BOEM Bureau of Ocean Energy Management

Alaska Annual Studies Plan FY 2018-2019

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

November 2018

Prepared by
U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Room 500
Anchorage, Alaska 99503-5823

November 2018

We have chosen to "go green" this year and are providing this document in electronic format only. It can be accessed 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 Dr. Heather Crowley at (907) 334-5281 or by email at Alaska.Studies@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: Searching for bearded seals in Wainwright, Alaska. Pinniped Movements and Foraging: Bearded Seals (AK-07-08).

Photo credit: Josh London, NOAA Fisheries.

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

November 9, 2018

Dear Stakeholder:

Thank you for your interest in the Environmental Studies Program (ESP) of the Bureau of Ocean Energy Management (BOEM). Initiation of a new *2019-2024 National Outer Continental Shelf Oil and Gas Leasing Program* has made this an especially busy year for BOEM and the ESP. We are providing this *Alaska Annual Studies Plan FY 2018-2019* as a convenient reference describing our recent programmatic updates and our plans for fiscal year (FY) 2019 and beyond.

The *Alaska Annual Studies Plan* is developed from submissions and 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 2020*, 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 (see a complete description of our process beginning on p. 3).

To assist us in processing any suggestions for new studies, we ask that you follow the formatting guidance for a study profile as 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 14, 2018, to ensure consideration for the 2020 fiscal year (October 1, 2019– September 30, 2020). Following revisions to the plan, we will issue a final *Alaska Annual Studies Plan FY 2020* in the fall of 2019.

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 (907) 334-5281.

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 2020

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.

Title: Enter a brief, descriptive title

Administered by: Alaska OCS Region

Period of Performance: FY 2020-202X

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.

Date information is required: Provide dates when products would be most useful and for what purpose, such as "Final report is needed by November 2022 to support NEPA analysis for scheduled lease sales."

** Please keep in mind that studies proposed for our consideration must address specific BOEM mission and decision needs.*

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LIST OF STUDY PROFILES

ONGOING STUDIES

ACRONYMS AND ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AMSS	Alaska Marine Science Symposium
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
ASP	Alaska Annual Studies Plan (BOEM)
AOOS	Alaska Ocean Observing System
bbl	Barrel (volume of oil)
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BSMP	Beaufort Sea Monitoring Program
BSEE	Bureau of Safety and Environmental Enforcement
CAB	Chemistry and Benthos
cANIMIDA	Continuation of Arctic Nearshore Impact Monitoring in Development Area
CESU	Cooperative Ecosystem Studies Unit
CIRCAC	Cook Inlet Regional Citizens Advisory Council
CMI	Coastal Marine Institute
COMIDA	Chukchi Offshore Monitoring in Drilling Area
CTD	Conductivity, Temperature, Depth sensor
DBO	Distributed Biological Observatory
DFO	Department of Fisheries and Oceans Canada
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
GIS	Geographic Information Systems
GPS	Global Positioning System
IARPC	Inter-agency Arctic Research Policy Committee
IOOS	Integrated Ocean Observing System
ITM	Information Transfer Meeting
LCC	Landscape Conservation Cooperative
LK	Local Knowledge

MML	Marine Mammal Laboratory
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
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
NOS	National Ocean Service
NPRB	North Pacific Research Board
NPS	National Park Service
NSB	North Slope Borough
NSSI	North Slope Science Initiative
NSF	National Science Foundation
NWS	National Weather Service
OCS	Outer Continental Shelf
OCSEAP	Outer Continental Shelf Environmental Assessment Program
OCSLA	Outer Continental Shelf Lands Act
ONR	Office of Naval Research
OSRA	Oil-Spill-Risk Analysis
PAH	Polycyclic Aromatic Hydrocarbons
PMEL	Pacific Marine Environmental Laboratory
PSD	Prevention of Significant Deterioration
SOAR	Synthesis of Arctic Research
TK	Traditional Knowledge
UAA	University of Alaska Anchorage
UAF	University of Alaska Fairbanks
UAS	Unmanned Aircraft System
USARC	U.S. Arctic Research Commission
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UT	University of Texas
UW	University of Washington
WHOI	Woods Hole Oceanographic Institution

SECTION 1.0 PROGRAMMATIC OVERVIEW

1.1 Introduction to the Region

Background

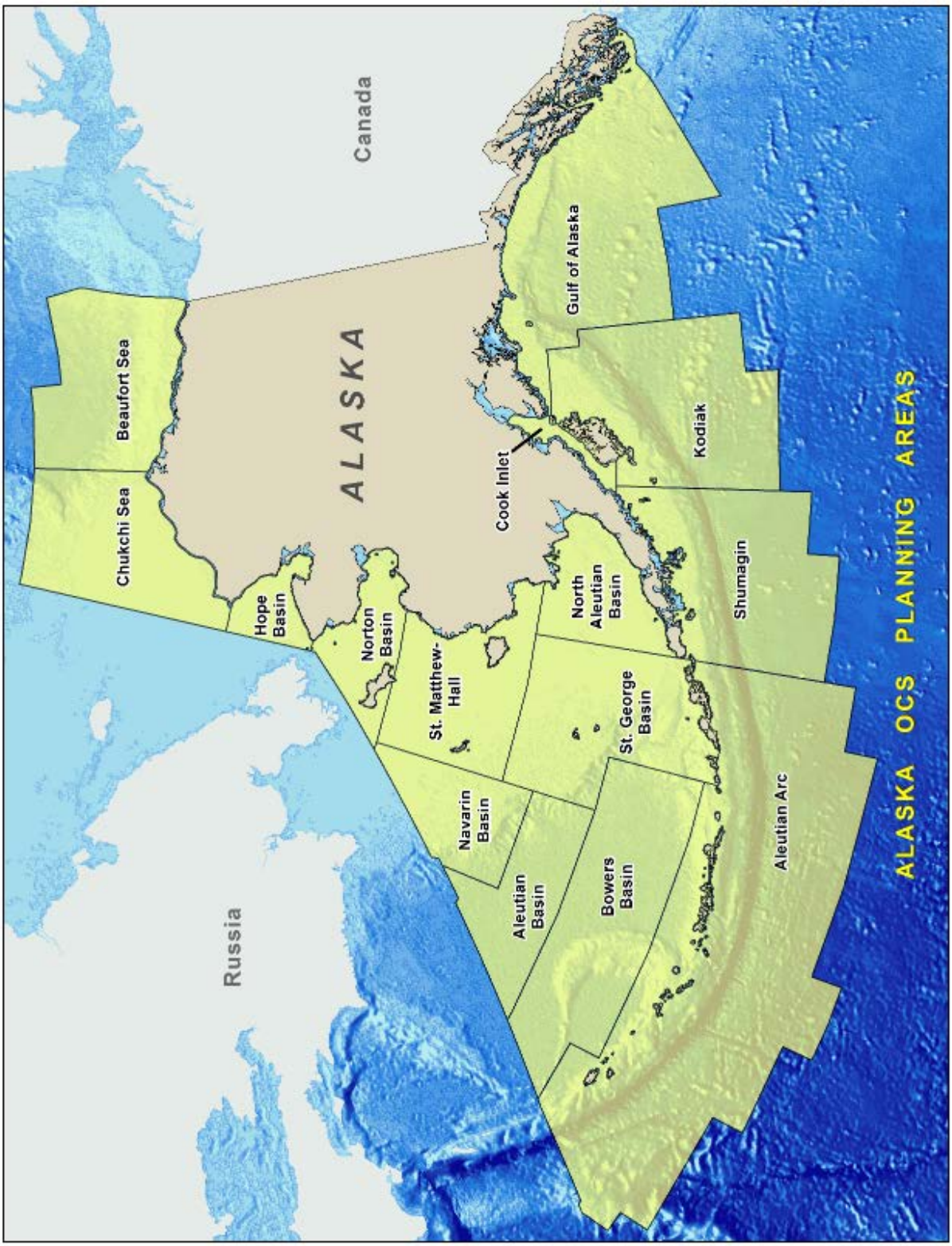
The U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) manages the responsible exploration and development of offshore energy and marine mineral resources on the U.S. Outer Continental Shelf (OCS). The bureau promotes energy independence, environmental protection, and economic development through responsible management of these offshore resources based on the best available science. The OCS refers to 1.7 billion acres of Federal jurisdiction lands submerged under the ocean seaward of state boundaries, generally beginning three statute miles off the coastline (for most states) and extending for 200 miles. The Alaska OCS Region alone contains approximately 1 billion acres.

