,000,000 images for subsequent analysis. While the target species were bearded seals, ringed seals, and polar bears, we opportunistically encountered a variety of wildlife during these surveys. Here we present the diversity of wildlife detected during aerial thermographic surveys in the eastern Chukchi Sea, demonstrating the potential for future projects to collect multispecies data using thermal imagery.

The Kids Are Alright – Bowhead Whale Calves in the Western Beaufort Sea, 2012-2017

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Presenter: Janet Clarke

The Aerial Surveys of Arctic Marine Mammals (ASAMM) project, funded by the Bureau of Ocean Energy Management (BOEM) and co-managed by BOEM and NOAA Fisheries, conducted surveys in the western Beaufort Sea (long. 140° W - 157° W) from July through October, 2012 to 2017. Bowhead whale (*Balaena mysticetus*) calves-of-the-year were observed in summer (July-August) and fall (September-October) each year. In summer, calves were distributed primarily in the eastern half of the study area, with highest calf densities east of Kaktovik; the exception was 2016, when calves were distributed throughout the study area. Calf distribution in summer 2013 was in deeper water (> 200 m) compared to other years. In fall, calves were broadly distributed throughout the study area, with highest densities in northern Camden Bay and lowest densities east of Kaktovik. Calf distribution did not appear temporally or geographically segregated from the overall population in any given year. Calf ratios (number of calves per number of total whales observed) ranged from 0.037 to 0.160 in summer and 0.027

to 0.135 in fall. Calf sighting rates (number of calves sighted per km surveyed) ranged from < 0.001 to 0.003 in summer and < 0.001 to 0.010 in fall. Calf totals in 2017 (161 calves) far surpassed any previous year; the next highest calf total was 90 in 2016. Although it is likely that some calves were sighted more than once, calf production was likely very high in 2017. High calf production is one of many positive indicators of the overall health of the Western Arctic stock of bowhead whales.

Movements and Dive Behavior of Young Bearded Seals as Related to Sea-Ice in the Pacific Arctic

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Bearded seals (*Erignathus barbatus*) are benthic foragers that use sea-ice for pupping, nursing, molting, and resting. Decreasing sea-ice associated with climate change may affect fish and invertebrate prey of bearded seals, and therefore affect seal foraging behavior. Our understanding of foraging habitats, dive behavior, and timing of movements, however, is limited. We worked with Alaska Native hunter-taggers along the Beaufort, Bering and Chukchi sea coasts to deploy satellite-linked dive recorders on 24 young (< 2 years old) bearded seals from June through November 2014–2017. Seals were tracked 10–457 days. During the open-water period seals were located in the Beaufort, Chukchi and Bering seas. As sea-ice advanced in December seals moved shoreward (toward the Alaska or Russian coast) or toward the southern ice edge in the Bering Sea. By mid-December, 11 of 13 seals were in the Bering Sea; >80% concentration), all seals made proportionally fewer benthic dives (80% benthic dives) than when in marginal ice (15–80% concentration; 85%) or open water (87%; $P < 0.01$), and benthic dive durations were shorter in heavy (4:35 min) and marginal (4:30 min) ice than in open water (5:00 min; $P < 0.01$). Dive behavior also differed by time of day with proportionally fewer benthic dives at night (1900–0000; 72–78%) than during morning and afternoon (0700–1400; 90–93%; $P < 0.01$), however, benthic dive durations were longer at night (2100–0200; 5:30 min) than morning and afternoon (0900–1800; 4:30 min; $P < 0.01$). The presence and concentration of sea-ice appears associated with reduced benthic foraging. Continued studies of bearded seal foraging behavior are necessary to monitor for changes in behavior with continued changes in sea-ice.

Shipping in the Western Canadian Arctic: Potential Impacts on Marine Mammals in Marine Protected Areas and Possible Management Solutions

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As the Arctic becomes more ice-free during the summer, ship traffic is increasing. The Northern Sea Route along the Russian coast is already used as a viable shipping route from Asia to Europe, and the Northwest Passage along the Canadian coast may not be far behind. In preparation for increased ship traffic, managers and policy makers must consider the impact of this increased traffic on sensitive Arctic ecosystems and animals. Here, we examine the acoustic impacts of shipping through the western Canadian Arctic on marine mammals. We use acoustic propagation modeling to examine the acoustic footprint of ships traveling along the proposed shipping corridor through the western Canadian Arctic, and examine the impact of this acoustic footprint on marine mammals in the marine protected areas in the region. We then examine automatic identification system data for ships to look at shipping within and around these marine protected areas, and examine management options to reduce the impact of ship traffic on whales in these marine protected areas. This work is an important first step in understanding the impact of shipping on marine mammals in the western Canadian Arctic, and offers potential solutions that managers can use to reduce the impacts on marine mammals in the region.

Seasonal Patterns in Ocean Ambient Noise Near Sachs Harbour, Northwest Territories

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Ocean ambient noise is a crucial habitat feature for marine animals because it represents the lower threshold of their acoustically active space. Ambient noise is affected by natural noise sources like wind and ice, and by anthropogenic sources like shipping and seismic surveys. Ambient conditions in the Arctic are quieter than conditions in other regions during the ice-covered season due to the dampening effect of sea-ice. Climate change-induced Arctic warming influences noise through both decreased sea-ice and increased human activity, which may negatively affect several species of marine mammals and other acoustically-sensitive marine fauna. We document ambient noise off the west coast of Banks Island near Sachs Harbour, Northwest Territories, to provide baseline noise levels in the eastern Beaufort Sea. Noise levels were comparable to other studies from the Canadian Arctic and Alaska, and were typically much quieter than levels from farther south. Wind caused increased noise, whereas increased ice concentration decreased noise, dampening the effect of wind speed. The results provide baseline soundscape data, important for accurately modelling and predicting human-based noise impact, particularly shipping, on marine animals in the region.

Assessing the Impact of Vessel Noise as a Function of Active Listening Space in the Western Canadian Arctic

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Sea-ice has effectively preserved the Canadian Arctic's natural underwater soundscape by making it impenetrable by commercial shipping. However, as climate change continues, the extent of sea-ice is retreating further north; opening the Northwest Passage to shipping and introducing the threat of masking for marine mammals that may prevent the detection of prey, predators or conspecifics. The active listening space is the area surrounding the animal in which a biologically-important source inside that area can be detected (i.e., predator, prey or conspecific). Here, we investigate the influence of shipping noise on the active listening space of bowhead whales, beluga whales and phocid seals to inform management on the expected effectiveness of vessel-slow down as a mitigation tool against acoustically-induced disturbances. Through advanced modelling based on in-situ acoustic data collected from within the Inuvialuit Settlement Region and real shipping data, we demonstrate a simple mathematical approach that can be used to show the acoustic masking footprint from a range of vessel classes for a marine mammal receiver. The simpler mathematical model for calculating reductions in the active listening space should be more effective than the traditional methods for communication space by redirecting the analysis from the receiver (which are based on poorly understood parameters such as the auditory system of the receiver, noise directionality and source levels) and towards environmental acoustic changes (i.e., the difference in sound pressures inside biologically-relevant bandwidths) in a three-dimensional environment.

Entangled Bowheads – Injury Rates from Fishing/Crab Gear via Aerial Photo-Recapture

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Fisheries bycatch is a leading source of mortality for whales worldwide. Entanglement scarring has been observed on Bering-Chukchi-Beaufort Sea (BCBS) bowhead whales (*Balaena mysticetus*), although historically their high-latitude distribution has been mainly north of commercial fishing operations. The black skin of the bowhead heals as a white scar, leaving a permanent record of past injury. In our recently published work, we noted that 12.2% of bowhead whales harvested by Alaska Native hunters show evidence of rope scarring, likely associated with Bering Sea commercial fisheries. Similarly, our analysis of a fully independent dataset of aerial photographs (n = 693) with adequate photo quality of the caudal peduncle from the 2011 spring survey near Point Barrow, Alaska, indicates that 12.6% (n = 87) show evidence of entanglement scarring – remarkable agreement. An additional two whales were observed dragging fishing gear. Subsequently, we examined photographs of all inter-year matches (between 1985, 1986, 2003, 2004, 2005 and 2011) from a multi-year photo mark-recapture study and identified whales that had acquired entanglement injuries during the study period, i.e., between the first photo capture and subsequent recapture. We estimated the probability of a bowhead acquiring an entanglement injury using two statistical methods: interval censored survival analysis and a simple binomial model. Both methods give similar results suggesting a 2.4% (1.2%, 3.6%) annual probability of acquiring a scar, and that about 40% of adult whales will be scarred after ~25 years. While the BCBS bowhead population is increasing at a relatively high rate, the findings reported here together with examinations of landed whales indicate that fishing gear entanglement is a more serious concern for BCBS bowheads than previously thought.

Movements and Behavior of Ringed Seals Tracked from Utqiagvik, AK, During the 2011 Unusual Mortality Event

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Ringed seals (*Pusa hispida*) and other ice-associated seals experienced an unusual mortality event (UME) in northwest Alaska during 2011. Hundreds of seals were reported with skin lesions and alopecia along Alaska's North Slope in 2011, ~40% of which were dead, and raised concerns for subsistence consumption. The ongoing UME coincides with a period of reduced sea-ice, and a determination of the cause is hampered by a limited understanding of how changing ecosystems affect seals. We captured or recovered 33 ringed seals near Utqiagvik, Alaska during July to October 2011 to examine responses to the 2011 UME, including movements and behavior of 11 seals equipped with satellite-linked transmitters. We captured all age classes of ringed seals in 2011, of which 19 (58%) were deemed diseased (i.e., presenting physical symptoms) and two were found dead. Of the 11 tagged ringed seals that provided locations >10 days, three were considered diseased and tracked from July to September 2011. Two diseased seals were repeatedly relocated at coastal haulouts near Utqiagvik during August and September, compared to the third seal that ranged to nearly lat. 76°N over the deep Canada Basin, with a maximum daily dive depth of 202 m (mean = 120 m). The eight other presumably healthy tagged seals were tracked from July 2011 to, at most, November 2013, and were located primarily offshore. August 2011 was the only month during which all 11 tagged seals were tracked, when 'healthy' seals used the mouth of Barrow Canyon, slope margins of the Alaskan Beaufort Sea, southwest portions of the Canada Basin, and one seal relocated near the Mackenzie River estuary. The maximum daily dive depth of healthy seals during August 2011 was 558 m (mean = 114 m, n = 7 seals equipped with dive-location tags). Our comparison of diseased and healthy seals informs our understanding of ecosystem properties and responses by ringed seals during the 2011 UME.

