BOEM Bureau of Ocean Energy Management

Alaska Annual Studies Plan FY 2022

U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska Outer Continental Shelf Region

Anchorage, Alaska
November 2021

Prepared by
U.S. Department of the Interior
Bureau of Ocean Energy Management
Anchorage, Alaska Office
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

November 2021

The Environmental Studies Program has chosen to "go green." This document can be accessed in electronic format at http://www.boem.gov/akstudies/. For assistance accessing the document or for further information about the Studies Program and our planning process, please contact Alaska.Studies@boem.gov or Dr. Heather Crowley at heather.crowley@boem.gov.

The inclusion of study profiles in this document does not constitute a commitment by the U.S. Department of the Interior, Bureau of Ocean Energy Management to conduct or fund any or all of the studies. Method of procurement may be selected at the discretion of BOEM. The scope of the studies is subject to change prior to initiation of any work.

Any use of trade names is for descriptive purposes only and does not constitute endorsement of these products by the Bureau of Ocean Energy Management.

Cover Image: Deploying sensors on Chukchi Sea landfast ice near Utqiaġvik, Alaska in March 2019.

Photo credit: *Measuring Wave Forces Along Alaska's Coastal Sea Ice* project team; OCS Study BOEM 2021-019.

United States Department of the Interior
BUREAU OF OCEAN ENERGY MANAGEMENT
Alaska Regional Office
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

November 2, 2021

Dear Stakeholder:

Thank you for your interest in the Environmental Studies Program (ESP) of the Bureau of Ocean Energy Management (BOEM). As BOEM's priorities evolve, we continue to assess our information needs and identify new study ideas each year to meet these needs. We are providing this *Alaska Annual Studies Plan FY 2022* as a convenient reference describing our recent programmatic updates and our plans for fiscal year (FY) 2022 and beyond.

We have worked to restructure and streamline the *Alaska Annual Studies Plan* while continuing to focus on input we receive from our partners within and outside of the Federal Government. We are interested to know your perspectives and to receive any suggestions you may have for the BOEM *Alaska Annual Studies Plan FY 2023*, which we are now beginning to formulate. We assess information needs and develop new study profiles each year, following a well-established process that involves a role for both stakeholder input and scientific peer review.

To assist us in processing suggestions for new studies, we ask that you follow the formatting guidance for a study profile shown on the next page. Please keep in mind that studies proposed for our consideration must address specific BOEM mission and decision needs. Suggestions may be submitted via email to Alaska.Studies@boem.gov, and must be received by us no later than December 6, 2021, to ensure consideration for the 2023 fiscal year (October 1, 2022– September 30, 2023). Following revisions to this plan, we will issue a final *Alaska Annual Studies Plan FY 2023* in the autumn of 2022.

We sincerely appreciate your participation in this process, and we look forward to receiving your suggestions. If you have any questions about the submission process, you are urged to contact Dr. Heather Crowley, Alaska Studies Coordinator, at heather.crowley@boem.gov.

Sincerely,

Catherine Coon
Chief, Environmental Sciences Management

Bureau of Ocean Energy Management
http://www.boem.gov/akstudies/
Alaska.Studies@boem.gov

Proposed Study for FY 2023

Formatting Guidance: We recommend study profiles be less than 2 pages. Profiles are not a detailed scope of work; BOEM will prepare a detailed scope of work if one is needed. Please keep in mind that studies proposed for consideration must address specific BOEM mission and decision needs as described in Section 2.0 of this document. The method of procurement for any funded study shall be selected at the discretion of BOEM.

Title: Enter a brief, descriptive title

Administered by: BOEM Alaska Regional Office

Period of Performance: FY 202X-202X

Study Framework: *(Provide one or two sentences for each of the following elements, as appropriate)*

Problem: Who or what is potentially affected? This includes baseline studies.

Intervention: What is your solution to the problem? How do you measure potential interactions and/or change?

Comparison: What is the intervention measured against? Consider in terms of hypothesis testing, control vs. treatment, and/or natural change.

Outcome(s): What is the expected outcome and understanding?

Context: What are the circumstances and/or geographic domain(s)?

BOEM Information Need(s): Provide brief and conclusive reason(s) why BOEM needs the information. Explain how this information will be used to manage Outer Continental Shelf (OCS) resources. The specific decision or document relying on the information should be stated.

Background: Provide a brief narrative of relevant issues. Explain what information is required and provide pertinent background. Include details about whether this study ties in with other efforts, and if so, how. Include a description of the current status of information. That is, what is the level of adequacy of existing information, does any exist, does it need to be more geographically specific?

Objectives: Clearly and succinctly state the overall purpose of the study by identifying one or more specific objectives.

Methods: Provide a brief description of how the objectives of the study will be accomplished, including what information, techniques or methods are available that could be used. Also note expected study products in this section (e.g., technical reports, database, model, bibliography)

Specific Research Question(s): Identify specific research questions this study will address.

Additional information: Provide additional relevant information, such as dates when products would be most useful and for what purpose.

TABLE OF CONTENTS

LIST OF STUDY PROFILES

STUDIES PLANNED FOR FY 2022

STUDIES TO BE CONSIDERED FOR FY 2023

ACRONYMS AND ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
ANTHC	Alaska Native Tribal Health Consortium
ASP	Alaska Annual Studies Plan (BOEM)
AOOS	Alaska Ocean Observing System
BOEM	Bureau of Ocean Energy Management
BSMP	Beaufort Sea Monitoring Program
BSEE	Bureau of Safety and Environmental Enforcement
CESU	Cooperative Ecosystem Studies Unit
CIRCAC	Cook Inlet Regional Citizens Advisory Council
CMI	Coastal Marine Institute
COMIDA	Chukchi Offshore Monitoring in Drilling Area
COSA	Committee on Offshore Science and Assessment of the National Academies of Sciences, Engineering, and Medicine
DPP	Development and Production Plan
DWM	Department of Wildlife Management (North Slope Borough)
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EP	Exploration Plan
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESP	Environmental Studies Program (BOEM)
ESPIS	Environmental Studies Program Information System
FY	Fiscal Year
G&G	Geological and Geophysical
IARPC	Inter-agency Arctic Research Policy Committee
MML	Marine Mammal Laboratory
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NPRB	North Pacific Research Board

NSB	North Slope Borough
OCS	Outer Continental Shelf
OCSEAP	Outer Continental Shelf Environmental Assessment Program
OCSLA	Outer Continental Shelf Lands Act
ONR	Office of Naval Research
PSD	Prevention of Significant Deterioration
TBD	To be determined
UAF	University of Alaska Fairbanks
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

SECTION 1.0 PROGRAM OVERVIEW

1.1 Introduction

The U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) uses high-quality scientific information to manage the responsible exploration and development of offshore energy and marine mineral resources on the U.S. Outer Continental Shelf (OCS). The Alaska OCS consists of approximately 1 billion acres of federal jurisdiction lands submerged under the ocean seaward of state boundaries, generally beginning three nautical miles off the coastline and extending for 200 miles.

Mandated by Section 20 of the Outer Continental Shelf Lands Act, BOEM's Environmental Studies Program (ESP) develops, funds, and manages scientific research used to support environmental analysis under the National Environmental Policy Act (NEPA) that informs policy decisions on the development of energy and mineral resources on the Outer Continental Shelf (OCS). The ESP has provided over $1.2 billion for research since its inception in 1973; more than $450 million of that amount has funded studies across Alaska's 15 planning areas in the Arctic, Bering Sea and Gulf of Alaska sub-regions (Figure 1) to produce more than 2,500 technical reports and innumerable peer-review publications.

The original focus of the ESP to obtain baseline information on the vast biological resources and physical characteristics of the Alaskan environment has evolved to include topical studies in smaller areas to answer specific questions and fill identified information needs. Currently, the ESP in Alaska manages approximately 60 ongoing study projects in disciplines such as physical oceanography, air quality, fate and effects of pollutants, protected species, marine ecology, and the social sciences, including Indigenous knowledge. BOEM analysts use final reports, data, and peer-review journal articles from ESP-funded studies to prepare NEPA documents, such as Environmental Impact Statements (EISs) and Environmental Assessments (EAs), and to develop documentation for consultations and other requirements under other Federal laws, including but not limited to the Marine Mammal Protection Act (MMPA); Endangered Species Act (ESA); Magnuson-Stevens Fishery Conservation and Management Act; Marine Protection, Research and Sanctuaries Act; and Clean Air Act.

Completed study reports are posted on the Environmental Studies Program Information System (ESPIS) at http://www.boem.gov/ESPIS/. BOEM Alaska Regional Office study reports can also be found at http://www.boem.gov/AKpubs. Project data are typically delivered to Federal data repositories such as the National Centers for Environmental Information (NCEI) and posted to the Alaska Ocean Observing System (AOOS) and customized project websites.

Figure 1. BOEM Alaska OCS Planning Areas

1.2 Issues to Be Addressed

1.2.1 Strategic Science Questions

BOEM's research mandate under Section 20 of the Outer Continental Shelf Lands Act (OCSLA; 43 U.S.C. 1346) is to conduct studies that will provide the information needed to assess and manage the impacts on the human, marine, and coastal environments from offshore energy and marine mineral development. As discussed in the ESP's Strategic Framework (USDOI, BOEM, ESP 2020), BOEM seeks to achieve this mandate through research that addresses the following Strategic Science Questions:

- How can BOEM best assess the affected environment and changing baselines within the framework of environmental assessments?
- What are the acute and chronic effects of sound from BOEM-regulated activities on marine species and their environment?
- What are the acute and chronic effects of exposure to hydrocarbons or other chemicals on coastal and marine species and ecosystems?

- What is the effect of habitat or landscape alteration from BOEM-regulated activities on ecological and cultural resources?
- What are the air emissions impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?
- How will future ocean conditions and dynamics amplify or mask effects of BOEM-regulated OCS activities?
- How does BOEM ensure the adequate study and integrated use of social sciences in assessing the impacts of OCS activities on the human environment?
- How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?
- What are the best resources, measures, and systems for long-term monitoring?

Studies in Alaska must also address the changing Arctic environment and how it will interact with OCS activities over the next 25–50 years:

- What role will ocean currents and sea ice play in distribution of anthropogenic pollutants near exploration and development prospects?
- How are ocean currents and biota affected by reduced sea ice conditions?
- How do cold temperatures and presence of sea ice alter the fate of spilled oil?

In addition to the physical and biological environment, the ESP in Alaska needs to consider many socioeconomic issues entrained by the observed changes. For example, increased shoreline erosion and permafrost melt threatens Arctic communities and infrastructure. Furthermore, the people of Alaska's remote arctic and subarctic communities rely heavily on subsistence resources and are especially concerned about changes in distribution and availability of hunted subsistence species, as well as industrial activities that may affect hunting success or the habitats of important subsistence species. In addition to subsistence, the people of Cook Inlet are also concerned about potential effects of OCS activities on commercial fishing, sport fishing, and tourism.

1.2.2 NEPA Analysis for OCS Activities in Alaska

The Lease Sale Stage

BOEM develops the National Outer Continental Shelf Oil and Gas Leasing Program (National OCS Program) for oil and gas development in accordance with OCSLA. The National OCS Program establishes a five-year schedule of oil and gas lease sales proposed for the OCS. Currently, BOEM is working under the approved Proposed Final OCS Oil & Gas Leasing Program 2017–2022 (USDOI, BOEM 2016). This Program includes Lease Sale 258 in Cook Inlet, which is expected to be held in 2022.

The Alaska Regional Office typically prepares an EIS for each specific lease sale described in the National Program. Studies at this stage often are focused at a regional scale. Updating past studies to address current information needs and changing conditions is also important to support these environmental analyses and to help facilitate informed leasing decisions. Alaska is a frontier region with large, remote planning areas and extreme environmental conditions, however. These challenges require long planning lead-time and complex logistics to conduct environmental studies that provide the needed information.

The Exploration and Development and Production Stages

BOEM typically prepares site-specific EISs and EAs to consider the impacts of Geological and Geophysical (G&G) Survey permits, Exploration Plans (EPs), or Development and Production Plans (DPPs). Studies at these stages tend to have a more specific focus and may consider individual resources or areas and related monitoring needs to supplement the broader studies that are the focus of the pre-lease stage. In addition to the requirements of OCSLA, BOEM has jurisdiction to regulate air emissions associated with oil and gas activities on portions of the Alaska OCS adjacent to the North Slope Borough.

1.3 Scientific Studies are Developed and Conducted in Partnership

Research planning follows an annual cycle (Figure 2) that begins with the autumn distribution of the *Alaska Annual Studies Plan* (ASP) to more than 200 partner and stakeholder groups across Federal, State, Alaska Native, Tribal, academic, and industry sectors. The ASP describes ongoing research, reveals proposed new studies for the coming fiscal year, and requests input from scientists, stakeholders, partners and the general public about information needs and suggestions for new studies.

More than 70 individual study suggestions are received from external stakeholders and BOEM staff each year, including ideas identified from programmatic reviews and public comments. The ESP's structured decision-making approach to prioritizing study ideas for funding consideration consists of an evaluation by BOEM subject-matter experts to identify a short-list of high priority study profiles for further consideration. This evaluation is based on the following seven criteria (detailed in the ESP's *Studies Development Plan 2022-2023* (USDOI, BOEM, ESP 2021)).

1. Need for the information in BOEM decision-making
2. Contribution to existing knowledge
3. Research concept, design, and methodology
4. Cost-effectiveness
5. Leveraging of funds
6. Partnerships and collaboration
7. Multi-regional and strategic utility

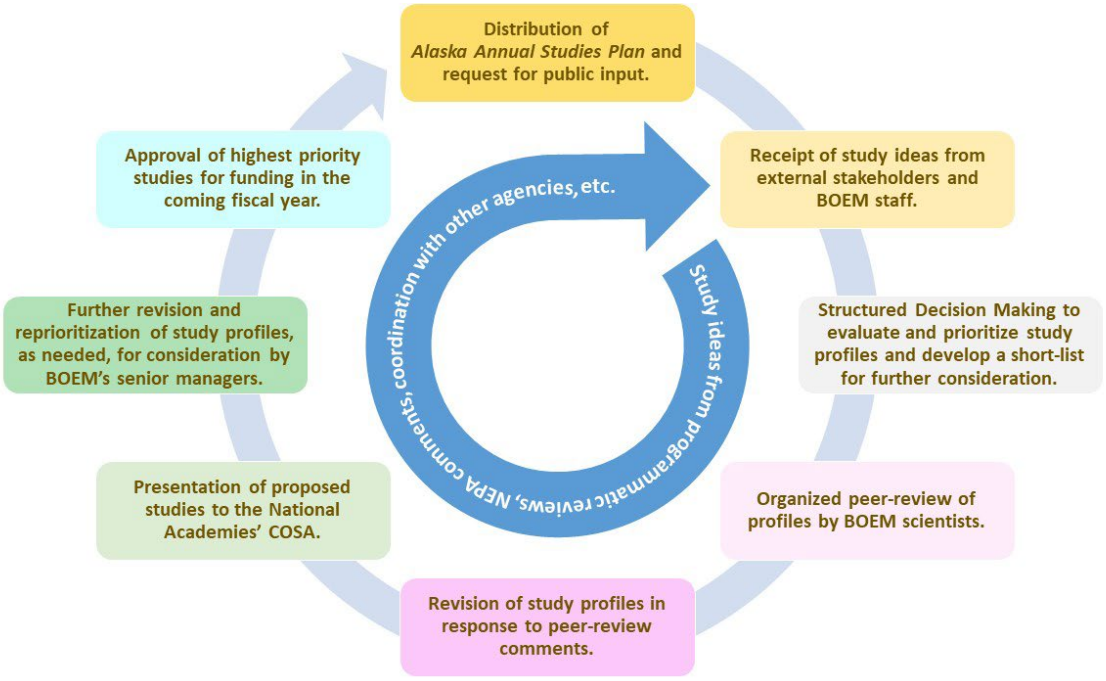

Figure 2. The Alaska Regional Office's Annual Studies Planning Cycle

Following this evaluation, the study profiles move through several additional steps before the circle is closed:

1. The proposed profiles undergo an organized process of peer-review by scientists throughout BOEM to evaluate the priority and quality of each proposed study, including providing feedback on technical aspects of proposed study methods.
2. The proposed studies are presented to the Committee on Offshore Science and Assessment (COSA) of the National Academies of Sciences, Engineering, and Medicine for additional input.
3. The profiles are again revised, reprioritized, and finalized during summer for consideration by senior managers at the regional and national levels to determine funding allocation in the new fiscal year.
4. The highest priority studies are approved for funding.
5. The ASP is published and circulated to the public in autumn, when the cycle begins again.

When conducting research projects, the ESP in Alaska coordinates routinely with numerous Federal entities, as well as active research and monitoring programs in Alaska supported by industry. In addition, the ESP works directly on specific projects with a wide range of Federal, State, and local agencies; tribal entities; non-governmental organizations; and academic institutions.

The University of Alaska Coastal Marine Institute (CMI), a cooperative arrangement created in 1993, allows the ESP to tap the scientific expertise of regional and local experts to collect and disseminate environmental information about coastal topics associated with the development of energy resources in the Alaska OCS. Through the CMI, the ESP stimulates important studies with a budget of up to $1 million and a cost-saving dollar-for-dollar match arrangement. In its first 28 years, the CMI has funded approximately 120 studies and leveraged over $22 million of agency funds into $45 million of relevant marine-based research, with non-Federal matching funds from more than 50 different organizations. During that time, the CMI program has also provided more than 210 years of student training and nearly $2.7 million in student support. More information about the CMI can be found at https://uaf.edu/cfos/research/cmi.

The ESP also conducts cooperative research with universities through the Cooperative Ecosystem Studies Units (CESUs). The CESUs are working partnerships among leading academic institutions, Federal, State, and non-governmental organizations. A national network of seventeen CESUs has been established to facilitate collaboration through the working partnerships to provide high quality research, education and technical assistance for stewardship of cultural and natural resources. BOEM currently participates in seven CESUs that encompass all areas of the OCS.

Additional linkages have been established at an international level with other arctic nations' research and regulatory entities. The ESP in Alaska coordinates with Arctic Council activities, including the Arctic Monitoring and Assessment Programme, Conservation of Arctic Flora and Fauna, Protection of the Arctic Marine Environment, and other working groups. The ESP provides information to these working groups through review of reports and plans, such as the Arctic Council Arctic Marine Strategic Plan 2015-2025, and helps to inform participants of available information sponsored by BOEM. Further, the ESP identifies and facilitates specific studies that can coordinate and integrate with working group activities.

BOEM also strives to incorporate Indigenous and local knowledge of Alaska Natives, Alaskan residents, and the permanent participants of the Arctic Council in its decision-making processes (Kendall et al. 2017; Brooks et al. 2019). The ESP considers and integrates Indigenous and local knowledge at all stages, beginning with the study development process through the preparation of study products and interpretation of results. In field-oriented studies sponsored by the ESP, researchers typically coordinate directly with local communities to discuss their plans, seek advice and ensure that interested individuals learn about the project and its results. The process of integrating Indigenous and local knowledge and community-based monitoring varies from project to project, but the outcome of better information for decision-making is a common goal.

SECTION 2.0 IDENTIFICATION OF INFORMATION NEEDS

BOEM has an ongoing need for updated information about the physical, biological, and human environment in Alaska to support NEPA analysis for future lease sales, EPs, or DPPs on the OCS. BOEM has placed primary emphasis on studying the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas. The ESP in Alaska is looking to broaden the geographic focus, however, due to the interconnectivity of the different regions and the potential for new areas to be included in a new National Program.

2.1 Specific Information Needs by Planning Area

2.1.1 OCS Activities in Alaska

Since 1976, a total of 2,365 leases have been issued in 26 OCS lease sales in Alaska, including 929 tracts leased in ten OCS lease sales in the Beaufort Sea Planning Area. Industry has drilled a total of 85 exploratory wells in seven planning areas, including 30 wells in the Beaufort Sea and six wells in the Chukchi Sea. As of October 2021, there are 19 active leases in the Beaufort Sea Federal offshore area (Figure 3) and 14 active leases in Cook Inlet (Figure 4). There are no active leases from previous lease sales in the Chukchi Sea, Bering Sea, or Gulf of Alaska subregions.

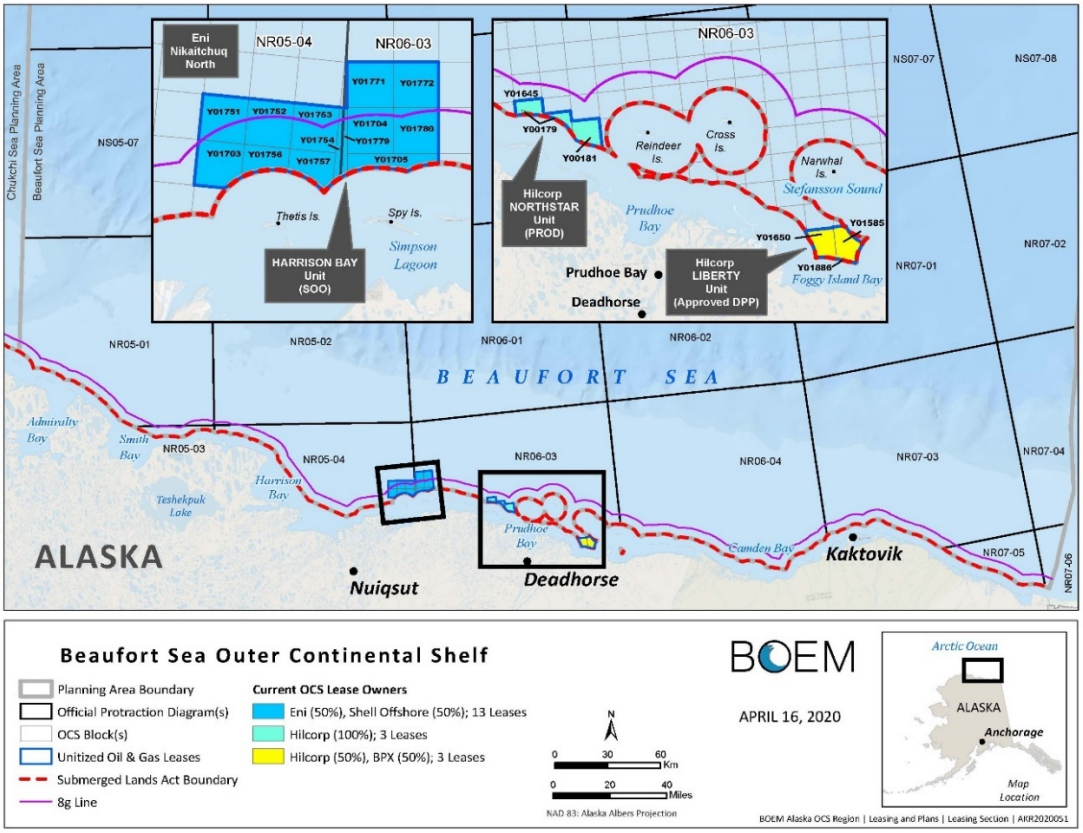

Figure 3. Beaufort Sea OCS Leases and location of Northstar, Liberty, and Eni project areas

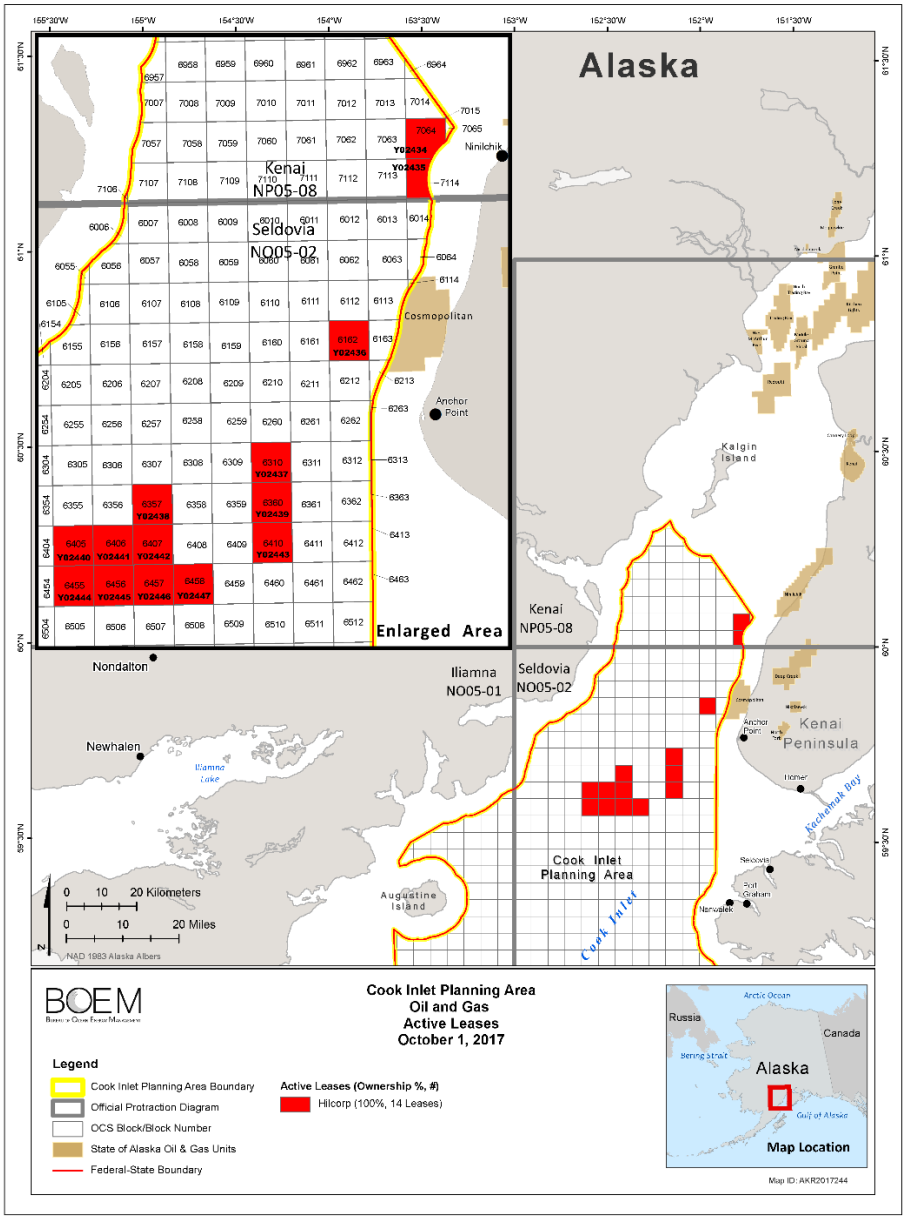

Figure 4. Cook Inlet OCS Leases

Production:
Northstar – Northstar is a joint Federal/State of Alaska unit located in state waters in the Beaufort Sea about 12 miles northwest of Prudhoe Bay (see Figure 3). The six producing Federal wells fall under Bureau of Safety and Environmental Enforcement (BSEE) regulatory authority, the State wells fall under the State's oversight. Production started in 2001 and peaked in 2004. Total production of crude oil through August 2021 is more than 179 million barrels, with the Federal portion comprising approximately 32 million barrels.

Development:
Liberty – The Liberty prospect is located in the central Beaufort Sea (see Figure 3). In November 2014, primary ownership and operation of Liberty was acquired by Hilcorp Alaska LLC. Hilcorp submitted a DPP (Hilcorp 2015) for the Liberty Unit, which is estimated to contain up to 150 million barrels of recoverable crude oil. In their DPP, Hilcorp proposes construction of a Liberty Drilling and Production Island, which will be built of reinforced gravel in 19 feet of water about 5 miles offshore in Foggy Island Bay. Process facilities on the island will separate crude oil from produced water and gas, which will be injected into the reservoir to provide pressure support and increase recovery from the field. A single-phase subsea pipe-in-pipe pipeline will transport sales-quality crude to shore, where an above-ground pipeline will transport crude to the existing Badami pipeline and into the Trans-Alaska Pipeline System. BOEM conditionally approved the Liberty Project Development and Production Plan on October 24, 2018. On December 26, 2019, BSEE approved Hilcorp's request for a Suspension of Production on the Liberty Unit.

Exploration:
Harrison Bay – On July 12, 2017, BOEM conditionally approved an Exploration Plan (EP) submitted by Eni US Operating Company, Inc. proposing to conduct drilling into leased OCS areas from an existing gravel island located in State waters (see Figure 5). BOEM approved a revision of Eni's EP on April 13, 2018.