BOEM's Environmental Studies Program (ESP) was established in 1973 to support the OCS oil and gas leasing program of the U.S. Department of the Interior (USDOI). Originally administered by the Bureau of Land Management (BLM) then by the Minerals Management Service (MMS) and now BOEM, the consistent mandate of the ESP since its inception has been to establish the scientific information used for assessment and management of potential impacts from oil and gas development on the human, marine and coastal environments of the OCS. Mandated by Section 20 of the Outer Continental Shelf Lands Act (OCSLA) of 1953, as amended (43 U.S. C. 1344 et seq.), the Environmental Studies Program is an indispensable requirement informing BOEM's decisions on offshore oil and gas, offshore renewable energy, and the marine minerals program for coastal restoration.

In addition, the National Environmental Policy Act (NEPA) of 1969 requires that all Federal Agencies use a systematic, interdisciplinary approach that will ensure the integrated use of the natural and social sciences in any planning and decision-making that may have effects on the environment. Final reports, data, and peer-review journal articles from ESP-funded studies are used by teams of NEPA analysts within the BOEM Environmental Analysis Sections when they prepare Environmental Impact Statements (EISs) and Environmental Assessments (EAs) related to lease sales, Geological and Geophysical permit applications, Exploration Plans (EPs), and Development and Production Plans (DPPs). The study products are also used within BOEM to develop documentation for consultations and other requirements under various 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.

In its 45 years, the ESP has provided more than $1 billion nationally for scientific research on the OCS. Nearly $500 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 1,000 technical reports and innumerable peer-reviewed publications.

Figure 1. Alaska OCS Region Planning Areas



Early in the development of the ESP, the focus was on obtaining baseline information on the vast biological resources and physical characteristics of the Alaskan environment for pre-lease decision-making. As a broader base of information was established, the focus turned to more topical studies in smaller areas to answer specific questions and fill identified information needs. Today, the ESP in Alaska typically manages about 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 traditional knowledge.

Completed study reports are posted on the Environmental Studies Program Information System (ESPIS) at http://www.boem.gov/ESPIS/. Alaska Region 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.

Scientific Studies are Developed and Conducted in Partnership

As studies information has been amassed, greater focus on collaboration and integration across scientific disciplines is required. BOEM co-sponsors the Alaska Marine Science Symposium each year to facilitate formation of partnerships, exchange of information, development of multidisciplinary research approaches, and sharing of study results. In fact, the entire studies planning, procurement, and dissemination process, from start to finish, involves constant coordination with multiple organizations and scientific entities.

In the Alaska OCS Region, research planning is a continual process that follows a longstanding annual cycle, beginning with the distribution of the *Alaska Annual Studies Plan* (ASP) in autumn to more than 200 partner and stakeholder groups across Federal, State, Alaska Native, Tribal, academic, and industry sectors spanning international, regional, and local interest groups. While the ASP describes ongoing research and reveals proposed new studies for the coming fiscal year, it also requests input from scientists, stakeholders, partners and the general public about information needs and suggestions for new studies.

More than 70 individual study ideas are received from external stakeholders and BOEM staff each year. Additional ideas for new research derive throughout the year from programmatic reviews and analyses, such as those coming from the National Academy of Sciences, the Interagency Ocean Policy Task Force, and the Arctic Council; public hearings; input from working groups and advisory panels such as the North Slope Science Initiative (NSSI); and correspondence from agencies such as NMFS, USFWS, and the State of Alaska related to interagency consultations under ESA and other processes.

The ESP takes a structured decision-making approach to prioritizing study ideas for funding consideration. Each submitted study idea is carefully evaluated by BOEM subject-matter experts based on the following seven criteria, which are detailed in the ESP's *Studies Development Plan 2019-2021* (USDOI, BOEM, ESP 2018):

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

From this evaluation, a short-list of high priority study profiles is identified for further consideration. The proposed profiles undergo an organized process of peer-review by scientists throughout the Bureau to evaluate the priority and quality of each proposed study, including providing feedback on technical aspects of proposed study methods. The proposed studies are then presented to the Committee on Offshore Science and Assessment of the National Academies of Sciences, Engineering, and Medicine for additional input. The profiles are again revised and reprioritized as needed, and finalized during summer for consideration by senior managers at the regional and national levels, and ultimately funding allocation in the new fiscal year. The ASP is then published and circulated to the public in autumn, when the cycle starts all over again.

When conducting research projects, the ESP in Alaska coordinates routinely with numerous Federal entities, including: the National Oceanographic Partnership Program (NOPP); National Oceanic and Atmospheric Administration (NOAA) and the National Marine Fisheries Service (NMFS)-Alaska Fisheries Science Center; NOAA's Marine Mammal Laboratory (MML); the National Weather Service (NWS); U.S. Geological Survey (USGS)-Alaska Science Center; U.S. Fish and Wildlife Service (USFWS); National Park Service (NPS); Office of Naval Research (ONR); the U.S. Integrated Ocean Observing System (IOOS); the National Aeronautics and Space Administration (NASA); National Science Foundation (NSF); U.S. Arctic Research Commission (USARC); the Polar Research Board; and NSSI. The ESP also coordinates closely with active industry research and monitoring programs in Alaska conducted by Hilcorp, ConocoPhillips, and others.

In addition, the ESP works directly on specific projects with AOOS; the North Pacific Research Board (NPRB); Alaska Department of Fish and Game (ADF&G); the North Slope Borough (NSB) Department of Wildlife Management; the Alaska Eskimo Whaling Commission (AEWC); the Alaska Native Tribal Health Consortium (ANTHC); and academic institutions including the University of Alaska Anchorage (UAA), University of Alaska Fairbanks (UAF), Woods Hole Oceanographic Institution (WHOI), University of Washington (UW), and University of Texas (UT).

BOEM strives to incorporate local and traditional knowledge of Alaska Natives, Alaskan residents, and the permanent participants of the Arctic Council in its decision-making processes (Kendall et al. 2017). The ESP considers and integrates local and traditional

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 local and traditional knowledge and community-based monitoring varies from project to project, but the outcome of better information for decision-making is a common goal.

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 Alaska's OCS. Through the CMI, the ESP stimulates important studies with a budget of up to $1,000,000 and a cost-saving dollar-for-dollar match arrangement. In its first 25 years, the CMI has funded approximately 110 studies and leveraged over $20 million of agency funds into $40 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 200 years of student training and nearly $2.5 million in student support. More information about the CMI can be found at http://www.cfos.uaf.edu/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 the State of Alaska, the Pacific Northwest, California, Hawaii and the Pacific Islands, the North Atlantic Coast, the South Atlantic Coast, and the Gulf of Mexico.

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, such as 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 Climate Impact Assessment, 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.

1.2 Issues To Be Addressed

BOEM's research mandate under OCSLA is fundamentally to assess and understand how the Bureau's decision-making impacts the environment, including the human environment, and how those impacts can be avoided or minimized. To achieve this mandate, the ESP seeks to develop science that addresses the following strategic questions:

- How can BOEM best assess cumulative effects 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?