Polar Bear (*Ursus maritimus*) Behavioral Response to Vessel Presence in the Chukchi and Beaufort Seas

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Polar bears (*Ursus maritimus*) were observed in the Chukchi and Beaufort seas from 2012 to 2014 and 2016. Polar bear behavioral response data were recorded during vessel-based marine mammal line-transect surveys in the summer and fall, when sea-ice is usually at a minimum extent, of 2012 to 2014 as part of the Chukchi Sea Environmental Studies Program, and during anchor retrieval operations in summer of 2016. Together, these two programs resulted in 11,318 hours of at-sea observation. Overall, 116 individuals (19 juveniles and 97 adults [10 confirmed females]) were observed. Most of these sightings occurred on ice. Data were further analyzed to describe initial behavioral responses by polar bears with regard to distance from vessel, sex/presence of cubs, and environment. For the purpose of this analysis, behavioral responses were categorized into two groups: more energetic and less energetic. More energetic behavioral responses included 'change direction', 'dive', 'flee', and 'increase speed'; less energetic behavioral responses included 'look', 'none', and 'unknown'. Overall, bears displayed less energetic responses more frequently than more energetic ones. More energetic responses were observed in the fewest number of encounters; bears 'dove' in 2% of encounters, 'fled' in 1%, and 'increased speed' in 1%. Polar bears exhibited more energetic behavioral responses when vessels were within 1,000 meters and those observed on ice were less likely to respond to vessel activity than bears in the water. While females with cubs responded much like the rest of observed bears, males displayed notably less energetic behavioral responses. Existing documentation of polar bear reaction to vessel presence, resulting behavioral responses, and distance at which such responses occur is not well understood. These findings are relevant to assessing potential impacts of increased vessel activity on polar bears as well as to developing appropriate and effective monitoring and mitigation strategies.

Validation of a Novel Method Using Claws to Create a Temporal Map of Reproductive and Stress-Related Hormones for Bearded and Ringed Seals

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In the Beaufort, Chukchi, and Bering Seas, bearded seals (*Erignathus barbatus*) and ringed seals (*Pusa hispida*), may be vulnerable to changes in climate and sea-ice that are predicted to intensify over time. The main objective of this study is to analyze serial samples of material from seal claws to examine carbon and nitrogen stable isotopes (SI) as a proxy for diet in conjunction with reproductive and stress-related hormones. Samples collected in 2009 to 2015, a period of shrinking sea-ice, will be compared to samples collected in 1963 to 1967 prior to changing sea-ice and the 1976-1977 regime shift. As ice seal claws grow, paired narrow and wide bands are deposited annually, creating a record of up to 14 years. SI have been examined in ice seal claws, and steroid hormones have been extracted from dog and turtle claws, but not yet from ice seal claws. Claw material was sampled from narrow bands and proximal and distal halves of each wide band using a Dremel tool. Powdered claw material was collected with deionized water, dried at 60° C for 72-96 hours, weighed, and hormones extracted with 100% methanol. Laboratory methods for validations of commercially available enzyme immunoassay kits (Arbor Assay) included recovery of added mass, parallelism, and dilution linearity and were performed for progesterone and cortisol using pools of methanol extract from multiple claws and bands. For individual samples, a subsample of extract was dried under forced air and reconstituted in assay buffer. Preliminary results from serial samples collected along individual claws show progesterone concentrations averaged 42.6 pg/mg (range 14.5-80.4 pg/mg, n = 91) in ringed seal claws and 50.6 pg/mg (range 8.6-182.7 pg/mg, n = 286) in bearded seal claws. Cortisol concentrations averaged 5.4 pg/mg (range 2.0-11.7 pg/mg, n = 57) in ringed seal claws and 13.4 pg/mg (range 3.6-49.1 pg/mg, n = 235) in bearded seal claws. Hormone concentrations will be examined based on known reproductive history, seal age, date of collection, narrow vs. wide band (proxy for season), SI data, and claw band widths. These method validations and preliminary results set the stage to assess multi-year ice seal diet and hormone information using this novel method.

Using Molecular Techniques to Assign Sex to Archaeological Walrus Remains

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It is difficult to assign sex to archaeological Pacific walrus (*Odobenus rosmarus divergens*) skeletal elements. Being able to reliably, quickly, and accurately identify sex of archaeological and archived walrus bone adds value to any research using faunal remains. We tested previously developed walrus-specific sex primers from fresh tissue using zinc finger proteins (ZFX, ZFY). Because we were unable to amplify archaeological walrus DNA extractions using these primers, we used the zinc finger genes to develop new walrus-specific sex primers targeting smaller amplicons (246 bp and 149 bp, respectively). With these new primers we can successfully identify over 300 samples of historic and archaeological walrus bones using PCR and gel electrophoresis. Our new primers will be advantageous for pre-historic and historic biogeochemical analyses of walrus remains related to foraging, migration patterns, and steroid hormones as well as trace patterns in subsistence hunter prey sex-ratio selection over time.

Testing a New Method for Measuring Nutritional Stress in an Ice Seal: Linking Hair Cortisol to Body Condition

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Relatively little is known about the physiological ecology of Arctic ice seals, which are difficult to handle and recapture due to logistical constraints. Because Antarctic Weddell seals have similar life histories and are much easier to study in the field, they can inform our understanding of processes in Arctic species. In this study, we are testing whether hair cortisol levels in Weddell seals relate to their body condition, and thus may be a useful biomarker of nutritional stress in ice seals. We first characterized mass and body condition dynamics in postpartum (moms, $n = 64$) and non-reproductive (skips, $n = 32$) female Weddell seals. We weighed seals and measured body condition near weaning, in Nov./Dec., and again during the molt in Jan./Feb. There was a large range in mass and condition: overall, moms were smaller and leaner than skips in Nov./Dec. (mean \pm SE 282.0 ± 4.6 kg, $31.8 \pm 0.5\%$ lipid vs. 437.4 ± 6.7 kg, $38.2 \pm 0.5\%$ lipid). After weaning, moms gained weight at an average rate of 0.6 ± 0.1 kg/day, accruing primarily lean mass. In contrast, during this same period skips lost an average of 1.0 ± 0.1 kg/day, mostly as lipid. Elevations in cortisol levels are often associated with mass loss and reduced lipid reserves, indicating stress with negative impacts on reproduction and other life history events. Prior work with this species has shown that serum cortisol is elevated in leaner, post-reproductive females in late summer, but these were single time-point measurements. We are measuring cortisol in hair that grew between the two handling periods to assess whether cortisol levels across a longer period relate to condition. Preliminary results show that levels are higher in moms than skips, suggesting hair cortisol may indicate nutritional stress in lean postpartum seals. We are testing whether hair cortisol correlates to body condition and mass flux, as well as serum cortisol. Results will indicate whether hair, which is relatively easy to collect and stable over time, may be used to monitor nutritional stress in Arctic ice seals facing changing environmental conditions.

Seal-Borne Satellite Transmitters Provide Ocean Conditions in the Pacific Arctic

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Arctic waters are difficult to study because they are remote, seasonally covered by sea-ice, and have limited daylight during the winter months. These difficulties are pronounced for studies of habitat selection for marine mammals, such as ice-associated seals, that spend substantial amounts of time under sea-ice. Although satellite-linked transmitters are an effective tool for documenting seal movements and dive behavior, understanding habitat selection also requires knowledge of the ocean environment. Oceanographic moorings collect data year-round, but only near the mooring site. Ship-based oceanographic surveys cover larger areas, but are expensive, may not overlap with seal movements, and are typically limited to the ice-free summer. A potential solution to the limitations of moored and ship-based sampling platforms is to have seals sample their oceanographic environment. In 2016 and 2017, Conductivity-Temperature-Depth (CTD) tags made by the Sea Mammal Research Unit of St. Andrews, Scotland, were deployed on three ringed (*Pusa hispida*), seven bearded (*Erignathus barbatus*), and 14 spotted seals (*Phoca largha*) at seven locations in Alaska. Seals were tagged with and by local seal hunters trained in seal capture, handling, and tagging. Tagged seals traveled within the Bering, Chukchi, and Beaufort seas mostly in waters less than 200 m deep. Profiles from the CTD tags identified water masses and oceanographic properties at places and times of year where few data have been collected. By combining CTD data from multiple seals across a wide area during the same time of year we can identify the distribution of water masses within that area. By subsequently combining CTD data from multiple seals within the same area during different times of year we can observe how the oceanographic environment of the region changes seasonally. With these data we can begin to determine if seals target particular water masses, fronts, or stratified

layers, which may help aggregate prey and therefore improve our understanding of factors that influence their movements. Examples of seal-sampled areas include 1) Chukchi Sea shelf break north of Wrangel Island, 2) Barrow Canyon, 3) Bering Strait, and 4) Bering Sea shelf (under ice).

Instrument-based Aerial Surveys to Detect Ice-associated Seals and Polar Bears: Preliminary Results from the Eastern Chukchi Sea

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Ice-associated seals and polar bears are key components of Arctic marine ecosystems and are a focus of conservation concern because they rely heavily on seasonal sea-ice, which is declining in the warming Arctic climate. Reliable distribution and abundance estimates for these species are crucial for developing sound plans for management, conservation, and responses to environmental impacts. The Chukchi and East Siberian Surveys (ChESS) were a joint U.S.-Russian effort to estimate the distribution and abundance of bearded seals, ringed seals, and polar bears. As part of ChESS, the NOAA Alaska Fisheries Science Center conducted instrument-based aerial surveys in the eastern Chukchi Sea during the spring of 2016. Here, we present a summary of preliminary results that will support new abundance and distribution estimates, including survey metrics, thermal camera detection rates, sightings by species, and seal misclassification rates.