Cook Inlet – On August 1, 2021, BOEM issued a permit to Hilcorp Alaska LLC to conduct a geohazard site clearance survey over several of its leases in Cook Inlet between August 11, 2021 and October 31, 2021. This survey is used to identify seafloor obstructions, shallow drilling hazards, and archaeological resources and is required by BOEM prior to further exploration activities. A permit also was issued on May 1, 2020, however Hilcorp chose not to execute that survey. Hilcorp conducted an exploratory seismic survey over these leases in the autumn of 2019.

Data related to these oil and gas activities are sparse. However, BOEM's science needs and environmental analyses in Alaska are further informed by activities located in coastal areas and State waters of Cook Inlet and the Beaufort Sea.

2.1.2 Geographic Variations in Environmental Conditions

The wide range of environmental conditions from the Gulf of Alaska and Cook Inlet to the Bering Sea and the Arctic is an important consideration during the process of formulating new studies. Though vastly diverse, these areas share many of the same information needs, such as the need for assessment of variability and long-term trends in oceanographic conditions and biological communities. For example, a better understanding of trophic and community structure in nearshore habitats is needed to support evaluation of resiliency of fish and invertebrate populations under changing environmental conditions in each area.

Residents of Beaufort Sea coastal communities have expressed concerns about long-term effects of OCS activities, particularly changes to ocean currents and sedimentation rates and potential effects on social systems, including subsistence whaling activities, in

the vicinity of Northstar and Liberty. To better address these concerns, BOEM needs more information about the about spatial and temporal trends in vessel traffic in the Arctic and potential impacts of vessel presence and sound on the marine environment and subsistence activities in the region.

OCS activities in the Beaufort Sea can potentially affect the Chukchi Sea due to the oceanographic and ecological connections between the two areas, in addition to the common vessel transit routes. The fundamental issues in the Chukchi Sea are very similar to those in the Beaufort Sea, although many species that regularly appear within the Chukchi Sea are not typically found in the Beaufort Sea. Research projects in these areas typically pursue multi-year data collection efforts on a regional scale, with careful attention to inter-annual variability and ecosystem processes. Most of the studies in the Arctic exhibit complex, multilateral collaborations, with explicit inter-disciplinary linkages between the physical and biological sciences, and many of them also provide a role for active participation by Alaska Native residents and input from sources of traditional knowledge.

In Cook Inlet, some particular interests include, but are not limited to: an improved understanding of distribution and geographic range of the endangered Cook Inlet beluga whale stock; studies of distribution, community composition, and habitat use of marine mammals, as well as fish and invertebrates; and enhanced interpretation of the surface and subsurface circulation and density fields, including improved modeling of rip currents.

2.2 Specific Information Needs by Discipline

Interdependent Physical, Biological and Social Processes

The Alaska Regional Office has a long history of supporting multidisciplinary research, beginning with the “Outer Continental Shelf Environmental Assessment Program” (OCSEAP) surveys conducted between the 1970s and early 1990s and the “Beaufort Sea Monitoring Program” (BSMP) in the 1980s. The “Arctic Nearshore Impact Monitoring in the Development Area” (ANIMIDA) program began in 1999 to provide baseline data and monitoring for trace metals and chemical contaminants, turbidity, and subsistence whaling in the vicinity of the Northstar and Liberty development sites. The monitoring was extended through two follow-on projects and expanded to include Camden Bay. Similarly, the multiple components of the “Chukchi Sea Oceanographic Monitoring in the Drilling Area” (COMIDA) program, which evolved from a planning workshop in November 2006, represent an ecosystem-based approach for providing baseline data and tracking environmental changes across the Chukchi Sea, with particular focus on the highly productive area around Hanna Shoal. This integrated approach to examining the interdependence of physical, biological and social processes is continuing through projects such as the Arctic Ecosystem Integrated Surveys and the Arctic Biodiversity Monitoring Program.

Ocean Circulation and Sea Ice

Accurate information on surface wind fields, ocean currents, and sea ice is important for assessing the fate of spilled oil and the potential impacts on biota in the area. It is particularly important to know locations and seasonal and interannual changes in water masses, ocean currents, and sea ice. The need for updated oceanographic baseline information is heightened by the pace of climate change seen in Alaska.

Air Quality

In December 2011, Congress transferred jurisdiction and authority for the regulation of oil and gas-related air emissions on the OCS adjacent to the North Slope Borough from the Environmental Protection Agency (EPA) to BOEM. Arctic oil and gas exploration and extraction activities proposed for the OCS require air quality operating approval, as well as environmental evaluations pursuant to NEPA and to comply with the impact analysis under BOEM's implementation of the OCSLA.

Pollutants

The environmental effects of oil and gas development on biota, including effects from potential oil spills, is a concern for residents of coastal communities in Alaska. Up-to-date information on how ocean currents and sea ice affect the motion of spilled oil is necessary to fully address these concerns. Residents of the North Slope are especially concerned about potential contamination of their food supply, which includes bowhead whales, seals, waterfowl, and fish.

Marine Mammals and Other Wildlife

Information is needed across Alaska about the current spatial and temporal use patterns on the OCS of sensitive species including cetaceans, sea otters, pinnipeds, and seabirds. BOEM is currently collaborating with the National Oceanic and Atmospheric Administration (NOAA) to identify the winter range of the critically endangered Cook Inlet beluga whale population. In the Arctic, BOEM has an ongoing need for information about the populations of bowhead whales, polar bears, spectacled eiders, spotted and ringed seals, walruses and other arctic species. Potential effects from loss of sea ice are a concern, especially for those species listed as threatened or endangered. More comprehensive abundance estimates for these ice-associated marine mammals enhance the assessment of potential impacts under NEPA and assist NOAA and the U.S. Fish and Wildlife Service (USFWS) in ensuring compliance with Federal management and regulatory mandates for marine mammals under the MMPA.

A particular information need is the effect of noise on the well-being and the behavior of bowhead whales. The bowhead whale is central to Alaska Native cultural and spiritual life and the Iñupiat rely heavily on bowhead whales for subsistence. Whale hunters have reported that migrating bowhead whales deflect from their normal migratory route well upstream of active industry vessels and may divert a great distance from their migration route, making them potentially more difficult to hunt. It is also important to assess the factors that may be affecting the habitat use, health, population status and migration

routes of bowhead whales and the potential cumulative impacts from multiple factors (e.g., noise from industry activities combined with environmental change) on the whales. Furthermore, North Slope residents are concerned about potential disturbance of beluga whales, bearded seals, waterfowl and other subsistence-wildlife species by oil and gas activities such as helicopter overflights.

Fish and Lower Trophic Communities

Fishes fill an essential role in the ecosystem by consuming small prey and in turn providing a food resource for larger fishes, birds, marine mammals, and people. Assemblages and populations of fish and benthic organisms in marine ecosystems off Alaska have undergone observable regime-shifts in diversity and abundance over the last 20-30 years. It is important to assess the distribution and abundance of fishes in the waters off Alaska and to distinguish between changes due to anthropogenic and natural effects. In addition, BOEM engages in consultation with NOAA's National Marine Fisheries Service (NMFS) under the Magnuson-Stevens Fishery Conservation and Management Act regarding any action that may adversely designated Essential Fish Habitat (EFH) for adult and late juvenile life-stages of a number of species, including Arctic cod, Pacific salmon, and saffron cod.

Alaska Native Culture

The Iñupiat report in public testimony that their culture is vulnerable to short-term, long-term and cumulative effects from OCS activities. They are concerned that OCS activities might lead to:

- Social disruption and a change in cultural values through population shifts (immigration of large numbers of non-Iñupiat to the North Slope)
- Impacts to community health
- Cumulative effects of multiple industrial activities, alteration of subsistence-harvest patterns, and displacement of hunters and subsistence resources

There is an ongoing need to monitor key indicators of socioeconomic and cultural changes on the North Slope. The Iñupiat rely on a wide variety of marine resources as significant sources of food. In addition, the harvesting, sharing and consuming of subsistence resources form an important part of the traditional Iñupiaq culture and spiritual life. A temporary or permanent elimination of primary subsistence foods could cause large numbers of North Slope residents either to shift to less desired subsistence resources or to replace subsistence foods with expensive store-bought foods. The Iñupiat are concerned about mitigation of impacts and compensation for potential losses, though an anticipated decline in oil revenues to the North Slope Borough (NSB) is also an issue of concern. Another key interest is the use of local and traditional knowledge in analysis of potential environmental effects. We continue to seek and include firsthand knowledge of local subsistence hunters to enhance the scientific knowledge base.

Archaeological Resources

The archaeological significance of offshore areas has been increasingly recognized in recent years and marine archaeological studies have been showing the presence of prehistoric sites on the shelves beneath the modern ocean. Basic information and analysis of archaeology potential on the Alaska Outer Continental Shelf is needed for assessments to support the National Historic Preservation Act and NEPA review.

2.3 Topical Areas for Future Research Consideration

Here, we present a general forecast of important topical issues and concerns for FY 2023 and beyond. In general, these topics conform with the research themes of the ESP. The great differences existing between Alaskan environments and other OCS areas and the uniqueness of issues in Alaska dictate the need to anticipate new topical areas for implementation. The discussion will focus on BOEM mission needs within the context of varying industry interest in OCS exploration, development and production, and altered baselines and potential trends in a changing environment.

The next *Outer Continental Shelf Oil and Gas Leasing Program* could lead to increased levels of oil and gas activities in the Beaufort Sea and Cook Inlet, and potentially additional Alaska OCS Planning Areas. Heightened attention to developing renewable energy resources would also expand BOEM's information needs across the Alaska OCS.

Environmental Change

In recent years, the extent, duration, and thickness of summer ice cover in the Arctic have decreased to record historical lows. The continuing loss of ice cover is causing changes to both physical oceanography and ecosystem productivity and has substantial ramifications for marine mammals, birds and fish species that live on, below, or near the ice. Oceanic current patterns in the Arctic, especially in nearshore regions, are strongly influenced by climatological factors such as winds, river runoff, and sea ice coverage. The rapid changes in each of these factors could lead to drastic alterations of the surface current fields. Oil-spill trajectory analyses performed by BOEM are based on surface current data derived from ocean circulation hindcast models. As climate change continues, oil-spill trajectory modeling may need to be updated on a more frequent basis.

Climate change is also associated with altered water chemistry, particularly a reduction in pH, which will likely produce substantial habitat stresses for calcifying marine organisms (Mathis and Cross 2014). In addition, the duration and extent of seasonal sea ice, seawater temperature, and water mass structure are critical controls on water column production, organic carbon cycling, and pelagic-benthic coupling. The recently observed changes in these factors have the potential to alter the current benthic-based food web to one more dominated by pelagic trophic transfers (Grebmeier and Cooper 2012). More research is needed to better understand the implications of such a shift, such as whether conditions may become less favorable for krill and arctic copepods, the preferred prey of bowhead whales.

Climate change also entrains many socioeconomic issues. Some immediate concerns include increased shoreline erosion and permafrost melt that threatens arctic villages and infrastructure; changes in distribution and availability of hunted subsistence species; and potential changes in commercial and subsistence fisheries as commercial species such as salmon move north. In consideration of such basic transition, scientists are challenged to project how climate change effects will interact with OCS activities in the Arctic over the next 25-50 years.

The effects of climate change are not limited to the Arctic. The northeastern Pacific has experienced a series of marine heat waves in recent years, beginning with an event known as "the Blob" that persisted from 2014 until early 2016. Direct impacts such as massive seabird die-offs and reduced breeding success for marine mammals and seabirds were seen as a result of this event and similar anomalies in the years since. Observed ecosystem shifts throughout the Gulf of Alaska and Cook Inlet are also attributed to these conditions.

Air Quality

While implementing its authority for the regulation of oil and gas-related air emissions, BOEM will need air quality monitoring information to assess the cumulative air quality impact of OCS Arctic oil and gas activity and to support compliance with the OCSLA and environmental justice initiatives. In particular, more information is needed to evaluate how high levels of substances such as black carbon and methane might impact climate change, as well as human health, in the region.

Physical Oceanography

An ongoing challenge in Alaska is the need for better, finer scale circulation and oil-spill models and higher resolution data. This need is underscored by the rapidly changing conditions in the Arctic. The need exists for continued development and application of state-of the-art couple ice-ocean circulation models to support future OSRA-based EIS analyses. Increased resolution of ice models and ice data is needed to address the propagation of fine scale, non-random interactions across hundreds of miles of pack ice, as evidenced by ice leads and extensive break-out events seen in satellite images in recent years.

BOEM needs a better understanding of the first order physics controlling regional circulation and ice conditions within the U.S. Beaufort and Chukchi Seas, as well as interactions with the Arctic basin and Canadian Beaufort, to inform and improve regional analyses for NEPA documents and review of oil-spill response planning documents. In particular, more information is needed to assess the impact of ice on the nature and amplitude of the upwelling/downwelling, to evaluate influences of Atlantic water and other water masses, and to gain a better understanding of the dynamics associated with river outflow plumes, especially under ice.

Fate and Effects

The Alaska Regional Office has been collecting baseline biological and chemical monitoring data in the Beaufort Sea since the 1980s, first under the BSMP and more recently through the suite of ANIMIDA studies. Similar monitoring work has been ongoing in the Chukchi Sea since 2008, through the component projects of the COMIDA program. The need for additional monitoring will continue to be re-evaluated as oil and gas exploration and development on the Alaska OCS evolves.

Available information about input of hydrocarbon to the environment through natural oil seeps across the OCS off Alaska is limited. The ESP is wrapping up a study to collate and synthesize currently available data regarding seeps offshore of Alaska, and to develop recommendations for future field research. Gathering information on the chemical composition and weathering characteristics of the oils from these seeps would provide insight for analysis of potential effects from oil spills. Furthermore, the presence of natural oil seeps is indicative of organisms adapted to metabolize the hydrocarbons and additional information is needed about hydrocarbon-consuming organisms resident in the Arctic.

Marine Mammals and Protected Species

Potential impacts to marine mammals from oil and gas-related activities will continue to be a concern. Species protected under the ESA, MMPA and the Migratory Bird Treaty Act are of particular concern. Possible risks include oil spills and other discharges, noise from various industrial and support activities, and increased human interaction with arctic offshore species. Future studies are expected to continue to explore use of satellite tagging for information on movements and residence times in development areas. Advancement of UAS technologies also will lead to expanded research opportunities for bowhead whales and other species.

Key subsistence species for which behavioral or monitoring studies may be needed include polar bears, beluga whales, walruses, ringed seals, ribbon seals and bearded seals. High priority information needs include the impacts of sea ice loss and other environmental change on both ice seals and polar bears. The status of the critically endangered North Pacific right whale and potential effects from future oil and gas activity is also of ongoing concern.

BOEM will continue to develop specific information on the hearing capabilities of baleen whales and other marine mammals with the goal of better understanding their behavior in response to industrial noise. Furthermore, potential impacts to marine mammals and other species from development of renewable energy resources will take on increased importance in the coming years.

Marine Fish Migrations, Recruitment, and Essential Fish Habitat

BOEM needs information to assess and manage the potential environmental effects of OCS development on marine fish. More detailed information about the biology and ecology of many marine fish species inhabiting areas of potential energy development

activity would be especially useful. The highest priority BOEM information needs include species presence, distribution, abundance and potential effects of oil spills, particularly during periods when ice is present. Also, more information is needed to evaluate EFH and to clarify environmental assessment and mitigation needs.

Alaska Natives are concerned that OCS activities will affect subsistence fish populations and reduce availability for subsistence harvest. Consequently, additional research on arctic fisheries and recruitment to nearshore feeding populations are an important consideration. In addition, more information is needed regarding the effects of seismic exploration on the health, behavior, distribution, and migration of the numerous important fish species of the Beaufort and Chukchi seas.

More information is needed on the forage fish resources and their relation to apex predators on the OCS. A better understanding of the seasonal distribution, abundance, and habitat use of forage fish, including the effects of changing temperatures and prey availability, will inform evaluation of the potential environmental impacts associated with OCS development. Understanding of key spawning and migration events that quickly transfer large amounts of energy to upper trophic levels is also important.

Subsistence and Socioeconomics

Residents of the North Slope coastal communities frequently express concern about cumulative impacts of offshore and onshore developments, as well as climate change, on their subsistence way of life. Some of the concerns of the Iñupiat include diminished access to hunting and fishing areas around oil industry infrastructure, reduced harvests, increased hunter efforts, increased hunter cost and general food security. How, and to what degree, subsistence activities have been affected by industry infrastructure and industry activity, or may be in the future, are concerns that will continue to be further addressed by additional research. Consideration of cumulative impacts is an important issue for BOEM in preparing NEPA documents.

Aggregate effects research encompasses a broader set of issues concerning how the Iñupiat society has been potentially affected. Relevant issues include a wide range of topics, such as the changing relationship between the cash economy and household subsistence activities, changing sources of anxiety and stress at multiple levels of organization, potential changes in sharing of subsistence resources and in the recruitment of youth into subsistence activities. Ongoing evaluation of social indicators is needed to serve as a basis for estimating long-term aggregate impacts.

Additional information is also needed regarding contaminant levels in the marine mammals and fish species of Cook Inlet and other OCS areas off Alaska. The potential impact of contamination or perception of tainting in relation to subsistence, commercial, and recreational fishing activities is a particular concern.

SECTION 3.0 CURRENT EFFORTS OF THE ESP IN ALASKA

This section, which describes ongoing and planned activities of the ESP in Alaska, provides additional context about our current and future information needs.

3.1 Notable Program Highlights

Arctic Marine Biodiversity Observing Network (AMBON): Funded through the National Ocean Partnership Program (NOPP), with additional contributions from NOAA, the Office of Naval Research (ONR), and the National Aeronautics and Space Administration (NASA), this study expands upon the pilot national Marine Biodiversity Observing Network. AMBON began as 5-year research partnership (2015-2020) between university and Federal investigators focused on the continental shelf in the Chukchi Sea with links to the Distributed Biological Observatory (DBO), which coordinates long-term monitoring of biologically productive regions across a broad latitudinal array in the Arctic. This continuation of AMBON builds on that work and extends the effort into the Beaufort Sea. Through these partnerships, AMBON will make biodiversity data available to a broad audience of users and stakeholders, from local to pan-Arctic to global.

Renewable Energy Research: BOEM has delegated regulatory authority over renewable energy resources on the U.S. OCS, and the development of a renewable energy program in Alaska would support current priorities identified in Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad*. In 2021, BOEM initiated a study to assess potential for offshore wind, ocean thermal, ocean wave, tidal, and ocean current energy for Alaska. Researchers will conduct a literature synthesis and focus group discussions to compile descriptive and spatial information about renewable energy potential on the Alaska OCS and recommend environmental research needed to support development.

Collaboration with the North Pacific Research Board (NPRB): Since 2015, BOEM has collaborated with NPRB as a co-sponsor of the "Arctic Integrated Ecosystem Research Program," which invested more than $16 million in studying marine processes in the U.S. Arctic through 2021. Final reports for the different components of this program, including the study "Arctic Integrated Ecosystem Survey, Phase II," will be published in early 2022. BOEM also regularly provides support to NPRB for the annual Alaska Marine Science Symposium, which allows our Principal Investigators to brief the scientific community about results from ongoing research.

IARPC support: As an active participant of the Inter-agency Arctic Research Policy Committee (IARPC), the BOEM Environmental Studies Program has played a lead role in implementing national research priorities in the Arctic. Appendix 1 provides a table that displays the substantial progress that BOEM has made in recent years toward fulfilling itemized IARPC research priorities while meeting its own regulatory mission.

3.2 Planned New Studies

Table 1. BOEM Alaska Regional Office Studies Planned for FY 2022*

Page Number	Discipline	Study Title	Planning Area(s)
19	BIO	Lower Cook Inlet Fish and Invertebrate Community Composition, Distribution, and Density	Cook Inlet
22	MM	Collaborative synthesis to understand the impacts of vessel presence and sound on the marine environment and subsistence activities in the Pacific Arctic	Beaufort, Chukchi
26	MM	Using Multiple Tools to Assess Marine Mammal Distribution, Numbers, and Habitat use in Cook Inlet	Cook Inlet
29	ID	Alaska Coastal Marine Institute	All Alaska Planning Areas
32	PO	Cook Inlet Physical Oceanography: Synthesis and Modeling	Cook Inlet
35	BIO	Linking pelagic and nearshore benthic ecosystems in lower Cook Inlet and Kachemak Bay through meroplankton: Collaborating with the Gulf Watch Alaska Monitoring Program in Cook Inlet	Cook Inlet
38	ID	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities	All Alaska Planning Areas
41	MM	Alaska Assessment for Cetaceans and Other Marine Mammals (ACOMM)	All Alaska Planning Areas

Discipline Codes	
BIO = Biology	ID = Interdisciplinary
MM = Marine Mammals & Protected Species	PO = Physical Oceanography

* Initiation and conduct of any of these planned studies is subject to availability of funds.

Title	Lower Cook Inlet Fish and Invertebrate Community Composition, Distribution, and Density
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Inter-agency Agreement or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2022–2027
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Recent observations document large-scale changes to some components of the lower Cook Inlet marine ecosystem. Evidence indicates a warming climate as a driving variable of these changes. Data on the fish and invertebrates of Cook Inlet is limited and much of it is dated, which limits our understanding of the current community structure and our ability to assess if any large-scale shifts have occurred. This information is necessary to analyze what effects resource development activities might have on these communities.
Intervention	This study will conduct systematic and comprehensive research to collect benchmark data on the fish and invertebrate community composition, distribution, relative abundance, diet, and energy density, as well as physical variables in the lower Cook Inlet region.
Comparison	This data will provide context for understanding the driving forces influencing changes to the current ecosystem.
Outcome	Products will include a current description of the fish and invertebrate community structure and distribution in lower Cook Inlet integrated with existing fish and mammal databases. A future monitoring plan will provide the tools and resolution needed to track future changes to these resources.
Context	Cook Inlet Region

BOEM Information Need(s): BOEM needs a better understanding of the natural variation in the lower Cook Inlet marine ecosystem to accurately assess potential effects from resource development activities. Information from this study will inform NEPA analyses, Essential Fish Habitat (EFH) Assessments, Endangered Species Act (ESA) consultations, and Oil Spill Risk Analysis (OSRA).

Background: To differentiate environmental changes and anthropogenic effects on marine populations, we must have a good understanding of the current marine ecosystem, how trophic levels interact, and how physical factors and oceanography influence biota. In the 1970s, the coastal ecosystem of the Gulf of Alaska and lower Cook Inlet shifted from a community dominated largely by crustaceans to one dominated by fish (Anderson, 2000; Anderson and Piatt, 1999; Ware, 1995). It is difficult to predict what the fish and invertebrate communities will look like in the future, but changes in the lower trophic community due to regime shifts are likely to echo throughout the food web (Hare and Mantua, 2000). In Cook Inlet, sea bird die-offs have been linked to depressions in forage fish communities (Piatt et al. 2020; AK-20-10). These forage fish provide food for other fish, and those community interactions haven't been studied in depth. Potential changes in groundfish community structure will have echoing effects on commercial, subsistence, and recreational fishing in the area. Documenting these changes will help BOEM to adequately analyze effects of potential resource development activities for NEPA analyses and EFH consultations. By examining the fish and invertebrate communities of Cook Inlet, we will grow our understanding of the region and increase the accuracy of our regulatory analyses.

Objectives:

- Establish new benchmark descriptions for fish and invertebrates in Cook Inlet by assessing current composition, distribution, relative abundance, and energy density, as well as the current diet of fish
- Identify indicators and drivers of community shifts and assess seasonal and interannual changes in zooplankton and fish distribution, relative abundance and diet data
- Develop an ecosystem model to predict shifts in fish and invertebrate communities and a future monitoring plan

Methods: This project will take a stepwise approach to addressing the objectives.

1. *Establish New Benchmark Descriptions for Fish and Invertebrates*: A systematic survey design with a sampling grid covering lower Cook Inlet will be developed. The design will include the sampling approaches necessary to describe the benthic and pelagic fish and invertebrate communities. Sampling will occur interannually and cover a temporal scale consisting of spring, summer/fall, and winter. For all fish and invertebrates captured, researchers will record the species composition, distribution, and relative abundance. The diet and energy density will also be determined for all fish species captured. Some invertebrates, such as shrimp, squid, and krill may also be analyzed for energy density and histology. At all sampling stations CTD casts and plankton sampling will occur.
2. *Identify Indicators/Drivers of Community of Shift*: Develop a statistical approach to assess seasonal and interannual changes to the fish, invertebrate, and zooplankton communities by compiling existing relevant biological, physical and, oceanographic datasets. Data collected from this study will then be compared to past datasets to assess community changes as well as the physical

and oceanographic factors correlated with those changes. Particular attention will be focused on describing community changes between warm and cold-water years.

3. *Provide Recommendations for a Future Monitoring Plan*: Develop an ecosystem-based model for predicting future changes to the fish and lower trophic communities. Using results from this study, provide a recommended monitoring plan that will provide the resolution needed to detect future regime shifts to the fish and lower trophic communities of lower Cook Inlet.

Specific Research Question(s):

1. What is the current fish and invertebrate community structure of lower Cook Inlet?
2. How can we better assess environmental variation on the fish and invertebrate communities of lower Cook Inlet?
3. How can we better understand ecosystem change resulting from a regime shift?
4. How can we better predict future changes to the lower Cook Inlet ecosystem using oceanographic and biological monitoring data?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Anderson PJ. 2000. Pandalid shrimp as indicators of ecosystem regime shift. Journal of Northwest Atlantic Fishery Science, 27.

Anderson PJ, Piatt JF. 1999. Community Reorganization in the Gulf of Alaska following Ocean Climate Regime Shift. Marine Ecology Progress Series. 189:117-23.

Hare SR, Mantua NJ. 2000. Empirical Evidence for North Pacific Regime Shifts in 1977 and 1989. Progress in Oceanography. 47.2: 103-145.

Piatt JF, Parrish JK, Renner HM, Schoen SK, Jones TT, Arimitsu ML, et al. 2020. Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. PLoS ONE 15(1): e0226087. https://doi.org/10.1371/journal.pone.0226087

Ware, DM. 1995. A Century and a Half of Change in Climate of the NE Pacific. Fisheries Oceanography. 4(4):267-277.

Sheridan P. 2008. Seasonal foods, gonadal maturation, and length-weight relationships for nine fishes commonly captured by shrimp trawl on the northwest Gulf of Mexico continental shelf. Panama City Beach (FL): National Marine Fisheries Service, Southeast Fisheries Science Center. 40 p. Report No.: NOAA Tech. Memo. NMFS-SEFSC-566.

Title	Collaborative synthesis to understand the impacts of vessel presence and sound on the marine environment and subsistence activities in the Pacific Arctic
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2022–2024
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Increased vessel traffic associated with reduced sea ice could lead to a range of effects in the Arctic. Marine mammals and other protected species may be exposed to higher noise levels, increased possibility of collision, and potential impacts from vessel discharges and other pollutants, including an increased chance of oil spills in a region with limited response capacity. These same factors could also impact subsistence communities.
Intervention	This study will synthesize spatial and temporal trends in vessel presence and quantify marine mammal vulnerability to related impacts. Indigenous knowledge holders, conventional scientists, and other partners will be invited to discuss and prioritize community concerns, to co-design and interpret research that measures effects of vessel traffic and sound data.
Comparison	This study will estimate the increase in vulnerability to marine mammals and those that rely on them for food security and cultural identity that might be attributed to increased vessel traffic in the Arctic.
Outcome	This study will provide spatial and temporal information on vessel activities, related vulnerabilities to marine mammals, and impact on subsistence activities, including noise footprints of these vessels.
Context	Bering Strait, Chukchi Sea, and Beaufort Sea

BOEM Information Need(s): BOEM considers information about effects on marine mammals and subsistence activities from vessel traffic in its NEPA documents. To support these analyses, better information is needed about spatial and temporal trends in vessel traffic in the Arctic and effects associated with their presence (e.g., increased noise, discharges). This study will estimate effects on species protected under the Marine Mammal Protection Act and Endangered Species Act (ESA) from the Bering

Strait, and into the Chukchi and Beaufort OCS areas to support NEPA and ESA Section 7 consultations. This research also will assess future vessel activity, which will inform development of mitigation measures.

Background: Increased vessel traffic in the Pacific Arctic triggers questions of potential effects and growing focus toward mitigating the impacts. The accelerated loss of sea ice has restructured physical and ecological patterns in the 'Pacific Arctic Gateway' and is leading to expanded anthropogenic activities in the region (Moore and Stabeno 2015, Duffy-Anderson et al. 2019, Wood et al. 2015). Vessel transits of the Bering Strait have notably increased in recent years, presenting environmental and cultural threats in the Arctic (Huntington et al. 2015, Raymond-Yakoubian 2018, Raymond-Yakoubian and Daniel 2018). Arctic marine mammals are particularly vulnerable to effects from vessels (Reeves et al. 2014), including potential increases in underwater noise, marine mammal strikes, disturbance to Indigenous hunters, vessel discharges and other pollutants, groundings, and oil spills (Hauser et al. 2018, Halliday et al. 2017, McWhinnie et al. 2018).