Due to the great differences that exist between Alaskan environments and those in other OCS Regions, the ESP in Alaska must remain especially flexible in planning and implementing needed studies. To be responsive to current and future OCS activities and changing technologies, the Alaska OCS Region continually proposes new studies and pursues information needs in conjunction with ESP goals. Additional questions that must be considered in Alaska include:

- 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 shifts, environmental change also entrains many socioeconomic issues. Some immediate concerns include: increased shoreline erosion and permafrost melt that threatens Arctic communities 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 the changing environment will interact with OCS activities over the next 25–50 years.

Because the people of Alaska's remote arctic and subarctic communities rely so heavily on subsistence resources of the marine environment, they are especially concerned about industrial activities that may directly or indirectly affect hunting success or the

habitats of the species important to subsistence. The people of Cook Inlet also have concerns about potential effects of OCS activities on subsistence, commercial fishing, sport fishing, and tourism. Many other related issues potentially could be affected by OCS activities, such as the well-being of marine mammals and threatened and endangered species. Coastal residents of Alaska have concerns about these resources, as do State and Federal agencies responsible for their management by law.

1.3 Projected OCS Activities

The *Alaska Annual Studies Plan* reflects consideration of the many changes occurring in the Alaska OCS Region, as well as anticipated needs for the future. In a frontier region such as the Arctic, additional planning lead-time is necessary to conduct adequate environmental studies. Specific challenges include: large and remote planning areas, diverse and extreme environmental conditions, still-evolving hydrocarbon extraction technology, and potential environmental hazards associated with OCS activities.

Considerations at the Lease Sale Stage

Preparation of an environmental document based on the best available information, pursuant to NEPA, is an essential part of the lease sale process and ensures that decisions on whether to make areas of the OCS available for leasing are based on consideration of potential environmental impacts. Although much relevant information exists for some Alaska OCS planning areas, data related to certain topics are sparse in some areas and environmental and other conditions are changing over time. Updating past studies to address current information needs and changing conditions can substantially improve the quality of the information upon which our environmental analyses are based and help facilitate informed leasing decisions.

In 2016, BOEM released the *Proposed Final OCS Oil & Gas Leasing Program 2017–2022* (USDOI, BOEM 2016), which includes a lease sale in the Cook Inlet Planning Area in 2021. However, as directed in Executive Order 13795 (April 28, 2017) and DOI Secretary's Order 3350 (May 1, 2017), BOEM is in the process of developing a new National OCS Program for 2019–2024 to replace the 2017–2022 Program. The *National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program* (USDOI, BOEM 2018), released on January 4, 2018, proposes 19 lease sales for Alaska OCS planning areas: three sales in the Beaufort Sea in 2019, 2021, and 2023; three sales in the Chukchi Sea in 2020, 2022, and 2024; two sales in Cook Inlet in 2021 and 2023; and one sale in each of the other Alaska OCS Planning Areas, except the North Aleutian Basin, in 2023.

Considerations at the Exploration and Development and Production Stages

In accordance with mandates of Section 20 of the OCSLA (43 U.S. C. 1346), the need for studies providing information to support environmental review and decision-making continues into the post-lease period. The ESP acquires additional information for environmental analyses related to exploration and development and production. Many of the studies at this stage are more closely related to proposed exploration and development schedules 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.

A total of 2,365 leases have been issued in 26 OCS lease sales in the Alaska Region, 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 2018, there are 40 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.

Data related to these oil and gas activities are sparse. However, environmental analyses for the U.S. Arctic are informed by activity at ten production units located in nearshore State waters along the Beaufort Sea coast, including the Oooguruk, Nikaitchuq, Prudhoe Bay, and Duck Island units, as well as production of natural gas condensate at the high-pressure Point Thomson reservoir since April 2016, and recent oil production within the National Petroleum Reserve-Alaska at the CD-5 site in the Alpine field.

Production:
Northstar – Northstar is a joint Federal/State of Alaska unit located in state waters in the Beaufort Sea about 6 miles northwest of Prudhoe Bay (see Figure 5). 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 September 2018 is in excess of 172 million barrels, with the Federal portion comprising more than 30 million barrels.

Development:
Liberty – The Liberty prospect is located in the central Beaufort Sea, to the east of the existing Endicott Satellite Drilling Island (see Figure 5). In November 2014, primary ownership and operatorship of Liberty was acquired by Hilcorp Alaska LLC. Hilcorp submitted a DPP for the Liberty Unit, which is estimated to contain up to 150 million barrels of recoverable crude oil. In their DPP (Hilcorp 2015), 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.

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, authorizing Eni to continue specified well operations during summer 2018.