Results of Application of Oil and Dispersed Oil on Drag on Bowhead Whale Baleen

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We studied the effects of oil and dispersed oil on the functional characteristics of bowhead whale (*Balaena mysticetus*) baleen at a mesocosm scale at the Oil and Hazardous Materials Simulated Environmental Test Tank (OMSETT) facility in Leonardo, NJ. The objective was to measure drag in baleen, estimate how it depends on various factors (control), and evaluate how drag changes when North Slope crude oil and Corexit 9500A dispersant are introduced (treatment). The principle assumption is that oil adhering to baleen plates and fringe “hairs” would increase drag. To secure baleen for movement through water at OHMSETT, a lever arm was fabricated at WHOI consisting of a baleen clamp, load cell, and pivot. An Omega load cell was used and bridge speeds data recorded. Baleen ranged from 1.1 to 2.7 meters in length, having 5 to 30 plates, orientated at 90° and 54°, and each sample was run through water from 0.2 to 1.6 knots, although only 54° and 0.6 knots were used for treatments. For analysis of the various independent racks of baleen, we calculated frontal area that combined plate number, length, and width per rack to create a single variable. For treatments, we applied oil and/or oil-dispersant in various ways, including submerging baleen with a crane and applying fresh oil to the water surface within a containing hoop. The baleen was then lifted through the oil. For dispersed oil treatment, Corexit 9500A was premixed with oil and dispensed through a series of underwater nozzles. Due to the limited number of available baleen racks and the inability to remove oil and dispersant from water in the tank or the baleen itself, we could only apply treatments once, leading to a qualitative assessment. The overall results indicate that under various treatments of oil and/or oil-dispersant the drag does not appear to increase.

Walrus Whiskers as a Tool to Explore Seasonal Diet and Migration

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Pacific walrus (*Odobenus rosmarus divergens*) are an important food resource for subsistence hunters, and are of cultural and spiritual significance to Alaska Native peoples. Walrus whiskers are continuously growing keratinous structures that incorporate stable carbon and nitrogen isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) and trace elements. Once deposited in the whiskers, stable isotopes and trace element concentrations are not modified, and can therefore be used to analyze short-term (potentially seasonal) diet and migratory patterns. Trace element concentrations can also reflect important information about high priority elements, such as cadmium and lead. We used a combination of $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and concentrations of 15 trace elements in four walrus whiskers (equal sexes) harvested in 2015 and 2016 by Alaska Native subsistence hunters on St. Lawrence Island. Whiskers were cut in half longitudinally. From one half of the whisker, a 0.5 mm segment was subsampled every 5 mm from root to tip for stable isotope analysis. Laser ablation inductively coupled plasma mass spectrometry was used to determine the concentrations of arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, strontium, vanadium, and zinc in a continuous transect from the root to the tip of the other half of the whisker. Males and females were analyzed separately to account for differences in their life histories, i.e., females migrate to the Chukchi Sea in spring, whereas males move to Bristol Bay. Males had higher mean $\delta^{13}\text{C}$ (males: $-16.2 \pm 0.5 \%$, females: $-16.9 \pm 0.9 \%$, $p < 0.01$) than females and lower mean $\delta^{15}\text{N}$ ($12.6 \pm 1.0 \%$, $13.3 \pm 0.9 \%$, respectively; $p < 0.001$). Stable isotope values fluctuated along the whisker, with males exhibiting more defined and evenly spaced peaks and troughs in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$. These fluctuations likely reflect seasonal and/or individual variability in prey abundance, foraging locations, and migrations. Combined with teeth of the same individual walrus, our data could also be used to estimate whisker growth rates.

Forensic Evidence of Shark Predation on Northern Pinnipeds: Preliminary Case Material from the Bering Strait and the North Slope, Alaska

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Sightings of cold water adapted sharks such as Pacific sleeper shark (*Somniosus pacificus*) and salmon shark (*Lamna ditropis*) within the Arctic Circle above the northern Pacific oceans are very limited. We report on historic and recent stranding evidence, aerial survey and bycatch of sharks in the Bering Strait, Chukchi and Beaufort Sea and present preliminary forensic evidence on shark inflicted wounds (e.g., flipper amputations, lacerations, circular bite wounds) in subsistence harvested and found dead ice seals. We speculate that ocean warming, diminished ice coverage and movement of prey species (e.g., fish; Steller sea lions, cetaceans) could result in expansion and distribution shift of cold water adapted shark species to higher latitudes. More research on shark distribution, stock structure, and interaction with northern pinnipeds is needed.

Umbilical Hernia in a Free-ranging Male Polar Bear (*Ursus maritimus*), Barrow, Alaska

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Acquired umbilical herniation has been reported in a few captive polar bears. Good body condition, limited exercise, or enclosure design are possible risk factors for the development of umbilical hernias in captive polar bears. We report a case of an umbilical hernia in a subsistence harvested male adult polar bear. A 6 × 6 cm swelling was located on the abdominal midline. The hernia sack was partially opened and entrapped fatty tissue (greater omentum) was grossly visible and protruded about 10 [sic] from the body wall. The greater omentum (a large apron-like fold of visceral peritoneum that hangs down from the stomach) was partially adhered to the internal body wall. A patent hernia ring with a diameter of 3 × 3 cm was present. Entrapped tissue was viable. Additional pathological findings included mild pneumonia and poor dental health. This is the 2nd case of an acquired umbilical hernia documented on the North Slope in free-ranging polar Southern Beaufort Sea polar bears (2017 PB 0424 HC; PB-B-5-8-1989). All cases are from male adult polar bears. Previously a single iatrogenic (illness caused by medical examination or treatment) case of an abdominal hernia associated with an abdominal implantation of a transmitter was reported from the North Slope (Philo et al. 1979). Small hernias without entrapment/strangulation of vital structures such as intestines remain clinically inconsequential for long periods of time. Entrapment of vital organs can be fatal. Our findings contribute to the body of knowledge on natural morbidity and mortality in free-ranging polar bears.

***Crassicauda* sp. Infection in Bering-Chukchi Beaufort Sea Bowhead Whales (*Balaena mysticetus*)**

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The Western Arctic Population of the bowhead whale (*Balaena mysticetus* L., 1758), a large and long-lived ice associated baleen whale ranges throughout Arctic Alaska waters including the central Bering Sea to the Canadian Beaufort Sea. Nematodes of the genus *Crassicauda* Leiper and Atkinson, 1914 (Nematoda; Spirurida) parasitize various organs of cetaceans (Cestacea: Mysticeti and Odontoceti), in special the urogenital tract and subcutaneous tissues. Five *Crassicauda* species have been reported in baleen whales (Mysticeti). Four of these in Balaenopteridae hosts: *Crassicauda crassicauda* (Creplin, 1829) in the fin whale (*Balaenoptera physalus*) and the blue whale (*Balaenoptera musculus*), and *Crassicauda boopis* Baylis, 1920 (syn. *Crassicauda pacifica* Margolis and Pike, 1955) in the two same host, and the humpback whale (*Megaptera novaeangliae*), *Crassicauda tortilis* Skrjabin, 1959 in the blue whale, and *Crassicauda delamureana* Skrjabin, 1966 in the sei whale (*Balaenoptera borealis*), and only one in a Balaenidae host: *Crassicauda costata* Skrjabin, 1969 in the southern right whale (*Eubalaena australis*). To our knowledge there have been no unequivocal reports of *Crassicauda* species infecting bowhead whales. We report a series of six cases of infection by *Crassicauda* sp. in Western Arctic bowhead whales integrating morphology, molecular and pathology. Climate-related sea-ice and ocean temperature changes, opening of the Northwest Passage and temporally extended range overlap with seasonal southern migrants known to carry kidney worms (i.e., humpback whales; fin whales, blue whales) may be setting the stage for shifts in prevalence rates of kidney worms in BCB bowhead whale stock.

Liver Fluke Disease: Prevalence and Distribution of Associated Pancreatic and Hepatobiliary Pathological Findings in Subsistence Harvested Bearded Seals (*Erignathus barbatus*) and Ringed Seals (*Phoca hispida*) From the North Slope and Bering Strait, AK

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Bearded seal and ringed seal are an important marine mammal subsistence species for Alaskan Eskimos. Liver fluke disease (*Orthnosplanthus* spp.) and its associated liver, bile duct, and pancreatic lesions were first described by Bishop (1979) in a bearded seal from Barrow, Alaska. Since this first documentation, no further in depth studies have been conducted in Alaska on the prevalence and distribution of pathological findings associated with liver fluke infection in bearded seals and ringed seals. The liver fluke life cycle and identity of intermediate hosts in the Arctic is not well known. Climate related sea-ice and ocean temperature changes; shifting foraging ecology may be setting the stage for shifts in prevalence rates of liver flukes in subsistence harvested ice seals. Tissue samples [liver (n = 122); pancreas (n = 110)] from subsistence harvested bearded seals (mixed age and sex cohort) and from ringed seal (Liver (n = 76) and pancreas (n = 63) collected from 2008 to 2016 were fixed in 10% buffered formalin, routinely processed for histopathology, sectioned at 5 µm, and stained with hematoxylin and eosin (H&E). On gross examination, liver fluke infestation in bearded seal was characterized by lumpy, ropy texture of liver lobes, thickened bile ducts on cross section, thickened (pasty) consistency of bile acid within intrahepatic ducts, firmness, atrophy, and pale discoloration of the pancreas, and discolored orange to yellow blubber (cholestatic jaundice). On histopathology, parasites and/or eggs were found in bearded seals with a prevalence of 26% (liver) to 30% (pancreas). No parasites were observed in ringed seal case material. Liver fluke associated lesions in bearded seals included: pancreatic periductitis or ductitis with or without fibrosis (24%), pancreatic atrophy with and without fibrosis (post-parasitic) (5%), periportal hepatic cholangitis or cholangiohepatitis with or without fibrosis (15%), and common bile duct and/or hepatic bile duct mucosal hyperplasia (11%). Similar lesions were absent in ringed seals. Based on our ice seal health assessment liver flukes disease is common in subsistence harvested bearded seals but absent in ringed seals. Our findings contribute to the body of knowledge on natural morbidity and mortality in free-ranging ice seals under a changing Arctic regime.