Objectives:

- Establish a collaborative Expert Steering Committee to share knowledge and expertise, and to prioritize and evaluate key indicators of vessel-related effects.
- Synthesize spatial and temporal trends in vessel presence within marine mammal concentration areas.
- Identify and catalog sound sources associated with vessel traffic.
- Quantify changes in vulnerability of marine mammals to vessel presence and sound in the Pacific Arctic.
- Engage with the Expert Steering Committee for shared perspectives on the results for shared or joint interpretation of the findings to allow for all voices and both knowledge systems to contribute.

Methods: Researchers will identify relevant partners to form an Expert Steering Committee. The perspectives of this diverse and collaborative panel (e.g. composed of Indigenous hunters and elders, agencies, academic scientists, co-management organizations, non-governmental organizations, industry representatives) will be incorporated using a collaborative research approach valuing different knowledge systems. The Committee will provide their expertise and input to determine information needs, scale, and concerns to be analyzed by researchers and mechanisms to deliver results.

Researchers will compile and analyze coastal and offshore vessel tracking data to document vessel presence and vessel speeds on monthly or seasonal scales, categorized by vessel type. They will develop geospatial products (as heatmaps or routes) to overlap vessel presence information with existing information on important habitat areas for feeding, migrations, and subsistence use. These products will be used to develop estimates of population-specific marine mammal exposure to vessels in areas and during periods of concern identified by local users. Researchers will develop methods to

quantify and analyze 'exposure' and 'sensitivity' for potentially affected populations. Methods may include artificial intelligence techniques for AIS data coupled with the exposure of species building from previously published estimates and incorporating factors such as relative species sensitivity to strikes, disturbance, noise exposure, and oil spill potential. Researchers and the Expert Steering Committee will address how best to look toward the future of both increased vessel traffic and changes in the environment relating to climate.

Specific Research Question(s):

1. How can vessel mitigation measures balance Indigenous community concerns, industry or research activities, and protected species conservation?
2. What trends have been observed in vessel presence, type, speed, cumulative sound in the Pacific Arctic?
3. Where, when, and how has marine mammal vulnerability to vessels changed in recent years?
4. How does population-specific vulnerability to vessels vary for different routing scenarios?
5. What has been the number and distribution of different types of vessels relative to traditional harvesting areas and/or seasons?
6. Where, when and how have there been potential vessel-based conflicts with subsistence species or harvest areas?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Duffy-Anderson JT, Stabeno P, Andrews AG III, Cieciel K, Deary A, Farley E, et al. 2019Responses of the Northern Bering Sea and Southeastern Bering Sea Pelagic Ecosystems Following Record-Breaking Low Winter Sea Ice. Geophys. Res. Lett. 46, 9833–9842.

Huntington HP, Daniel R, Hartsig A, Harun K, Heiman M, et al. 2015. Vessels, risks, and rules: Planning for safe shipping in Bering Strait. Mar. Policy 51, 119–127.

Moore SE, Stabeno PJ. 2015. Synthesis of Arctic Research (SOAR) in marine ecosystems of the Pacific Arctic. Prog. Oceanogr. 136, 1–11.

Halliday WD, Insley SJ, Hilliard RC, de Jong T, Pine MK. 2017. Potential impacts of shipping noise on marine mammals in the western Canadian Arctic. Mar. Pollut. Bull. 123, 73–82.

Hauser DDW, Laidre KL, Stern HL. 2018. Vulnerability of Arctic marine mammals to vessel traffic in the increasingly ice-free Northwest Passage and Northern Sea Route. Proc. Natl. Acad. Sci. 15, 7617–7622.

McWhinnie LH, Halliday WD, Insley SJ, Hilliard C, Canessa RR. 2018. Vessel traffic in the Canadian Arctic: Management solutions for minimizing impacts on whales in a changing northern region. Ocean Coast. Manag. 160, 1–17.

Raymond-Yakoubian J. 2018. Arctic Vessel Traffic and Indigenous Communities in the Bering Strait Region of Alaska. in Sustainable Shipping in a Changing Arctic, eds. Hildebrand LP, Brigham LW, Johansson TM; Springer International Publishing. pp. 275–295.

Raymond-Yakoubian J, Daniel R. 2018. An Indigenous approach to ocean planning and policy in the Bering Strait region of Alaska. Mar. Policy 97, 101–108.

Reeves RR, Ewens PJ, Agbayani S, Heide-Jørgensen MP, Kovacs KM, et al. 2014. Distribution of endemic cetaceans in relation to hydrocarbon development and commercial shipping in a warming Arctic. Mar. Policy 44, 375–389.

Wood KR, Bond NA, Danielson SL, Overland JE, Salo SA, Stabeno PJ, Whitefield J. 2015. A decade of environmental change in the Pacific Arctic region. Prog. Oceanogr. 136, 12–31.

Title	Using Multiple Tools to Assess Marine Mammal Distribution, Numbers, and Habitat use in Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Inter-agency Agreement
Conducting Organization(s)	NOAA
Total BOEM Cost	TBD
Performance Period	FY 2022–2025
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Updated information is needed on the temporal occurrence, distribution, and habitat use of cetaceans in Cook Inlet to evaluate potential effects from future OCS activities. Federal agencies need reliable information on the abundance and distribution on various ESA-listed large whale species (e.g., humpback, fin) and endangered Cook Inlet beluga whales to accurately evaluate potential impacts to these species and inform mitigation.
Intervention	A combination of aerial surveys and acoustic monitoring, paired with eDNA sampling, will provide seasonal information on abundance and distribution and year-round documentation of occurrence and quantification of the potential for disturbance.
Comparison	The implementation of a directed study will provide this information for a variety of uses by multiple agencies, including agency analyses, incidental harassment authorization requests, and future comparisons of anthropogenic impacts on cetacean distribution in this important area.
Outcome	This study will provide up-to-date information on the abundance, distribution, and habitat use of endangered large whales, Cook Inlet beluga, and other cetacean species in a key area of interest for oil and gas operations.
Context	Cook Inlet

BOEM Information Need(s): Information gained from this study is needed to establish abundance and distribution of several species of marine mammals, including two endangered large whale species (i.e., humpback, fin) and Cook Inlet beluga whales in lower Cook Inlet. Increased understanding of the seasonal density and distribution of the relevant species will assist BOEM and NMFS in pre- and post-lease NEPA assessment, design of temporal and spatial mitigation, and monitoring effects of

activities. Results will support future Section 7 ESA consultations and preparation of future BOEM Biological Assessments/Evaluations and NMFS Biological Opinions.

Background: There are numerous species of marine mammals that occur within Lower Cook Inlet (LCI). Endangered fin whales are known to be present and to feed in this and adjacent areas in large numbers year-round, and feed intensively within and downstream of this area seasonally. Up to three populations of humpback whales (including one threatened and one endangered) occur in this area; assessment of the extent of use by these three populations is currently based on dated information. Aerial surveys, satellite-tag data, and passive acoustics show belugas inhabit LCI waters; knowledge of their distribution and use of the lower Inlet is scarce due to limited survey effort. Detection of the critically endangered North Pacific right whale in the bays of eastern Kodiak Island and historical sightings along the southern entrance to Shelikof Strait and near the Barren Islands demonstrate the potential presence of this ESA-listed species near Cook Inlet. Several other marine mammal species are present in or near these areas, including blue, sei, gray, killer, and minke whales, as well as harbor and Dall's porpoise, but their year-round seasonal distribution is not well documented and seasonal estimates of density from dedicated surveys are unavailable.

Objectives:

- Document the geospatial and temporal distribution of cetaceans in the LCI, from Kalgin Island to Shelikof Strait, and to the east and west of the entrance to Cook Inlet.
- Document Cook Inlet beluga seasonal occurrence throughout the LCI for multiple years.
- Develop a database cataloging DNA and acoustic signatures for specific cetacean species for use in comparisons in the field.
- Assess the relative strength of low-cost emerging technologies (eDNA) compared to more traditional methods in monitoring marine mammal presence in LCI

Methods: Quarterly aerial surveys for endangered large whales and Cook Inlet belugas will be conducted in the LCI from March to October to provide information on abundance and distribution. Researchers will investigate the use of modern video-capture and analysis methods, including artificial intelligence techniques, to supplement or substitute for some crewed survey efforts. Year-round passive acoustics monitoring will be conducted for no less than three (3) years to determine the interannual variability in the spatio-temporal distribution of all calling and echolocating marine mammals. Seasonal eDNA sampling will be used to develop a database of genetic samples, which can then be compared to, and potentially augment, results from survey and acoustic data. Coastal sampling will be informed by current efforts funded by BOEM, including the Cook Inlet Beluga Acoustic Monitoring in Lower Cook Inlet Rivers project. Moorings will be deployed in year 1 and turned around every six months to reduce potential mooring loss and to allow continuous year-round monitoring at maximum sampling rates, until they are retrieved in year 3. Recordings will be analyzed to determine the inter-annual variability in the geospatio-temporal distribution of all

calling and echolocating marine mammals, vessel and airgun signals, and ambient soundscape. Existing data on humpback and fin whales will be mined to understand the relative proportions of various populations in this area; directed field work will occur in outyears if existing data are insufficient to indicate why humpback and fin whale populations might be using the area.

Specific Research Question(s):

1. What is the cetacean density and seasonal distribution in and around the Cook Inlet lease areas, as well as in the surrounding coastal areas that could be impacted by OCS development?
2. How is cetacean distribution changing in response to various changes in environmental and anthropogenic parameters?
3. Can eDNA expand capabilities for population assessment of cetaceans, facilitate research on their behavior and habitat requirements, and improve understanding about their population status and habitat use in a warming Cook Inlet?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

Environmental Studies Program: Alaska Annual Studies Plan | FY 2022

Title	Alaska Coastal Marine Institute
Administered by	Alaska Regional Office
BOEM Contact(s)	Dr. Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	CMI, UAF
Total BOEM Cost	TBD
Performance Period	FY 2022–2024
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	The BOEM Environmental Studies Program needs applied scientific studies to provide information for making responsible decisions for managing energy and marine mineral resources on the U.S. Outer Continental Shelf (OCS).
Intervention	Scientific information collected for leasing, exploration, and development decisions tends to be more readily accepted by the local and regional populace if the studies are conducted by well-known and scientifically respected local experts and institutions.
Comparison	Through the Coastal Marine Institute (CMI), BOEM will obtain high quality scientific research to meet the shared goals of BOEM and the State of Alaska at substantial savings due to the one-to-one cost match requirement.
Outcome	The CMI program will use the highly qualified, scientific expertise at local levels to collect and disseminate environmental information needed for OCS oil and gas and renewable energy decisions; address local and regional OCS-related environmental and resource issues of mutual interest; and strengthen the BOEM-State partnership in addressing OCS oil and gas information needs.
Context	All Alaska OCS Planning Areas.

BOEM Information Need(s): This cooperative agreement supports improved leasing decisions and National Environmental Policy Act (NEPA) analyses pertinent to potential oil and gas-related actions on the Outer Continental Shelf (OCS). Final reports will be available for lease sales and post-sale decisions; interim data products and inputs will be used to address information needs. Topical areas to be addressed under the Coastal Marine Institute (CMI) have been identified through the Alaska Annual Studies Planning process and a set of identified Framework Issues. The CMI, which operates on a five-year funding cycle, also will develop information and public products for various audiences that address public concerns raised during outreach efforts.

Background: The CMI is cooperative program between BOEM and the University of Alaska, with State of Alaska participation, began in 1993 with the goals of updating and expanding our understanding of OCS environmental information and addressing future needs related to the offshore oil and gas program in Alaska. This large program of scientific research is guided by framework issues related to potential future lease sales and other oil and gas-related actions in the Alaska Office. Beginning in 2016, the CMI instituted a program of Student Research Awards, which provide up to $25,000 in funding for up to three student-led projects each year. Through an established cost-sharing arrangement, the CMI is expected to leverage additional scientific results and logistics capability at levels comparable to the BOEM contribution of up to $1,000,000 per year. Typically, five to seven new projects are funded each year.

Objectives: The Framework Issues which guide the CMI are:

- Scientific studies for better understanding marine, coastal, or human environments affected or potentially affected by offshore oil and gas or other mineral exploration and extraction on the OCS.
- Modeling studies of environmental, social, economic, or cultural processes related to OCS oil and gas activities in order to improve scientific predictive capabilities.
- Experimental studies for better understanding of environmental processes, or the causes and effects of OCS activities.
- Projects which design or establish mechanisms or protocols for sharing data or scientific information regarding marine or coastal resources or human activities in order to support prudent management of conventional energy resources and potential development of renewable energy and marine mineral resources on the OCS offshore the State of Alaska.
- Synthesis studies of scientific environmental or socioeconomic background information relevant to the OCS oil and gas program.

Methods: This request will provide funding to initiate new projects in FY 2022. A proposal process is initiated each year with a request for letters of intent to address one or more of the Framework Issues from university researchers and other scientific researchers in State agencies. The letters of intent are reviewed by BOEM scientists and a Technical Steering Committee (TSC), made up of scientific representatives of the cooperators, to identify which submissions merit submission of a full-length proposal. BOEM scientists and the TSC then evaluate the proposals' research concepts, methodology, and cost effectiveness to inform funding decisions. External peer reviews may be requested for new projects. Each CMI project produces a final report that is publicly disseminated through the BOEM website. Principal investigators also give presentations at a scheduled annual CMI Science Review, scientific conferences, and various public meetings.

The structure of the CMI not only promotes extensive input from BOEM's academic partners in Alaska, but it allows for a great deal of flexibility to rapidly address priority information needs as they arise. Furthermore, the requirement for matching funds at a

one-to-one level facilitates extensive leveraging and partnership arrangements for the projects.

Specific Research Question(s): What are the highest priority OCS-related environmental and resource issues that are of mutual interest to BOEM, the State of Alaska, and the University of Alaska?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: https://www.uaf.edu/cfos/research/cmi/

Title	Cook Inlet Physical Oceanography: Synthesis and Modeling
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2022–2025
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Physical oceanographic information for Cook Inlet is not synthesized into a regional framework and is difficult to access. This dispersion of data, particularly for the most recent period, adds complexity for evaluating a changing baseline or for use in general circulation model (GCM) verification and validation.
Intervention	This partnership will collate physical oceanographic data since 2000 in Cook Inlet and Shelikof Strait. Synthesize it into a regional framework, identify information needs for sampling, and generate a three-dimensional oceanographic hindcast product using the NOAA Cook Inlet Operational Forecast System (CIOFS).
Comparison	This study will compare areas to determine where low resolution, little, or dated sampling exists to inform the future collection of physical oceanographic measurements. The study will also conduct detailed model hindcast-to-data and model-to-model hindcast comparisons to improve GCMs and observe trends in a changing climate.
Outcome	A comprehensive and understandable reference of Cook Inlet oceanography datasets and data visualization tools, that are readily available for environmental analyses. The study will also provide a 20-year GCM hindcast simulation for Cook Inlet.
Context	Cook Inlet Planning Area

BOEM Information Need(s): BOEM uses baseline physical oceanographic information, including their seasonal variation and how the baseline is changing, to inform National Environmental Policy Act analyses in Cook Inlet. Teasing apart impacts

to the environment from multiple stressors, including a warming Gulf of Alaska, requires historical and up-to-date physical oceanographic measurements. These measurements are also necessary to verify and validate GCM output to assure quality products for use in oil spill trajectory analyses.

Background: Because Cook Inlet physical oceanographic data depict relatively short-term deployments focused on specific features of Cook Inlet's complex oceanography, there is a need to: assemble the data and make it accessible; synthesize it into a comprehensive understanding of the spatial and temporal circulation of the region; and plan for coordinated focused sampling where information needs are identified to improve GCMs (Johnson and Okkonen, 2000; Two Crow, 2006). Recently Johnson (2021) compiled surface and upper layer Lagrangian drifter data, collected mostly from spring through fall.

Accurate information on surface wind fields, ocean currents, and sea ice is important for oil spill trajectory simulations and the potential impacts on Cook Inlet physical, biological, or social resources from a large spill. It is particularly important to know locations and seasonal changes in oceanographic features that have substantial impact on oil transport. Prior GCM validation by Danielson et al. (2016) identified areas for improvement in Cook Inlet, including a bias towards summer conditions, inability to model high resolution features that are known to impact oil fate in the Inlet (e.g. convergence zones on the scale of ~100 m), and over-stratification of the water column by the model (sometimes by 10 psu). In addition, the Gulf of Alaska is warming substantially (Litzow et al. 2020) and the downstream influences on the oceanography of Cook Inlet and Shelikof Strait are not well documented.

Objectives:

- Improve access to and utility of existing oceanographic data in Cook Inlet.
- Enhance the understanding of the large-scale surface and subsurface circulation and density fields and their interannual variation with focus on these four primary areas:
    a. Fronts: Investigate the dominant physical forces governing circulation and the development of fronts in Cook Inlet and their spatial and temporal timescales.
    b. Buoyancy-forced Coastal/Estuarine Circulation: Gain better understanding of the processes which enhance or inhibit transport and their seasonality in lower Cook Inlet including snowmelt and freshwater discharge.
    c. Lateral Ocean Boundaries: Develop a better understanding of Gulf of Alaska boundary influences including the seasonality of Cook inlet outflow and the degree of infiltration and seasonality of Alaska coastal water into eastern Cook Inlet.
    d. Offshore Boundary: Investigate processes that control exchange between the Gulf of Alaska and Cook Inlet.

- Identify improved algorithms and data tools to support future development of oceanographic process models, particularly for tide rips.

Methods: This partnership will identify and gather existing, relevant, and readily available physical oceanographic datasets for the Cook Inlet and Shelikof Strait. The datasets will be organized into a common framework for review and identification of specific information needs to guide development of field plans. Researchers will develop recommendations for additional oceanographic measurements needed to provide stratification, freshwater forcing, and higher resolution surface and subsurface current data to enhance the ability to model 3-D currents. When possible, researchers will leverage existing data research efforts to opportunistically collect these data. Researchers will generate a three-dimensional oceanographic hindcast product using the NOAA Cook Inlet Operational Forecast System (CIOFS) to elucidate relevant oceanographic processes and help identify additional model improvements through model intercomparisons. Information from all project components will be synthesized to describe and discuss the physical oceanography of Cook Inlet and Shelikof Strait within a regional framework. Data products and associated metadata will be disseminated through the AOOS web portal.

Specific Research Question(s):

1. What is the current physical oceanographic baseline in Cook Inlet and Shelikof Strait?
2. Where and what types of additional data collections and algorithms will improve GCM model output?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Danielson SL, Hedström KS, Curchitser E. 2016. Cook Inlet Circulation Model Calculations. OCS Study BOEM 2015-050. Anchorage, AK: USDOI BOEM, Alaska OCS Region. 71 pp.

Johnson MA 2021. Subtidal Surface Circulation in Lower Cook Inlet and Kachemak Bay, Alaska. Regional Studies in Marine Science: 101609. First published online 11 January 2021

Johnson MA, Okkonen SR. 2000. Proceedings Cook Inlet Oceanography Workshop. OCS Study MMS 2000-043. Fairbanks, AK: University of Alaska, Coastal Marine Institute and Oil Spill Recovery Institute. 103 pp.

Two Crow, ed. 2006. Cook Inlet Physical Oceanography Workshop Proceedings. Kenai, AK: AOOS, CIRCAC and Kachemak Bay Research Reserve. 172 pp.

Title	Linking pelagic and nearshore benthic ecosystems in lower Cook Inlet and Kachemak Bay through meroplankton: Collaborating with the Gulf Watch Alaska Monitoring Program in Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2022–2025
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	The current Gulf Watch Alaska (GWA) program considers top-down effects (predation from sea stars, otters, and shore birds) on rocky intertidal community composition, but the influence of larval recruitment (supply-side) is not being investigated. Especially in times of prominent environmental drivers (e.g., heatwaves and resulting ecological responses), the repopulation and genetic mixing provided by larval recruitment is likely to play a vital role in nearshore community recovery and resilience.
Intervention	This study will provide molecular species-level identifications of meroplankton collections to identify patterns in meroplankton abundance and key intertidal species at high taxonomic resolution.
Comparison	The GWA program has monitored the oceanography, phytoplankton, and zooplankton in Kachemak Bay (monthly) and lower Cook Inlet (seasonally), allowing for analysis of spatial and temporal patterns. Nearshore community composition in Kachemak Bay has been monitored systematically since 2012; these data and those from other ongoing studies provide a rich database as a framework for spatial and temporal comparisons. This study will also assess the extent to which Kachemak Bay is a representative system for lower Cook Inlet.
Outcome	Using existing meroplankton data, augmented with new meroplankton collections, this study will provide information on how interannual and seasonal changes in the timing and abundance of meroplankton larval supply affects recruitment of key rocky intertidal species.
Context	Kachemak Bay and lower Cook Inlet. In addition to GWA, this study links to other ongoing efforts in Kachemak Bay

BOEM Information Need(s): Nearshore ecosystems are especially vulnerable to climatic (e.g., heatwaves) and anthropogenic (e.g., oil contamination) disturbances. They also serve as rich feeding grounds for many higher trophic levels and subsistence regions for local human residents. Information on how closely linked intertidal communities are to larval supply will assist BOEM with understanding the recovery potential of these nearshore systems in the Cook Inlet OCS region and providing updated baseline information to support NEPA analysis. This project provides an opportunity for BOEM to partner with the Gulf Watch Alaska (GWA) program, leveraging funding from *Exxon Valdez* Oil Spill Trustees Council.

Background: Nearshore habitats such as rocky intertidal systems are common throughout Cook Inlet and provide many essential ecosystem functions, such as high productivity, high diversity, feeding grounds, and nursery habitats. These systems are also particularly prone to disturbances from natural and anthropogenic sources that can disrupt healthy communities and food webs. For example, loss of macroalgal foundation species with the recent heatwave, and the spread of sea star wasting syndrome has led to dramatic changes in rocky intertidal community composition. Better understanding of possible bottlenecks to the recovery potential of these systems from larval recruitment will help to determine the long-term resilience of these systems and inform decision-making. Building on a rich dataset of meroplankton (benthic invertebrate larvae) and rocky intertidal community composition as well as environmental conditions from ongoing GWA monitoring, patterns can be seen of linkages between the pelagic and the benthic system. However, taxonomic identification of meroplankton based on morphology can only be done on a coarse level (e.g., bivalves, echinoderms). Supplemental analyses using molecular techniques are needed to specifically link abundance in key intertidal species (e.g., mussels, sea stars) to meroplankton availability. Furthermore, we need to evaluate similarities in synchrony and drivers of community composition between Kachemak Bay and the broader lower Cook Inlet to refine and prioritize future study plans.

Objectives:

- Characterize the seasonal progression in meroplankton species composition
- Evaluate spatial meroplankton differences across the estuarine-to-shelf oceanographic gradient in Cook Inlet
- Examine interannual variability both in species composition and seasonal timing of peak abundances of key meroplankton
- Link key meroplankton taxa identified to species level using molecular techniques to patterns in rocky intertidal communities.

Methods: Existing data since 2012 on seasonal meroplankton composition from the GWA Environmental Drivers work will be analyzed in the context of simultaneously collected physical oceanographic data (temperature, salinity). This information will guide new collections of meroplankton during the proposed study for DNA-metabarcoding so that species-level information can be obtained for taxa that cannot be identified at sufficient level using morphological criteria (esp. bivalves and

echinoderms). Metabarcoding will target several key taxa as well as composite samples (eDNA) using gene primers for invertebrates (CO1 and16S) followed by high-throughput sequencing. Bioinformatics using the National Center for Biotechnology Information (NCBI) nucleotide and Barcode of Life Data (BOLD) databases will be used to match these meroplankton sequences to known species sequences. Then, meroplankton information can be linked to nearshore community composition, including appropriate lag times (months, year). Variability in patterns will then be evaluated in the context of environmental conditions using multivariate statistics.

Specific Research Question(s):

1. How do patterns in meroplankton based on large taxonomic groups relate to rocky intertidal community composition since 2012?
2. How does the abundance of specific meroplankton taxa (e.g., mussels, sea stars; identified from DNA barcoding) relate to the abundance of these taxa in rocky intertidal communities?
3. How do temporal patterns and drivers compare between Kachemak Bay and lower Cook Inlet?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: https://gulfwatchalaska.org/monitoring/

Title	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2022–2024
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Quantitative information about historical Alaska Outer Continental Shelf (OCS) oil and gas exploration, development, and production activities (historical Alaska OCS activities) is not readily available for SMEs to validate lease sale exploration and development (E&D) scenarios or for geospatial and temporal evaluation of impact producing factors in National Environmental Policy Act (NEPA) analyses.
Intervention	This study will collate, quantify, and synthesize information about individual historical Alaska OCS activities, including various related parameters, and their geospatial and temporal footprints.
Comparison	The synthesis will enable prompt access to information, understanding of how historical Alaska OCS activities relate to the current activities in Alaska, as well as provide validation for E&D scenario levels of activities.
Outcome	A synthesis of historical Alaska OCS activity information will improve access, supply context, and support integrated geospatial and temporal assessments of potential future impacts.
Context	All Alaska OCS Areas

BOEM Information Need(s): Collating and synthesizing information on historical Alaska OCS activities and associated parameters will support the validation of BOEM's E&D scenarios for future NEPA analyses, quantify levels of historical impact producing factors, and contribute to a better understanding of the spatial and temporal scope of past, present, and reasonably foreseeable activities for evaluating impacts.

Background: BOEM uses information regarding historical Alaska OCS activities and their associated impact producing factors to evaluate potential impacts that may be associated with Alaska OCS oil and gas exploration, development, and production activities. In BOEM's NEPA assessments, impact producing factors are correlated with a range of parameters, such as the number, timing, location, water depth, well cellar

depth, and results of wells drilled; discharges; facility types; and aircraft/vessels/vehicles utilized, including transportation routes used and the number and frequency of trips. Much of the historical information is contained within Environmental Studies Program monitoring reports (e.g., Burden et al. 1985, Kevin Waring and Associates 1985; Northern Resource Management 1980) and operator reports submitted to BOEM or its predecessors. BOEM's Alaska Resource Evaluation section has collated information on the 107 Alaska OCS wells drilled. However, it is difficult to find and synthesize activity information in a timely manner to answer questions related to historical Alaska OCS activities.

Objectives: This study will examine and compile information about historical Alaska OCS activities and associated parameters between 1979 and 2021. Specific objectives include:

- Quantify historical Alaska OCS activity information and relevant parameters for verification or validation of E&D scenarios.
- Establish a dataset of temporal and spatial information from historical Alaska OCS activities in the marine environment to inform identification of relevant impact producing factors for NEPA assessments.
- Develop a detailed written synthesis of Alaska historical oil and gas activity to inform SMEs and capture and curate institutional knowledge for NEPA assessment.

Methods: Researchers will conduct a detailed review, compile, and collate available information about historical Alaska OCS activities and associated parameters to establish a framework of consistent data elements for synthesis and analysis. Information that addresses the aforementioned objectives gathered from peer-reviewed literature, reports, and summary documents will be synthesized into a geodatabase as well as a report. Researchers will craft concise statements that can be easily and readily used in future environmental analyses to describe the levels of oil and gas exploration, infrastructure, and activities in context with proposed activities to support future planning and decision-making.