Figure 3. Beaufort Sea OCS Leases

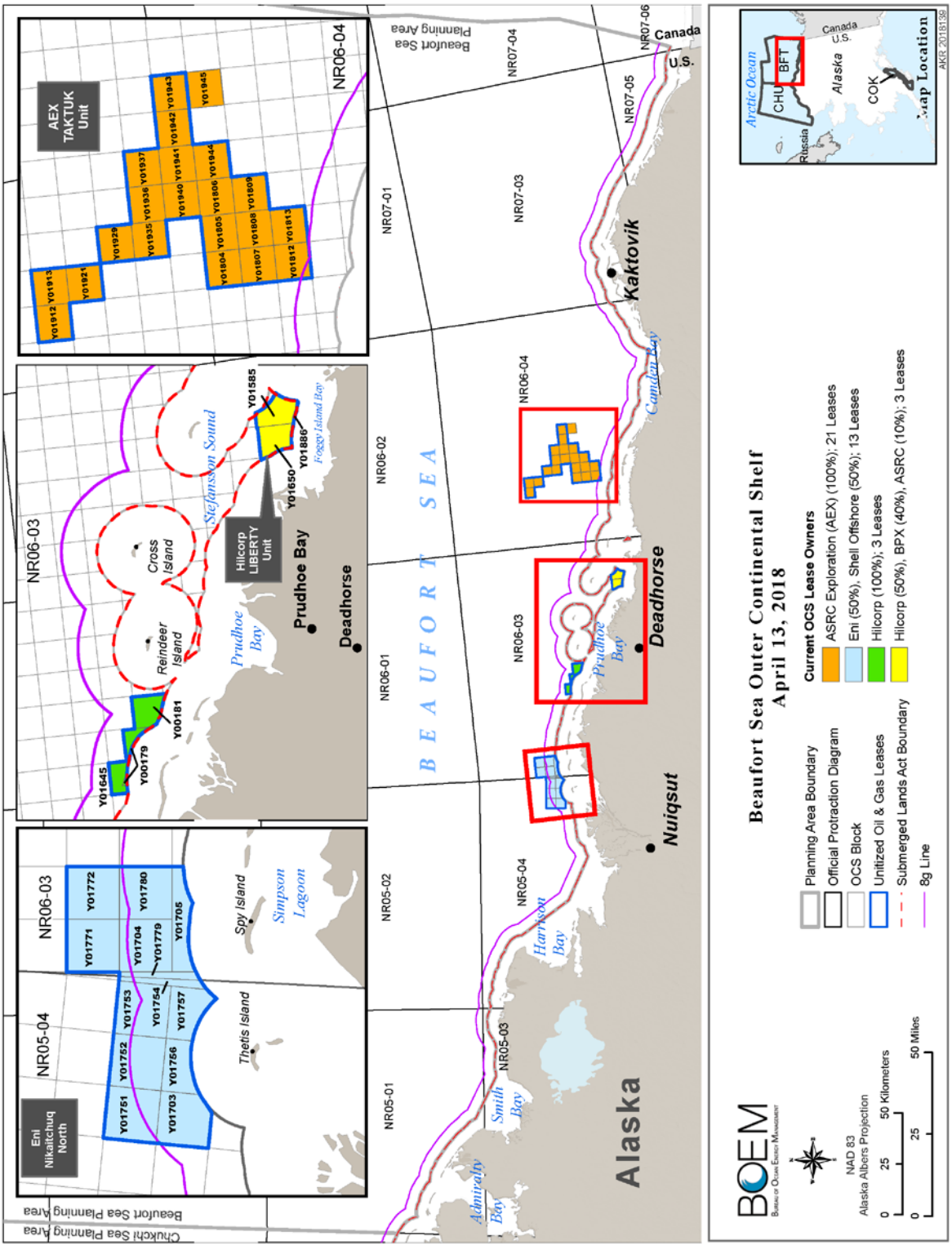


Figure 4. Cook Inlet OCS Leases

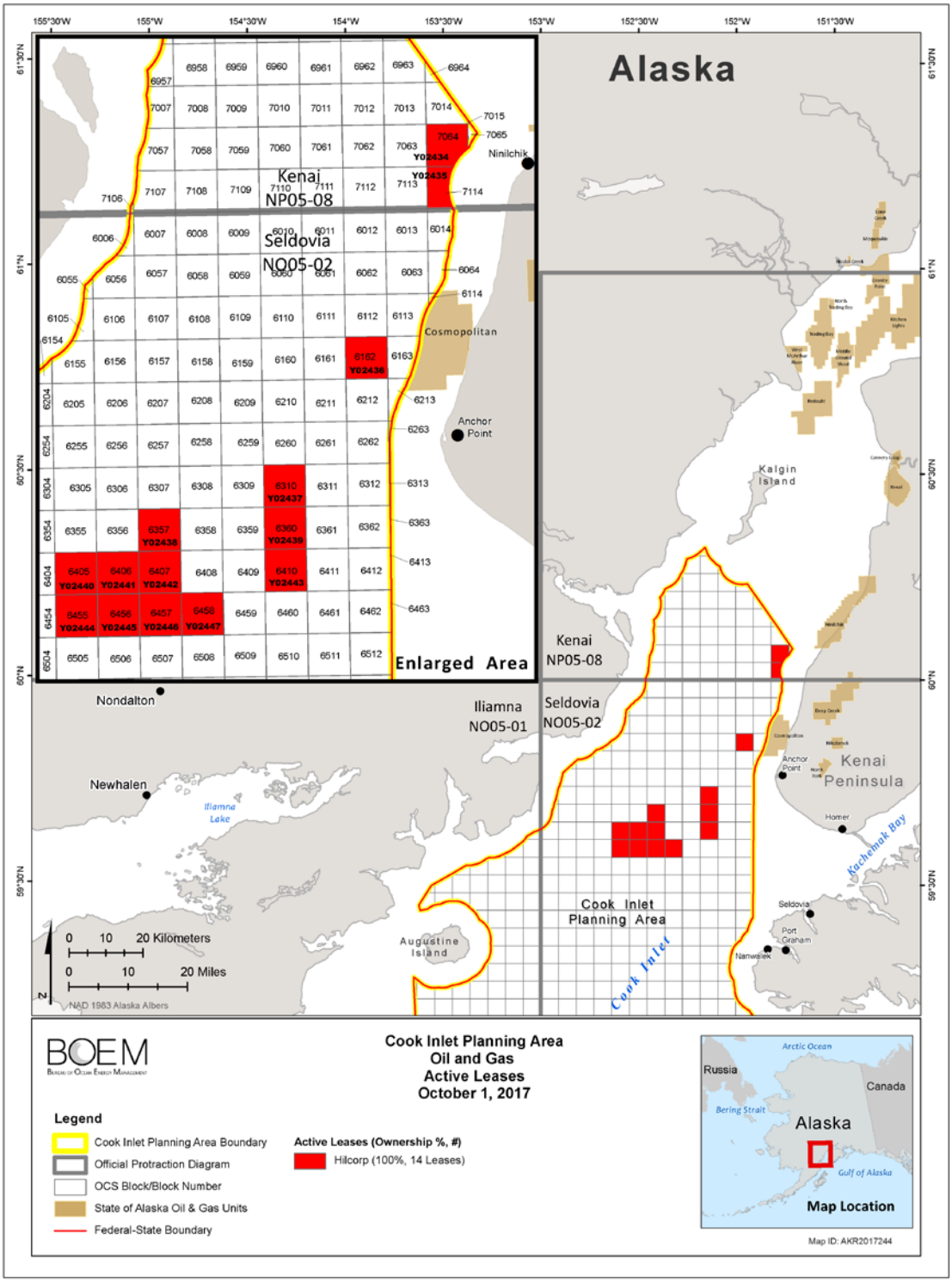
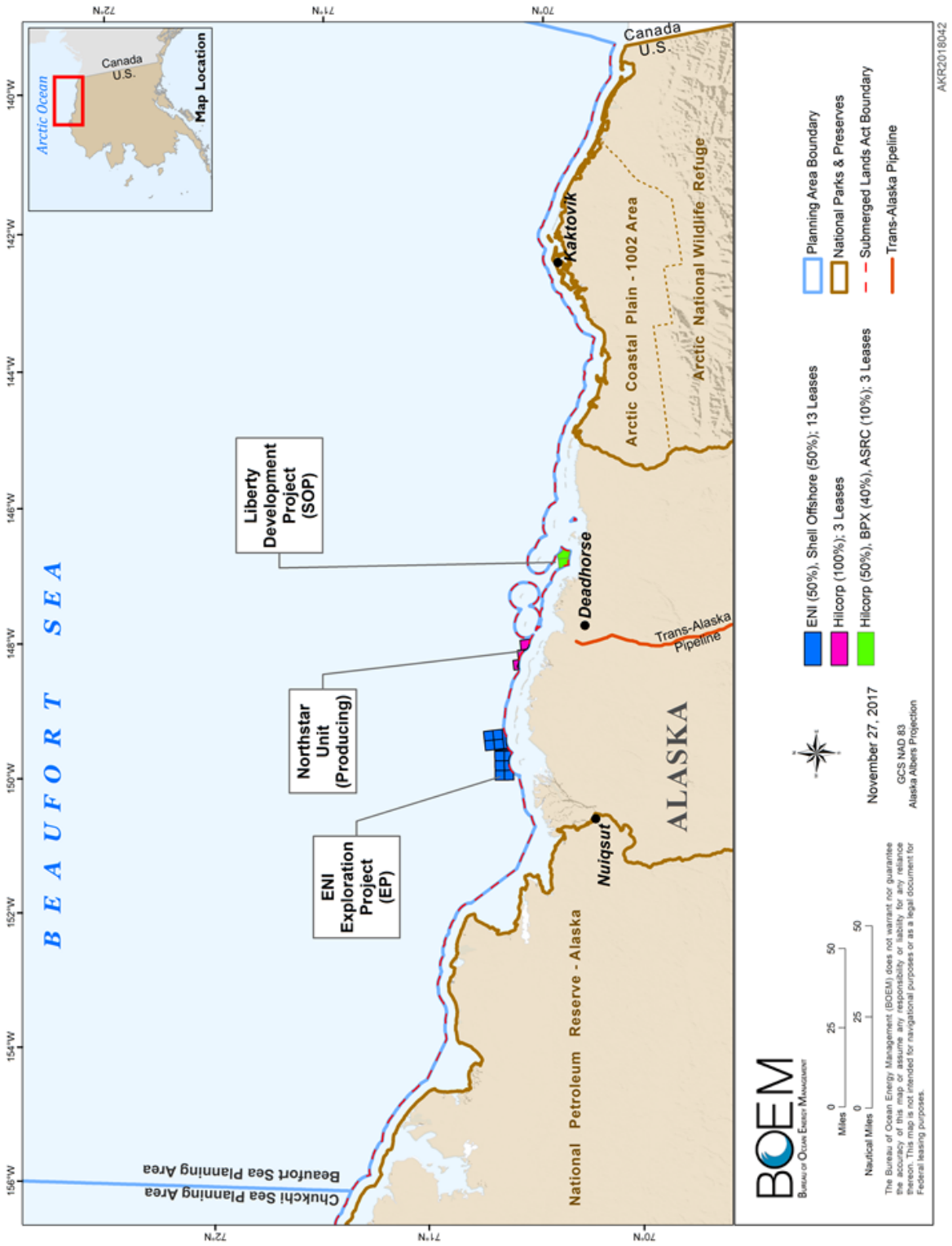