Ice Seal Energetics: Measuring Seasonal Changes in Metabolism for Ringed, Bearded, and Spotted Seals

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Ringed (*Pusa hispida*), bearded (*Erignathus barbatus*), and spotted (*Phoca largha*) seals are important components of Arctic and sub-Arctic ecosystems with unique life-histories and foraging strategies. Although all ice seals will be affected by ongoing climate change and sea-ice loss, the nature and extent of consequences will differ by species. Information about seasonal patterns in metabolic requirements can provide insight into individual and population-level resource needs—including identification of sensitive life-stages and improved understanding of the energetic costs associated with specific seasonal physiological cycles. Resting metabolic rate (RMR) is a commonly accepted measure of individual energy needs. As the foundation of individual energy budgets, it scales with other measures of energy expenditure and is a standardized measure to compare metabolic requirements both within and across species. We are using open-flow respirometry to longitudinally measure the in-water RMR of ringed ($n = 2$), bearded ($n = 1$), and spotted ($n = 4$) seals. Study animals are trained to rest daily in a metabolic enclosure, in a post-absorptive state, which enables measurement of rates of resting oxygen consumption. Standard calculations are employed to convert oxygen consumption into units of energy. The seals are located at two research institutions in the United States: Long Marine Lab (Santa Cruz, CA) and the Alaska SeaLife Center (Seward, AK); environmental conditions vary between institutions, but behavioral and research protocols are matched. While measurements are ongoing, preliminary results confirm that all species exhibit seasonal changes in RMR reflective of both physiological cycles (e.g., molt, reproductive status) and environmental conditions (e.g., water temperature). Using this comparative framework, we have documented species-specific differences in RMR, which appear to extend beyond differences that would be predicted based on body size alone.

Time Matters: Lessons Learned from Three Large-Scale Surveys of Ice-Associated Seals

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A series of aerial surveys was carried out in Northern Pacific and Arctic waters of Russia with a broad aim to assess current status of four ice-associated seal populations – ringed, ribbon, bearded and spotted. All surveys were conducted in April and/or May, and each required several weeks to complete, due to logistical and weather-related reasons as well as the vast study areas. The surveys ranged from 9 days in 2013 in the Sea of Okhotsk to 15 days in 2012 and 19 days in 2013 in the Bering Sea, and to 30 days in 2016 in the Chukchi Sea. The surveys were planned to coincide as close as possible with peak pupping season, in order to have the majority of seals hauled-out on ice and hence accessible for detection by survey instruments and observers. Another factor in the choice of timing was to ensure that the majority of seals were in their breeding/molting areas, rather than engaged in their seasonal migrations north with the summer ice retreat, which could pose difficulties for estimation of the regional populations. Analysis of seal spatial and temporal distributions revealed significant variations in seal densities observed within the same area on different dates within the same year, and in different years but on similar dates. These differences likely reflect a combination of variability in the observation process (e.g., track line variation, time of day) and spatial variability in seal distributions driven by interannual variation in environmental conditions, leading to local shifts in patchiness of seal distributions, proportion of time spent on the ice, and timing of regional movements (e.g., onshore/offshore). These variations, if not accounted for, can lead to biased abundance estimates and misinterpreted results. We demonstrate the necessity of using environmental parameters including regional weather conditions, ice characteristics, snow-melt onset data, and others in assessments of ice-associated seal abundance.

Photo-identification of Gray Whales in the Eastern Chukchi Sea, Summer, and Fall 2017

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The eastern Chukchi Sea has important foraging and weaning grounds for gray whale (*Eschrichtius robustus*) cow-calf pairs of the Eastern North Pacific population during summer and fall. It is unknown how many gray whale cow-calf pairs use the eastern Chukchi Sea in any particular year. In an attempt to answer this question, in 2016 the Aerial Surveys of Arctic Marine Mammals (ASAMM) project collected opportunistic photographs of gray whale cow-calf pairs during systematic line-transect surveys conducted in the eastern Chukchi Sea (67°-72°N, 169°-155°W) from July through October. During 2017, ASAMM refined the photographic protocols to focus on images with flukes having skin pigmentation, scarring, notching, and mottling that allowed for a robust comparison and evaluation of images to identify intra-annual resightings of gray whales, including cow-calf pairs. Images were analyzed for July and August, when gray whale relative density and calf sighting rates are known to be highest. Although further sampling and analysis are needed, preliminary image analysis indicates that not a single gray whale was resighted and photographed in 2017, indicating that gray whale resightings may be fewer than previously thought. Furthermore, preliminary results suggest that gray whale fluke images can be used to derive a mark-recapture estimate of gray whale cow-calf pairs in the ASAMM study area. Knowing how many individual whales are potentially resighted within a single season could be used to strengthen

conservation and management efforts relating to, for example, climate change and disturbance from anthropogenic activities that occur in the eastern Chukchi Sea. ASAMM is funded and co-managed by the Bureau of Ocean Energy Management and conducted and co-managed by the National Oceanic and Atmospheric Administration.

Contribution of Microbially-derived Carbon to Benthic Invertebrates Across the Chukchi Sea Shelf Using Amino Acid Specific Stable Isotope Analyses

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Ongoing changes in the Arctic marine system necessitate a better understanding of organic matter pathways in marine food webs, especially the role of microbially-derived carbon. Carbon stable isotope values of individual essential amino acids (EAA) ($\delta^{13}\text{CEAA}$) can be used as biochemical markers to estimate the proportional contribution of microbially-derived carbon to consumers. Amino acids from different primary producers (terrestrial plants, marine algae, fungi, and microbes) have distinct patterns of $\delta^{13}\text{CEAA}$ values that are conserved within the consumer. Here, we used $\delta^{13}\text{CEAA}$ to determine carbon sourcing in nine benthic invertebrate species belonging to four benthic feeding types (suspension-, surface deposit-, subsurface deposit-feeders, and predator/scavengers) across the Chukchi Sea shelf. Low $\delta^{13}\text{CEAA}$ variation within species indicated consistent utilization of carbon sources within a species. Low variability in $\delta^{13}\text{CEAA}$ values in the feeding type predators/scavengers also indicated similar exploitation of carbon sources within their feeding type. The isoleucine-leucine ratio, which can be used as an index to infer microbial versus C3 photosynthetic sources, showed predator/scavengers carbon derived primarily from photosynthetic sources. In contrast, suspension-, surface-, and subsurface deposit-feeders sourced from a wide variety of carbon producers. High variability in these feeding types may be related to different productivity regimes and sampling locations on the shelf, or also indicate that feeding habits are more species specific rather than feeding type specific. Subsurface and surface deposit-feeders had the greatest proportion of microbially-derived carbon to their diet among feeding types.

Physical and Biological Factors Affecting Distribution of Crab Larvae in the Northeastern Bering Sea and Southern Chukchi Sea in 2012

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Planktonic crab larvae are common constituents of zooplankton communities over the Arctic shelf during summer. While taxonomic composition of the crab larvae is known, the detailed species- and stage-specific distribution and abundance have not been analyzed. To better understand larval crab ecology and ontogenetic changes, we examined stage-specific abundances of larval crabs in the northern Bering and Chukchi seas using data from the 2012 Arctic Ecosystem Integrated Survey. Specifically, we analyzed Anomura and Brachyura species composition and development stage structure relative to environmental variation. We relate larval abundances estimated from 505 μ m mesh 60cm Bongo zooplankton net samples to concurrent pelagic environmental data, zooplankton catches, and benthic adult crab distributions to infer potential pathways of larval dispersal. Our preliminary analysis suggests that crab larvae in the region segregate by water mass, similar to the holoplanktonic community. Late zoeae stages of snow crab, *Chionoecetes opilio*, were found throughout the study region, while a hot-spot in settling megalopae was found in the Chirikov Basin. Principle component analysis suggests that early larval stages of Paguridae (hermit crabs) inhabited warmer, less saline Alaska Coastal Waters, while late planktonic and settling larvae of Lithodidae, Haplogastriidae, and Cheiragonidae species were associated with colder, saltier Chukchi Shelf Waters. Stage-specific frequency analysis of *C. opilio* larval distribution was applied to develop an index for larval duration and to determine possible spawning locations. We conclude that despite general northward drift, physical processes result in disparate larval assemblages across the shelf, and that composition and demographic structure of these assemblages is influenced by asynchronous adult spawning and by sampling time.

Identifying Environmental Drivers of Microbial Community Composition in the Arctic Benthos

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Benthic microbes play an integral role in nutrient cycling and organic matter (OM) degradation in marine sediments. In the Arctic, changing climatic conditions has reduced sea-ice cover and resulted in a shift of marine primary productivity patterns, which affects the quality of OM deposited to the seafloor. Benthic organisms rely on advected material from overlying water masses and local replenishment and degradation of these nutrients and OM. Bacteria and archaea represent a biological link between the abiotic and biotic realms, in that their diverse metabolic pathways make them key mediators of biogeochemical processes. Unlike higher trophic level organisms, these microbes can metabolize both organic and inorganic compounds, making them essential in the replenishment and removal of nutrients to surrounding organisms. Previously ice-covered waters have also been opened to human activity including petroleum exploration, increasing the likelihood of contaminant exposure. Bacterial and archaeal diversity and community composition can reflect local biogeochemical processes, exposure to contaminants, and nutrients/OM available to the benthic food web. Next-generation DNA sequencing (NGS) was employed to investigate I) diversity, II) community composition, and III) environmental drivers of bacteria and archaea from over 100 sampling sites from the Chukchi shelf and Borderlands, across the Alaskan and Canadian sectors of the Beaufort Sea shelf and slope, to the Amundsen Gulf. Microbial community data was analyzed in conjunction with associated environmental data, chlorophyll-a, phaeopigment, temperature, depth, salinity, Carbon to Nitrogen ratio, grain size, and total organic carbon (TOC), to identify key correlates of microbial community structure and diversity. Additionally, distance decay relationships were explored on spatial scales from cm to km across a broad swath of the Pacific Arctic region. As different microbial taxa can perform distinct biogeochemical functions, baseline data generated here may be used to predict how these communities might respond to a changing Arctic.