Specific Research Question(s):

1. What are the levels of historical Federal OCS oil and gas activities and can they be used as input to or validation of E&D Scenarios used in NEPA assessments?
2. What are the levels and spatial and temporal distribution of historical Alaska OCS activities and related parameters compared to activities on existing leases?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Burden PL, Feldman ML, Barloon KL. 1985. Monitoring OCS Activity in The Bering Sea. OCS Study MMS 85-0027/Technical Report 114. Prepared by Patrick Burden &

Associates and Dames & Moore for USDOI, MMS, Alaska OCS Office. 193 pp. + Appendices. https://espis.boem.gov/final%20reports/1570.pdf

Kevin Waring Associates. 1985. Monitoring Oil Exploration Activities in the Beaufort Sea. OCS Study MMS 84-0060/Technical Report 107. Anchorage, AK: Prepared for USDOI, MMS, Alaska OCS Office. 193 pp. + Appendices. https://espis.boem.gov/technical%20summaries/1688.pdf

Northern Resource Management. 1980. Monitoring Oil Exploration Activities in the Lower Cook Inlet. Technical Report 55. Anchorage, AK: Prepared for USDOI, BLM, Alaska OCS Office. 206 pp. https://marinecadastre.gov/espis/#/search/study/26124

Title	Alaska Assessment for Cetaceans and Other Marine Mammals (ACOMM)
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Inter-agency Agreement
Conducting Organization(s)	NOAA
Total BOEM Cost	TBD
Performance Period	FY 2022–2026
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Marine ecosystems surrounding Alaska support a high diversity of cetacean species, several of which are listed as endangered under the Endangered Species Act (ESA). Additional data on species abundance and trends, seasonal distribution and movements, and habitat use is needed in this region to more fully assess the potential effects on cetaceans and other marine mammals of current and future oil and gas activities associated with the Outer Continental Shelf.
Intervention	Rotational, large-scale, visual and acoustic ship-board or aerial surveys and acoustic moorings, are proposed seas across the Alaska OCS to obtain data on the presence, distribution, and abundance of marine mammals with particular focus on subsistence-harvested species such as bowhead and beluga whales; endangered species such as North Pacific right and fin whales; and species such as beaked whales, which may be vulnerable to noise from seismic air guns and other loud sound sources.
Comparison	These surveys will provide baseline information and facilitate future comparisons to examine the potential effects of natural and anthropogenic disturbances. The resulting habitat density models for key cetacean species will be compared to areas of interest for potential future oil and gas activities.
Outcome	This program will provide data on the abundance, trends, and distribution of cetaceans in the Alaska OCS, including Cook Inlet and the Beaufort Sea, to facilitate the development of habitat-based density models to better understand how natural and anthropogenic disturbances may affect marine mammal species.
Context	All Alaska OCS Areas

BOEM Information Need(s): Information on abundance and distribution of cetaceans and other marine mammals is needed to assess overlap between species' habitat and potential oil and gas activities in the coastal and offshore regions of Alaska.

The ACOMM program would provide BOEM and collaborating federal agencies with cetacean information needed to meet their regulatory requirements under the ESA, Marine Mammal Protection Act (MMPA), and National Environmental Policy Act (NEPA).

Background: Federal agencies are responsible for assessing and managing protected species within the waters of the U.S. EEZ. Data on cetacean abundance, distribution and habitat use are critical for assessing potential natural and anthropogenic impacts. This need for cetacean information has led to the development of three very successful large-scale, multi-agency, cetacean assessment programs jointly established and funded by BOEM, NOAA, and the U.S. Navy: 1) Atlantic Marine Assessment Program for Protected Species (AMAPPS), 2) Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS), and 3) Pacific Marine Assessment Program for Protected Species (PacMAPPS). The missing sector in this national effort is the Arctic, and an Arctic Marine Assessment Program for Protected Species (ArMAPPS) is in the planning stages. Establishing the ArMAPPS program will fill the remaining regional gap to provide basic cetacean assessments across U.S. territorial waters.

The proposed Alaska-focused program, ACOMM, would leverage and closely collaborate with the PacMAPPS and ArMAPPS programs to address BOEM's information needs.

Objectives: By conducting comprehensive rotational marine mammal research on the Alaska OCS, the ACOMM program will improve the knowledge base of federal agencies with protected species responsibilities. Specifically, the objectives are to:

- Use visual and acoustic survey techniques and acoustic moorings to collect information about abundance, trends, and distribution for cetaceans in Alaska.
- Collect data on life-history, residence time, and stock structure when possible.
- Develop habitat-based density models for generating finer-scale predictions of cetacean seasonal density or occurrence and for understanding how these are changing with the environment.
- Evaluate the optimal frequency for future tagging studies to better assess foraging behavior and seasonal movements of target species.

Methods: Visual and acoustic shipboard or aerial surveys will be conducted on a rotational basis in the throughout the Alaska OCS to collect needed abundance, trend, and distribution data of cetaceans. The survey design will consist of predetermined track lines within survey strata, defined for each geographic region given current information on cetacean distribution. A higher proportion of survey effort will be allocated within areas where cetacean abundance for some species is expected to be higher and have a higher potential to be affected by BOEM-regulated activities. Researchers will investigate the use of modern video-capture and analysis methods, including artificial intelligence techniques, to supplement or substitute for some crewed aerial survey efforts.

Researchers will analyze acoustic and line-transect survey data independently to calculate abundance estimates or trends for as many cetacean species as possible. Visual

and auditory detections also will be combined to examine spatial variation in the probability of occurrence for cetacean species following emerging analytical techniques. Additionally, distribution data will be linked to habitat characteristics to create fine-scale spatially explicit density estimates that can be used to meet regulatory requirements of BOEM. Finally, a refined survey schedule for future monitoring will be developed collaboratively through discussion among BOEM and NOAA staff. For example, it may be desirable to shift annual survey efforts in a 5-6-year rotation among sub-regions of the research area.

Specific Research Question(s):

1. What is the abundance and distribution of cetacean species, particularly subsistence-harvested and endangered species, that utilize habitats or migrate through areas potentially affected by activities associated with oil and gas exploration and development?
2. What is the overlap between the predicted habitat of cetacean species and areas associated with oil and gas exploration, development, and future lease sales?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

Table 2. BOEM Alaska Regional Office Studies to be Considered for FY 2023

Page Number	Discipline	Study Title	Planning Area(s)
45	BIO	Using Predator Diets to Monitor Trends in Forage Fish Populations in Lower Cook Inlet	Cook Inlet
48	BIO	Seabird and Forage Fish Distribution, Trends, and Community Structure in Lower Cook Inlet	Cook Inlet
51	BIO	Collaboration with North Pacific Research Board (NPRB): Arctic Marine Synthesis	Beaufort, Chukchi
54	PO	Comprehensive Synthesis of the Physical Oceanography of the U.S. Arctic 2005–2020	Cook Inlet
57	BIO	Ecological Response to the Presence of Oil and Gas Production Platforms in Cook Inlet, Alaska	Cook Inlet
60	BIO	Using Emerging Technologies to Update Lower Cook Inlet Seabird Colony Counts	Cook Inlet
Discipline Codes			
BIO = Biology ID = Interdisciplinary & Information Management PO = Physical Oceanography			

Title	Using Predator Diets to Monitor Trends in Forage Fish Composition in Lower Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Inter-agency Agreement
Conducting Organization(s)	NOAA
Total BOEM Cost	TBD
Performance Period	FY 2022–2024
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Research in the Cook Inlet region indicates that ecosystem changes associated with warming conditions and marine heatwaves have caused declines in fish and seabird populations. Information on forage species variability is needed to link the lower trophic patterns to changes in fish, marine bird and marine mammal populations.
Intervention	This study will focus on using fish (salmon and groundfish) and seabird diet data gathered by port sampling and citizen science to develop an index of seasonal and interannual changes in forage species composition over time. It will also develop a mobile phone application to facilitate long term data collection by researchers and fishermen.
Comparison	Study results will be evaluated in the context of ecosystem monitoring data, as well as other time series data on fish, seabird and marine mammal populations.
Outcome	This study will provide a cost-effective tool to track temporal variability of forage fish composition in Cook Inlet. Products may include a new mobile phone application to facilitate collection of predator fish diet data.
Context	Cook Inlet Region, linking with the ongoing Gulf Watch Alaska program

BOEM Information Need(s): BOEM needs updated information regarding temporal changes to forage fish populations and their relation to predators. This study will develop a cost-effective tool to help monitor potential ecosystem level changes that will provide insight to when new research is needed to update existing baseline descriptions and offer further insight into changes in fish, seabirds and marine mammal populations. Results from this study will support NEPA analysis and documentation for lease sales, Explorations Plans (EPs), and Development and Production Plans (DPPs).

Background: Time series data provide information on spatial and temporal variability of marine conditions and lower trophic species that enhances understanding of upper trophic changes in fish, seabird, and marine mammal populations in lower Cook Inlet. Better data for forage species variability, especially forage fish like capelin, sand lance and herring, is needed to more effectively link the lower trophic patterns to changes in fish, marine bird and marine mammal populations. This study will use fish and seabird diet observations to obtain seasonal and interannual information on variability of forage species in Cook Inlet. This study will complement ongoing BOEM-supported efforts assessing seabird and forage fish status, trends, and ecology in lower Cook Inlet (AK-16-09, AK-20-10).

Objectives:

- Evaluate fish (salmon and groundfish) and seabird diet data to develop an index of seasonal and interannual changes in forage species composition in lower Cook Inlet.
- Characterize seasonal progression and interannual differences in forage fish community composition over time in the context of oceanographic and biological time series.
- Enhance citizen science in the Cook Inlet region.

Methods: This 3-year study will leverage the efforts of Gulf Watch Alaska to develop and implement a predator fish and seabird diet monitoring program to provide an index of changes in forage fish populations.

To develop a time series index of predator fish diets, salmon and groundfish diet samples will be observed from fish caught by sport and subsistence fishermen in lower Cook Inlet (including Kachemak Bay and Deep Creek) and potentially other surrounding areas (Seward and Prince William Sound). Fish stomach contents will be collected from fishermen at fish cleaning areas at harbors, canneries, and annual fishing derbies. Stomach contents will be photographed, and forage species would be either identified on-site by trained researchers or identified later from photographs submitted. Information on general fishing locations and fish species ID will be recorded and/or provided from fishermen. Collection of eDNA will also be considered. Initial data collection, image collection, and fish identification protocols will be developed by researchers conducting the fish stomach observations. A simplified data collection and species identification protocol will also be developed for use by volunteer fishermen in the region, with on-line data sharing of results to promote participation by residents. After sampling protocols have been developed and tested, they will be incorporated into a mobile phone application that facilitates data collection, species identification and data sharing, by researchers and volunteer fishermen.

To develop a time series of seabird diets on forage fish this study will establish protocols to sample food loads delivered by adult Black-legged kittiwakes to their chicks at the deep-water dock in Homer and other harbor nesting sites, if applicable. Kittiwakes are a popular study species, having a circumpolar distribution, being widespread, and easy to work with. The proposed location in Homer is unique in terms of accessibility because

several hundred kittiwakes nest on harbor infrastructure that is easily accessible from the road system. Given the easy access, seabird diet sampling at the Homer dock could be done in a morning by 2-3 people.

An immediate product of this study will be a matrix of forage fish species and their numbers per food load. Specimens will be preserved in the field and shared with collaborators for identification and further analysis. Auxiliary information, like size, wet-mass (or caloric content) will provide valuable additional data. The community composition matrix will be compared through time (using tools like canonical correspondence analysis), as well as analyzed for species of particular interest (e.g. prevalence of capelin associated with colder water conditions).

Specific Research Question(s):

1. How does the relative community composition of forage fish species change seasonally and between years in lower Cook Inlet?
2. How are changes in community composition of forage fish related to changes in environmental conditions and plankton in lower Cook Inlet, and to changes in fish, seabird and marine mammal populations?
3. How does the forage fish community here compare to other sites (e.g. Middleton Island)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: https://gulfwatchalaska.org/monitoring/

Title	Seabird and Forage Fish Distribution, Trends, and Community Structure in Lower Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Intra-agency Agreement
Conducting Organization(s)	USGS
Total BOEM Cost	TBD
Performance Period	FY 2022–2025
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Recent perturbations to the Gulf of Alaska marine ecosystem have resulted in massive seabird die-offs, reduced breeding success, historically low at-sea densities of fish-eating seabirds, and a large-scale forage fish community collapse. Continued assessments of seabirds and forage fish will provide information on the recovery of ecosystem resources in the region.
Intervention	This study will quantify spatial and temporal variation in seabird and forage fish communities in lower Cook Inlet to inform the status of ecological resources in areas of oil and gas development.
Comparison	Results will be evaluated in the context of extensive historical data to quantify changes in seabird and forage fish populations in Cook Inlet.
Outcome	Continued assessments of seabird and forage fish communities will provide managers with information needed to assess resiliency of ecological resources to impacts from oil and gas-related activities in Cook Inlet.
Context	Cook Inlet Planning Area

BOEM Information Need(s): More accurate evaluation of resiliency in fish and seabird resources with respect to natural or anthropogenic stressors in Cook Inlet requires a better understanding of trophic interactions and community structure. Assessing seabird and forage fish communities in potential oil and gas lease areas has been a BOEM priority for decades, to both mitigate impacts of offshore oil exploration and development activities and evaluate the impact of potential oil spills. An unprecedented and prolonged marine heatwave in the Gulf of Alaska and Cook Inlet during 2014-2016 dramatically altered seabird and forage fish community structure and trophic interactions. Thus, it is important to continue assessments to understand resultant changes in the pelagic trophic system, and whether they are temporary or persistent at longer time scales. The information collected and synthesized in this

ongoing study will be used to support evaluation of observed trends and environmental analyses for future lease sales, as well as exploration, development, and production activities in Cook Inlet.

Background: The USGS led seabird and forage fish studies in lower Cook Inlet during the 1990s assessed factors regulating seabird populations, in the context of seabird population recovery following the 1989 M/V Exxon Valdez oil spill. The original project was designed to measure the population response of seabirds to fluctuating forage fish densities around seabird colonies in the region. Beginning in 2016 the USGS has supported research that repeated these historical studies of the 1990s to document the effects of a large-scale seabird die-off in the North Pacific. This ongoing work demonstrates that an unprecedented multi-year marine heatwave caused a major disruption to the Gulf of Alaska trophic system, with major consequences for seabird and forage fish populations in Cook Inlet. In 2015-2016, about 1 million common murres died from starvation, and seabirds failed to produce offspring at multiple colonies in the Gulf of Alaska, including several colonies in Cook Inlet (Piatt et al. 2020). The large and conspicuous seabird die-off was accompanied by reduced quality and a synchronous collapse of key forage fish populations, including capelin, herring, and sand lance. Impacts to ecological resources were observed across trophic levels and did not return to a normal state in the years that followed the heatwave. For example, at-sea densities of several fish-eating seabird species, including common murre, pigeon guillemot, marbled murrelets, and Kittlitz's murrelets, were the lowest ever documented during 2018. Additionally, horned and tufted puffin densities were consistently lower in 2016-2019 compared to baseline data from the late-1990's (Piatt et al. 2020). These observations make clear the need to continue assessments of seabird and forage fish communities to better understand the relationship between natural ecosystem change and potential impacts from oil and gas activities on ecological communities.

The consequence of multiple years of seabird breeding failures in lower Cook Inlet can be evaluated in the coming years because common murres require 4-5 years to reach sexual maturity, and therefore population level effects can only become apparent when the new cohorts fail to show up at the colonies. Furthermore, at-sea surveys of seabirds and forage fish provide data on all species, which facilitates a greater understanding of variability in seabird and forage fish communities. Continuation of this work is needed to better understand the response of predator-prey populations to major perturbations, trophic interactions, and changes in community structure in the region.

Objectives: Assess contemporary trends in abundance and distribution of ecological resources to aid in oil and gas development planning by identifying changes in seabirds and forage fish community structure, trophic interactions, and linkages to the marine environment within lower Cook Inlet.

Methods: Protocols for monitoring forage fish and seabirds in lower Cook Inlet were developed during the 1995-2001 years of colony work for BOEM, and details can be found in the final report on that project (Piatt 2002). At-sea work will be conducted along fixed transects within 50 km of two colonies, Gull Island in Kachemak Bay, and Chisik Island on the west side of lower Cook Inlet. Forage fish abundance and community composition will be assessed using mid-water trawls and acoustic surveys.

At-sea densities of seabird communities will also be measured on acoustic transects. To provide an index of forage fish food availability and habitat, zooplankton biomass and a suite of physical conditions will be measured in conjunction with each trawl. At colonies, we will census kittiwakes and murres on established monitoring plots and conduct full island censuses, obtain an index of reproductive success of adult birds, and collect data on diet composition of adults and chicks.

Specific Research Question(s):

4. What are the trends in seabird and forage fish distribution and abundance in lower Cook Inlet?
5. How have seabird and forage fish communities changed following a major perturbation in the marine ecosystem?
6. What are the most important linkages between seabird predators, their forage fish prey, and stressors related to marine habitat?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Piatt JF (Ed) (2002) Response of Seabirds to Fluctuations in Forage Fish Density. Final Report to Exxon Valdez Oil Spill Trustee Council and Minerals Management Service. U.S. Geological Survey, Anchorage, AK. 406 pp. Available at: https://www.boem.gov/newsroom/library/scientific-and-technical-publications-2002

Piatt JF, Parrish JK, Renner HM, Schoen SK, Jones TT, Arimitsu ML, et al. (2020). Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. PloS ONE, 15(1), e0226087.

Title	Collaboration with North Pacific Research Board (NPRB): Arctic Marine Synthesis
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	NPRB
Total BOEM Cost	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	The BOEM Environmental Studies Program needs applied scientific studies to provide information for making responsible decisions for managing energy and marine mineral resources on the U.S. Outer Continental Shelf (OCS). BOEM, NPRB and other organizations have a long history of supporting field data collection projects. Further efforts are needed to synthesize the results and identify ongoing information needs to develop recommendations for future projects.
Intervention	BOEM will partner with NPRB to build upon recent and ongoing Arctic research through financial cooperation, coordinated Request for Proposals (RFPs), and data sharing agreements. Approaches will draw on data collected by multiple field programs funded by BOEM and other organizations in recent decades and will support new statistical analyses and new collaborations.
Comparison	This partnership will examine areas where collaborative studies could help enhance informed decision-making on the sustainable use of resources
Outcome	Results will address mutual information needs through new synthesis projects.
Context	Beaufort Sea, Chukchi Sea

BOEM Information Need(s): BOEM and the North Pacific Research Board (NPRB) have worked together programmatically and scientifically on the Arctic Integrated Ecosystem Research Program (Arctic IERP, https://www.nprb.org/arctic-program) since 2016. Based on this successful collaboration, BOEM and NPRB intend to partner to fund new synthesis projects that will build upon the research of the Arctic IERP and other projects conducted in the Arctic to address mutually-identified information needs.

Background: The Alaska Regional Office has a long history of supporting multidisciplinary research, beginning with the "Outer Continental Shelf Environmental Assessment Program" (OCSEAP) surveys conducted between the 1970s and early 1990s and the "Beaufort Sea Monitoring Program" (BSMP) in the 1980s. The "Arctic Nearshore Impact Monitoring in Development Area" (ANIMIDA) program and its continuation (cANIMIDA) started in 1999 to provide baseline data and monitoring results for chemical contamination, turbidity, and subsistence whaling in the vicinity of the Northstar and Liberty development sites. This work was continued through the "ANIMIDA III: Boulder Patch and Other Kelp Communities in the Development Area" and "ANIMIDA III: Contaminants, Sources, and Bioaccumulation," studies, which were expanded to include Camden Bay. In 2007, the Alaska Regional Office developed a new suite of studies in the Chukchi Sea, conducting interim baseline research and monitoring in all the following fields of interest: meteorology, ice dynamics and basic oceanography, benthic fauna and sedimentation, marine mammals (including whales, walrus, seals, and polar bear), fish, birds, and social systems. Most of the projects exhibited complex, multilateral collaborations, with explicit inter-disciplinary linkages between the physical and biological sciences, with careful attention to inter-annual variability and ecosystem processes. Many of them also provided a role for active participation by Alaska Native residents and input from sources of traditional knowledge.

The Arctic IERP, which BOEM funded in partnership with NPRB, the North Slope Borough/Shell Baseline Studies Program, and the Office of Naval Research Marine Mammals & Biology Program, supports multi-disciplinary studies of the marine ecosystem in the northern Bering, Chukchi, and Beaufort Seas during the period 2016-2021. The research program employs a coordinated approach to conducting continued analyses of all aspects of the marine system, from primary and secondary producers, to pelagic and benthic invertebrates, fishes, seabirds, and marine mammals, and examines the trophic linkages among them under changing physical and chemical environmental conditions during a period of rapid transition. The program has documented surprises, including the reduction of thermal barriers to northward movement of subarctic species in the northern Bering Sea and the movement of significant numbers of commercially important predatory fishes (walleye pollock and Pacific cod) northward into the Chukchi Sea. The program has also documented a significant northward shift in the distribution of Arctic cod. The Arctic IERP includes a social science study focused on the relative influence of environmental conditions and socioeconomic factors in determining food security for Arctic residents. Representatives of Alaska Native communities have participated in annual Principal Investigator meetings throughout the research program.

Scientists leading several projects that BOEM funded separately in recent years (e.g., Aerial Surveys of Arctic Marine Mammals; Alaska Marine Biodiversity Monitoring Program, Chukchi Acoustic, Oceanography, and Zooplankton study; Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area) have developed collaborations through the Arctic IERP.

Objectives: BOEM would build upon existing working relationships with NPRB and others by establishing financial cooperation, coordinated Request for Proposals (RFPs), and data sharing agreements. The foundation for such partnerships remains based on the BOEM Annual Studies Planning Process. The new collaboration will involve established funding partners and existing research implementation strategies (e.g., Interagency Arctic Research Policy Committee, the Arctic Council's Circumpolar Biodiversity Monitoring Program, Distributed Biological Observatory).

Methods: BOEM, NPRB and other funding partners will build upon past synthesis projects (e.g., Synthesis of Arctic Research [SOAR; Moore et al. 2018], Pacific Marine Arctic Regional Synthesis [PacMARS; Grebmeier et al. 2015]) and field data collection projects (e.g., the Arctic Integrated Ecosystem Study) to examine areas where collaborative studies could help enhance informed decision-making on the sustainable use of resources. This partnership will be guided by an oversight committee formed of senior scientists and accomplished through an annual RFP process. Recommendations for select studies would be based on program development goals. Topics for studies include, but are not limited to, inter- and intra-relationships of oceanographic circulation, sea ice, hydrography, fisheries and lower-trophic abundance and distribution, and marine mammal and seabird distributions and behavior; changes in trophic linkages under changing physical/chemical environmental conditions; and implications for food security for Arctic residents. Working groups will draw on data collected by multiple field programs funded by BOEM and other organizations in recent decades and will support new statistical analyses and new collaborations. New field data collection will not be supported. Deliverables from this study will include working group and summary recommendation reports, as well as peer-review journal publications.

Specific Research Question(s): How can we better synthesize existing data and other available information to enhance informed decision-making on the sustainable use of resources?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Grebmeier JM, Cooper LW, Ashjian CA, Bluhm BA, Campbell RB, Dunton KE, Moore J, Okkonen S, Sheffield G, Trefry J, Pasternak SY. 2015. Pacific Marine Arctic Regional Synthesis (PacMARS) Final Report. North Pacific Research Board, 259 pp.

Moore SE, Stabeno PJ, Sheffield Guy LM, Van Pelt TI. 2018. Synthesis of Arctic of Research (SOAR): Physics to Marine Mammals in the Pacific Arctic. US Dept. of the Interior, Bureau of Ocean Energy Management, Alaska OCS Region, Anchorage. OCS Study BOEM 2018-0017, 61pp.

Title	Comprehensive Synthesis of the Physical Oceanography of the U.S. Arctic 2005–2021
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Contract or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	In the last decade, a substantial volume of physical oceanography observational data was collected and analyzed across several large oceanographic programs in the northern Bering, Chukchi, and U.S. and Canadian Beaufort seas. This site- or region-specific information is not comprehensively synthesized across the broad Arctic region adjacent to the U.S. to provide context for use in NEPA analyses or developing information needs in a rapidly changing Arctic.
Intervention	This study will synthesize relevant oceanographic peer-reviewed journal articles and reports to develop a synthesis document that is readily accessible to BOEM's analysts and the public.
Comparison	The synthesis will provide an enhanced understanding of the physical oceanography, noting trends, and providing recommendations for addressing physical oceanographic information needs most relevant for the U.S. Arctic.
Outcome	A synthesis and description of physical oceanography in the U.S. Arctic with topical recommendations for further study identifying information needs to ensure that first-order ocean physics are understood and provided data to validate future model results.
Context	Beaufort Sea, Chukchi Sea, Northern Bering Sea

BOEM Information Need(s): This study will provide BOEM, other Federal agencies, and industry analysts with a current synthesis and description of the physical oceanography of the U.S. Arctic. A concise synthesis describing the physical oceanography and outlining information needs in a rapidly changing Arctic, would support BOEM's mission with respect to leasing, exploration, and development. It would inform NEPA documents and guide future ESP study profile development.

Background: Current regulations from the Council for Environmental Quality implement page limits for environmental impact statements and promote incorporation by reference. An important component of environmental analysis in NEPA documents is the description of the affected physical oceanographic environment. Site-specific or region-specific oceanographic programs are not comprehensively synthesized across the broad Arctic region adjacent to the U.S. Such a synthesis could be incorporated by reference in NEPA documents or provide readily available context for a rapidly changing Arctic baseline (Timmermans and Marshall, 2020).

Topical study recommendations are used to focus study profile development. MBC (2003) conducted a workshop with experts in Arctic oceanography that reviewed the physical oceanography of the Beaufort Sea and Weingartner et al. (2010) developed topical study recommendations. For nearly a decade those recommendations were developed into study profiles resulting in a wealth of observational programs and scientific literature that focused on the most relevant information needs to BOEM (Lin et al. 2020; Weingartner et al. 2017).

Objectives: The goal of this study is to improve understanding of physical processes and boundary influences in the U.S. Arctic. Specific objectives include:

- Synthesize information from various physical oceanographic studies in the northern Bering, Chukchi, and Beaufort seas from 2005–2021.
- Develop a series of topical recommendations for addressing information needs in a rapidly changing Arctic.
- Identify additional data sets needed to facilitate the evaluation of regional ocean-ice coupled circulation models.

Methods: Researchers will work with Subject Matter Experts (SMEs) from academia, state and federal agencies, and non-governmental organizations to obtain data and review pertinent literature (e.g., peer reviewed literature and reports). Information that addresses the aforementioned objectives in peer-reviewed literature, reports, and summary documents will be synthesized into concise statements that can be easily and readily used or referenced in future environmental analyses, study profiles, and statements of work to describe the existing environment, identify observational information needs, or to enhance model development, skill assessment, or validation and verification. The report will include recommendations for future efforts to address ongoing information needs. These efforts will focus on a mix of field (observational) and idealized model studies.

Specific Research Question(s):

1. What additional insights can be gained through synthesis and integration of available U.S. Arctic oceanographic data and information?
2. What physical processes need further elucidation to better understand first order oceanic physics in a changing Arctic?

3. What is the current range of observing or idealized modeling approaches and how can new technologies further address identified information needs?
4. What additional observational datasets will enhance the verification and validation of model results?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Lin P, Pickart RS, Fissel D, Ross E, Kasper J, Bahr F, Torres DJ et al. 2020. Circulation in the vicinity of Mackenzie Canyon from a Year-Long Mooring Array. Progress in Oceanography 187: 102396.

MBC Applied Environmental Sciences. 2003. Physical Oceanography of the Beaufort Sea Workshop Recommendations, Thomas Weingartner Ph. D. Workshop Chair. OCS Study MMS 2003-045. Anchorage, AK: USDOI, MMS, Alaska OCS Region. 48 pp. https://marinecadastre.gov/espis/#/search/study/332

Timmermans, ML and J Marshall. 2020. Understanding Arctic Ocean Circulation: A Review of Ocean Dynamics in a Changing Climate. Journal of Geophysical Research- Oceans. 125(4): e2018JC014378

Weingartner TJ, Danielson SL, Potter RA, Trefry JH, Mahoney A, Savoie M, Irvine C, Sousa L. 2017. Circulation and Water Properties in the Landfast Ice Zone of the Alaskan Beaufort Sea. Continental Shelf Research. 148: 185-198.

Weingartner TJ, RS Pickart, and MA Johnson. 2010. Recommended Physical Oceanography Studies in the Alaskan Beaufort Sea. OCS Study MMS 2010-018. Anchorage, AK: USDOI, MMS, Alaska OCS Region. 98 pp. https://espis.boem.gov/final%20reports/4921.pdf

Title	Ecological Response to the Presence of Oil and Gas Production Platforms in Cook Inlet, Alaska
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Contract or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Current NEPA and ESA consultations require analyses of impacts to marine mammal, avian, and fish species from the installation and operation of offshore oil and gas platforms. In recent years, studies have been conducted in the Gulf of Mexico and along the west coast of the United States, investigating such impacts. This type of information is limited for cold water areas, such as Alaska, however.
Intervention	This study will survey existing production platforms, facilities, and surrounding areas located in state waters within Cook Inlet, Alaska for trends in species diversity, richness, and distribution.
Comparison	This study will compare data on plant, invertebrate, fish, avian, and mammalian species diversity, species richness, and localized distribution on and near existing production platforms in Cook Inlet with similar data from control areas to identify trends and patterns that may be attributed to the presence of the platforms.
Outcome	This study will provide insight into the ecological effects of offshore oil and gas platforms in state waters of Cook Inlet, Alaska to inform assessment of potential changes related to future platforms in OCS waters.
Context	Cook Inlet Planning Area and Gulf of Alaska.