Figure 5. Location of Northstar, Liberty, and ENI exploration project areas in the Beaufort Sea



1.4 Identification of Information Needs

BOEM has an ongoing need for updated information about the physical and biological environment in Alaska to support NEPA analysis for future lease sales, EPs, or DPPs on the OCS. Questions to be addressed include the characteristics of major oceanographic and meteorological processes and how they influence the human, marine, and coastal environments. In recent years, BOEM has placed primary emphasis on studying the Beaufort Sea, Chukchi Sea and Cook Inlet Planning Areas, conducting interim baseline research and monitoring for trends in diverse fields of interest. Most of the projects have exhibited complex, multilateral collaborations, with explicit inter-disciplinary linkages between the physical and biological sciences. Many of them also provide a role for active participation by Alaska Native residents and input from sources of traditional knowledge.

Under the new *Draft Proposed Program*, the Studies Program is looking to broaden its geographic focus to consider studies across the OCS in Alaska. The wide range of environmental conditions from the Gulf of Alaska and Cook Inlet to the Bering Sea and the Arctic is, of course, an important consideration during the process of formulating new studies. However, these vastly diverse 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.

Residents of Beaufort Sea coastal communities have expressed concerns about long-term effects of OCS activities, particularly changes to currents and sedimentation rates and potential effects on social systems, including subsistence whaling activities, in the vicinity of Northstar and Liberty. The need for information about Arctic cod is particularly acute, including description of essential fish habitat and details about timing and location of spawning. Additional information also is needed about recent changes in landfast ice and under ice circulation, and improved tools are needed to help assess the effects on marine mammals of anthropogenic activities, including increased noise and vessel traffic through the Chukchi and Beaufort seas in support of oil and gas exploration and development activities.

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. 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 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 for information include, but are not limited to: an improved understanding of distribution and geographic range of the endangered

Cook Inlet beluga whale stock; assessment of variability and long-term trends in oceanographic conditions and biological communities, including the presence and distribution of the critically endangered North Pacific right whale; and obtaining further baseline information about potential impacts from oil and gas-related activities to the economy and subsistence use of lower Cook Inlet.

As noted above, oil and gas lease sales are also proposed for 11 of the other 12 Alaska Planning Areas through the Bering Sea and Gulf of Alaska. Collation and synthesis of existing baseline information is needed to support NEPA analyses for these areas, which have not been considered for leasing in decades. In addition, the Alaska Region is partnering with the University of Alaska Fairbanks to assess the environmental feasibility of a wave energy project in State of Alaska waters off Yakutat. This project represents a uniquely cost-effective opportunity for BOEM to help establish methods and procedures that can be employed in future wave energy site resource assessments in both State and Federal waters across the Nation.

Specific Information Needs by Discipline

Interdependent Physical, Biological and Social Processes: The Alaska OCS Region 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 and its continuation (cANIMIDA) began in 1999 to provide baseline data and monitoring results for trace metal and other chemical contamination, turbidity, and subsistence whaling in the vicinity of Northstar and Liberty development sites. The second follow-on project (ANIMIDA III) continued this monitoring and was 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.

In addition to the ongoing need for integrated research programs like ANIMIDA and COMIDA, there is also a need for synthesis of results from multiple studies to facilitate interpretation of data across disciplines. The recently completed "Synthesis of Arctic Research" (SOAR) study has worked to explore and integrate information from completed and ongoing marine research in the northern Bering, Chukchi and Beaufort Seas, aiming to increase scientific understanding of the complex biophysical processes that exist in the arctic ecosystem, and their relationship to the marine food web in the region. A number of ongoing studies also take an integrated approach to examining the interdependence of physical, biological and social processes and filling identified information needs across the various disciplines.

Ocean Circulation and Sea Ice: Accurate information on surface wind fields, ocean currents, and sea ice is important for determining the fate of spilled oil and the potential impacts on biota in the area. It is particularly important to know locations and seasonal changes in the distribution of polynyas, leads, and landfast ice, as well as the motion of

the seasonal ice pack. Studies conducted by the Alaska OCS Region have demonstrated that water motion is very different under landfast ice than in adjoining open or pack-ice areas. Information about ice gouge characteristics and recurrence rates also supports assessments of risks associated with burial of oil production pipelines to support BOEM's fault tree modeling.

Air Quality: The transfer to BOEM of authority to regulate emissions from oil and gas activities in OCS areas adjacent to the North Slope Borough of Alaska necessitates increased focus on Arctic OCS air quality considerations. Arctic oil and gas exploration and extraction activities proposed for the OCS require environmental evaluations pursuant to NEPA, as well as air quality operating approval, 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 ocean currents and sea ice and how they affect the motion of spilled oil is necessary to fully address these concerns. North Slope residents are especially concerned about potential contamination of their food supply. In the Beaufort Sea such foods include bowhead whales, seals, waterfowl and fish.

Information on 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 NOAA Fisheries to identify the winter range of the critically endangered Cook Inlet beluga whale population. In the Arctic, the populations of bowhead whales, polar bears, spectacled eiders, spotted and ringed seals, walruses and other arctic species are an ongoing concern. Potential effects from loss of sea ice are a particular 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 USFWS in ensuring compliance with Federal management and regulatory mandates for marine mammals under the MMPA.

A particular concern 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 also 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. 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, 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.

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) governs U.S. marine fisheries management for all OCS waters. Under the Magnuson-Stevens Act, each fishery management plan must describe and identify Essential Fish Habitat (EFH) for the fishery, minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to encourage the conservation and enhancement of EFH. BOEM engages in consultation with NMFS regarding any action that may adversely affect EFH, conferring on EFH assessment related to 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 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 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 is needed for assessments of archaeology potential in the Beaufort and Chukchi seas to support the National Historic Preservation Act and NEPA review.

1.5 Notable Programmatic Highlights

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.

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 is investing more than $16 million in studying marine processes in the U.S. Arctic through 2021. The study "Arctic Integrated Ecosystem Survey, Phase II" is a key component of this program. In addition, BOEM regularly co-sponsors with NPRB the annual Alaska Marine Science Symposium to allow our Principal Investigators to brief the scientific community about results from ongoing research.

Renewable Energy Research: In partnership with UAF, BOEM is assisting the State of Alaska in its effort to assess the feasibility and potential environmental effects of a wave energy converter project off Yakutat in the Gulf of Alaska. The "Alaska Wave Energy Converter Impact Assessment" study is collecting data to improve scientific understanding of seabed dynamics, ambient underwater noise, and fish and marine mammal presence and habitat requirements in the project area. A key goal of the project is to evaluate implications of findings from the Yakutat Wave Energy Project to inform feasibility studies in other coastal regions of Alaska, including extensions onto the OCS.