A Comparison in Functional Diversity of Two Alaska Arctic Shelf Systems

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Biodiversity is a foundation for many ecosystem processes, contributing greatly to ecosystem productivity and stability. Functional diversity is a relatively novel component in biodiversity assessments; it is defined as the range of biological traits of the organisms within a community that influence ecosystem functioning. Functional diversity emphasizes the functional composition and level of functional redundancy via shared biological traits (i.e., morphology, life history, and behavior) in a community. This study compares functional diversity of epibenthic communities of the Beaufort and Chukchi sea shelves. We hypothesize that the Beaufort and Chukchi sea shelves will differ in functional diversity based on the effects that different water flow, nutrient influx, and riverine input have on the epibenthic communities. Biological traits were examined for three epibenthic phyla, Mollusca, Echinodermata, and Arthropoda, and community trait profiles based on the biomass of species were compared between the two shelves. Preliminary results show both shelf communities share high levels of lecithotrophic larval development and diversity of feeding types, but differ in levels of surface affinity. Therefore, shared life history strategies may cause the two shelf communities to respond similarly to environmental changes, while they may respond differently to changes involving substrate conditions.

Tracing the Presence of Sea-ice Algae in Arctic Benthic Consumers Using the Biomarker IP25

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The relative abundance of the two main sources of primary production, ice-associated particulate organic matter (iPOM) and pelagic particulate organic matter (pPOM), in the Arctic Ocean may change with ongoing reduction of seasonal sea-ice coverage in the Chukchi and Beaufort seas. Such a change could affect the relative contribution of these sources to benthic invertebrate consumers. A possible reduction of iPOM, an early-season and high-energy food source, could have a detrimental impact on various benthic feeding types represented in crabs, bivalves and polychaetes. We analyzed the presence of iPOM in different benthic feeding types (omnivores, suspension feeders, surface deposit feeders and subsurface deposit feeders), utilizing the sea-ice biomarker IP25. The production of IP25, a highly branched isoprenoid, is specific to select Arctic sea-ice algae and is not found in open water phytoplankton. This analysis was complemented by measurements of brassicasterol, a sterol that serves as a phytoplankton biomarker. Average IP25 concentrations were highest in suspension feeders and lowest in omnivores, while brassicasterol concentrations were highest in omnivores. Assuming that all feeding types have access to the same abundance of food sources, these results indicate that suspension feeders may preferentially feed on iPOM and might be more affected by possible reductions in iPOM.

Hidden Ocean 2016: Diversity and Vertical Structure of Zooplankton Communities from the Chukchi Borderlands

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The Arctic's Chukchi Borderlands is a crossroads consisting of Arctic, Pacific, and Atlantic water masses layered over a complex bottom topography. This region has undergone extreme summer sea-ice reduction over the last several decades, however; pelagic diversity is poorly characterized due to historical challenges associated with sampling in this remote environment. Stratified zooplankton samples were collected in the Chukchi Borderlands during the July 2016 Hidden Ocean cruise. Samples were collected in up to eight strata to maximum depths of 2000 m with a vertically hauled Multinet fitted with 150 μm mesh nets. Distinct zooplankton communities were observed in the three major water masses within the study region. Mean abundance and biomass in the 0-50 m layer were 450 ind. m^3 and 5 mg DW m^3 , respectively. Mean abundance declined to 405 and 91 ind. m^3 in the 50-100 and 100-200 m intervals, respectively. In contrast, species richness generally increased with depth. The surface layer was dominated by the copepods *Oithona similis*, *Microcalanus pygmaeus*, and *Calanus glacialis* that contributed 54% to 76% of the abundance. *Spinocalanus* species and the family Aetidaeidae became more important contributors as depth increased. The larvaceans *Oikopleura vanhoeffeni* and *Fritillaria borealis* were important non-crustacean contributors in the 0-50 m layer; *F. polaris* was observed only at depths below 50 m. Other common gelatinous taxa included *Aglantha digitale*, *Solmundella bitentaculata*, *Sminthea arctica*, *Bathykorus bouilloni*, and *Botrynema* spp. These results are part of a multi-disciplinary effort to understand the declining spectrum of biodiversity within the Chukchi Borderlands ecosystem as one moves from microbes to marine mammals.

Resolving the *Harmothoe imbricata* Species Complex

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Cryptic diversity in seemingly widespread species leads to the underestimation of true biodiversity and hinders the understanding of species distributions. Cryptic diversity is known to be prevalent in polychaete worms. Recent studies of mitochondrial DNA sequence variation suggests that the scale worm *Harmothoe imbricata* represents a species complex comprised of six distinct lineages, which have been proposed as provisional species. Since the provisional species do not show apparent morphological variations, *H. imbricata* may be another example of cryptic diversity in polychaetes. The overarching goal of this study is to document patterns of genetic diversity within the species complex *H. imbricata*. We examined samples collected from waters surrounding Alaska, Canada, and Scandinavia. Analyses of DNA sequences from multiple regions of the nuclear genome, including U2, H3, 18S, 28S, ITS1 and ITS2, will be used to produce a phylogenetic tree to determine whether the distinct lineages identified from mitochondrial genome variation are supported and/or congruent with variability of the nuclear genome. Preliminary results show low levels of variation in non-coding regions and no variation in coding regions, suggesting that mitochondrial lineages are the product of very recent and ongoing genetic diversification processes.

Linking Organic Carbon Sources and Cycling with Microbenthic Abundance and Diversity Across the Coastal Shelf of the Mackenzie Delta

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During the Arctic spring freshet, the Mackenzie River releases large amounts of dissolved and particulate terrestrial organic carbon into the Canadian Beaufort Shelf Sea. The accompanying pulse of nutrients fuels phytoplankton in late spring and summer, and together with under ice production, contributes marine-derived carbon to the water column and sediment. Regional carbon budgets suggest both may contribute to benthic production. As part of the Marine Arctic Ecosystem Study (MARES) program, we examined a transect across the western Mackenzie coastal shelf in fall 2016 to determine relative contribution of marine and terrestrial carbon to marine sediments and its relationship with meiobenthic diversity and abundance. Organic biomarker analysis via tandem mass spectrometry of specific lipid proxies were used to constrain the amount and type of organic sources together with total hydrolysable amino acids (THAA) employed as markers of organic matter lability and cycling. Organic carbon sources (lipids and amino acids) were then compared to meiofaunal abundance and diversity across the same upper 5 cm of surface sediments. Across shelf transect, both organic proxies and meiofaunal abundance showed enrichment at mid-shelf stations and had abundances of meiofauna greatest in the upper 3 cm of sediment. Dominant taxa included Foraminifera, Polychaeta, Crustacea, and Nematoda. Results of lipid biomarker analysis show significant amounts of algal derived carbon remained in late fall with major contributions by both diatom and dinoflagellates to bottom sediments as seen as diagnostic sterols and highly unsaturated fatty acids. Total hydrolysable amino acids show increased breadth of structures and contributions to organic carbon in sediments, and were elevated at the mid-shelf stations in parallel with benthic abundance. Diatom frustules were also abundant at the two mid-shelf locations but low in abundance in the shallowest and deep stations sampled. Overall results suggest that that mid-shelf waters receive relatively higher contributions of labile marine carbon than shallow or deep waters along the eastern Beaufort Sea shelf and over time these inputs are reflected by increased meiofauna diversity and abundance. Higher meiofaunal abundance appear the result of localized amounts of marine primary production rather than terrestrial carbon carried through the Mackenzie outflow.

The Role of Sea-Ice Decline on Arctic Ocean and Sea-Ice Ecosystems

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Models of the Arctic Ocean ecosystem can provide insights into the mechanistic control of the rapidly changing physical environment on marine productivity. Here we have simulated the impact of reduced sea-ice on the regional dynamics of the lower trophic level Arctic ecosystem. We performed hindcast experiments with the ACME-HiLAT global Earth system model, using two approaches to simulate reduced sea-ice. Firstly, the baseline air temperature from version two of the Coordinated Ocean-ice Reference Experiments was modified by varying degrees using moderate and more extreme predictions of future temperature change from the Intergovernmental Panel on Climate Change atlas of global and regional climate projections. Secondly, model parameters related to snow grain size and thermal conductivity, previously shown to influence sea-ice extent, area and volume, were modified to simulate a reduced sea-ice environment. The relative control of ice cover and water temperature on water column structure and the resultant ice and ocean biological productivity is discussed. The heterogeneous seasonal and net response of primary production, diagnosed for each of the Arctic shelves and basins, to the physical perturbations are compared and contrasted in an effort to better predict the overall response of the Arctic ecosystem structure and carbon budget to a warming Arctic.

Benthic Habitat Associations in the Arctic Chukchi Borderland

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The Chukchi Borderland (CBL) area, the topographically and hydrographically complex region connecting the Chukchi shelf to the Arctic deep basin, is undergoing dramatic environmental changes with climate warming. Yet, it is one of the biologically least explored regions in the Pacific Arctic. In summer 2016, we explored the epibenthic diversity of the CBL using a remotely operated vehicle (ROV), specifically focusing on fauna associated with unique benthic features such as pockmarks. We found that most pockmarks did not harbor any different species than the surrounding plateaus but the overall species composition inside the pockmarks often was unique. The unique communities of the pockmarks did not seem related to any gas extrusion or chemosynthetic production but were related to the general topographic features. A number of species distribution range extensions, as well as potentially new species were observed. These results document the high level of unknown biodiversity and unique habitat associations in this Arctic region that is prone to change dramatically in the coming decades.

Particulate Bioactive Trace Metal Cycling in Arctic Sea-Ice

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Sea-ice is an intrinsic component of the Arctic system that influences the chemistry of the Arctic Ocean including the distribution of trace metals. An understanding of trace metal cycling in Arctic waters is necessary because of their roles in primary production and as tracers of oceanographic processes. Limited studies have measured trace metals within the sea-ice matrix leaving an unclear understanding how rapidly changing sea-ice dynamics will affect trace metal distributions. This study aims to understand the partitioning of trace metals between dissolved and particulate species within the sea-ice matrix and surface waters of the Arctic environment. Sea-ice and water column samples were collected during the U.S. GEOTRACES Arctic Section cruise in September 2015. Sea-ice cores collected with a custom-made trace metal clean ice corer were obtained from 6 stations north of 82.5° N. In general, the sea-ice sampled was permeable with a bulk salinity less than 4 and relatively warm temperatures (~1.5° C to -2.5° C). Cores were sectioned into 5 subsections, melted, and filtered using a 0.2µm support membrane. Preliminary data will be presented for particulate and dissolved bioactive trace elements (Mn, Fe, Ni, Cu, Zn, Cd, and Pb), and will be compared to results from Beaufort Sea landfast ice collected in May 2015.