BOEM Information Need(s): Analyses of impacts in NEPA and consultation documents related to the presence of oil and gas platforms presently rely on inferences derived from a few studies conducted in the North Sea, the Gulf of Mexico and along the west coast of the U.S. Differences between these areas and Cook Inlet add an element of uncertainty into impact analyses in Alaska. Results from this study will support effects analyses under NEPA, MMPA, and ESA for future lease sales, exploration plans, and development and production plans in Cook Inlet.

Background: Analysis of production platform colonization and use by invertebrates, fish, birds, and marine mammals in Alaska currently relies on information collected in other areas of the world. Though studies are not currently available for Alaska, a body of literature exists describing the effects of platform presence in California (e.g., Claisse et al. 2014), the Gulf of Mexico (e.g. Stanley and Wilson 1996), the North Sea (Delefosse et al. 2018, Fujii 2016, Sodal et al. 2002, Todd et al. 2016), Russia (Reeves 2005, Thomson and Johnson 1996), and other areas around the world (Bull and Love 2019, van Elden et al. 2019).

Objectives:

- Identify and quantify species, their diversity and distribution on and in the vicinity of production platforms in Cook Inlet to develop baseline information for Cook Inlet platforms.
- Conduct statistical analyses comparing data collected around production platforms with data from control areas that are not directly adjacent to production platforms

Methods: Researchers will survey production platforms in Cook Inlet to identify and enumerate vertebrate, invertebrate, and plant species present on or near those platforms. Water and biological samples will also be monitored for contaminants. Control areas will be identified and surveyed using the same methodologies. Final results will be tabulated, quantified, and compared to identify trends in biodiversity and species richness between platforms and control areas, and between different platforms. The findings will be converted to geospatial data suitable for subsequent use by BOEM personnel and shall be presented in a report to BOEM.

Specific Research Question(s):

1. What biological communities occur on and near production platforms?
2. How do the biological assemblages compare to control areas that have remained undisturbed?
3. What species, if any have benefited or suffered from the installation of production platforms?
4. Do contaminant levels in platform associated flora or fauna differ from control samples?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Bull AS, Love MS. 2019. Worldwide Oil and Gas Platform Decommissioning: a review of practices and reefing options. Ocean and Coastal Management, 168:274-306.

Claisse JT, Pondella DJ, Love M, Zahn LA, Williams CM, Williams JP, Bull AS. 2014. Oil Platforms Off California are among the most Productive Marine Fish Habitats Globally. Proceedings of the National Academy of Sciences - PNAS 111 (43): 15462-15467.

Delefosse M, Rahbek ML, Roesen L, Clausen KT. 2018. Marine Mammal Sightings Around Oil and Gas Installations in the Central North Sea. Journal of the Marine Biological Association of the United Kingdom 98 (5): 993-1001. doi:10.1017/S0025315417000406.

Fujii, T. 2016. Potential Influence of Offshore Oil and Gas Platforms on the Feeding Ecology of Fish Assemblages in the North Sea. Marine Ecology Progress Series 542: 167-186.

Reeves RR. 2005. Impacts of Sakhalin II Phase 2 on Western Pacific Gray Whales and Related Biodiversity. Report of the Independent Scientific Review Panel. World Conservation Union. IUCN 132 p.

Sodal AV, Svellingen I, Jørgensen T, Løkkeborg S. 2002. Rigs-to-Reefs in the North Sea: Hydroacoustic Quantification of Fish in the Vicinity of a “semi-Cold” Platform. ICES Journal of Marine Science 59: S281-S287.

Thomson DH, Johnson SR. 1996. Effects of Offshore Oil Development and Production Activities off Sakhalin Island on Sea Associated Birds and Marine Mammals. LGL Ltd., Environmental Research Associates, King City, Ontario, Canada, for Marathon Upstream Sakhalin Services, Ltd., Houston, TX, USA. 82 p.

Todd VLG, Warley JC, Todd IB. 2016. Meals on Wheels? A Decade of Megafaunal Visual and Acoustic Observations from Offshore Oil & Gas Rigs and Platforms in the North and Irish Seas. PloS One 11 (4): e0153320.

van Elden S, Meeuwig JJ, Hobbs RJ, Hemmi JM. 2019. Offshore Oil and Gas Platforms as Novel Ecosystems: A Global Perspective. Frontiers in Marine Science 6 (Article 548).

Title	Using Emerging Technologies to Update Lower Cook Inlet Seabird Colony Counts
Administered by	Alaska Regional Office
BOEM Contact(s)	alaska.studies@boem.gov
Procurement Type(s)	Intra-agency Agreement
Conducting Organization(s)	USFWS
Total BOEM Cost	TBD
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	October 22, 2021
PICOC Summary	
Problem	Colony surveys provide important information needed to mitigate disturbance and other potential effects on seabird populations from oil and gas activities, vessel traffic, oil spills. Traditionally, breeding seabird populations are estimated from colony-based censuses, though seabirds from these colonies forage offshore (up to 200 km) and diverse survey methods are needed to minimize undercounting these populations. Furthermore, large fluctuations in seabird breeding distribution and abundance are occurring at multiple colonies, likely due to drastic environmental perturbations in the Gulf of Alaska (GOA) in recent decades (Piatt et al. 2020). A comprehensive review of all seabird colonies in the region is necessary to understand the extent of these fluctuations, and such a survey has not been conducted in decades.
Intervention	Updated information on seabird colony locations, species, and abundance will be collected to guide prudent oil and gas development activities for Lower Cook Inlet (LCI). Census efforts will prioritize colony size and species of concern within the outflow of LCI, including Shelikof Strait, the Kodiak Archipelago, and the Kenai Peninsula.
Comparison	Traditional boat-based census counts, population estimates using emerging technology, photographic counts with machine learning software, and indices derived from marine-band radar will be used to compare and quantify numbers of breeding seabirds at colonies in the LCI region. Results will be evaluated with historic colony estimates to document changes in seabird abundance and breeding distribution.
Outcome	This study will produce robust estimates of breeding bird populations in the Cook Inlet Planning Area.
Context	Cook Inlet

BOEM Information Need(s): A better understanding of ongoing seabird population fluctuations in Cook inlet is needed to support evaluation of potential impacts to these populations from oil and gas activities. Updating population estimates of breeding seabirds in LCI will help to mitigate impacts of potential industry activities and improve assessment of effects of potential oil spills. Advances in seabird colony survey methods using innovative technology can provide cost-efficient, precise, and accurate estimates of population abundance, and can be used to improve traditional boat-based seabird colony surveys. The information collected will inform environmental analyses for current and future lease sales, exploration, and development activities, including Endangered Species Act Section 7 consultations, NEPA analyses, and other documentation for lease sales, exploration plans, and development and production plans.

Background: The LCI and outflow (Shelikof Strait, northern Kodiak Archipelago, Kenai Peninsula) supports approximately 325 seabird colonies totaling over half a million breeding birds. With the support of the Outer Continental Shelf Environmental Assessment Program, the U.S. Fish and Wildlife Service (USFWS) led marine bird surveys in the 1970s and 1980s in the LCI to provide information needed for decisions regarding offshore oil and gas development. However, assessing the damage to marine bird populations following the 1989 *Exxon Valdez* Oil Spill (EVOS) in Prince William Sound was difficult because of the lack of updated baseline information (Ford et al. 1996). After EVOS, USFWS received funds to investigate marine bird populations in the spill-affected area. Nearly 25 years later, an unprecedented multi-year marine heatwave occurred in the GOA, where massive seabird die-off events occurred and populations at many colonies experienced complete reproductive failure. Updating information on locations, species composition, and size of seabird colonies in LCI and associated regions is important to guide prudent development of oil and gas leases.

Objectives:

- Update information on breeding distribution, abundance, and species composition at seabird colonies in the lower Cook Inlet region.
- Publicly disseminate the updated data through the North Pacific Seabird Colony Register.

Methods: Diverse techniques are required to accurately assess breeding numbers of different seabird species, depending on behavior (i.e., ledges vs burrow/crevice nesting) and colony accessibility. Alaska poses unique challenges because of the number of remote colonies. The USFWS and U.S. Geological Survey (USGS) continue to develop and refine methods to improve estimates of seabird abundance at colonies and minimize possible undercounting. New and current technologies such as marine-band radar and photographic surveys from fixed-wing aircraft and helicopters will be used to collect relative abundance of species and densities of seabird colonies. Researchers at USFWS will collaborate with the USGS Alaska Science Center to develop emerging technology protocols for determining abundance estimates of ledge nesting breeding seabirds (e.g., murres, kittiwakes). Working with partners at the Alaska Maritime National Wildlife Refuge and the Alaska Biological Research, Inc., researchers will develop indices of

burrow nesting seabirds (e.g., tufted and horned puffins). Methods used to update census information at the 325 colonies will complement current work being conducted by USGS to expand understanding of all seabird species breeding in the LCI region.

Specific Research Question(s):

1. What are the current population estimates, locations, and species composition of seabird colonies in LCI and adjacent coastlines?
2. How have seabird breeding distribution and estimates of abundance changed since previous colony surveys in the 1970s and 1980s? What are the ranges of variability for colony population changes over the last 40 years?
3. Do new technologies for quantifying seabird distribution and abundance provide robust measures (i.e., repeatable and defensible during oil spill mitigation)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Ford G, Bonnell M, Varoujean D, Page G, Carter H, Sharp B, Heinemann D, and Casey J. 1996. Total direct mortality of seabirds from the Exxon Valdez Oil Spill. Pages 684-711 in Rice S, Spies R, Wolfe D, Wright B, editors. Proceedings of the Exxon Valdez oil spill symposium. American Fisheries Society Symposium 18.

Piatt J, Parrish J, Renner H, Schoen S, Jones T, Arimitsu M, et al. 2020. Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. PloS ONE, 15(1), e0226087.

3.3 Ongoing Studies

Study profiles for each of the studies identified in Table 3 can be found at the Ongoing Studies Table link on the page http://www.boem.gov/AKstudies

This information, which is updated three times each year, includes:

- An updated status of each study.
- Report due dates.
- Related publications.
- Affiliated websites.

Table 3. BOEM Alaska Regional Office Ongoing Studies

NSL #	Study Title	Planning Area(s)	Start FY	Partners
ONGOING STUDIES				
Biology				
AK-16-07†	Arctic Integrated Ecosystem Survey, Phase II	Beaufort, Chukchi	2017	NOAA; UAF; USFWS
AK-17-02†	Wave Energy Converter Impact Assessment	All Alaska Planning Areas	2017	CESU-UAF
AK-17-03	Marine Bird Distribution and Abundance in Offshore Waters	Beaufort, Chukchi, Cook Inlet	2017	USFWS
AK-17-x11	Nearshore fish surveys in the Beaufort Sea	Beaufort	2017	USGS
AK-18-01	Environmental Resource Areas: Developing Products to Support Oil-Spill Risk Analysis (OSRA) and National Environmental Policy Act (NEPA)	All Alaska Planning Areas	2018	USGS
AK-19-01	Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea	Beaufort	2019	UT-Austin
AK-19-02-02	Kelp Restoration in the Boulder Patch	Beaufort	2019	CMI
AK-19-02-03†	Utilization of the Under-ice Habitat by Arctic Cod in the Western Arctic Ocean: A Multidisciplinary Collaborative Study	Beaufort, Chukchi	2019	CMI
AK-19-02-07	Ocean Migration and Behavior of Steelhead Kelts in the Northern Gulf of Alaska, Examined with Satellite Telemetry	Cook Inlet, Gulf of Alaska	2020	CMI
AK-19-02-10	Are expanding Pink Salmon populations in the Arctic produced from regional watersheds?	Beaufort, Chukchi	2020	CMI
AK-19-92-13	Harnessing the Power of eDNA as a Real-time Assessment tool of Nearshore Arctic Marine Communities	Beaufort	2021	CMI
AK-19-02-14	Delineating Species and Stock Boundaries in the Arctic-Bering Cisco Species Pair	Beaufort	2021	CMI

AK-19-02-15	Understanding Spatial Dynamics and Movement of Pacific Halibut (*Hippoglossus stenolepis*) in the Northern Bering Sea	Chukchi, Bering	2021	CMI
AK-19-07	Model-based essential fish habitat (EFH) descriptions for Arctic cod, saffron cod and snow crab in the Alaskan Arctic	Beaufort, Chukchi	2019	CESU-UAF
AK-20-07	Early Detection Plan for Marine Non-native Species on the Arctic Outer Continental Shelf (OCS)	Beaufort, Chukchi	2020	SI
AK-20-10	Monitoring the Recovery of Seabirds and Forage Fish Following a Major Ecosystem Disruption in Lower Cook Inlet	Cook Inlet	2020	USGS
AK-20-11	The Impact of Marine Fish Communities on Red-throated Loon Productivity in the Beaufort Sea	Beaufort	2020	USGS
AK-21-03	Resource Areas to Support Oil Spill Risk Analysis (OSRA) and National Environmental Policy Act (NEPA) Needs in the Cook Inlet Region	Cook Inlet	2021	ADF&G
AK-21-06	GPS Tagging of Seabirds to Obtain Areas of Foraging Aggregations and Forage Fish Schools in Lower Cook Inlet	Cook Inlet	2021	USGS
NT-20-10†	A sustainable, integrated AMBON in the US Arctic	Beaufort, Chukchi	2020	NOPP
Fates and Effects				
AK-16-04	Oil-Spill Occurrence Estimators for the Alaska Outer Continental Shelf	Beaufort, Chukchi	2017	
AK-18-x11	Hydrocarbon Seeps in the Lower Cook Inlet, Gulf of Alaska, Chukchi Sea and Beaufort Sea OCS Planning Areas	All Alaska Planning Areas	2018	UAF
AK-19-02-11	Investigating the Impacts of Oil Exposure and Changing Snow Cover on Sea Ice Microbial Communities	Beaufort	2020	CMI
AK-19-02-12	Hydrocarbon Oxidation Products in Cook Inlet: Formation and Bioaccumulation in Mussels	Cook Inlet	2020	CMI
AK-19-02-16	Biological effects of Cook Inlet crude oil degradation products and suspect screening of oxidized polycyclic aromatic hydrocarbons (PAHs)	Cook Inlet	2021	CMI
AK-20-05	Improvements to the Oil Spill Risk Analysis (OSRA) Input Quality Assurance/Quality Control (QA/QC) and Validation	All Alaska Planning Areas	2020	
AK-21-02	Synthesis of Contaminants Data for Cook Inlet: Evaluation of Existing Data as “Baseline Conditions” and Recommendations for Further Monitoring	Cook Inlet	2021	CIRCAC
Information Management				
AK-16-02†	Collaboration with North Pacific Research Board (NPRB) Arctic Marine Research Program	Beaufort, Chukchi	2016	NPRB
AK-19-02†	Alaska Coastal Marine Institute	All Alaska Planning Areas	2019	CMI
AK-19-02-09	Arctic Marine Biodiversity and Ecosystem Structure Data Analysis and Synthesis	Beaufort Chukchi	2020	CMI
AK-20-02†	Support for Alaska Marine Science Symposium	All Alaska Planning Areas	2020	NPRB
AK-21-x07	Feasibility Study for Renewable Energy Technologies in Alaska Offshore Waters	All Alaska Planning Areas	2021	NREL

Marine Mammals and Protected Species				
AK-19-02-05	Evaluating Novel Assessment Approaches for Coastal Ice Seal Haulout Areas and Behavior in the Alaskan Beaufort Sea	Beaufort	2019	CMI
AK-20-01	Cook Inlet Beluga Acoustic Monitoring in Lower Cook Inlet (LCI) Rivers	Cook Inlet	2020	NOAA
AK-20-04	Quantifying Sea Otter Abundance, Distribution, and Foraging Intake in Cook Inlet Alaska	Cook Inlet	2020	USGS
AK-20-08	Comprehensive Synthesis of Impacts to Marine Mammals from Oil and Gas Activities in the Alaska Outer Continental Shelf (OCS), 2000–2020	Beaufort, Chukchi, Cook Inlet	2020	
AK-21-01	Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas	Beaufort	2021	ADF&G
AK-21-04	Bowhead Whale Migration Patterns along the Alaskan Beaufort Shelf in During a Period of Rapid Environmental Change	Beaufort	2021	CESU-UAF
AK-Ofc-01	NOAA-BOEM Partnership: Range-Wide Distribution of Cook Inlet Beluga Whales (*Delphinapterus leucas*) in the Winter	Cook Inlet	2019	NOAA
Physical Oceanography				
AK-17-01	Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea	Beaufort	2017	CESU-UAF; USGS
AK-19-02-04	Western Beaufort and Chukchi Sea Surface Current Analysis	Beaufort, Chukchi	2019	CMI
AK-19-02-08	Exploring radium isotopes as tracers of groundwater inputs, flushing rates, and produced water in Cook Inlet	Cook Inlet	2020	CMI
AK-19-03	Landfast Ice Climatology in the Beaufort and Chukchi Seas	Beaufort, Chukchi	2019	CESU-UAF
AK-20-03	Update of River Overflood on Sea Ice and Strudel Scour Database	Beaufort	2020	
Social Science and Economics				
AK-15-05†	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	Beaufort, Chukchi	2016	NSB
AK-19-05	Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty DPP	Beaufort	2019	
AK-20-06	Subsistence Harvest and Iñupiaq Knowledge of Beluga Whales for Kaktovik, Alaska	Beaufort	2021	ADF&G
AK-20-x09	Kenai Peninsula Borough Socioeconomic Profile, 2008 to 2020	Cook Inlet	2021	
AK-21-05	Coastal and Submerged Historic Properties and Precontact Sites on the Alaska Outer Continental Shelf	All Alaska Planning Areas	2021	

Partner Codes

ADF&G = Alaska Department of Fish and Game
CESU = Cooperative Ecosystem Studies Unit
CIRCAC = Cook Inlet Regional Citizens Advisory Council
CMI = University of Alaska Coastal Marine Institute
MML = Marine Mammal Laboratory (NOAA)
NOAA = National Oceanic and Atmospheric Administration
NOPP = National Oceanographic Partnership Program
NPRB = North Pacific Research Board
NREL = National Renewable Energy Laboratory
NSB = North Slope Borough
SI = Smithsonian Institution
UAF = University of Alaska Fairbanks
USFWS = U. S. Fish and Wildlife Service
USGS = U. S. Geological Survey
UT = University of Texas

† Integrated, Multi-disciplinary Studies

3.4 Recent Reports and Publications

The ESP in Alaska has published approximately 65 OCS Study reports in the past five years (Appendix 2). These reports address a broad range of topics, including:

- Initiating an Arctic Marine Biodiversity Observing Network (AMBON)
- Marine Arctic Ecosystem Study (MARES): Moorings on the Beaufort Sea Shelf (2016–2018) and Program Synthesis
- Coastal Community Vulnerability Index and Visualizations of Change in Cook Inlet, Alaska
- Satellite Tracking of Bowhead Whales Habitat Use, Passive Acoustics and Environmental Monitoring
- Ice Seal Movements and Foraging: Village-Based Satellite Tracking and Collection of Traditional Ecological Knowledge Regarding Ringed and Bearded Seals
- Oil Spill Occurrence Rates for Cook Inlet, Alaska Oil and Gas Exploration, Development, and Production

Reports from completed ESP Studies can be found on the ESP Information System at http://www.boem.gov/ESPIS/. Alaska study reports can also be found at http://www.boem.gov/AKpubs.

During the same five-year period, studies in Alaska generated over 220 peer review journal publications (Appendix 3). These publications include two project-focused special journal issues:

Arctic Ecosystem Integrated Survey:

Mueter, F. J., J. Weems, E. V. Farley, M. F. Sigler (editors). 2017. *Arctic Ecosystem Integrated Survey (Arctic Eis): Marine ecosystem dynamics in the rapidly changing Pacific Arctic Gateway*. Deep Sea Research Part II: Topical Studies in Oceanography. 135:1-190.

Hanna Shoal Ecosystem Study:

Dunton, K., J. Grebmeier, and J. Trefry (editors). 2017. *The Hanna Shoal Ecosystem Study of the Northeastern Chukchi Sea*. Deep Sea Research Part II: Topical Studies in Oceanography. 144:1-190.

SECTION 4.0 LITERATURE CITED

Brooks JJ, Crowley HA, Coon CC, Kendall JJ. 2019. Traditional Knowledge & Ocean Research. The Journal of Ocean Technology. 14(1) 49-58.

Grebmeier JM and Cooper LW. 2012. Water Column Chlorophyll, Benthic Infauna and Sediment Markers. In: Dunton, K. H. Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Chemical and Benthos (CAB) Final Report. Prepared for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Anchorage, Alaska. OCS Study BOEM 2012-012, p. 103-142.

Hilcorp. 2015. *Liberty Development Project Development and Production Plan Revision 1*. September 8, 2015. Anchorage, AK: Hilcorp Alaska LLC. 288 pp.

Kendall JJ, Brooks JJ, Campbell C, Wedemeyer KL, Coon CC, Warren SE, Auad G, Thurston DK, Cluck RE, Mann FE, Randall SA, Storzer MA, Johnston DW, Meyer-Pietruszka D, Haller ML. 2017. Use of Traditional Knowledge by the United States Bureau of Ocean Energy Management to Support Resource Management. Czech Polar Reports. 7(2): 151-163.

Mathis J and Cross J. 2014. Biogeochemical assessment of the OCS Arctic Waters: Current Status and Vulnerability to Climate Change. University of Alaska Coastal Marine Institute, Fairbanks, Alaska. OCS Study BOEM2014-668. 319 pp.

USDOI, BOEM. 2016. Proposed Final OCS Oil & Gas Leasing Program 2017–2022. Sterling, Virginia.

USDOI, BOEM, ESP. 2020. Environmental Studies Program Strategic Framework. Sterling, Virginia.

USDOI, BOEM, ESP. 2021. BOEM Studies Development Plan 2022-2023. Sterling, Virginia.

APPENDIX 1: U.S. ARCTIC RESEARCH PLAN: Intersection with BOEM Environmental Studies

This table is organized to display recent BOEM-directed research as it supports relevant Research Goals and Objectives outlined in IARPC's *Arctic Research Plan: 2017-2021* released in December 2016. These studies also establish a strong footing to build upon in addressing the Priority Areas and Goals outlined in IARPC's *Draft Arctic Research Plan: 2022-2026*.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
Research Goal 1: Enhance Understanding of Health Determinants and Improve the Well-being of Arctic Residents				
Research Objective 1.1: Support integrative approaches to human health that recognize the connections among people, wildlife, the environment, and climate.				
Performance Element 1.1.2: In collaboration with the ANTHC, support community-based monitoring and Indigenous Knowledge and Local Knowledge by maintaining and strengthening the Local Environmental Observer (LEO) Network to help describe connections between climate change, environmental impacts, and health effects.				
AK-16-05 Community Based Monitoring: LEO Network	ANTHC	$400,000	2016-2021	Supports continued maintenance and expansion of the LEO network to improve reporting from the North Slope and Cook Inlet and enhance the quality, rigor, and consistency of data collection.
Performance Element 1.1.4: Increase understanding of how both natural climate change and the effects of human activities are affecting the ecosystem by documenting observations of changing sea ice conditions, with implications for development and subsistence.				
AK-13-03-16 Northern Alaska Sea Ice Project Jukebox OCS Study BOEM 2018-027	UAF-CMI	$60,663	2016-2018	Documented personal observations and traditional knowledge about ice near Barrow and Kotzebue to assess what has changed and how the Iñupiat are adapting to the changes.
AK-19-03 Landfast Ice in the Beaufort and Chukchi Seas	UAF	$1.70M	2019-2023	Developing protocols to analyze satellite data and create and maintain a landfast ice climatology database for the Beaufort and Chukchi seas.
AK-21-04 Bowhead Whale Migration Patterns along the Alaskan Beaufort Shelf in During a Period of Rapid Environmental Change	UAF	$2.75M	2021-2024	This project will provide new basic information on hydrography, circulation, and zooplankton prey fields encountered by migrating bowhead whales to improve understanding of the recently observed behavioral changes of the whales.
Research Goal 3: Enhance Understanding and Improve Predictions of the Changing Arctic Sea Ice Cover				
Research Objective 3.1: Conduct coordinated/integrated atmosphere-ice-ocean observations and research to understand the processes that determine the spatial and temporal variation of the thickness, extent, and volume of sea ice and their effects on atmosphere-ice-ocean interactions and feedbacks over multiple time scales (hourly, daily, weekly, seasonal, inter-annual, decadal).				
Performance Element 3.1.1: Support investigator-driven observations and process studies of the pack ice (e.g., ice thickness distribution, topography/surface roughness and strength; ice motion and deformation; snow depth distribution and melt pond characteristics; surface albedo and energy balance) and landfast ice (e.g., extent, stability, and break-up).				