Recent Reports and Publications: The ESP in Alaska has published more than 60 OCS Study reports (Appendix 2) since 2014 that address a broad range of topics, including:

- ShoreZone Imaging and Mapping along the Alaska Peninsula
- Marine Arctic Ecosystem Study—Biophysical and Chemical Observations From Glider and Benthic Surveys in 2016
- Arctic Air Quality Impact Assessment Modeling Study
- Social Indicators in Coastal Alaska: Arctic Communities
- Testing the Use of Unmanned Aircraft Systems for Intertidal Surveys
- Alaska Arctic Marine Fish Ecology Catalog
- Seasonality of Seabird Distribution in Lower Cook Inlet
- Arctic Currents: A Year in the Life of a Bowhead Whale
- Biogeochemical Assessment of the OCS Arctic Waters
- Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas

During this same period, studies in Alaska generated nearly 300 peer review journal publications and public presentations (Appendix 3). These publications include five special journal issues derived from four projects:

Synthesis of Arctic Research (SOAR): This study conducted a synthesis of multidisciplinary marine science information in the northern Bering, Chukchi and Beaufort Seas from recent and ongoing research conducted by BOEM, as well as other Federal and State agencies and industry. In addition to two OCS Study reports (BOEM 2012-031 and BOEM 2018-017), the SOAR project produced two special journal issues:

Moore, S. E. and P. J. Stabeno (editors). 2015. *Synthesis of Arctic Research (SOAR)*. Progress in Oceanography. 136:1-274.

Moore, S. E., P. J. Stabeno, and T. I. Van Pelt (editors). 2018. *Synthesis of Arctic Research SOAR Phase II*. Deep Sea Research Part II: Topical Studies in Oceanography. 152:1-214.

Arctic Ecosystem Integrated Survey: This partnership with NOAA and UAF documented and characterized the distribution of pelagic and demersal fish and invertebrate communities in the Chukchi Sea. The study included field surveys to obtain baseline data on the structure and function of the Chukchi ecosystem and the ecology of important fish species in the region. Products from this study include an OCS Study report (BOEM 2017-077) and an issue of Deep Sea Research Part II:

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: This study built on the ecological monitoring of the COMIDA-CAB study with a specific focus on the area of Hanna Shoal. The study documented the circulation and density fields, as well as ice conditions, at Hanna Shoal and examined important chemical, physical and biological interactions with the unique ecological regime in this highly productive area. Products include an OCS Study report (BOEM 2016-047) and an issue of Deep Sea Research Part II:

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.

Chukchi Sea Offshore Monitoring in Drilling Area: Chemistry and Benthos: This syudy, also known as COMIDA-CAB, aimed to provide baseline information on the biological, physical and chemical characteristics of the northeastern Chukchi Sea. Biological surveys documented the abundance and spatial distributions of benthic infauna and epifauna. Sediments within the study area were examined for grain size, organic carbon, radioisotopes for down core dating, trace metals and concentrations of hydrocarbons. Lastly, this research related organic carbon dynamics to the sources, cycles and fates of selected trace metals within the coastal Chukchi Sea. Results were reported in an OCS Study report (2012-012) and an issue of Deep Sea Research Part II:

Dunton, K. H., J. M. Grebmeier, and J. H. Trefry (editors). 2014. *The Northern Chukchi Sea Benthic Ecosystem: Characterization, Biogeochemistry, and Trophic Linkages*. Deep Sea Research Part II: Topical Studies in Oceanography. 102:1-164.

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SECTION 2.0 STUDY PROFILES

The following sections provide specific details about

Up-to-date information about planned new studies, as well as ongoing projects, can be found at: http://www.boem.gov/AKstudies

This information is updated three times each year and includes:

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

Reports from completed ESP Studies can be found at: http://www.boem.gov/ESPIS/ and http://www.boem.gov/AKpubs.

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2.1 Profiles of Planned New Studies

Table 1. BOEM Alaska OCS Region Studies Planned for FY 2019*

Page Number	Discipline	Study Title
23	BIO	Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea
27	ID	Alaska Coastal Marine Institute
29	PO	Landfast Ice in the Beaufort and Chukchi Seas
33	ID	Synthesis of Current Environmental Literature for OCS Planning Areas in the Northern Gulf of Alaska
35	SSE	Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty DPP
39	ID	Underwater Sound Signatures and Propagation for OCS Activities Permitted by BOEM
41	BIO	Model-based essential fish habitat (EFH) Descriptions for Arctic Cod, Saffron Cod and Snow Crab in the Alaskan Arctic
45	FE	Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbls

Discipline Codes	
BIO = Biology	FE = Fates & Effects
PO = Physical Oceanography	ID = Interdisciplinary & Information Management
SSE = Social Science & Economics	

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

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Title	Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea (AK-19-01)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Cooperative Agreement
Approx. Cost	TBD
Performance Period	FY 2019–2022
Conducting Org.	TBD
Date Revised	November 8, 2018
PICOC Summary	
Problem	The Boulder Patch provides complex and unique habitat and supports high biodiversity in an area of considerable oil and gas interest, which includes the proposed construction of Liberty Island (less than half a mile away). Impacts of industry activity may smother/bury/kill productive biological area, but mitigation measures may be possible.
Intervention	This study will conduct a monitoring program to examine long-term drivers of community variability during Liberty development activities. In addition, it will test possible mitigation measures using common industry materials to "reseed" or replace habitat lost due to Liberty Island development activities.
Comparison	The post-development community structure will be compared against historic data to assess impacts of oil and gas activity. Further, artificial substrate will be compared to buried boulders to test efficacy of using industry materials to mitigate development impacts.
Outcome	Results will include defined spatial gradients and temporal trends in environmental conditions, benthic community structure, and kelp production in the Boulder Patch community; evaluation of the effect of sediments on Boulder Patch community; and assessment of test artificial substrates as possible habitat mitigation.
Context	Liberty Development and Production Island construction, Beaufort Sea

BOEM Information Need(s): Impacts to the Boulder Patch from proposed gravel island construction were identified by local communities as a concern during scoping for Liberty Island. Information about how development activities and other disturbances affect Boulder Patch organisms will inform potential future NEPA and EFH analyses for island construction in the Beaufort Sea. Potential mitigation measures will be explored, and may be incorporated in future analyses.

Background: The Boulder Patch, which is located close to the proposed Liberty Development Project (less than a half a mile away), is an area of hard bottom substrate uncommon to the region. Its high biodiversity supports tightly linked food webs, and connects to higher trophic levels such as fishes, seals, and polar bears. It is highly vulnerable to both natural and anthropogenic disturbances. Spatial isolation of boulder

fields and slow development of benthic communities limits ecosystem recovery from disturbances. Previous BOEM-sponsored studies have shown that recovery in this area from disturbances can take a decade or more to resolve (Konar 2007 and 2013). Resiliency to anthropogenic disturbances is unknown, yet critically important to understand in maintaining ecological integrity. Sediment collecting on the hard-bottom rocky habitat could slow community recovery even more through burial and smothering rather than whole organism removal, since the hard-substrate would no longer be available to colonizers. This proposed study builds on previous work and provides an opportunity to assess possible ecological effects of environmental disturbances before and during the construction of a gravel island. Future lease sales in the Beaufort Sea are expected. This study provides invaluable information about impacts of gravel island construction on complex, specialized habitat and will assess potential mitigation measures.

Objectives:

- Define spatial gradients and temporal trends in environmental conditions, benthic community structure, and kelp production in the Boulder Patch community
- Evaluate the effect of sediments and nearby island construction on Boulder Patch community
- Test artificial substrates as possible habitat mitigation.

Methods: Monitoring of Boulder Patch habitat will occur before and during Liberty Island construction. Biological and physical data collected will include: kelp production, salinity, depth, temperature, depth, pH, irradiance, turbidity, fish and invertebrate presence, and stable isotopic trophic structure. Data collected during island construction can be contrasted with historic data. Artificial colonization substrates will be assessed and compared to existing Boulder Patch habitat using typical island materials. Recolonization will be assessed from settling plate experiments and reciprocal transplant manipulations of cobbles.