Development of an Ice Condition Index for the Great Lakes

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An ice condition index (ICECON) and an accompanying vessel classification system was developed for the U.S.-Canada Great Lakes. The index, which ranges from 0 to 5, indicates the difficulty of vessel travel through the ice; a higher ICECON index indicates greater difficulty for ships. The ICECON is calculated based on a number of ice-related environmental parameters including ice thickness, ice concentration, surface temperature, wind condition, and ice type. These ICECON parameters are developed by making use of Great Lakes Coastal Forecasting System module (GLCFS) developed by National Oceanic and Atmospheric Administration's (NOAA) Great Lakes Environmental Research Laboratory (GLERL). Under current plans, ICECON will be nowcasted and forecasted 72 hours in advance by the National Ice Center. The goal of ICECON is to optimize the U.S. Coast Guard 9th District's icebreaker deployment and improve strategic decision-making and security for the Great Lakes region.

Arctic Saildrone Measurements in 2017

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Presenter: Edward Cokelet

A saildrone is a sail- and solar-powered unmanned surface vehicle (USV) developed by Saildrone Inc. in conjunction with NOAA/PMEL, UW/JISAO and NOAA/AFSC to make remote, season-long meteorological and oceanographic measurements at sea. It sails autonomously between user-controlled waypoints and transmits data ashore via satellite. These innovative vehicles conducted their first-ever scientific missions in the Bering Sea in 2015 and were deployed again in 2016. In July to September 2017, the saildrones made new strides with two sailing through Bering Strait into the Chukchi Sea while one remained in the Bering Sea for a mission total of 228 days and 23,405 km. All three saildrones measured wind, humidity, barometric pressure, air and water temperature, sea-surface salinity, dissolved oxygen, chlorophyll a, colored dissolved organic matter (CDOM), and optical backscatter. In addition, the Bering vehicle made acoustic measurements of the abundance and distribution of walleye pollock, conducted focal follows of satellite-tagged fur seals and recorded whale sounds. Some data were provided in near-realtime to the World Meteorological Organization's Global Telecommunication System (GTS) to aid in weather forecasting. The Chukchi saildrones observed atmosphere-ocean carbon dioxide (CO₂) exchange with a pCO₂ system. Wind speeds exceeded 40 knots at times. Low salinity and elevated levels of CDOM and pCO₂ were found 200 km seaward of the Yukon River mouth indicating the influence of river runoff past the inner shelf. North and south of Bering Strait, the saildrones observed areas of high chlorophyll-a and oxygen saturation implying enhanced biological production. The northernmost saildrone reached 75° N in the Arctic Ocean basin where

it measured a cold surface temperature of -0.23°C and a low salinity of 26.5 (PSS-78) on 13 August. Meteorological and oceanographic measurements were compared with those on U.S. Coast Guard Cutter *Healy*, EcoFOCI mooring M2 and between closely spaced saildrones to confirm instrument accuracy. This mission demonstrated the high-latitude capability of the saildrone as an ecosystem research tool.

Ocean Acidification in the Pacific Arctic and the Distributed Biological Observatory

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Presenter: Jessica Cross

Ocean acidification (OA), driven by rising anthropogenic carbon dioxide (CO₂), is rapidly advancing in the Pacific Arctic Region (PAR), producing conditions newly corrosive to biologically important carbonate minerals like aragonite. Naturally short linkages across the PAR food web highlighted by the Distributed Biological Observatory (DBO) array mean that species-specific acidification stress can be rapidly transmitted across multiple trophic levels, resulting in widespread impacts. Recently, several large programs have combined observations from ships, moorings, and surface autonomous vehicles in an innovative observing system in order to capture the annual formation and persistence of acidified conditions across the Pacific Arctic System. Here, we present data as far back as 2011, with an emphasis on the Northern Chukchi Integrated Study from 2017. This data shows the formation of corrosive conditions in colder, denser winter-modified Pacific waters over shallow shelves, resulting from the combination of seasonal terrestrial and marine organic matter respiration with anthropogenic CO₂. While biological impacts from this recent acidification remain unclear, they could have detrimental effects on ecosystems already undergoing substantial environmental pressure from other forms of global climate change. In order to support the management and sustainability of the fisheries in the PAR, it will be critical to continue to monitor global emissions and the rate of OA in the Arctic.

Water Column Distributions of Particulate Organic Matter in Western Arctic Ocean During Late Summer and Fall

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Presenter: Miguel Goni

A key climate-related change in coastal Arctic regions is the increase in the extent and duration of ice-free conditions during the late summer and fall. Our research group has been investigating the biogeochemical effects of an increasingly prolonged open-water season over the past few years. These effects include increases in autochthonous productivity driven by mixing and upwelling of deeper, nutrient-enriched waters into highly stratified surface waters and input of allochthonous materials mobilized by resuspension events and coastal erosion due to higher wave activity. Here, we present data collected over different months (August through October) and years (2012-2017) on the distribution and composition of suspended particulate matter in surface and subsurface waters of the Chukchi shelf. Our results show large ranges in particulate organic carbon concentrations in surface waters (1-40 micromolar) and spatial distributions indicative of high surface productivity areas associated with either bathymetric and coastline features and/or high-wind events that facilitate mixing. Data collected along cross-shelf transects at several locations highlight the importance of particle-rich subsurface features, such as deep chlorophyll maxima and benthic boundary layers, associated with productivity events and lateral transport of allochthonous materials. We interpret the patterns in particulate organic matter distributions and compositions as they relate to other measurements (e.g., dissolved gases and nutrients) carried out by our group and discuss the implications of these findings in the context of ongoing climatic changes in this region of the Arctic Ocean.

Coastal Erosion Modeling in Elson Lagoon, Alaska, with a One-line Model Adapted for Arctic Conditions

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One-line models have been successfully used throughout the world to model shoreline change due to alongshore variation in alongshore sediment transport. In a one-line model, the coastal zone is represented as a single line, the shoreline, which moves landward or seaward due to diverging or converging alongshore sediment transport, respectively. The beach profile, in the cross-shore direction is assumed to be the equilibrium beach profile, and it moves landward or seaward as the shoreline moves. Most one-line models allow for additional sources or sinks of sediment along the shoreline that contribute to shoreline movement. This feature can be used to account for beach nourishment or storm-induced cross-shore sediment transport out of the littoral system. In this paper, we apply the one-line modeling approach to the study of coastal erosion in Elson Lagoon, Alaska, where both alongshore transport due to wave action and cross-shore transport associated with thawing coastal permafrost bluffs are known to occur. The Elson Lagoon coastline is about 20 km long, and it runs west to east with the lagoon to the north. The coastline is protected on the west side by Point Barrow and on the north by a series of barrier islands that are parallel to the shoreline and about 10 km offshore. The eastern Elson Lagoon shoreline is exposed to waves from the east, and it consequently experiences significantly more erosion than the western shoreline. The erosion is due to both thermal and mechanical processes, and the particular mechanism is the niche erosion / block collapse mechanism, which is a common form of cross-shore sediment transport in the Arctic. In this paper, the niche erosion/block collapse erosion mechanism is incorporated into the one-line model using an empirical expression involving wave height, water temperature, and water surface elevation. This approach allows a determination of the relative importance of alongshore and cross-shore sediment transport processes in an arctic setting.

Bureau of Ocean Energy Management Geospatial Databases: Understanding the Physical Environment and Building a Legacy Database for the Alaska Outer Continental Shelf Region

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Presenter: Warren Horwitz

Over the past 20 years, physical scientists from BOEM and database programmers from Resource Data Incorporated have jointly developed geospatial databases and integrated user interfaces for ESRI ArcGIS software to better understand the physical environment of the Beaufort and Chukchi, Alaska Outer Continental Shelf (OCS), including Cook Inlet, and to leave a legacy database for current and future scientists at the agency. BOEM has developed integrated databases and user interfaces for sea-ice, oceanography, meteorology, coastal fresh water systems, and offshore hazards. The data used to build these databases are publically available having been derived from BOEM-funded studies, with supplemental data coming from other federal agencies, the University of Alaska Fairbanks, the oil and gas industry and foreign research vessels. The sea-ice database covers the entire Alaska OCS, providing readily retrievable data of the daily, seasonal, annual, and inter-annual changes in sea-ice conditions. The oceanography, meteorology, hazards and coastal stream gauge databases predominately cover the Beaufort and Chukchi seas. The oceanography database stores water column data, including data on water masses, ocean currents, ice thickness, and ice velocities collected from High Frequency Radar, CTD casts, gliders, drifters, and moorings. The meteorology database combines coastal stations, offshore buoys, and shipboard observations with high-resolution atmospheric model data. The North Slope coastal stream gauge database provides information on the timing of breakup, whereas the hazards database provides supporting data on the offshore extent of overflowing, the locations of ice gouges, strudel scours and other potentially hazardous seabed and sub-seabed features. These databases have been utilized to plan and assist in both research designs to support the BOEM Environmental Studies Program and to provide input for environmental analysis related to U.S. offshore energy development. They have supported field programs in the deployment of a coastal and offshore instrumentation, helped define the timing of ice-free drilling seasons to provide safer offshore drilling and response operations, and assisted in the preparation of environmental assessments and environmental impacts statements.