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
AK-13-03-07 Development and Testing of a Low-Cost Satellite-Tracked Ice Drifter for Arctic Waters OCS Study BOEM 2017-079	UAF-CMI	$243,286	2014-2018	Deployed drifters on landfast and mobile pack ice to develop new information on the fate of landfast ice in the Chukchi and Beaufort seas.
AK-13-03-17 Measuring Wave Forces along Alaska's Coastal Sea Ice OCS Study BOEM 2021-019	UAF-CMI	$311,392	2016-2020	Improve understanding of wave energy propagation into sea ice and determine its effect on landfast ice stability along the Chukchi coast.
AK-19-03 Landfast Ice in the Beaufort and Chukchi Seas	UAF	$1.70M	2019-2023	Developing protocols to analyze satellite data and create and maintain a landfast ice climatology database for the Beaufort and Chukchi seas.
AK-20-03 Update of River Overflood on Sea Ice and Strudel Scour Database		$347,055	2020-2022	This study will document maximum river overflood boundaries and collate industry acquired strudel scour data from Smith Bay to Camden Bay between 2008 and 2019.
Performance Element 3.1.5: Use multiple remote sensing data sets to: (1) investigate sea ice properties and processes and atmosphere-ice-ocean interactions; and (2) develop algorithms for automated ice edge detection and delineation of the marginal ice zone, landfast ice extent, ice classification (e.g., age/type of ice, melt ponds, floe size), and ice motion and deformation.				
AK-19-03 Landfast Ice in the Beaufort and Chukchi Seas	UAF	$1.70M	2019-2023	Developing protocols to analyze satellite data and create and maintain a landfast ice climatology database for the Beaufort and Chukchi seas.
AK-20-03 Update of River Overflood on Sea Ice and Strudel Scour Database		$347,055	2020-2022	This study will document maximum river overflood boundaries and collate industry acquired strudel scour data from Smith Bay to Camden Bay between 2008 and 2019
Performance Element 3.1.6: Develop and deploy new technologies that enable persistent data collection on a variety of environmental variables using mobile platforms and sensors operating above, on, in, and under the Arctic sea ice cover to support a framework of observations that will improve forecasting and prediction of sea ice.				
AK-13-03-17 Measuring Wave Forces along Alaska's Coastal Sea Ice OCS Study BOEM 2021-019	UAF-CMI	$311,392	2016-2020	Improve understanding of wave energy propagation into sea ice and determine its effect on landfast ice stability along the Chukchi coast.
AK-19-03 Landfast Ice in the Beaufort and Chukchi Seas	UAF	$1.70M	2019-2023	Developing protocols to analyze satellite data and create and maintain a landfast ice climatology database for the Beaufort and Chukchi seas.
AK-20-03 Update of River Overflood on Sea Ice and Strudel Scour Database		$347,055	2020-2022	This study will document maximum river overflood boundaries and collate industry acquired strudel scour data from Smith Bay to Camden Bay between 2008 and 2019
Performance Element 3.1.7: Investigate Arctic Ocean processes, interactions and feedbacks that affect the dynamics and thermodynamics of the sea ice cover, including ocean circulation and stratification, turbulence and mixing, horizontal and vertical heat transport, and freshwater transport and storage.				
NT-13-05 Marine Arctic Ecosystems Study (MARES): A Multi-Agency NOPP Partnership OCS Study BOEM 2017-017; OCS Study BOEM 2018-024; OCS Study BOEM 2019-009: OCS Study BOEM 2020-029	NOPP	$5.42M	2015-2020	Describing ocean currents at different depths along the Beaufort Sea continental shelf, including the biogeochemical-physical interactions and feedback processes in ice free and ice-covered areas.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
AK-12-03a Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas OCS Study BOEM 2017-065	CESU-UAF	$5.06M	2012-2018	Characterized the flow regimes and surface water exchange among areas of the inner and outer Chukchi shelf and the western Beaufort shelf under varying conditions of wind forcing and sea ice coverage.
AK-17-01 Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea	CESU-UAF; USGS	$2.12M	2017-2022	Using observations and a coupled ocean-wave model to obtain a better understanding of the physical processes related to wave conditions and their effects within Stefansson Sound in the Beaufort Sea.
AK-19-02-04 Western Beaufort and Chukchi Sea Surface Current Analysis	UAF-CMI	$77,640	2019-2022	Assessing the relationships between the wind and the surface flow field structure and evolution.
AK-19-03 Landfast Ice in the Beaufort and Chukchi Seas	UAF	$1.70M	2019-2023	Evaluating how changes in landfast ice relate to local and regional changes in temperature, pressure, and major storms.
AK-20-03 Update of River Overflood on Sea Ice and Strudel Scour Database		$347,055	2020-2022	This study will document maximum river overflood boundaries and collate industry acquired strudel scour data from Smith Bay to Camden Bay between 2008 and 2019
Research Objective 3.2: Improve models for understanding sea ice processes and for enhanced forecasting and prediction of sea ice behavior at a range of spatial and temporal scales.				
Performance Element 3.2.1: Support investigator-driven modeling studies designed to understand and parameterize key sea ice properties and processes, including ice thickness distribution, topography, and strength; ice motion, deformation and mechanics; snow depth distribution and melt pond characteristics; surface albedo and energy balance; and biogeochemistry.				
AK-15-02 Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas OCS Study BOEM 2018-018; OCS Study BOEM 2018-007	CESU-Rutgers University; UAF	$489,735	2015-2018	Developed an updated coupled ice-ocean circulation model of the Arctic Ocean, including nested domains for high-resolution computations on the Beaufort Sea shelf.
AK-19-03 Landfast Ice in the Beaufort and Chukchi Seas	UAF	$1.70M	2019-2023	Producing data that will support verification and validation of sea ice models.
AK-17-01 Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea	CESU-UAF; USGS	$2.12M	2017-2022	Using observations and a coupled ocean-wave model to obtain a better understanding of the physical processes related to wave conditions and their effects within Stefansson Sound in the Beaufort Sea.
Performance Element 3.2.2: Enhance operational sea ice forecasting and research-oriented prediction capabilities through improvements to model physics (explicit and parameterized); initialization techniques; assimilation of observations, including newly available and future data sources such as VIIRS, AMSR2, CryoSat-2, SMOS, and ICESat-2; model evaluation and verification; evaluation of model skill, post-processing techniques and forecast guidance tools used in operational forecasts and decision support.				
AK-15-02 Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas OCS Study BOEM 2018-018; OCS Study BOEM 2018-007	CESU-Rutgers University; UAF	$489,735	2015-2018	Contributed to advancement of predictive capabilities for sea ice in ocean circulation models.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
Research Goal 4: Increase Understanding of the Structure and Function of Arctic Marine Ecosystems and Their Role in the Climate System and Advance Predictive Capabilities				
Research Objective 4.1: Increase knowledge on the distribution and abundance of Arctic marine species across all trophic levels and scales, including an improved understanding of the formation and maintenance of biological hotspots and proximate causes of shifts in range.				
Performance Element 4.1.1: Continue distribution and abundance surveys of Arctic marine species, for example, concurrent monitoring of polar bears and their ice seal prey.				
AK-11-05 Synthesis of Arctic Research (SOAR): Physics to Marine Mammals in the Pacific Arctic OCS Study BOEM 2018-017	NOAA-PMEL	$1.79M	2011-2018	The project used a synthesis approach to increase scientific understanding of the relationships of oceanographic conditions, lower trophic prey species and marine mammal distribution and behavior in the Pacific Arctic. The Arctic Marine Pulses (AMP) model was developed that depicts seasonal biophysical 'pulses' across a latitudinal gradient by linking processes across contiguous ecological domains.
AK-12-05 Ice Seal Movements and Foraging: Village-based Satellite Tracking of Ringed and Bearded Seals OCS Study BOEM 2019-079	ADF&G	$1.17M	2012-2019	This project tagged ice seals in the Beaufort, Chukchi, and northern Bering seas to better understand their movements and habitat use.
AK-12-07 Arctic Whale Ecology Study (ARCWEST): Use of the Chukchi Sea by Endangered Baleen and Other Whales OCS Study BOEM 2018-022; OCS Study BOEM 2019-024	MML	$4.60M	2012-2018	Assessed spatial and temporal patterns of use of the Chukchi Sea by endangered bowhead, fin and humpback whales, and beluga and gray whales and evaluated ecological relationships for the species.
AK-13-02 Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ) OCS Study BOEM 2018-008; OCS Study BOEM 2019-024	MML	$3.93M	2013-2019	Assessed the spatial and temporal distribution of marine mammals near Hanna Shoal and the extent that environmental conditions such as sea ice, oceanic currents, water temperature and salinity, and prey abundance influence whale distribution and relative abundance.
AK-13-06 Walrus Seasonal Distribution and Habitat Use in the Eastern Chukchi Sea	USGS	$1.69M	2013-2018	Evaluating seasonal abundance, distribution, and habitat use of walruses in the Chukchi Sea.
AK-16-07 Arctic Integrated Ecosystem Survey, Phase II	NOAA; UAF; USFWS	$2.50M	2017-2022	Quantifying the distribution, abundance, and condition of fishes, shellfishes, and seabirds throughout the U.S. shelf waters of the Chukchi Sea and Western Beaufort Sea.
AK-17-03 Marine Bird Distribution and Abundance in Offshore Waters	USFWS	$500,000	2017-2021	Using long-term surveys to determine seabird spatial distribution, species composition, and seasonal changes in species abundance in the Arctic.
AK-16-01 Aerial Surveys of Arctic Marine Mammals (ASAMM) OCS Study BOEM 2020-027	MML	$11.44M	2016-2019	Long-term surveys to document the distributions and relative densities of marine mammals in the Chukchi Sea and Beaufort Sea Planning Areas.
AK-16-06 Estimation of Abundance and Demographic Rates of Pacific Walruses Using a Genetics-based Mark-Recapture Approach OCS Study BOEM 2019-059	USFWS	$250,000	2016-2019	Estimating annual abundance of walruses for evaluation of population status and trends by applying mark-recapture analytical techniques to biopsy samples.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
AK-19-02-03 Utilization of the Under-ice Habitat by Arctic Cod in the Western Arctic Ocean: A Multidisciplinary Collaborative Study	UAF-CMI	$258,539	2019-2022	Conducting under-ice surveys of Arctic cod to obtain better understanding of the under-ice associations of Arctic cod life history and key under-ice habitat locations.
AK-19-02-05 Evaluating Novel Assessment Approaches for Coastal Ice Seal Haulout Areas and Behavior in the Alaskan Beaufort Sea	UAF-CMI	$204,990	2019-2021	Evaluating the potential of time-lapse cameras to assess the seasonal presence, behavior, and numbers of spotted and bearded seals at known summer-fall coastal haulouts.
AK-21-04 Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas	ADF&G	$500,000	2021-2025	Establish viable methods to locate ringed seals and their under-snow structures using satellite-telemetry tags and monitor under-snow structures for ringed seal activity.
AK-22-xx Alaska Assessment for Cetaceans and Other Marine Mammals (ACOMM)			2022-2025	Rotational, large-scale, visual and acoustic ship-board or aerial surveys and acoustic moorings to obtain data on the presence, distribution, and abundance of marine mammals with particular focus on subsistence-harvested species.
Performance Element 4.1.2: Continue studies to document Arctic marine species biodiversity (e.g. Arctic Marine Biodiversity Observation Network—AMBON—and programs that monitor loss of sea ice) and habitat use in the Arctic.				
AK-15-01 Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring OCS Study BOEM 2021-017	NOPP; NOAA; UAF	$1.75M	2015-2020	Examining the phenology, distribution, and life history of upper trophic predators in response to availability of lower trophic prey resources; and improving knowledge about rates of consumption, growth, and reproduction of benthic and pelagic organisms.
AK-16-02 Collaboration with North Pacific Research Board (NPRB) Arctic Marine Research Program	NPRB	$1.00M	2016-2021	Provides support for NPRB's Arctic Integrated Ecosystem Research Program, including coordination among the ASGARD and Arctic IES (AK-16-07) components.
AK-16-07 Arctic Integrated Ecosystem Survey, Phase II	NOAA; UAF; USFWS	$2.50M	2017-2022	Quantifying the distribution, abundance, and condition of fishes, shellfishes, and seabirds throughout the U.S. shelf waters of the Chukchi Sea and Western Beaufort Sea.
AK-19-01 Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea	UT-Austin; UAF	$750,000	2019-2024	Conducting a monitoring program to examine long-term drivers of community variability during Liberty development activities.
AK-19-02-02 Kelp Restoration in the Boulder Patch	UAF-CMI	$138,884	2020-2023	Evaluating the value of artificial reefs as a mitigation tool for potential disturbances to foundation kelp in the Boulder Patch.
AK-19-07 Model-based Essential Fish Habitat (EFH) Descriptions for Arctic Cod, Saffron Cod and Snow Crab in the Alaskan Arctic	UAF	$125,000	2019-2021	Identifying habitat characteristics most important to distributions and habitat suitability of larval (if data is available), juvenile and adult Arctic cod, saffron cod and snow crab.
AK-20-07 Early Detection Plan for Marine Non-native Species on the Arctic Outer Continental Shelf	Smithsonian Istitution	$650,000	2020-2025	Establishing a monitoring scheme for detection of marine non-native species in the Arctic.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
AK-20-11 The Impact of Marine Fish Communities on Red-throated Loon Productivity in the Beaufort Sea	USGS	$1.0M	2020-2023	This study will evaluate the offshore marine use areas of red-throated loons in the context of differences in nearshore fish communities that vary in space and time.
NT-20-10 A sustainable, integrated AMBON in the US Arctic	NOPP; NOAA	$450,000	2020-2022	This study is extending and expanding biodiversity monitoring activities established by the AMBON program (AK-15-01)
AK-21-04 Bowhead Whale Migration Patterns along the Alaskan Beaufort Shelf in During a Period of Rapid Environmental Change			2021-2024	This project will provide basic information on hydrography, circulation, and zooplankton prey fields encountered by migrating bowhead whales to improve understanding of the recently observed behavioral changes of the whales.
Performance Element 4.1.3: Assess winter distributions of key Arctic species, via passive acoustic sampling and satellite tagging for marine mammals to include further development of autonomous, unmanned surface and underwater vehicles equipped with sensors capable of recording marine mammal vocalizations.				
AK-12-02 Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring	ADF&G	$2.70M	2012-2019	Deployed satellite transmitters with environmental and passive acoustic monitoring capabilities to track the movements and document the behavior of bowhead whales.
AK-12-07 Arctic Whale Ecology Study (ARCWEST): Use of the Chukchi Sea by Endangered Baleen and Other Whales OCS Study BOEM 2018-022 ; OCS Study BOEM 2019-024	MML	$4.60M	2012-2018	Used passive acoustic monitoring to assess spatial and temporal patterns of use of the Chukchi Sea by endangered bowhead, fin and humpback whales, and beluga and gray whales.
AK-13-02 Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ) OCS Study BOEM 2018-008 ; OCS Study BOEM 2019-024	MML	$3.93M	2013-2019	Used passive acoustic monitoring to assess spatial and temporal distribution of marine mammals near Hanna Shoal.
AK-21-04 Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas	ADF&G	$500,000	2021-2025	Establish viable methods to locate ringed seals and their under-snow structures using satellite-telemetry tags and monitor under-snow structures for ringed seal activity.
Research Objective 4.3: Advance the understanding of how climate-related changes, biophysical interactions, and feedbacks at different scales in the marine ecosystems impact Arctic marine resources and human communities that depend on them.				
Performance Element 4.3.1: Continue Distributed Biological Observatory (DBO) sampling in regions 1-5 and make data publicly available through upload of metadata to the Earth Observing Laboratory/DBO data portal.				
AK-16-07 Arctic Integrated Ecosystem Survey, Phase II	NOAA; UAF; USFWS	$2.50M	2017-2022	Sampling plan includes DBO regions.
AK-15-01 Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring OCS Study BOEM 2021-017	NOPP; NOAA; UAF	$1.75M	2015-2020	Sampling plan includes DBO regions.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
NT-20-10 A sustainable, integrated AMBON in the US Arctic	NOPP; NOAA	$450,000	2020-2022	Sampling plan includes DBO regions.
Performance Element 4.3.4: Continue research and make simultaneous observations of biological, chemical, and physical variables to examine linkages among marine species, oceanographic and sea ice conditions, and climate change to understand the mechanisms that affect performance and distribution. Quantify feedbacks and interactions of bottom-up and top-down processes that regulate production.				
AK-11-03 Hanna Shoal Ecosystem Study OCS Study BOEM 2016-047	CESU-UT	$5.69M	2011-2018	Examined important chemical, physical and biological interactions with the unique ecological regime in the highly productive area of Hanna Shoal.
AK-13-02 Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ) OCS Study BOEM 2018-008 ; OCS Study BOEM 2019-024	MML	$3.93M	2013-2019	Assessed the spatial and temporal distribution of marine mammals near Hanna Shoal and the extent that environmental conditions such as sea ice, oceanic currents, water temperature and salinity, and prey abundance influence whale distribution and relative abundance.
AK-16-02 Collaboration with North Pacific Research Board (NPRB) Arctic Marine Research Program	NPRB	$1.00M	2016-2021	Provides support for NPRB's Arctic Integrated Ecosystem Research Program, including coordination among the ASGARD and Arctic IES (AK-16-07) components.
AK-16-07 Arctic Integrated Ecosystem Survey, Phase II	NOAA; UAF; USFWS	$2.50M	2017-2022	Quantifying the distribution, abundance, and condition of fishes, shellfishes, and seabirds throughout the U.S. shelf waters of the Chukchi Sea and Western Beaufort Sea.
AK-19-01 Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea			2019-2022	Conducting a monitoring program to examine long-term drivers of community variability during activities at the Liberty Development.
AK-19-02-02 Kelp Restoration in the Boulder Patch	UAF-CMI	$138,884	2020-2023	Evaluating the value of artificial reefs as a mitigation tool for potential disturbances to foundation kelp in the Boulder Patch.
AK-21-04 Bowhead Whale Migration Patterns along the Alaskan Beaufort Shelf in During a Period of Rapid Environmental Change			2021-2024	This planned project will provide new basic information on hydrography, circulation, and zooplankton prey fields encountered by migrating bowhead whales to improve understanding of the recently observed behavioral changes of the whales.
NT-13-x11 WALRUS – Walrus Adaptability and Long-term Responses; Using multi-proxy data to project Sustainability	NSF	$200,000	2013-2019	Tracking changes in walrus trophic position, foraging location, and genetic structure and diversity over the past 2500 years using multi-proxy datasets.
Performance Element 4.3.7: Continue development, testing, and runs of prognostic models that use Intergovernmental Panel on Climate Change (IPCC) scenarios in a regional context to explore current understanding of biophysical interactions and feedbacks, such as perturbations across several modeled food webs from the subarctic to the Arctic to estimate relative ecosystem sensitivities and rates of change.				
AK-11-05 Synthesis of Arctic Research (SOAR): Physics to Marine Mammals in the Pacific Arctic OCS Study BOEM 2018-017	NOAA-PMEL	$1.80M	2011-2018	This synthesis project included a component that examined sea-ice cover timing in the Pacific Arctic based on IPCC scenarios.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
Research Goal 8: Strengthen Coastal Community Resilience and Advance Stewardship of Coastal Natural and Cultural Resources by Engaging in Research Related to the Interconnections of People, Natural, and Built Environments				
Research Objective 8.1: Engage coastal communities in research to advance knowledge on cultural, safety, and infrastructure issues for coastal communities.				
Performance Element 8.1.1: Engage coastal community members in research by seeking cooperative opportunities between community members, IK holders, and/or LK holders, and researchers in knowledge co-production research processes. Employ IK and/or LK to jointly conceive of and plan research activities and to report research results back to communities.				
AK-15-05 Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$359,470	2016-2020	Develops panels of subject matter experts to systematically incorporate Traditional (Indigenous) Knowledge from community members through co-production of knowledge and sharing with western scientists.
AK-20-07 Early Detection Plan for Marine Non-native Species on the Arctic Outer Continental Shelf	Smithsonian Institution	$650,000	2020-2025	Capturing LK related to marine invertebrates and introductions of non-native species. Local citizens will be involved with field surveys and plans to establish a long-term monitoring scheme.
AK-22-xx Collaborative synthesis to understand the impacts of vessel presence and sound on the marine environment and subsistence activities in the Pacific Arctic			2022-2024	IK holders and conventional scientists will co-design and interpret research that evaluates effects of vessel traffic and sound on marine mammals and subsistence.
Performance Element 8.1.2: Engage coastal community members in research by supporting community-based monitoring focused on measuring physical and biotic information by strengthening initiatives led by groups such as the Arctic-focused LCCs, BOEM, NOAA, and FWS.				
AK-19-05 Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty DPP		$481,852	2019-2025	Engaging with Alaska Native hunters to monitor the annual bowhead whale hunt at Cross Island and document the hunters' IK/LK.
AK-17-01 Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea	CESU-UAF; USGS	$2.12M	2017-2022	Involving local community members in collecting ocean observations.
AK-20-06 Subsistence Harvest and Iñupiaq Knowledge of Beluga Whales for Kaktovik, Alaska			2020-2023	Documenting how the people of Kaktovik hunt belugas and how beluga is processed and examining the cultural importance of belugas and beluga harvest for Kaktovik.
Performance Element 8.1.4: Investigate and protect cultural resources through research to identify and document archaeological sites in high-risk, rapidly eroding Arctic coastal areas.				
AK-21-05 Coastal and Submerged Historic Properties and Precontact Sites on the Alaska Outer Continental Shelf			2021-2023	The planned study will develop information on Alaska's submerged and coastal historic properties and precontact sites, including their known, reported, or potential locations.
Research Objective 8.2: Advance knowledge of ecosystems and environmental health in coastal areas by monitoring trends and modeling biological processes.				
Performance Element 8.2.1: Monitor and conduct studies to understand trends, processes, and biotic-abiotic feedback loops affecting the distribution, abundance, and ecology of coastal species in relation to food security, biodiversity, and ecosystems through projects such as the Arctic Council Conservation of Arctic Flora and Fauna working group Coastal Biodiversity Monitoring Programme.				

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
AK-15-01 Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring OCS Study BOEM 2021-017	NOPP; NOAA; UAF	$1.75M	2015-2020	Examined influences of sea ice dynamics on the phenology, distribution, and life history of upper trophic predators in response to availability of lower trophic prey resources to understand rates of consumption, reproduction and growth, of benthic and pelagic organisms.
AK-19-02-01 Coastal Marine Institute (CMI) Program Administration 2019-2024	UAF-CMI	$375,212	2019-2022	This award is supporting synthesis efforts for the State of the Arctic Marine Biodiversity Report (SAMBR).
AK-19-02-03 Utilization of the Under-ice Habitat by Arctic Cod in the Western Arctic Ocean: A Multidisciplinary Collaborative Study	UAF-CMI	$258,539	2019-2022	Conducting under-ice surveys of Arctic cod to obtain better understanding of the under-ice associations of Arctic cod life history and key under-ice habitat locations.
AK-19-07 Model-based Essential Fish Habitat (EFH) Descriptions for Arctic Cod, Saffron Cod and Snow Crab in the Alaskan Arctic	UAF	$125,000	2019-2021	Identifying habitat characteristics most important to distributions and habitat suitability of larval (if data is available), juvenile and adult Arctic cod, saffron cod and snow crab.
NT-20-10 A sustainable, integrated AMBON in the US Arctic	NOPP; NOAA	$450,000	2020-2022	This study is extending and expanding biodiversity monitoring activities established by the AMBON program (AK-15-01)
Performance Element 8.2.4: Understand and monitor processes to manage and mitigate potential and realized threats from coastal invasive species, biotoxicoses, and wildlife diseases by leveraging research under initiatives and programs such as One Health, the DBO network, AMBON, and Aerial Surveys of Arctic Marine Mammals (ASAMM) work.				
AK-20-07 Early Detection Plan for Marine Non-native Species on the Arctic Outer Continental Shelf	Smithsonian Institution	$650,000	2020-2025	Establishing a monitoring scheme for detection of marine non-native species in the Arctic.
Research Objective 8.3: Advance knowledge of the physical coastal processes impacting natural and built environments.				
Performance Element 8.3.1: Improve understanding of coastal erosion and deposition, including related geomorphic changes due to permafrost degradation, reduced sea ice extent, storm surge, increased wave action, and sea level rise. This Element includes work by the USGS Coastal and Marine Geology Program, USGS Alaska Science Center, U.S. Army Corps of Engineers (USACE), and others.				
AK-17-01 Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea	CESU-UAF; USGS	$2.12M	2017-2022	Involving local community members in collecting ocean observations.
Research Goal 9: Enhance Frameworks for Environmental Intelligence Gathering, Interpretation, and Application toward Decision Support				
Research Objective 9.3: Enhance climate prediction capabilities for the Arctic System from subseasonal to decadal timescales and climate projection capabilities up to centennial timescales by focusing on improving earth system models and their interactions, and assessing the strengths and weaknesses of the various coupled regional Arctic and earth system models by conducting intercomparison and model evaluations.				
Performance Element 9.3.4: Support model development of Regional Arctic System Models focusing on improved resolution, better coupling, inclusion of new process models, and better assimilation techniques for improved seasonal predictions.				
AK-15-02 Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas OCS Study BOEM 2018-018; OCS Study BOEM 2018-007	CESU-Rutgers University; UAF	$489,735	2015-2018	Contributed to advancement of predictive capabilities for sea ice in ocean circulation models.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
Research Objective 9.4: Enhance availability, discoverability, understanding, and interoperability of Arctic data and tools across Federal data centers.				
Performance Element 9.4.4: Advance agile situational awareness and decision support for Arctic operators through efforts like ADAC's Arctic Information Fusion Capability28, ERMA, and NASA ACE project.				
AK-12-03b Arctic Tracer Release Experiment (ARCTREX): Applications for Mapping Spilled Oil in Arctic Waters OCS Study BOEM 2017-062	BSEE; UAF	$1.25M	2013-2018	Tested the ability of available observational technology to sample a simulated oil spill in the Chukchi Sea and to transmit data to NOAA's Arctic Environmental Response Management Application (ERMA).

APPENDIX 2: RECENT OCS STUDY REPORTS: 2017—2021

These and all Alaska study reports can be found at http://www.boem.gov/AKpubs and http://www.boem.gov/ESPIS/.

OCS Study #	Title
BOEM 2021-019	Measuring Wave Forces Along Alaska's Coastal Sea Ice
BOEM 2021-018	High Frequency characterization of the physicochemical parameters of cook Inlet, Alaska
BOEM 2021-017	Initiating an Arctic Marine Biodiversity Observing Network (AMBON)
BOEM 2020-051	Oil Spill Occurrence Rates for Cook Inlet, Alaska Oil and Gas Exploration, Development, and Production
BOEM 2020-050	Oil Spill Occurrence Rates from Alaska North Slope Oil and Gas Exploration, Development and Production
BOEM 2020-033	Microbial Biodegradation of Alaska North Slope Crude Oil and Corexit 9500 in the Arctic Marine Environment
BOEM 2020-029	Marine Arctic Ecosystem Study (MARES): Moorings on the Beaufort Sea Shelf (2016–2018) and Program Synthesis
BOEM 2020-027	Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi Sea, Eastern and Western Beaufort Sea, and Amundsen Gulf, 2019 Annual Report
BOEM 2019-079	Ice Seal Movements and Foraging: Village-Based Satellite Tracking and Collection of Traditional Ecological Knowledge Regarding Ringed and Bearded Seals
BOEM 2019-078	Nearshore Food Web Structure on the OCS in Cook Inlet
BOEM 2019-076	Satellite Tracking of Bowhead Whales Habitat Use, Passive Acoustics and Environmental Monitoring
BOEM 2019-075	Assessment of nearshore communities and habitats: Lower Cook Inlet Nearshore Ecosystem 2015-2018
BOEM 2019-067	CMI Graduate Student Projects Volume 3: The Influence of Water Flow, Water Conditions, and Seasonality on Fish Communities in Estuarine Nearshore Habitats in Kachemak Bay, Alaska; Identifying Hatch Dates and Potential Hatch Location of Arctic Cod (*Boreogadus saida*) through Otolith Analysis
BOEM 2019-059	Estimation of abundance and demographic rates of Pacific walruses using a genetics-based mark-recapture approach
BOEM 2019-053	ANIMIDA III Boulder Patch and Other Kelp Communities in Development Area

BOEM 2019-032	Arctic Aerial Calibration Experiments (Arctic ACEs): Comparing Manned Aerial Surveys to Unmanned Aerial Surveys for Cetacean Monitoring in the Arctic
BOEM 2019-031	Coastal Community Vulnerability Index and Visualizations of Change in Cook Inlet, Alaska
BOEM 2019-030	Identifying sources of organic matter to benthic organisms in the Beaufort and Chukchi outer continental shelves
BOEM 2019-024	Chukchi Sea Acoustics, Oceanography, and Zooplankton Study: Hanna Shoal Extension (CHAOZ-X) and Arctic Whale Ecology Study (ARCWEST) Supplemental Report
BOEM 2019-021	Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2018 Annual Report
BOEM 2019-009	Marine ARctic Ecosystem Study (MARES): Moorings on the Beaufort Sea shelf, 2016-2017
BOEM 2019-005	Coastal Marine Institute (CMI) Annual Report 25: Calendar Year 2018
BOEM 2018-064	University of Alaska Coastal Marine Institute, Program Administration 2013-2017
BOEM 2018-059	Migration Trends for King and Common Eiders and Yellow-billed Loons past Point Barrow in a Rapidly Changing Environment
BOEM 2018-058	CMI Graduate Student Projects: Volume 2: Functional Diversity of Epibenthic Communities on the Chukchi and Beaufort Sea Shelves; Using Trace Elements in Pacific Walrus Teeth to Track the Impacts of Petroleum Production in the Alaskan Arctic
BOEM 2018-048	Oil-Spill Occurrence Estimators: Fault Tree Analysis for One or More Potential Future Beaufort Sea OCS Lease Sales
BOEM 2018-037	ShoreZone Imaging and Mapping along the Alaska Peninsula
BOEM 2018-036	Fate and Persistence of Oil Spill Response Chemicals in Arctic Seawater
BOEM 2018-032	US Outer Continental Shelf Oil Spill Causal Factors Report (2018)
BOEM 2018-027	Northern Alaska Sea Ice Project Jukebox: Phase III
BOEM 2018-024	Marine Arctic Ecosystem Study—Biophysical and Chemical Observations from Glider and Benthic Surveys in 2016
BOEM 2018-023	Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2017 Annual Report
BOEM 2018-022	Arctic Whale Ecology Study (ARCWEST): Use of the Chukchi Sea by Endangered Baleen and Other Whales (Westward Extension of the BOWFEST)

BOEM 2018-021	CMI Graduate Student Projects: Characterizing Bacterial Communities in Beaufort Sea Sediments in a Changing Arctic; Chukchi-Beaufort Seas Storms and Their Influence on Surface Climate; Using Genotyping-by-Sequencing (GBS) Population Genetics Approaches to Determine the Population Structure of Tanner Crab (*Chionoecetes bairdi*) in Alaska
BOEM 2018-020	Arctic Air Quality Impact Assessment Modeling Study: Final Project Report
BOEM 2018-018	Development of a Very High-Resolution Regional Circulation Model of Beaufort Sea Nearshore Areas
BOEM 2018-017	Synthesis of Arctic Research (SOAR): Physics to Marine Mammals in the Pacific Arctic
BOEM 2018-016	Development of an Autonomous Carbon Glider to Monitor Sea-Air CO2 Fluxes in the Chukchi Sea
BOEM 2018-008	Chukchi Sea Acoustics, Oceanography, and Zooplankton Study: Hanna Shoal Extension (CHAOZ-X)
BOEM 2018-007	Technical Manual for a Coupled Sea-Ice/Ocean Circulation Model (Version 5)
BOEM 2018-006	US Outer Continental Shelf Oil Spill Statistics
BOEM 2017-087	Crude Oil Infiltration and Movements in First-Year Sea Ice; Impacts on Ice-Associated Biota and Physical Constraints
BOEM 2017-080	U.S.-Canada Northern Oil and Gas Research Forum Final Report
BOEM 2017-078	Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2016 Annual Report
BOEM 2017-077	Arctic Ecosystem Integrated Survey Final Report on Distribution of Fish, Crab, and Lower Trophic Communities in the Northeastern Bering Sea and Chukchi Sea
BOEM 2017-076	IceTrackers: Low-Cost Tracking of Sea Ice in Remote Environments
BOEM 2017-072	Alaska Monitoring and Assessment Program (AKMAP) Survey of Estuaries within the National Petroleum Reserve - Alaska
BOEM 2017-066	Genomics of Arctic Cod
BOEM 2017-065	Characterization of the Circulation on the Continental Shelf Areas of the Northeastern Chukchi and Western Beaufort Seas
BOEM 2017-062	Arctic Tracer Release Experiment (ARCTREX), Applications for Mapping Spilled Oil in Arctic Waters
BOEM 2017-043	Siku Sea Ice Discrete Element Method Model

BOEM 2017-040	Arctic Air Quality Impact Assessment Modeling - Evaluation of the Exemption Thresholds
BOEM 2017-035	Social Indicators in Coastal Alaska: Arctic Communities
BOEM 2017-034	US-Canada Transboundary Fish and Lower Trophic Communities
BOEM 2017-033	Central Beaufort Sea Marine Fish Monitoring
BOEM 2017-032	Arctic Nearshore Impact Monitoring in Development Area III (ANIMIDA): Contaminants, Sources and Bioaccumulation
BOEM 2017-029	Arctic Air Quality Modeling Study - Final Near-Field Dispersion Modeling Report
BOEM 2017-020	Demography and Behavior of Polar Bears Summering on Shore in Alaska (USFWS)
BOEM 2017-019	Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2015 Annual Report
BOEM 2017-017	Marine Arctic Ecosystem Study - Pilot Program: Marine Mammals Tagging and Tracking
BOEM 2017-011	Seasonality of Seabird Distribution in Lower Cook Inlet
BOEM 2017-004	Seabird Distribution and Abundance in the Offshore Environmental Final Report

APPENDIX 3: RECENT PUBLICATIONS FROM ALASKA STUDIES: 2017—2021

2021

Ashjian CJ, Campbell RG, Okkonen SR. 2021. Biological environment. In: Craig JC, Thewissen JGM, editors. The bowhead whale. San Diego (CA): Elsevier. p. 403-416.