Specific Research Question(s):

1. What physical and chemical factors affect spatial distribution and abundance of kelp in the Boulder Patch?
2. What are the production and community composition responses of kelp in the Boulder Patch to year-round variations in light availability and oceanographic conditions?
3. How do invertebrate and fish use of under ice habitat in the Boulder Patch vary over time?
4. What is the effect of sedimentation on resilience and the abundance and distribution of Boulder Patch biota under winter and summer conditions?
5. What are potential mitigation and monitoring methods to minimize lost Boulder patch habitat through replacement or substitute substrates?

References:

Konar, B., 2007. Recolonization of a high latitude hard-bottom nearshore community. Polar Biology 30.5: 663-667.

Konar, B., 2013. Lack of recovery from disturbance in high-arctic boulder communities. Polar Biology 36.8: 1205-1214.

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Environmental Studies Program: Alaska Annual Studies Plan

Title	Alaska Coastal Marine Institute (AK-19-02)
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$1,000 (in thousands)
Performance Period	FY 2019
Conducting Org.	UAF
Date Revised	November 8, 2018
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 OCS Region. 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 $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: 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.

Environmental Studies Program: Alaska Annual Studies Plan

Title	Landfast Ice in the Beaufort and Chukchi Seas (AK-19-03)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Cooperative Agreement
Approx. Cost	TBD
Performance Period	FY 2019–2023
Conducting Org.	TBD
Date Revised	November 8, 2018
PICOC Summary	
Problem	Landfast ice is used as a platform for subsistence hunting and potentially for wintertime activities related to oil and gas exploration and development in the Beaufort Sea and Chukchi Sea. Understanding of the extent, stability, and seasonality of landfast ice is important for its safe use, but available data is quite old and conditions have been changing rapidly in recent years. Updated information about landfast ice extent and duration is also needed to validate coupled ice-ocean models used in BOEM's Oil Spill Risk Analysis (OSRA).
Intervention	This study will analyze landfast ice data interpreted by the National Weather Service (NWS) for the U.S. Arctic and produce improved estimates of minimum, mean, and maximum extents over time. Contributions of physical forcing mechanisms to changes in landfast ice will also be evaluated.
Comparison	The results will document changes in landfast ice cover over time.
Outcome	The analysis will document the role of physical forcing mechanisms on landfast ice extent and duration, offer information for validation of coupled ice-ocean circulation models, and improve understanding of the existing environment to support National Environmental Policy Act (NEPA) analyses.
Context	Beaufort Sea, Chukchi Sea

BOEM Information Need(s): Improved understanding of changes in landfast ice extent and stability is needed to provide context for interpretation of changing subsistence patterns and inform reviews and decision-making regarding oil and gas exploration and development plans involving on-ice activities. In addition, BOEM needs information about under ice circulation, including the influence of local freshwater river discharges, and the extent of landfast ice over time to validate coupled ice-ocean circulation models used to support OSRA.

Background: Offshore landfast ice can be used as a platform during potential winter oil and gas exploration or development, as well as subsistence activities. Ongoing environmental change in the Arctic has altered the extent, stability, and seasonality of the landfast ice along the U.S. Arctic coast and updated information is needed to facilitate planning and ensure the safety of on-ice activities. The monthly minimum, mean, and maximum landfast ice extents along the Beaufort Sea coast were last quantified by Mahoney *et al.* (2012), but these data were collected up to 2008 and are

more than 10 years old. Landfast ice extent is interpreted by the National Ice Center on a weekly basis (U.S. National Ice Center, 2018), whereas the NWS Alaska Sea Ice Program (ASIP) interprets landfast ice extent on the shelf areas surrounding Alaska on a daily basis (National Weather Service, 2018). The higher spatial and temporal resolution of these products will provide better understanding of ice stability and how storms and other physical processes influence landfast ice extent.

Documentation of the extent of landfast ice will also support validation of results from coupled ice-ocean circulation models used to support trajectory analyses for OSRA. In the Arctic, the oil-spill trajectory analysis must adequately represent how the movement of oil would be influenced by the presence of fixed, landfast ice.

Previous work by Weingartner and Kasper (2011) used idealized analytical and numerical models to examine the effects of spatially variable landfast ice cover on under-ice circulation. The results demonstrate that circulation under landfast ice cover is profoundly different from ice-free shelf circulation. Buoyancy forced experiments also showed that a landfast ice cover alters the behavior of a buoyant plume considerably, spreading it further offshore than in the ice free scenario. A recent publication by Weingartner *et al.* (2017) found similar results in their analysis of observations collected between 1999 and 2006 in Stefansson Sound. Results from this new study will provide additional context to these findings.

Objectives:

- Assess and document the landfast ice extent in the Beaufort Sea and Chukchi Sea at a higher temporal resolution and determine how it has changed over time.
- Evaluate how changes in landfast ice relate to local and regional changes in temperature, pressure, and major storms, as well as to global climate shifts.

Methods: Researchers will compile a time-series of landfast ice data for the Beaufort Sea and Chukchi Sea from interpreted sea ice data available from the NWS Alaska Sea Ice Program from 2008 through 2022. Results will be analyzed to produce a climatology that includes daily, weekly, monthly minimum, mean, and maximum landfast ice extent and to evaluate the changes in landfast ice over time. Researchers will compile and evaluate available hydrographic data and other physical data, including freshwater river discharge, on the central Beaufort Sea shelf. These data will be supplemented with additional moorings (est. 4–5) that will collect temperature, salinity, ice thickness, and ice velocities, mostly beneath the landfast portion of the sea ice. Researchers will use these data to examine the physical forces that drive changes in seasonal and interannual landfast ice extents, including large breakout events. Local and traditional knowledge from coastal communities along the Chukchi Sea also will be considered when identifying conditions associated with freeze-up, formation of landfast ice, and major breakouts linked to storm events.

Specific Research Question(s):

1. How has landfast ice extent in the Beaufort Sea and Chukchi Sea changed over time?

2. How has the stability and seasonal duration of landfast ice in the U.S. Arctic been altered in recent decades and what can be inferred about its use as a platform for on-ice activities, including subsistence hunting and oil and gas exploration and development?
3. How is landfast ice affected by physical forcings, including the winter and springtime under-ice circulation in the central Beaufort Sea, freshwater discharges from rivers in the area, variations in hydrography, and storms? Is this relationship changing over time?

References:

Mahoney, A., Eicken, H., Shapiro, L., Gens, R., Heinrichs, T., Meyer, F., and Gaylord, A., 2012. *Mapping and characterization of recurring spring leads and landfast ice in the Beaufort and Chukchi Seas*, OCS Study BOEM 2012-067. University of Alaska Coastal Marine Institute, Fairbanks, Alaska.

National Weather Service, 2018. Webpage: https://www.weather.gov/afc/ice (accessed May 8, 2018)

U.S. National Ice Center, 2018. Webpage: http://www.natice.noaa.gov (accessed May 8, 2018)

Weingartner, T., Danielson, S. L., Potter, R. A., Trefry, J. H., 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, T. and Kasper, J. L., 2011. *Idealized modeling of circulation under landfast ice*, OCS Study BOEMRE 2011-056. University of Alaska Coastal Marine Institute, Fairbanks, Alaska.

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Environmental Studies Program: Alaska Annual Studies Plan

Title	Synthesis of Current Environmental Literature for OCS Planning Areas in the Northern Gulf of Alaska (AK-19-04)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Contract
Approx. Cost	TBD
Performance Period	FY 2019–2021
Conducting Org.	TBD
Date Revised	November 8, 2018
PICOC Summary	
Problem	The 2019–2024 National Outer Continental Shelf (OCS) Oil and Gas Leasing Draft Proposed Program identifies lease sales in 11 OCS Planning Areas that have not been considered for leasing in decades. Collation of available environmental information is needed to support analyses under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), etc. for these lease sales and other activities regulated by BOEM.
Intervention	This study will complete a regionally-based literature search and synthesis of environmental information for the OCS Planning Areas in the northern Gulf of Alaska.
Comparison	Results from this award will provide a resource to help guide BOEM NEPA analysts in locating the reference information they will need.
Outcome	The project would produce an annotated bibliography of relevant literature and a summary report documenting the current environment for various resources.
Context	Gulf of Alaska, Kodiak, and Shumagin OCS Planning Areas

BOEM Information Need(s): The 2019–2024 National OCS Oil and Gas Leasing Draft Proposed Program identifies lease sales in 14 Alaska OCS planning areas. These lease sales will require NEPA analyses of the existing environment and potential impacts from possible future oil and gas exploration and development activities. The last lease sale in the Gulf of Alaska Planning Area occurred in 1981, and no lease sales have occurred in the Kodiak and Shumagin Planning Areas. BOEM requires updated information to support NEPA analysis and documentation for the proposed lease sales in these areas.