Nutrients, Trace Metals, and Radium Isotopes in the Mackenzie River Estuary

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Presenter: Lauren Kipp

Investigating the transformations and fluxes of nutrients and trace metals in the estuaries of Arctic rivers is vital to understanding the impacts of river discharge on the biogeochemistry of the coastal Arctic Ocean. We measured the concentrations of dissolved trace metals, carbon, nutrients, and radium isotopes across the salinity gradient at the mouth of the east channel of the Mackenzie River during a June 2016 transect. Concentrations of iron decreased sharply at the freshwater-saltwater transition, suggesting strong non-conservative removal; other metals (manganese, cobalt, copper, nickel) did not exhibit this behavior. Increased concentrations of all five of these metals were measured between salinity 2 – 10, indicating non-conservative addition in the estuarine mixing zone. Radium isotope activities also increased in this zone, reflecting desorption from particles in brackish water. Dissolved inorganic carbon concentrations across the salinity gradient indicate possible addition of inorganic carbon in the estuarine mixing zone. Dissolved organic carbon (DOC) and total nitrogen concentrations decreased sharply between salinity 0 and 2, perhaps due to removal via flocculation, then increased slightly in the mixing zone, indicative of a DOC source in the lower river delta. Nitrate and silicate were generally highest in the freshwater reaches of the river, then decreased to near constant concentrations by salinity 10. Ammonium and phosphate did not show clear trends across the salinity gradient. The non-conservative behavior of nutrients and trace metals observed in this estuary is evidence that using freshwater endmembers to determine riverine fluxes is not an accurate measure of the concentrations ultimately released to the coastal ocean. We will use our observations from the Mackenzie River Estuary to estimate fluxes of nutrients and trace metals from this river to the coastal Arctic, and results will be compared against historical measurements from other arctic rivers.

Characteristics and Dynamics of Wind-Driven Upwelling in the Alaska Beaufort Sea

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Mooring data from the Alaskan Beaufort Sea slope, together with meteorological observations and reanalysis fields, are used to quantify the occurrence of wind-driven upwelling and the associated atmospheric forcing over a 6-year period. The canonical upwelling event, composited from 115 individual events, reveals that when the easterly wind is strongest the entire shelfbreak jet is reversed to the west. At the end of the event a bottom-intensified, eastward-flowing “rebound jet” spins up that is stronger than the normal shelfbreak jet. The reversed shelfbreak jet is oriented slightly onshore, which influences the structure of the cross-isobath flow by overwhelming the cross-isobath surface Ekman transport. Atlantic water (AW) is upwelled to the shelfbreak during more than two-thirds of the events, while for the remaining events only Pacific water (PW) is upwelled. The primary driving factor behind this is the seasonal variation in the PW-AW interface depth offshore of the shelfbreak, which is controlled by the local wind stress curl. The seasonality of the wind stress curl is due to the influence of the two regional atmospheric centers of action — the Aleutian Low and the Beaufort High.

Impacts of Baroclinic Instabilities Derived from Bering Sea Inflow on Chukchi Shelf Sea-ice

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Presenter: Kofan Lu

Warm, moderately salty Bering Sea Water (BSW) is often observed as in the form of distinct 10 – 20 m thick patches or horizontal plumes intruding within the shallow (~20 m depth) pycnocline that separates cold, dilute, surface meltwater (MW) from near-freezing, salty, winter-formed waters (WW) along the bottom. These BSW intrusions are believed to result in an oceanic heat flux convergence that, along with the atmospheric heat flux influences the seasonal sea-ice distribution on the Chukchi Sea shelf, but the details of the heat balance are not well known. A set of sea-ice models using the Regional Ocean Modeling System (ROMS) are integrated to determine: (a) the importance of ocean-to-ice heat flux contributed from BSW (both laterally and vertically) compared to the atmospheric heat flux in melting ice, (b) the role of intra-pycnocline eddies versus the mean flow in feeding the sub-surface heat flux from BSW referenced to bathymetry, and (c) the role of air temperature in modifying the impacts of BSW on sea-ice distribution and Chukchi Sea hydrography.

Forecasting for the Arctic: Methods of Downscaling Environmental Data for Coastal Modelling

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Presenter: Euan-Angus MacLeod

Climate change is one of the greatest threats faced by Arctic coastal communities including those in Arctic Alaska. The Arctic coastal zone has seen a rapid rise in air and water temperature, a lengthening of the open water period, and an increase in the spatial extent of open water due to sea-ice reductions. The changing environmental conditions have led to larger ocean waves and to accelerating thaw of coastal permafrost which together contribute to increased coastal erosion rates and coastal flooding. To understand and adapt to this reality, erosion and flood modelling is utilized to convey the risk and vulnerability that these communities face. Process-based and semi-empirical coastal erosion models have been developed for Arctic Alaska. They have been calibrated and validated with historic environmental data. The objective of this project is to develop methodologies to forecast environmental data in formats that will be used in forecasting for coastal erosion and coastal flooding models. Forecasted environmental data for coastal erosion forecasts will be developed based on output from coupled atmosphere-ocean Global Circulation Models (GCM). The environmental parameters to be forecasted are sea surface temperature, sea-ice extent, wind vectors and atmospheric pressure. First, output from five GCMs, taken from the Coupled Model Inter-comparison Project 5 (CMIP5) experiment, will be selected based their relevance to Arctic Alaska. Second, the methodology for down-scaling four environmental parameters from the GCM output into a format useful for driving a coastal erosion model will be developed. High-resolution historic data will be mined in order to develop relationships between the high-resolution data in the historic period and the low-resolution data from the GCM's output. Once this relationship is obtained, we will use it to develop high-resolution data for driving the coastal erosion forecast model based on the low-resolution GCM output. The primary focus will be to develop the short term (5-30 year) forecast that will be the most useful for the end users of the erosion/flood modelling in the planning process. We will also investigate the long-term (50-100 year) environmental parameters in order generate projections further into the future.

Hydromedusae and Ctenophores of the Northeastern Chukchi Sea During 2017

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Presenter: Heidi Mendoza-Islas

Gelatinous zooplankton abundances and distributions were recorded during August 2017 as part of the Arctic Marine Biodiversity Observation Network (AMBON). Seventy-eight stations were live-sorted along eight transects encompassing much of the Alaska Chukchi Sea. A total of 21 species corresponding to three different taxa were collected, with hydromedusae being the most diverse with 14 species, followed by four species of ctenophores, and three species of scyphomedusae. The hydromedusae *Aglantha digitale* showed the highest abundance (30.3%), being present in the most of the sampling stations, followed by *Melicertum octocostatum* (16.6%), with the ctenophore *Mertensia ovum* (11.4%) ranking third. Similarity in species composition among stations was explored using the Bray-Curtis index, which revealed five principal contiguous clusters. These clusters corresponded to differences in water masses and their crustacean zooplankton communities. Thus, it appears jellies provide a tractable method for real-time characterization of water masses in a region known for its high spatial and temporal variability.

Spectral Analysis of Sea-Ice Draft and Drift from Sonars

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Presenter: Todd Mudge

The roughness of the sea-ice canopy is an important factor for many physical processes, including acoustic propagation and drag. Roughness can be determined by multiple methods such as measuring the near boundary currents, from satellite imagery or from the direct measurement of ice draft with upward looking sonars. Unfortunately, roughness estimates determined by these multiple methods are not always consistent. This has led to a spectral analysis of sea-ice drafts and drifts to determine if the different methods are sensitive to certain spectral bands. The multi-site multi-year measurement program of Beaufort and Chukchi sea ice draft, funded by Shell (2005-2014), provides an excellent test data set. The ice profiling sonars provide a temporal resolution of 1-2 seconds of ice draft. When combined with ice drift data from acoustic Doppler current profilers, the spatial resolution is 1 m. Previous analysis of the near-ice ocean current data from the Chukchi Sea has provided drag based estimates of roughness. There is also concurrent RADARSAT high resolution (~10 m) imagery products available. Initial analysis at one Chukchi site indicates that the spectra of the ice draft from the sonars is well behaved. Over a wavenumber band of $4e-2$ to $1e-1$ cpm the slope tends to be constant when grouped by periods of similar overall energy. Thus, for this range the ice tends to be fractal in nature. The slope is dependent on the overall energy of the system, with the most energetic spectral (periods of largest ice keels) falling off at about k^{-2} . This would suggest that the roughest ice is slope conserving at these scales. Early analysis in frequency space suggests that the spectral characteristics of sea-ice draft are independent of location. Additional analysis will be completed of ice drift velocities and sea-ice draft in wavenumber space to test the apparent lack of spatial variability. If time allows, a cross-spectral analysis will be completed of sonar and RADARSAT derived ice roughness. This has the potential of leading to estimates of sub-pixel ice roughness from relatively coarse resolution RADARSAT data.

Transport of Volume, Freshwater, Heat, and Ice From an Arctic Ice-Ocean Circulation Model

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Presenter: Dave Musgrave

We calculated the transports of total volume, freshwater, heat, and ice from a model based on the Regional Ocean Model System dubbed the Pan-Arctic ROMS, which is described in more detail in other presentations in this session. We used monthly output (1983 to 2015) from the model to calculate monthly climatologies and their anomalies of the transports along various sections from the Bering Strait to lat. 74° N. We compare the mean and annual (1991-2011) transports to previous studies of observations across Bering Strait. The mean transports are within 25% of the previous results and the annual transports from 1991 to 2011 are similar to the ranges from the previous studies.

Oil Spill Arctic Trajectory Analysis Planner

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Presenter: Dylan Righi

The Arctic is home to sensitive natural resources. These waters are also host to oil exploration and production activities, heavy vessel traffic, and are bordered by land-based facilities that transfer, store, and handle oil. This combination of sensitive resources and potential oil spill sources increases the risk of a damaging spill. In the face of many unknowns, NOAA and others in the oil spill response profession are being called upon to make important decisions about oil spill response plans, habitat protection, and habitat restoration. NOAA developed the Arctic Trajectory Analysis Planner (TAP) to answer the crucial question in any Area Contingency Plan: How do I develop a plan that protects my area against likely spills? TAP graphically uses the results of thousands of simulated oil spills to help understand and anticipate many possible outcomes and habitats with potential to be affected by a spill. This tool can show statistically valid scenarios to develop realistic local-area contingency plans for oil spill response.

Vertical Structure and Temporal Variability of Currents Over the Chukchi Sea Continental Slope

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Presenter: Phyllis Stabeno

Observations from a series of three moorings deployed on the northern Chukchi Sea continental slope near the 1,000 m isobath, and spanning September 2014 to August 2017 are presented. The presentation focuses on the vertical structure and temporal variability of subtidal upper slope currents and water properties. Strongest flows (> 20 cm/s) occurred in the upper water column, as expected, during the ice-limited summer season and were primarily westward along the slope. This westward flowing Chukchi Slope Current is consistent with a recent analysis using historical hydrographic data; in the mooring record it extended from the surface to at least 200–300 m depth depending on the year. Upper water column currents decreased in magnitude to *(sic; abstract incomplete)*.