Ashjian CJ, Okkonen SR, Campbell RG, Alatalo P. 2021. Lingering Chukchi Sea sea ice and Chukchi Sea mean winds influence population age structure of euphausiids (krill) found in the bowhead whale feeding hotspot near Pt. Barrow, Alaska. PLoS One. 16(7):e0254418.

Blackwell SB, Thode AM, Conrad AS, Ferguson MC, Berchok CL, Stafford KM, Marques TA, Kim KH. 2021. Estimating acoustic cue rates in bowhead whales, *Balaena mysticetus*, during their fall migration through the Alaskan Beaufort Sea. The Journal of the Acoustical Society of America. 149(5):3611-3625.

Bonsell C, Dunton KH. 2021. Slow community development enhances abiotic limitation of benthic community structure in a high arctic kelp bed. Frontiers in Marine Science. First Published Online 18 February 2021.

Charapata P, Horstmann L, Misarti N. 2021. Steroid hormones in Pacific walrus bones collected over three millennia indicate physiological responses to changes in estimated population size and the environment. Conservation Physiology. 9(1):10.

Citta J, Olnes J, Okkonen S, Quakenbush L, George J, Maslowski W, Osinski R, Heide-Jørgensen M. 2021. Influence of oceanography on bowhead whale (*Balaena mysticetus*) foraging in the Chukchi Sea as inferred from animal-borne instrumentation. Continental Shelf Research.104434. First Published Online 17 April 2021.

Citta JJ, Quakenbush L, George JC. 2021. Distribution and behavior of Bering-Chukchi-Beaufort bowhead whales as inferred by telemetry. In: George JC, Thewissen JGM, editors. The bowhead whale. San Diego (CA): Elsevier. p. 31-56.

Clark CT, Horstmann L, Misarti N. 2021. Walrus teeth as biomonitors of trace elements in Arctic marine ecosystems. Science of The Total Environment. 772:145500.

Dilliplaine K, Oggier M, Collins RE, Eicken H, Gradinger R, Bluhm BA. 2021. Crude oil exposure reduces ice algal growth in a sea-ice mesocosm experiment. Polar Biology. 44(3):525-537.

Ferguson MC, Clarke JT, Brower AA, Willoughby AL, Okkonen SR. 2021. Ecological variation in the western Beaufort Sea. In: Craig JC, Thewissen JGM, editors. The bowhead whale. San Diego (CA): Elsevier. p. 365-379.

Gemery L, Cooper LW, Magen C, Cronin TM, Grebmeier JM. 2021. Stable oxygen isotopes in shallow marine ostracods from the northern Bering and Chukchi Seas. First published online 31 March 2021.

Halliday WD, Pine MK, Citta JJ, Harwood L, Hauser DD, Hilliard RC, Lea EV, Loseto LL, Quakenbush L, Insley SJ. 2021. Potential exposure of beluga and bowhead whales to underwater noise from ship traffic in the Beaufort and Chukchi Seas. Ocean & Coastal Management.105473. First published online 30 November 2020.

Johnson MA. 2021. Subtidal surface circulation in lower Cook Inlet and Kachemak Bay, Alaska. Regional Studies in Marine Science.101609. First published online 11 January 2021.

Johnson MA, Marchenko AV, Dammann DO, Mahoney AR. 2021. Observing wind-forced flexural-gravity waves in the Beaufort Sea and their relationship to sea ice mechanics. Journal of Marine Science and Engineering. 9(5):471.

Kędra M, Cooper LW, Silberberger MJ, Zhang M, Biasatti D, Grebmeier JM. 2021. Organic carbon source variability in Arctic bivalves as deduced from the compound specific carbon isotopic composition of amino acids. Journal of Marine Systems.103547. First published online 30 November 2020.

Larsen Tempel JT, Wise S, Osborne TQ, Sparks K, Atkinson S. 2021. Life without ice: Perceptions of environmental impacts on marine resources and subsistence users of St. Lawrence Island. Ocean & Coastal Management. 212:105819.

Lin P, Pickart RS, Fissel DB, Borg K, Melling H, Wiese FK. 2021. On the nature of wind-forced upwelling and downwelling in Mackenzie Canyon, Beaufort Sea. Progress in Oceanography. 198:102674

Lindsay JM, Laidre KL, Conn PB, Moreland EE, Boveng PL. 2021. Modeling ringed seal *Pusa hispida* habitat and lair emergence timing in the eastern Bering and Chukchi seas. Endangered Species Research. 46:1-17.

Madrigal BC, Crance JL, Berchok CL, Stimpert AK. 2021. Call repertoire and inferred ecotype presence of killer whales (*Orcinus orca*) recorded in the southeastern Chukchi Sea. The Journal of the Acoustical Society of America. 150(1):145-158.

McMahon R, Taveras Z, Neubert P, Harvey HR. 2021. Organic biomarkers and Meiofauna diversity reflect distinct carbon sources to sediments transecting the Mackenzie continental shelf. Continental Shelf Research.104406. First published online 20 March 2021.

Miller CA, Kelley AL. 2021. Seasonality and biological forcing modify the diel frequency of nearshore pH extremes in a subarctic Alaskan estuary. Limnology and Oceanography. First published online 20 January 2021.

Minks SL, Pereira TJ, Sharma J, Blanchard AL, Bik HM. 2021. Composition of marine nematode communities across broad longitudinal and bathymetric gradients in the Northeast Chukchi and Beaufort seas. Polar Biology. 44(1):85-103.

Mordy CW, Eisner L, Kearney K, Kimmel D, Lomas MW, Mier K, Proctor P, Ressler PH, Stabeno P, Wisegarver E. 2021. Spatiotemporal variability of the nitrogen deficit on the eastern Bering Sea shelf. Continental Shelf Research.104423. First published online 9 April 2021

Muth AF, Bonsell C, Dunton KH. 2021. Inherent tolerance of extreme seasonal variability in light and salinity in an Arctic endemic kelp *(Laminaria solidungula*). Journal of Phycology. First published online 20 May 2021.

Olnes J, Breed G, Druckenmiller M, Citta J, Crawford J, Von Duyke A, Quakenbush L. 2021. Juvenile bearded seal response to a decade of sea ice change in the Bering, Chukchi, and Beaufort seas. Marine Ecology Progress Series. 661:229-242. First published online 04 March 2021.

Spiesberger JL, Berchok CL, Iyer P, Schoeny A, Sivakumar K, Woodrich D, Yang E, Zhu S. 2021. Bounding the number of calling animals with passive acoustics and reliable locations. The Journal of the Acoustical Society of America. 150(2):1496-1504.

Stafford KM, Citta JJ, Okkonen SR, Zhang J. 2021. Bowhead and beluga whale acoustic detections in the western Beaufort Sea 2008–2018. PLoS One. 16(6):e0253929.

Tian F, Pickart R, Lin P, Pacini A, Moore GWK, Stabeno P, Weingartner T, Dobbins E, Bell S, Woodgate RA, et al. 2021. Mean and seasonal circulation of the eastern Chukchi Sea from moored timeseries in 2013-14. Journal of Geophysical Research Oceans. First published online 30 April 2021.

Vestfals C, Mueter F, Hedstrom K, Laurel B, Petrik C, Duffy-Anderson J, Danielson S. 2021. Modeling the dispersal of polar cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*) early life stages in the Pacific Arctic using a biophysical transport model. Progress in Oceanography.126:102571.

Walker A, Leigh M, Mincks S. 2021. Patterns in Benthic Microbial Community Structure Across Environmental Gradients in the Beaufort Sea Shelf and Slope. Frontiers in Microbiology. 12:37.

Zinkann A-C, Wooller MJ, O'Brien DM, Iken K. 2021. Does feeding type matter? Contribution of organic matter sources to benthic invertebrates on the Arctic Chukchi Sea shelf. Food Webs.29:e00205. First published online 12 August 2021.

2020

Baker MR, Farley EV, Ladd C, Danielson SL, Stafford KM, Huntington HP, Dickson DMS. 2020. Integrated ecosystem research in the Pacific Arctic – understanding ecosystem processes, timing and change. Deep Sea Research Part II: Topical Studies in Oceanography. 177:104850.

Barton MB, Vollenweider JJ, Heintz RA, Norcross BL, Boswell KM. 2020. Spatiotemporal variation of environmental conditions and prey availability that drive Arctic nearshore fish community structure in the Point Barrow, Alaska, region. Canadian Journal of Fisheries and Aquatic Sciences. (999):1-13. First published online 31 August 2020.

Beatty WS, Lemons PR, Sethi SA, Everett JP, Lewis CJ, Lynn RJ, Cook GM, Garlich-Miller JL, Wenburg JK. 2020. Panmixia in a sea ice-associated marine mammal: evaluating genetic structure of the Pacific walrus (*Odobenus rosmarus divergens*) at multiple spatial scales. Journal of Mammalogy. 101(3):755-765.

Boucher NP, Derocher AE, Richardson ES. 2020. Spatial and temporal variability in ringed seal (*Pusa hispida*) stable isotopes in the Beaufort Sea. Ecology and Evolution. 10(10):4178-4192.

Clark CT, Horstmann L, Misarti N. 2020. Evaluating tooth strontium and barium as indicators of weaning age in Pacific walruses. Methods in Ecology and Evolution. 11(12):1626-1638.

Clark CT, Horstmann L, Misarti N. 2020. Zinc concentrations in teeth of female walruses reflect the onset of reproductive maturity. Conservation Physiology. 8(1): coaa029; doi:10.1093

Copeman L, Spencer M, Heintz R, Vollenweider J, Sremba A, Helser T, Logerwell L, Sousa L, Danielson S, Pinchuk AI, et al. 2020. Ontogenetic patterns in lipid and fatty acid biomarkers of juvenile polar cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*) from across the Alaska Arctic. Polar Biology. 43(8):1121-1140.

Danielson SL, Hennon TD, Hedstrom KS, Pnyushkov A, Polyakov I, Carmack E, Filchuk K, Janout M, Makhotin M, Williams W, et al. 2020. Oceanic routing of wind-sourced energy along the Arctic continental shelves. Frontiers in Marine Science. 7:509. First Published Online 10 July 2020.

Danielson SL, Hill DF, Hedstrom KS, Beamer J, Curchitser E. 2020. Demonstrating a high-resolution Gulf of Alaska ocean circulation model forced across the coastal interface by high-resolution terrestrial hydrological models. Journal of Geophysical Research Oceans. 125(8): e2019JC015724.

Fang YC, Weingartner TJ, Dobbins EL, Winsor P, Statscewich H, Potter RA, Mudge TD, Stoudt CA, Borg K. 2020. Circulation and thermohaline variability of the Hanna Shoal region on the northeastern Chukchi Sea shelf. Journal of Geophysical Research Oceans. 125(7):e2019JC015639.

Forster CE, Norcross BL, Mueter FJ, Logerwell EA, Seitz AC. 2020. Spatial patterns, environmental correlates, and potential seasonal migration triangle of polar cod (*Boreogadus saida*) distribution in the Chukchi and Beaufort seas. Polar Biology. 43(8): 1073-94.

Forster CE, Norcross BL, Spies I. 2020. Documenting growth parameters and age in Arctic fish species in the Chukchi and Beaufort seas. Deep Sea Research Part II: Topical Studies in Oceanography. 177:104779.

Givens GH, Ferguson MC, Clarke JT, Willoughby A, Brower A, Suydam R. 2020. Abundance of the eastern Chukchi Sea stock of beluga whales, 2012–17. Arctic.

Gofstein TR, Perkins M, Field J, Leigh MB. 2020. The interactive effects of crude oil and Corexit 9500 on their biodegradation in Arctic seawater. Applied and Environmental Microbiology. 86 (21) e01194-20.

Gradinger R, Bluhm BA. 2020. First analysis of an Arctic sea ice meiofauna food web based on abundance, biomass and stable isotope ratios. Marine Ecology Progress Series. 634:29-43.

Huntington HP, Danielson SL, Wiese FK, Baker M, Boveng P, Citta JJ, De Robertis A, Dickson DMS, Farley E, George JC, et al. 2020. Evidence suggests potential transformation of the Pacific Arctic ecosystem is underway. Nature Climate Change. 10(4):342-348.

Johnson AC, Derocher AE. 2020. Variation in habitat use of Beaufort Sea polar bears. Polar Biology. 43(9):247-1260.

Johnson MA, Mahoney A, Sybrandy A, Montgomery G. 2020. Measuring acceleration and short-lived motion in landfast sea-ice. Journal of Ocean Technology. 15(3):115-131.

Koch CW, Cooper LW, Lalande C, Brown TA, Frey KE, Grebmeier JM. 2020. Seasonal and latitudinal variations in sea ice algae deposition in the Northern Bering and Chukchi Seas determined by algal biomarkers. PloS One. 15(4):e0231178.

Kuletz K, Cushing D, Labunski EA. 2020. Distributional shifts among seabird communities of the Northern Bering and Chukchi seas in response to ocean warming during 2017-2019. Deep Sea Research Part II: Topical Studies in Oceanography. 181-182:104913.

Lalande C, Grebmeier JM, Hopcroft RR, Danielson SL. 2020. Annual cycle of export fluxes of biogenic matter near Hanna Shoal in the northeast Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 177:104730.

Lin P, Pickart RS, Fissel DB, Ross E, Kasper J, Bahr F, Torres DJ, O'Brien J, Borg K, Melling H. 2020. Circulation in the vicinity of Mackenzie Canyon from a year-long mooring array. Progress in Oceanography. 187:102396.

Logerwell EA, Busby M, Mier KL, Tabisola H, Duffy-Anderson J. 2020. The effect of oceanographic variability on the distribution of larval fishes of the northern Bering and Chukchi seas. Deep Sea Research Part II: Topical Studies in Oceanography. 177:104784.

Lovvorn JR, Rocha AR, Danielson SL, Cooper LW, Grebmeier JM, Hedstrom KS. 2020. Predicting sediment organic carbon and related food web types from a physical oceanographic model on a subarctic shelf. Marine Ecology Progress Series. 633:37-54

Lu K, Danielson S, Hedstrom K, Weingartner T. 2020. Assessing the role of oceanic heat fluxes on ice ablation of the central Chukchi Sea Shelf. Progress in oceanography. 184:102313.

Marsh JM, Mueter FJ, Quinn TJ. 2020. Environmental and biological influences on the distribution and population dynamics of polar cod (*Boreogadus saida*) in the US Chukchi Sea. Polar Biology. 43(8):1055–1072.

Marsh JM, Mueter FJ. 2020. Influences of temperature, predators, and competitors on polar cod (*Boreogadus saida*) at the southern margin of their distribution. Polar Biology. 43(8):995-1014.

Mikan MP, Harvey HR, Timmins-Schiffman E, Riffle M, May DH, Salter I, Noble WS, Nunn BL. 2020. Metaproteomics reveal that rapid perturbations in organic matter prioritize functional restructuring over taxonomy in western Arctic Ocean microbiomes. The ISME Journal. 14(1):39-52.

Mordy CW, Bell S, Cokelet ED, Ladd C, Lebon G, Proctor P, Stabeno P, Strausz D, Wisegarver E, Wood K. 2020. Seasonal and interannual variability of nitrate in the eastern Chukchi Sea: Transport and winter replenishment. Deep Sea Research Part II: Topical Studies in Oceanography. 177:104807.

Muth AF, Esbaugh AJ, Dunton KH. 2020. Physiological Responses of an Arctic Crustose Coralline Alga (*Leptophytum foecundum*) to Variations in Salinity. Frontiers in Plant Science. 11:1272.

Nishizawa B, Yamada N, Hayashi H, Wright C, Kuletz K, Ueno H, Mukai T, Yamaguchi A, Watanuki Y. 2020. Timing of spring sea-ice retreat and summer seabird-prey associations in the northern Bering Sea. Deep-Sea Research Part II-Topical Studies in Oceanography. 181-182:104898.

Oggier M, Eicken H, Wilkinson J, Petrich C, O'Sadnick M. 2020. Crude oil migration in sea-ice: Laboratory studies of constraints on oil mobilization and seasonal evolution. Cold Regions Science and Technology. (174):102924.

Okkonen S, Ashjian C, Campbell RG, Alatalo P. 2020. Krill diel vertical migration: A diagnostic for variability of wind forcing over the Beaufort and Chukchi Seas. Progress in Oceanography.

Olnes J, Cita JJ, Quakenbush L, George C, Harwood L, Lea E, Heide-Jorgensen MP. 2020. Use of the Alaskan Beaufort Sea by bowhead whales (*Balaena mysticetus*) tagged with satellite transmitters 2006-018. Arctic. 7(3):278-291.

Olnes J, Crawford J, Citta JJ, Druckenmiller ML, Von Duyke AL, Quakenbush L. 2020. Movement, diving, and haul-out behaviors of juvenile bearded seals in the Bering, Chukchi and Beaufort seas, 2014–2018. Polar Biology. 43(9):1307-1320.

Ravelo AM, Bluhm BA, Foster NR, Iken K. 2020. Biogeography of epibenthic assemblages in the central Beaufort Sea. Marine Biodiversity. 50(1):8.

Reedy K. 2020. Neoliberal Aleutians: Seeing like a fishing company, seeing like a coastal community. Marine Policy. 118:103981.

Romano MD, Renner HM, Kuletz KJ, Parrish JK, Jones T, Burgess HK, Cushing DA, Causey D. 2020. Die–offs, reproductive failure, and changing at–sea abundance of murres in the Bering and Chukchi Seas in 2018. Deep Sea Research Part II: Topical Studies in Oceanography. 181-183:104877.

Siegert, D., M. Lindeberg, B. Konar, S. Saupe, and K. Iken. (In Prep) Trophic Structure of Rocky Intertidal Communities in Contrasting High-Latitude Environments. Deep Sea Research Part II: Topical Studies in Oceanography.

Smé NA, Lyon S, Mueter F, Brykov V, Sakurai Y, Gharrett AJ. 2020. Examination of saffron cod *Eleginus gracilis* (Tilesius 1810) population genetic structure. Polar Biology. 43(8):963-977.

Spear A, Napp J, Ferm N, Kimmel D. 2020. Advection and in situ processes as drivers of change for the abundance of large zooplankton taxa in the Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 177:104814.

Stabeno PJ, McCabe RM. 2020. Vertical structure and temporal variability of currents over the Chukchi Sea continental slope. Deep Sea Research Part II: Topical Studies in Oceanography. 177:104805.

Stabeno PJ, Mordy CW, Sigler MF. 2020. Seasonal patterns of near-bottom chlorophyll fluorescence in the eastern Chukchi Sea: 2010–2019. Deep Sea Research Part II: Topical Studies in Oceanography.177:104842.

Sutton L, Iken K, Bluhm BA, Mueter FJ. 2020. Comparison of functional diversity of two Alaskan Arctic shelf epibenthic communities. Marine Ecology Progress Series. 651(1):1-21.

Taylor N, Clark CT, Misarti N, Horstmann L. 2020. Determining sex of adult Pacific walruses from mandible measurements. Journal of Mammalogy. 101(4):941-950.

Whitehouse GA, Aydin KY. 2020. Assessing the sensitivity of three Alaska marine food webs to perturbations: an example of Ecosim simulations using Rpath. Ecological Modelling. 429:109074.

Willoughby AL, Ferguson MC, Stimmelmayr R, Clarke JT, Brower AA. 2020. Bowhead whale (*Balaena mysticetus*) and killer whale (*Orcinus orca*) co-occurrence in the U.S. Pacific Arctic, 2009–2018: evidence from bowhead whale carcasses. Polar Biology. 43(11):1669-1679.

Wilson RE, Sonsthagen SA, Smé N, Gharrett AJ, Majewski AR, Wedemeyer K, Nelson RJ, Talbot SL. 2020. Mitochondrial genome diversity and population mitogenomics of polar cod (*Boreogadus saida*) and Arctic dwelling gadoids. Polar Biology. 43(8):979–994.

2019

Barton MB, Litvin SY, Vollenweider JJ, Heintz RA, Norcross BL, Boswell KM. 2019. Experimental determination of tissue turnover rates and trophic discrimination factors for stable carbon and nitrogen isotopes of Arctic Sculpin (*Myoxocephalus scorpioides*): A common Arctic nearshore fish. Journal of Experimental Marine Biology and Ecology. 511:60-67.

Barton, M.B., S.Y. Litvin, J.J. Vollenweider, R.A. Heintz, B.L. Norcross, and K.M. Boswell. 2019a. Barton MB, Litvin SY, Vollenweider JJ, Heintz RA, Norcross BL, Boswell KM. 2019. Implications of trophic discrimination factor selection for stable isotope food web models of low trophic levels in the Arctic nearshore. Marine Ecology Progress Series. 613:211-216.

Biddlecombe BA, Derocher AE, Richardson ES, Stirling I. 2019. Behaviour and characteristics of mating polar bears (*Ursus maritimus*) in the Beaufort Sea, Canada. Polar Biology. 5:919-929.

Boucher NP, Derocher AE, Richardson ES. 2019. Space use patterns affect stable isotopes of polar bears (*Ursus maritimus*) in the Beaufort Sea. Polar Biology. 42(8):1581-1593.

Boucher NP, Derocher AE, Richardson ES. 2019. Variability in polar bear *Ursus maritimus* stable isotopes in relation to environmental change in the Canadian Beaufort Sea. Marine Ecology Progress Series. 630:215-225. .

Brooks JJ, Crowley HA, Coon CC, Kendall JJ. 2019. Traditional Knowledge & Ocean Research. The Journal of Ocean Technology. 14(1):49-58.

Carothers C, Sformo TL, Cotton S, George JC, Westley PAH. 2019. Pacific salmon in the rapidly changing Arctic: Exploring local knowledge and emerging fisheries in Utqiaġvik and Nuiqsut, Alaska. Arctic. 72(3):273-288. M09AC15378 P.

Clark CT, Horstmann L, de Vernal A, Jensen AM, Misarti N. 2019. Pacific walrus diet across 4000 years of changing sea ice conditions. Quaternary Research.1-17. doi:10.1017

Clark CT, Horstmann L, Misarti N. 2019. Lipid normalization and stable isotope discrimination in Pacific walrus tissues. Scientific Reports. 9(1):5843.

Crance JL, Berchok CL, Wright DL, Brewer AM, Woodrich DF. 2019. Song production by the North Pacific right whale, *Eubalaena japonica*. The Journal of the Acoustical Society of America. 145(6):3467-3479.

Divine LM, Mueter FJ, Kruse GH, Bluhm BA, Jewett SC, Iken K. 2019. New estimates of weight-at-size, maturity-at-size, fecundity, and biomass of snow crab, *Chionoecetes opilio*, in the Arctic Ocean off Alaska. Fisheries Research. 218:246-258.

Duffy JE, Benedetti-Cecchi L, Trinanes JA, Muller-Karger FE, Ambo-Rappe R, Boström C, Buschmann AH, Byrnes JE, Coles RG, Creed J. 2019. Toward a coordinated global observing system for marine macrophytes. Frontiers in Marine Science. 6(317):1-6.

Durell GS, Neff JM. 2019. Effects of offshore oil exploration and development in the Alaskan Beaufort Sea: Long-term patterns of hydrocarbons in sediments. Integrated Environmental Assessment and Management. 15(2):224-236.

Ershova E, Descoteaux R, Wangensteen O, Iken K, Hopcroft R, Smoot C, Grebmeier JM, Bluhm BA. 2019. Diversity and distribution of meroplanktonic larvae in the Pacific Arctic and connectivity with adult benthic invertebrate communities. Frontiers in Marine Science. 6:490.

Frouin-Mouy H, Mouy X, Berchok CL, Blackwell SB, Stafford KM. 2019. Acoustic occurrence and behavior of ribbon seals (*Histriophoca fasciata*) in the Bering, Chukchi, and Beaufort seas. Polar Biology. 42(4):657-674.

Grebmeier JM, Moore SE, Cooper LW, Frey KE. 2019. The distributed biological observatory: A change detection array in the Pacific Arctic – An introduction. Deep Sea Research Part II: Topical Studies in Oceanography. 162:1-7.

Gryba RD, Wiese FK, Kelly BP, Von Duyke AL, Pickart RS, Stockwell DA. 2019. Inferring foraging locations and water masses preferred by spotted seals *Phoca largha* and bearded seals *Erignathus barbatus*. Marine Ecology Progress Series. 631:209-224.

Iken K, Mueter F, Grebmeier JM, Cooper LW, Danielson SL, Bluhm BA. 2019. Developing an observational design for epibenthos and fish assemblages in the Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 162:180-190.

Kędra M, Cooper LW, Zhang M, Biasatti D, Grebmeier JM. 2019. Benthic trophic sensitivity to on-going changes in Pacific Arctic seasonal sea ice cover–Insights from the nitrogen isotopic composition of amino acids. Deep Sea Research Part II: Topical Studies in Oceanography. 162:137-151.

Kuletz KJ, Cushing D, Osnas EE, Labunski EA, Gall A. 2019. Representation of the Pacific Arctic seabird community within the Distributed Biological Observatory array, 2007–2015. Deep Sea Research Part II: Topical Studies in Oceanography. 162: 191-210.

Lewis BJ, Hutchings JK. 2019. Leads and Associated Sea Ice Drift in the Beaufort Sea in Winter. Journal of Geophysical Research: Oceans. 124(5):3411-3427.

Li C, Boswell KM, Chaichitehrani N, Huang W, Wu R. 2019. Weather induced subtidal flows through multiple inlets of an arctic microtidal lagoon. Acta Oceanologica Sinica. 38(3):1-16.

Li M, Pickart RS, Spall MA, Weingartner TJ, Lin P, Moore GWK, Qi Y. 2019. Circulation of the Chukchi Sea shelfbreak and slope from moored timeseries. Progress in Oceanography. 172:14-33.

McGuire R, Suydam R, Quakenbush L, Powell AN. 2019. Population trends of king and common eiders from spring migration counts at Point Barrow, Alaska between 1994 and 2016. Polar Biology. 42(11):2065-2074.

Mölders N. 2019. Outdoor Universal Thermal Comfort Index Climatology for Alaska. Atmospheric and Climate Sciences. 9(4):558-582.

Okkonen S, Ashjian C, Campbell RG, Alatalo P. 2019. The encoding of wind forcing into the Pacific-Arctic pressure head, Chukchi Sea ice retreat and late-summer Barrow Canyon water masses. Deep Sea Research Part II: Topical Studies in Oceanography. 162:22-31.

Randall JR, Busby MS, Spear AH, Mier KL. 2019. Spatial and temporal variation of late summer ichthyoplankton assemblage structure in the eastern Chukchi Sea: 2010-2015. Polar Biology. 42(10):1811-1842.

Rowe AG, Iken K, Blanchard AL, O'Brien DM, Døving Osvik R, Uradnikova M, Wooller MJ. 2019. Sources of primary production to Arctic bivalves identified using amino acid stable carbon isotope fingerprinting. Isotopes in Environmental and Health Studies. 55(4):366-384.

Smith MA, Sullender BK, Koeppen WC, Kuletz KJ, Renner HM, Poe AJ. 2019. An assessment of climate change vulnerability for important bird areas in the Bering Sea and Aleutian Arc. PloS One. 14(4):e0214573.

Sonsthagen S, Haughey C, Sexson M, Solovyeva D, Petersen M, Powell A. 2019. Temporal variation in genetic structure within the threatened spectacled eider. Conservation Genetics. 21(1): 175-179.

Spear A, Duffy-Anderson J, Kimmel D, Napp J, Randall J, Stabeno P. 2019. Physical and biological drivers of zooplankton communities in the Chukchi Sea. Polar Biology. 42(6):1107-1124.

Trefry JH, Neff JM. 2019. Effects of offshore oil exploration and development in the Alaskan Beaufort Sea: A three-decade record for sediment metals. Integrated Environmental Assessment and Management. 15(2):209-223.

Vestfals CD, Mueter FJ, Duffy-Anderson JT, Busby MS, De Robertis A. 2019. Spatio-temporal distribution of polar cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*) early life stages in the Pacific Arctic. Polar Biology. 45(5):969-990.

Walker DA, Epstein HE, Šibík J, Bhatt U, Romanovsky VE, Breen AL, Chasníková S, Daanen R, Druckenmiller LA, Ermokhina K. 2019. Vegetation on mesic loamy and sandy soils along a 1700-km maritime Eurasia Arctic Transect. Applied Vegetation Science. 22(1):150-167.

Wilson RE, Sage GK, Wedemeyer K, Sonsthagen SA, Menning DM, Gravley MC, Sexson MG, Nelson RJ, Talbot SL. 2019. Micro-geographic population genetic structure within Arctic cod (*Boreogadus saida*) in Beaufort Sea of Alaska. Ices Journal of Marine Science. 76(6):1713-1721.

Wright DL, Berchok CL, Crance JL, Claphan PJ. 2019. Acoustic detection of the critically endangered North Pacific Right Whale in the northern Bering Sea. Marine Mammal Science. 35(1):311-326.

2018

Angliss RP, Ferguson M, Hall PG, Helker VT, Kennedy A, Sformo T. 2018. Comparing manned to unmanned aerial surveys for cetacean monitoring in the Arctic: Methods and operational results. Journal of Unmanned Vehicle Systems. 6(3):109-127.

Berchok CL, Braen EK, Crance J, Grassia SL, Harlacher JM, Ives EG, Kimber JM, Mocklin JA, Wood MA, Wright DL. 2018. Long-term marine mammal occurrence in the distributed biological observatory 2010–2015. The Journal of the Acoustical Society of America. 144(3):1957-1957.

Bond N, Stabeno P, Napp J. 2018. Flow patterns in the Chukchi Sea based on an ocean reanalysis, June through October 1979–2014. Deep Sea Research Part II: Topical Studies in Oceanography. 152:35-47.

Bonsell C, Dunton KH. 2018. Long-term patterns of benthic irradiance and kelp production in the central Beaufort Sea reveal implications of warming for Arctic inner shelves. Progress in Oceanography. 162: 160-170.

Brower AA, Clarke JT, Ferguson MC. 2018. Increased sightings of subArctic cetaceans in the eastern Chukchi Sea, 2008–2016: population recovery, response to climate change, or increased survey effort? Polar Biology. 41:1-7.

Citta JJ, Lowry LF, Quakenbush LT, Kelly BP, Fischbach AS, London JM, Jay CV, Frost KJ, Crowe GOC, Crawford JA. 2018. A multi-species synthesis of satellite telemetry data in the Pacific Arctic (1987–2015): Overlap of marine mammal distributions and core use areas. Deep Sea Research Part II: Topical Studies in Oceanography. 152:132-153.

Citta JJ, Okkonen SR, Quakenbush LT, Maslowski W, Osinski R, George JC, Small RJ, Brower Jr H, Heide-Jørgensen MP, Harwood LA. 2018. Oceanographic characteristics associated with autumn movements of bowhead whales in the Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 152:121-131.

Clarke JT, Ferguson MC, Willoughby AL, Brower AA. 2018. Bowhead and Beluga Whale Distributions, Sighting Rates, and Habitat Associations in the Western Beaufort Sea in Summer and Fall 2009–16, with Comparison to 1982–91. Arctic. 71(2): 115-138.

Cooper LW, Grebmeier JM. 2018. Deposition patterns on the Chukchi shelf using radionuclide inventories in relation to surface sediment characteristics. Deep Sea Research Part II: Topical Studies in Oceanography. 152:48-66.

Cross JN, Mathis JT, Pickart RS, Bates NR. 2018. Formation and transport of corrosive water in the Pacific Arctic region. Deep Sea Research Part II: Topical Studies in Oceanography. 152:67-81.

Dammann DO, Eriksson LEB, Mahoney AR, Stevens CW, van der Sanden J, Eicken H, Meyer FJ, Tweedie CE. 2018. Mapping Arctic bottomfast sea ice using SAR interferometry. Remote Sensing. 10(5):720.

Dissen JN, Oliveira ACM, Horstmann L, Hardy SM. 2018. Regional and temporal variation in fatty acid profiles of polar cod (*Boreogadus saida*) in Alaska. Polar Biology. 41(12):2495–2510.

Druckenmiller ML, Citta JJ, Ferguson MC, Clarke JT, George JC, Quakenbush L. 2018. Trends in sea-ice cover within bowhead whale habitats in the Pacific Arctic. Deep Sea Research Part II: Topical Studies in Oceanography152:95-107.

Ferguson MC, Angliss RP, Kennedy A, Lynch B, Willoughby A, Helker V, Brower AA, Clarke JT. 2018. Performance of manned and unmanned aerial surveys to collect visual data and imagery for estimating Arctic cetacean density and associated uncertainty. Journal of Unmanned Vehicle Systems. 6(3):128-154.

Ferguson MC, Clarke JT. 2018. Update on analysis of ASAMM 2016 data to derive a "minimum population estimate" for the Bering-Chukchi- Beaufort bowhead whale stock. In: Proceedings, IWC Scientific Committee, April 2018, Bled Slovenia: Paper SC

Hauri C, Danielson S, McDonnell AMP, Hopcroft RR, Winsor P, Shipton P, Lalande C, Stafford KM, Horne JK, Cooper LW. 2018. From sea ice to seals: A moored marine ecosystem observatory in the Arctic. Ocean Science. 14(6):1423-1433.

Hill V, Ardyna M, Lee SH, Varela DE. 2018. Decadal trends in phytoplankton production in the Pacific Arctic Region from 1950 to 2012. Deep Sea Research Part II: Topical Studies in Oceanography. 152:82-94.

Kedra M, Grebmeier JM, Cooper LW. 2018. Sipunculan fauna in the Pacific Arctic region: a significant component of benthic infaunal communities. Polar Biology. 41:163-174.

Konar B, Iken K. 2018. The use of unmanned aerial vehicle imagery in intertidal monitoring. Deep Sea Research Part II: Topical Studies in Oceanography. 147:79-86.

Logerwell E, Rand K, Danielson S, Sousa L. 2018. Environmental drivers of benthic fish distribution in and around Barrow Canyon in the northeastern Chukchi Sea and western Beaufort Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 152:170-181.

Marsay CM, Aguilar-Islas A, Fitzsimmons JN, Hatta M, Jensen LT, John SG, Kadko D, Landing WM, Lanning NT, Morton PL, et al. 2018. Dissolved and particulate trace elements in late summer Arctic melt ponds. Marine Chemistry. 204: 70-85.

Masbou J, Sonke JE, Amouroux D, Guillou Gl, Becker PR, Point D. 2018. Hg-stable isotope variations in marine top predators of the western Arctic Ocean. ACS Earth and Space Chemistry. 2(5):479-490.

McCloskey SE, Uher-Koch BD, Schmutz JA, Fondell TF. 2018. International migration patterns of red-throated loons (*Gavia stellata*) from four breeding populations in Alaska. PloS One. 13(1):e0189954.

McFarlin KM, Perkins MJ, Field JA, Leigh MB. 2018. Biodegradation of crude oil and Corexit 9500 in Arctic seawater. Frontiers in microbiology. 9:1788.

Moore SE, Grebmeier JM. 2018. The distributed biological observatory: Linking physics to biology in the Pacific Arctic region. Arctic. 71(5):1-7.

Moore SE, Stabeno PJ, Grebmeier JM, Okkonen SR. 2018. The Arctic marine pulses model: linking annual oceanographic processes to contiguous ecological domains in the Pacific Arctic. Deep-Sea Research Part II: Topical Studies in Oceanography. 152:8-21.

Moore SE, Stabeno PJ, Van Pelt TI. 2018. The synthesis of Arctic research (SOAR) project. Deep-Sea Research Part II: Topical Studies in Oceanography. 152:1-7.

Okkonen SR, Clarke JT, Potter RA. 2018. Relationships among high river discharges, upwelling events, and bowhead whale (*Balaena mysticetus*) occurrence in the central Alaskan Beaufort Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 152:195-202.

Pomerleau C, Matthews CJD, Gobeil C, Stern GA, Ferguson SH, Macdonald RW. 2018. Mercury and stable isotope cycles in baleen plates are consistent with year-round feeding in two bowhead whale (*Balaena mysticetus*) populations. Polar Biology. 41:1881-1893.

Rand K, Logerwell E, Bluhm B, Chenelot H, Danielson S, Iken K, Sousa L. 2018. Using biological traits and environmental variables to characterize two Arctic epibenthic invertebrate communities in and adjacent to Barrow Canyon. Deep Sea Research Part II: Topical Studies in Oceanography. 152:154-169.

Robards MD, Huntington HP, Druckenmiller M, Lefevre J, Moses SK, Stevenson Z, Watson A, Williams M. 2018. Understanding and adapting to observed changes in the Alaskan Arctic: Actionable knowledge co-production with Alaska Native communities. Deep Sea Research Part II: Topical Studies in Oceanography. (152):203-213.

Santora JA, Eisner LB, Kuletz KJ, Ladd C, Renner M, Hunt GL. 2018. Biogeography of seabirds within a high-latitude ecosystem: Use of a data-assimilative ocean model to assess impacts of mesoscale oceanography. Journal of Marine Systems. 178:38-51.

Schuelke T, Pereira TJ, Hardy SM, Bik HM. 2018. Nematode-associated microbial taxa do not correlate with host phylogeny, geographic region or feeding morphology in marine sediment habitats. Molecular Ecology. 27(8):1930-1951.

Sme N, Lyon S, Canino M, Chernova N, O'Bryhim J, Lance S, Jones K, Mueter F, Gharrett A. 2018. Distinction of saffron cod (*Eleginus gracilis*) from several other gadid species by using microsatellite markers. Fishery Bulletin. 116(1):60-68.

Spall M, Pickart RS, Li M, Itoh M, Lin P, Kikuchi T, Qi Y. 2018. Transport of Pacific water into the Canada Basin and the formation of the Chukchi slope current. Journal of Geophysical Research: Oceans. 132:7453-7471.

Stabeno P, Kachel N, Ladd C, Woodgate R. 2018. Flow patterns in the eastern Chukchi Sea: 2010–2015. Journal of Geophysical Research: Oceans. 123(2):1177-1195.

Stafford KM, Castellote Ml, Guerra M, Berchok CL. 2018. Seasonal acoustic environments of beluga and bowhead whale core-use regions in the Pacific Arctic. Deep Sea Research Part II: Topical Studies in Oceanography. 152:108-120.

Stimmelmayr, R., J.C. George., A. Willoughby, J. Clarke, M. Ferguson, G. Sheffield, K. Stafford, A. Von Duyke, T. Sformo, B. Person, L. Sousa, B. Tudor, and R. Suydam. 2018. 2017 health report for the Bering-Chukchi-Beaufort seas bowhead whales – preliminary findings. In: Proceedings, IWC Scientific Committee, April 2018, Bled Slovenia: Paper SC/67/XX (unpublished).

Suryan RM, Kuletz KJ. 2018. Distribution, Habitat Use, and Conservation of Albatrosses in Alaska. Iden. 72:156-164.

Wang M, Yang Q, Overland JE, Stabeno P. 2018. Sea-ice cover timing in the Pacific Arctic: The present and projections to mid-century by selected CMIP5 models. Deep Sea Research Part II: Topical Studies in Oceanography. 152:22-34.

Willoughby AL, Ferguson MC, Clarke J T, and Brower AA. 2018. Short Note: First photographic match of an anomalously white gray whale (*Eschrichtius robustus*) in the northeastern Chukchi Sea, Alaska, and Baja California, Mexico. Aquatic Mammals. 44(1):7-12.

Wilson, RE, Menning CM, Wedemeyer K, and Talbot SL. 2018. A Transcriptome Resource for the Arctic Cod (*Boreogadus saida*). Marine Genomics. 41: 57-61.

Zhang J, Stegall ST, Zhang X. 2018. Wind-SST-sea ice relationship in the Chukchi-Beaufort seas during autumn. Environmental Research Letters. 13:034008.

2017

Ashjian C, Campbell RG, Gelfman C, Alatalo P, Elliott SM. 2017. Mesozooplankton abundance and distribution in association with hydrography on Hanna Shoal, NE Chukchi Sea, during August 2012 and 2013. Deep Sea Research Part II: Topical Studies in Oceanography. 144:21-36.

Barton MB, Moran JR, Vollenweider JJ, Heintz RA, Boswell KM. 2017. Latitudinal dependence of body condition, growth rate, and stable isotopes of juvenile capelin (*Mallotus villosus*) in the Bering and Chukchi Seas. Polar Biology. 40(7):1451-1463.

Battaile BC, Jay C, Udevitz M, Fischbach A. 2017. Evaluation of a method using survey counts and tag data to estimate the number of Pacific walruses (*Odobenus rosmarus divergens*) using a coastal haulout in northwestern Alaska. Polar Biology. 40(7):1359-1369.

Berman M, Kofinas G, BurnSilver S. 2017. Measuring Community Adaptive and Transformative Capacity in the Arctic Context. In: Fondahl G, Wilson GN, editors. Northern Sustainabilities: Understanding and Addressing Change in the Circumpolar World. Cham: Springer International Publishing. p. 59-75.

Brower AA, Ferguson MC, Schonberg SV, Jewett SC, Clarke JT. 2017. Gray whale distribution relative to benthic invertebrate biomass and abundance: northeastern Chukchi Sea 2009–2012. Deep Sea Research Part II: Topical Studies in Oceanography. (144):156-175.

Buckley TW, Whitehouse GA. 2017. Variation in the diet of Arctic Cod (*Boreogadus saida*) in the Pacific Arctic and Bering Sea. Environmental Biology of Fishes. 100(4):421-442.

BurnSilver S, Boone R, Kofinas G, Brinkman T. 2017. Tradeoffs in the mixed economies of village Alaska: Hunting, working and sharing in the context of change. In: Hegmom M, editor. The Give and Take of sustainability: Archaeological and Anthropological Perspectives. Cambridge University Press. p. 52-83. M07AC12496

Busby M, Blood D, Matarese A. 2017. Identification of larvae of three arctic species of Limanda (Family Pleuronectidae). Polar Biology. 40(12):2411-2427.

Churchwell RT, Kendall S, Brown SC, Blanchard AL, Hollmen TE, Powell AN. 2017. The first hop: use of Beaufort Sea deltas by hatch-year semipalmated sandpipers. Estuaries and Coasts. 41(1):1-13.

Conn PB, Thorson JT, Johnson DS. 2017. Confronting preferential sampling when analyzing population distributions: diagnosis and model based triage. Methods in Ecology and Evolution. 8(11):1535-1546.

Corlett WB, Pickart RB. 2017. The Chukchi slope current. Progress in Oceanography. 153:50-65.

Crance JL, Berchok CL, Keating JL. 2017. Gunshot call production by the North Pacific right whale *Eubalaena japonica* in the southeastern Bering Sea. Endangered Species Research. 34:251-267.

Danielson SL, Iken K, Hauri C, Hopcroft RR, McDonnell AM, Winsor P, Lalande C, Grebmeier JM, Cooper LW, Horne JK, et al. 2017. Collaborative approaches to multi-disciplinary monitoring of the Chukchi shelf marine ecosystem: Networks of networks for maintaining long-term Arctic observations. In: Oceans 2017; Anchorage, AK. IEEE. p. 1-7.

Divine LM, Bluhm BA, Mueter FJ, Iken K. 2017. Diet analysis of Alaska Arctic snow crabs (*Chionoecetes opilio*) using stomach contents and δ13C and δ15N stable isotopes. Deep Sea Research Part II: Topical Studies in Oceanography. 135:124-136.

Dunton KH, Grebmeier JM, Trefry JH. 2017. An integrative study of a high arctic marine ecosystem in the Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 144:1-5.

Elliott SM, Ashjian CJ, Feng Z, Jones B, Chen C, Zhang Y. 2017. Physical control of the distributions of a key Arctic copepod in the northeast Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 144:37-51.

Fang Y-C, Potter RA, Statscewich H, Weingartner TJ, Winsor P, Irving BK. 2017. Surface current patterns in the northeastern Chukchi Sea and their response to wind forcing. Journal of Geophysical Research: Oceans. 122(12):9530-9547.

Fox AL, Trefry JH, Trocine RP, Dunton KH, Lasorsa BK, Konar B, Ashjian CJ, Cooper LW. 2017. Mercury biomagnification in food webs of the northeastern Chukchi Sea, Alaskan Arctic. Deep Sea Research Part II: Topical Studies in Oceanography. 144:63-77.

Gall AE, Morgan TC, Day RH, Kuletz KJ. 2017. Ecological shift from piscivorous to planktivorous seabirds in the Chukchi Sea, 1975–2012. Polar Biology. 40(1):61-78.

Gallaway BJ, Konkel WJ, Norcross BL. 2017. Some thoughts on estimating change to arctic cod populations from hypothetical oil spills in the eastern Alaska Beaufort Sea. Arctic Science. 3(4): 716-729.

Glass JR, Kruse GH. 2017. Spatiotemporal variability of benthic communities on weathervane scallop beds off Alaska, USA. Marine and Coastal Fisheries. 9(1):521-524.

Goethel CL, Grebmeier JM, Cooper LW, Miller TJ. 2017. Implications of ocean acidification in the Pacific Arctic: Experimental responses of three Arctic bivalves to decreased pH and food availability. Deep Sea Research Part II: Topical Studies in Oceanography. 144:112-124.

Gonsior M, Luek J, Schmitt-Kopplin P, Grebmeier JM, Cooper LW. 2017. Optical properties and molecular diversity of dissolved organic matter in the Bering Strait and Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 144:104-111.

Gray BP, Norcross BL, Beaudreau AH, Blanchard AL, Seitz AC. 2017. Food habits of Arctic staghorn sculpin (*Gymnocanthus tricuspis*) and shorthorn sculpin (*Myoxocephalus scorpius*) in the northeastern Chukchi and western Beaufort Seas. Deep Sea Research Part II: Topical Studies in Oceanography. 135:111-123.

Groß J, Konar B, Brey T, Grebmeier JM. 2017. Size-frequency distribution, growth, and mortality of snow crab (*Chionoecetes opilio*) and arctic lyre crab (*Hyas coarctatus*) in the Chukchi Sea from 2009 to 2013. Deep Sea Research Part II: Topical Studies in Oceanography. 144:142-155.

Hardison AK, McTigue ND, Gardner WS, Dunton KH. 2017. Arctic shelves as platforms for biogeochemical activity: nitrogen and carbon transformations in the Chukchi Sea, Alaska. Deep Sea Research Part II: Topical Studies in Oceanography. 144:78-91

Harvey, H.R. and K.A. Taylor. 2017. Alkane and Polycyclic Aromatic Hydrocarbons in Sediments and Benthic Invertebrates of the Northern Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 144: 52-62.

Harwood, L.A., L.T. Quakenbush, R.J. Small, J.C. George, J. Pokiak, C. Pokiak, M.P. Heide-Jørgensen, E.V. Lea, and H. Brower. 2017. Movements and Inferred Foraging by Bowhead Whales in the Canadian Beaufort Sea during August and September 2006–12. Arctic. 70(2): 161-176.

Hauser DDW, Laidre KL, Stafford KM, Stern HL, Suydam RS, Richard PR. 2017. Decadal shifts in autumn migration timing by Pacific Arctic beluga whales are related to delayed annual sea ice formation. Global Change Biology. 23(6):2206-2217.

Hauser DDW, Laidre KL, Stern HL, Moore SE, Suydam RS, Richard PR. 2017. Habitat selection by two beluga whale populations in the Chukchi and Beaufort seas. PloS One. 12(2):e0172755.

Helser TE, Colman JR, Anderl DM, Kastelle CR. 2017. Growth dynamics of saffron cod (*Eleginus gracilis*) and Arctic cod (*Boreogadus saida*) in the northern Bering and Chukchi Seas. Deep Sea Research Part II: Topical Studies in Oceanography. 135:66-77.

Huntington HP, Quakenbush LT, Nelson M. 2017. Evaluating the effects of climate change on indigenous marine mammal hunting in northern and western Alaska using traditional knowledge. Frontiers in Marine Science. 4:319.

Jay CV, Taylor RL, Fischbach AS, Udevitz MS, Beatty WS. 2017. Walrus haul-out and in water activity levels relative to sea ice availability in the Chukchi Sea. Journal of Mammalogy. 98(2):386-396.

Johnson AC, Pongracz JD, Derocher AE. 2017. Long-distance movement of a female polar bear from Canada to Russia. Arctic. 70(2):121-128.

Kotwicki S, Lauth RR, Williams K, Goodman SE. 2017. Selectivity ratio: A useful tool for comparing size selectivity of multiple survey gears. Fisheries Research. 191:76-86.

Lapham L, Marshall K, Magen C, Lyubchich V, Cooper LW, Grebmeier JM. 2017. Dissolved methane concentrations in the water column and surface sediments of Hanna Shoal and Barrow Canyon, Northern Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 144:92-103.

Lowry LF, Kingsley M, Hauser D, Clarke J, Suydam R. 2017. Aerial survey estimates of abundance of the eastern Chukchi Sea stock of beluga whales (*Delphinapterus leucas*) in 2012. Arctic. 70(3).

Marsh JM, Mueter FJ, Iken K, Danielson S. 2017. Ontogenetic, spatial and temporal variation in trophic level and diet of Chukchi Sea fishes. Deep Sea Research Part II: Topical Studies in Oceanography. 135:78-94.

McClintock BT, London JM, Cameron MF, Boveng PL. 2017. Bridging the gaps in animal movement: hidden behaviors and ecological relationships revealed by integrated data streams. Ecosphere. 8(3):e01751.

McClintock BT. 2017. Incorporating telemetry error into hidden markov models of animal movement using multiple imputation. Journal of Agricultural, Biological and Environmental Statistics. 22(3):1-21.

McKinney MA, Atwood TC, Pedro S, Peacock E. 2017. Ecological change drives a decline in mercury concentrations in southern Beaufort Sea polar bears. Environmental Science & Technology. 51(14):7814-7822

McKinney MA, Atwood TC, Pedro S, Peacock E. 2017. Ecological change drives a decline in mercury concentrations in southern Beaufort Sea polar bears. Environmental Science & Technology. 51(14):7814-7822.

McTigue ND, Dunton KH. 2017. Trophodynamics of the Hanna Shoal Ecosystem (Chukchi Sea, Alaska): Connecting multiple end-members to a rich food web. Deep Sea Research Part II: Topical Studies in Oceanography. (144):175-189.

Mueter FJ, Weems J, Farley EV, Sigler MF. 2017. Arctic Ecosystem Integrated Survey (Arctic Eis): Marine ecosystem dynamics in the rapidly changing Pacific Arctic gateway. Deep Sea Research Part II: Topical Studies in Oceanography. 135:1-6.

Murphy JM, Howard KG, Gann JC, Cieciel KC, Templin WD, Guthrie CM. 2017. Juvenile Chinook Salmon abundance in the northern Bering Sea: Implications for future returns and fisheries in the Yukon River. Deep-Sea Research Part II: Topical Studies in Oceanography. 135:156-167.

Nguyen L, Pilfold NW, Derocher AE, Stirling I, Bohart AM, Richardson E. 2017. Ringed seal (*Pusa hispida*) tooth annuli as an index of reproduction in the Beaufort Sea. Ecological Indicators. 77:286-292.

Pilfold NW, McCall A, Derocher AE, Lunn NJ, Richardson E. 2017. Migratory response of polar bears to sea ice loss: to swim or not to swim. Ecography. 40(1):189-199.

Pinchuk AI, Eisner LB. 2017. Spatial heterogeneity in zooplankton summer distribution in the eastern Chukchi Sea in 2012–2013 as a result of large-scale interactions of water masses. Deep Sea Research Part II: Topical Studies in Oceanography. 135:27-35.

Pongracz J, Derocher A. 2017. Summer refugia of polar bears (*Ursus maritimus*) in the southern Beaufort Sea. Polar Biology. 40(4):753-763.

Ravelo AM, Konar B, Bluhm B, Iken K. 2017. Growth and production of the brittle stars *Ophiura sarsii* and *Ophiocten sericeum* (Echinodermata: Ophiuroidea). Continental Shelf Research. 139:9-20.

Shelden KEW, Mocklin JA, Goetz KT, Rugh DJ, Brattström LV, Friday NA. 2017. Late summer distribution of cetaceans near Barrow, Alaska: Results from aerial surveys conducted during the bowhead whale feeding ecology study, 2007-11. Marine Fisheries Review. 79(2):1-22.

Smoot CA, Hopcroft RR. 2017. Cross-shelf gradients of epipelagic zooplankton communities of the Beaufort Sea and the influence of localized hydrographic features. Journal of Plankton Research. 39(1):65-78.

Smoot CA, Hopcroft RR. 2017. Depth-stratified community structure of Beaufort Sea slope zooplankton and its relations to water masses. Journal of Plankton Research. 39(1):79-91.

Thode A, Bonnel J, Thieury M, Fagan A, Verlinden C, Wright D, Berchok CL, Crance J. 2017. Using nonlinear time warping to estimate North Pacific right whale calling depths in the Bering Sea. The Journal of the Acoustical Society of America. 141(5):3059-3069.

Udevitz MS, Jay CV, Taylor RL, Fischbach AS, Beatty WS, Noren SR. 2017. Forecasting consequences of changing sea ice availability for Pacific walruses. Ecosphere. 8(11):e02014.

Wechter ME, Beckman BR, Andrews AG III, Beaudreau AH, McPhee MV. 2017. Growth and condition of juvenile chum and pink salmon in the northeastern Bering Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 135:145-155.

Weingartner TJ, Danielson SL, Potter RA, Trefry JH, Mahoney A, Savoie M, Irvine C, Sousa L. 2017. Circulation and water properties in the landfast ice zone of the Alaskan Beaufort Sea. Continental Shelf Research. 148:185-198.

Weingartner TJ, Fang Y, Winsor P, Dobbins E, Potter H, Mudge T, Irving B, Sousa LBK. 2017. The summer hydrographic structure of the Hanna Shoal region on the northeastern Chukchi Sea Shelf: 2011 - 2013. Deep Sea Research Part II: Topical Studies in Oceanography. 144:6-20.

Weingartner TJ, Potter RA, Stoudt CA, Dobbins EL, Statscewich H, Winsor PR, Mudge TD, Borg K. 2017. Transport and thermohaline variability in Barrow Canyon on the Northeastern Chukchi Sea Shelf. Journal of Geophysical Research: Oceans. 122(5):3565-3585.

Whitehouse AG, Buckley TW, Danielson SL. 2017. Diet compositions and trophic guild structure of the eastern Chukchi Sea demersal fish community. Deep Sea Research Part II: Topical Studies in Oceanography. 135:95-110.

Wiig O, Born EW, Laidre KL, Dietz R, Villum M, Durner GM, Pagano AM, Regehr E, St Martin M, Atkinson S, et al. 2017. Performance and retention of lightweight satellite radio tags applied to the ears of polar bears (*Ursus maritimus*). Animal Biotelemetry. 5(9):11 pp.

Young JK, Black BA, Clarke JT, Schonberg SV, Dunton KH. 2017. Abundance, biomass and caloric content of Chukchi Sea bivalves and association with Pacific walrus (*Odobenus rosmarus divergens*) relative density and distribution in the northeastern Chukchi Sea. Deep Sea Research Part II: Topical Studies in Oceanography. 144:125-141.

CONTRIBUTING BOEM ALASKA REGIONAL OFFICE STAFF

Dr. Christina Bonsell, Marine Ecologist

Sean Burril, Fish Biologist

Cathy Coon, Chief Environmental Sciences Management Section

Dr. Heather Crowley, Oceanographer

Carla Langley, Chief Leasing Section and GIS Specialist

Dr. James Lima, Sr. Minerals Leasing Specialist

Dr. Jeffrey Brooks, Sociocultural Specialist

Rick Raymond, Wildlife Biologist

Caryn Smith, Oceanographer