Development of Arctic Xbeach

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Presenter: Michael Ulmgren

Advanced coastal geomorphic change models are being used today in non-Arctic settings to forecast erosion and sedimentation processes due to storms. For example, the U.S. Army Corps of Engineers, Deltares, and the University of Miami have collaborated on the development of the open source Xbeach model. Xbeach simulates the nearshore hydrodynamic (wave and current) environment, as well as the sediment transport and geomorphic change due to the hydrodynamics. However, the Xbeach model and similar tools focus on mechanical processes and are not applicable in Arctic settings where both mechanical and thermal processes are important. In Arctic settings, coastal soils and sediments are either seasonally frozen or permafrost and thawing of those sediments/soils is required before they can be moved by mechanical processes. In this presentation, we describe the development and validation of an Arctic-capable version of the Xbeach model which we refer to as Arctic Xbeach. To create Arctic Xbeach, we have added a thermal module that computes the temperature and phase of the nearshore water and the sediment/soils as a function of time. The thermal module is integrated with the mechanical model. For example, the mechanical model computes the nearshore wave condition and that data is used to determine the convective heat transfer coefficient for computing heat transfer between the nearshore water and the submerged sediments. Also, the thermal module passes information on the phase of the soil/sediment to the mechanical model. Frozen soil/sediment is treated as “non-erodible” material using a feature already included in the original Xbeach model. The new Arctic Xbeach is validated in a number of ways. Simulations of geomorphic change in Arctic locations (e.g., Barter Island) show that accounting for thermal processes is necessary for achieving realistic calculations of geomorphic change. Simulations show that an early season storm (when the nearshore water is unfrozen but the submerged sediments are still frozen) causes significantly less geomorphic change (i.e., erosion) than a late season storm that occurs after significant seasonal thaw of sediment has already occurred.

Marine ARctic Ecosystem Study (MARES): New Measurements on the Eastern Beaufort Sea Shelf

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Presenter: Francis Wiese

The MARES program is focused on understanding the structure and function of the Beaufort Sea shelf marine ecosystem and the role the MacKenzie River Delta region plays in its dynamics. Consultations with the local Hunters and Trappers Committees in Aklavik, Inuvik and Tuktoyaktuk, and presentation to the Inuvialuit Game Council provided needed and valued input, and resulted in Inuvialuit Final Agreement Environmental Impact Screening Committee approval and Northwest Territories Scientific Research License. Five moorings and an underwater SLOCUM glider were deployed in fall of 2016. The SLOCUM glider conducted a season-long, high-resolution hydrographic survey in the Mackenzie Trough region downstream of the mouth of the Mackenzie River. We found that the spatial distribution of the Mackenzie plume is in part controlled by the direction of the coastal flow and the Beaufort shelf break jet. Dynamical factors such as the sea surface height gradient and wind forcing further control the flow pattern in and around Mackenzie Trough and serve to entrain plume water and deepen the seasonal pycnocline. Rapid changes on the order of hours in upper water column stratification and shelf break flow direction were observed. The five moorings were recovered and four were redeployed for another year in October 2017. The biophysical moorings spanned water depths from 14 m to 440 m and were instrumented to measure numerous biological and physical parameters throughout the water column including salinity, temperature, nitrate, carbon dioxide, turbidity, fluorescence, photosynthetically active radiation, underwater sound, currents, ice draft, ice velocity, and fish and zooplankton abundance. MARES observations address an important spatial gap in the study of the oceanography and sea-ice of the eastern Beaufort Sea continental margin. The analysis and synthesis of the different data products from year one, which is now underway, will lead to a deeper understanding of

the Arctic marine ecosystem, including tracking the presence and movements of zooplankton and fishes on the Beaufort Sea slope, and a description of the important physical drivers.

The Influence of Arctic Storms on Surface Climate in the Chukchi-Beaufort Seas

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Increases in the frequency and intensity of Arctic storms and resulting weather hazards may endanger the offshore environment, coastal community, and energy infrastructure in the Arctic as sea-ice retreats. Advancing ability to identify fine-scale variations in surface climate produced by progressively stronger storms would be extremely helpful to resource management and sustainable development for coastal communities. In this study, we analyzed the storms and their impacts on surface climate over the Beaufort-Chukchi seas by employing the data sets from both the hindcast simulations of the coupled Arctic regional climate model HIRHAM-NAOSIM and the recently developed Chukchi-Beaufort High-resolution Atmospheric Reanalysis (CBHAR). Based on the characteristics of spatial pattern and temporal variability of the Arctic storm activity, we categorized storms to three groups by their different origins: the East Siberian Sea, Alaska, and the central Arctic Ocean. The storms originating from the central Arctic Ocean have the strongest intensity in winter with relatively less storms. Storms traveling from Alaska to the Beaufort Sea most frequently occurred in autumn with weaker intensity. Further statistical analysis suggests that increases in surface air temperature and wind speed could be attributed to the increased frequency of storm occurrence in autumn along the continental shelf in the Beaufort Sea.

WORKSHOPS

WORKSHOPS

Monday – January 22

All Day

AMERICAN GEOPHYSICAL UNION COMMUNICATIONS WORKSHOP

This year, the Alaska Marine Science Symposium is partnering with the American Geophysical Union and their "Sharing Science" group to deliver a 1.5 day science communication workshop. Open to all scientists, science communicators, media, and other audiences. One-on-one consultation sessions will be available Monday morning for critique and evaluation of materials, products, and project ideas.

Tuesday – January 23

9AM – 12:00PM

COMMUNICATING OCEAN SCIENCES WORKSHOP

Each year, the Communicating Ocean Sciences Workshop provides practical information, great speakers and information on current best practices in education, outreach and media. Join internationally acclaimed outdoor and conservation photographer, Chris Linder (<http://www.chrislinder.com>) as he will be leading a hands-on workshop that focuses on effective still and video imagery in the field, how to tell a story with science photography, and how to improve your images without breaking the budget. This workshop is free and space is not limited.

Wednesday – January 24

12:00 - 1:30PM

ALASKA CLIMATE INTEGRATED MODELING (ACLIM) PROJECT: STAKEHOLDER WORKSHOP

North Pacific waters are warming. Come hear how the Alaska Climate Integrated Modeling (ACLIM) Project team is evaluating what a changing environment

means for Bering Sea fisheries management. We will discuss current research and some of the lessons learned about how changing climate impacts marine populations in the Bering Sea and Aleutian Islands, the Gulf of Alaska, and the US West Coast. We need your help and input! What are your concerns regarding climate change? What impacts do you anticipate? What scientific questions would you like answered? How will you adapt? How can management help ease the burden?

Thursday – January 25

12:00 – 1:00PM

STATE OF THE ARCTIC - CIRCUMPOLAR BIODIVERSITY MARINE PROGRAM PROGRESS

Come hear about accomplishments of the Circumpolar Biodiversity Monitoring Program. Since 2014 this international network brought together scientists, governments, Indigenous organizations and conservation groups to monitor Arctic changes. Endorsed by the Arctic Council, the CBMP is the biodiversity component of the Sustaining Arctic Observing Networks (SAON). Don't get lost in the acronyms – come learn about the program components (from plankton to marine mammals) and who is involved. A recent program accomplishment was completion of the State of the Arctic Marine Biodiversity Monitoring Program. We will cover highlights of the report and preview program plans to facilitate rapid detection, communication and response to the biodiversity trends and pressures in the circumpolar Arctic. Share your thoughts on data and reporting; coordination and outreach; capacity building – help further our understanding and tracking of the rapidly changing Arctic.

Thursday – January 25

7:00 – 9:00PM

ARCTIC RESEARCH PLANNING NIGHT

Fairweather Science is hosting the annual Arctic Research Planning Night at the Quarterdeck. This event is held to facilitate collaboration, networking, and knowledge sharing among Arctic researchers. We welcome everyone interested in discussing Arctic research. As with previous years, please either send in advance or bring a thumb drive with a few slides that outlines your research plans for 2018 and beyond. Please include vessel, location of study, duration of cruise, objectives, types of data to be collected, available bunk space, and length

of contract. Onshore researchers are also welcome to share information. No RSVP is required and it is an open invitation. Beer/wine and appetizers will be provided by Fairweather Science. The Arctic Research Consortium of the U.S. (ARCUS) will have a resource table at the event, with staff present to help you get better connected with the broader Arctic research community through communication, coordination, and collaboration.

Friday – January 26

9:00AM – 12:00PM

METADATA 411

This workshop will provide an overview of how to write metadata to describing scientific datasets. Presenters will demystify the content and scope of scientific metadata, describe its value to funders and scientists, and guide attendees on best practices for writing standards-compliant metadata. Attendees will gain a practical understanding of the information that makes up a metadata record while practicing by using the Research Workspace Metadata Editor. This workshop is aimed at scientists and technicians tasked with writing metadata or who want to better understand metadata and its creation. Attendees should bring a laptop and dataset of their own that they want to begin documenting.

Friday – January 26

9:00AM – 12:00PM

MICROPLASTICS CONTAMINATION OF THE NORTH PACIFIC AND BERING SEAS

Friday – January 26

9:00 – 11:00AM

CMI ANNUAL RESEARCH REVIEW

This workshop presents updates on 15 current environmental research projects, including graduate student works, funded through the Coastal Marine Institute 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.

Friday – January 26

9:00 – 11:00AM

CIRCULATION AND HYDROGRAPHY OF THE NORTHEASTERN CHUKCHI SEA

An intensive sampling program of the northeastern Chukchi Sea was conducted from 2009 to 2014 with BOEM and partner funding. Thomas Weingartner will present a synthesis of data collected during this program, along with that from other agencies, to develop an improved understanding of the physical oceanography of the northeastern Chukchi shelf, as well as exchanges between the Chukchi/Beaufort shelves and the adjacent basin.

Friday – January 26

9:00AM – 3:00PM

COOK INLET BELUGA WHALE MANAGEMENT, RESEARCH, AND PARTNERSHIP OPPORTUNITIES