Research in the northern Gulf of Alaska by a broad array of organizations—including the National Oceanic & Atmospheric Administration (NOAA), Alaska Department of Fish & Game, Exxon Valdez Oil Spill Trustee Council (Gulf Watch) and academia—has produced an extensive body of literature that can be synthesized to support NEPA analysis for potential future lease sales in the Shumagin, Kodiak, and Gulf of Alaska OCS Planning Areas.

Background: The northern Gulf of Alaska exhibits a productive ecosystem supported by a dynamic ocean circulation that disperses marine life and nutrients from deeper waters across the continental shelf. The diverse biological communities support some of the most productive fisheries in the United States. Bays and estuaries represent important nursery habitats for young fishes, and feeding grounds for seabirds and marine mammals.

This region is rapidly changing due to climate warming. Sea temperatures have been anomalously warm, and process studies have provided data that illustrates sustained periods of warming can change the trophic structure of the ecosystem, reducing energy to upper trophic level juvenile fishes, leading to increased winter mortality. Recent and ongoing field work and modeling by NOAA and others suggests that the manifestations of warming in the Gulf of Alaska ("The Blob", El Niño, toxic algal blooms, small-copepod-dominated community, cetacean die-offs, and temperate and tropical fish species collected off Alaska's coasts) will continue highlighting the need for continued research and monitoring of conditions and emergent events.

Objectives: Describe the current environmental understanding of the northern Gulf of Alaska.

Methods: Researchers will conduct a careful literature search and compilation of all relevant information on the environment and resources of the Gulf of Alaska, Kodiak, and Shumagin Planning Areas in the northern Gulf of Alaska.

Specific Research Question(s): What is the current status of physical, biological, social, and economic resources in the northern Gulf of Alaska?

Title	Monitoring the Cross Island Subsistence Whale Hunt for Effects from Liberty Development and Production, Central Beaufort Sea, Alaska (AK-19-05)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Contract
Approx. Cost	TBD
Performance Period	FY 2019–2024
Conducting Org.	TBD
Date Revised	November 8, 2018
PICOC Summary	
Problem	Iñupiaq Eskimo traditional knowledge states that bowhead whales deflect from anthropogenic noise. Nuiqsut hunters engage in subsistence harvest of bowhead whales at Cross Island, which is downstream from the proposed Liberty development. Whalers are concerned that noise associated with construction activities and vessel and aircraft traffic at the site will cause bowheads to deflect from Cross Island since they potentially will encounter anthropogenic noise from Liberty when they migrate from east to west. This could result in lower than usual success in harvesting, more difficulties in whaling, and negatively affect cultural practices, sharing networks, and important community celebrations where bowhead is primarily served to elders and other residents.
Intervention	This study will monitor the annual bowhead whale hunt at Cross Island, identify any source of disturbance, and identify whaling hunters' scouting tracks and locations of strikes and landings. In addition, the study will document the harvest and processing of whales, the hunters' traditional and local knowledge (TK/LK), and other external drivers such as weather, wind, sea states, and ice conditions.
Comparison	Whaling at Cross Island has been documented through collection of Global Positioning System (GPS) data since 1999. Results from this study will be evaluated against that baseline.
Outcome	This study will provide documentation of any changes in number and distribution of bowhead whales available for harvest, as well as changes in the whales' behavior (specifically increased skittishness).
Context	The area surrounding Cross Island in the Beaufort Sea Planning Area

BOEM Information Need(s): The Bureau of Ocean Energy Management (BOEM) has a continuing, ongoing need to monitor Cross Island whaling activities for potential impacts from oil and gas-related activities on the Outer Continental Shelf (OCS). Information obtained from this study will inform BOEM and BSEE about potential temporal and special conflicts between subsistence use and activities associated with proposed oil and gas development activities at Liberty, including marine vessel passage, excavation, drilling and construction. The information will also inform future National Environmental Policy Act (NEPA) analysis and documentation related to potential

future lease sales, as well as potential future exploration plans and development and production plans (DPPs). This information includes new data on potential effects of anthropogenic noise on subsistence whaling activities, TK/LK regarding migrating bowhead whale behavior, and possible effects of presence or absence sea ice on the whale hunt.

Background: The DPP for the Liberty Development Project proposes an offshore gravel island with a pipeline to land. The facility will be constructed southeast of Cross Island, where Iñupiat subsistence bowhead whale hunters launch their annual fall hunt for bowhead whales. Subsistence whalers have expressed concerns about potential effects to the bowhead whale hunt, due to the potential disturbance of the bowheads as they migrate from the east to the west in the fall. The concern, based on TK/LK, is that anthropogenic noise emanating from the Liberty site will affect the whales, causing them to deflect and reduce their prospects for successful harvests. This study will renew the long-term BOEM-funded ethnographic monitoring effort of subsistence whaling activities, incorporating TK/LK about bowhead whales and real-time information about proximity of sea ice to GPS recorded whaling tracks. The study will build upon prior efforts to document the effects of the development at Northstar on Cross Island subsistence conducted between 2001 and 2012 under the multi-disciplinary Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) project and its continuation (cANIMIDA) (Galginaitis, 2014).

Objectives:

- Evaluate variation in Cross Island subsistence whaling over time
- Assess whether OCS oil development activities at Liberty are likely to result in changes to bowhead whale subsistence hunting practices, or to hunting success at Cross Island

Methods: This study continues the methods established during the ANIMIDA and cANIMIDA projects. It calls for systematic observations and discussions with local informants about: a) number of whales taken; b) GPS location of whale sightings and strikes, with direction and distance from Cross Island; c) number of crews, composition of crews, total number of crew; d) periodic "census" of whaling participants on Cross Island; e) duration of whaling season by active days; f) timing of whaling; g) length of trips and area searched while whaling; h) records of catch per unit effort; i) observations of whaling participants; j) real time records of the location of sea ice relative to Cross Island; k) collection of TK/LK regarding bowhead whale and hunting practices; and l) weather, wind, and sea states. Recorded data will be presented in an annual report using tabular information on harvest levels and locations of subsistence resources taken on or near Cross Island, with hard copy maps showing the locations of subsistence whaling activities.

This study will leverage multiple recently completed and ongoing projects supported by the State of Alaska, North Slope Borough, and private industry.

Specific Research Question(s):

1. Would subsistence whaling activity and whale behaviors in the vicinity of Cross Island be affected by offshore oil and gas development at Liberty?
2. If so, in what ways?
3. Do the whales become skittish and more difficult to harvest, and if so, what behaviors comprise "skittishness" and how long does it take for whales to resume normal behavior?
4. Do the whales dive or deflect, and if so, for how long and how far? How long does it take for whales to resume normal behavior?
5. Did these alterations in behavior increase the level of effort or seem to limit the ability to harvest the quota of whales? Did it result in placing whalers in hazardous conditions? Please describe.
6. What TK can be documented regarding typical whale migratory whale behavior?

References:

Galginaitis, M., 2014. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, AK. OCS Study, BOEM 2013-212. 208 pp.

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Title	Underwater Sound Signatures and Propagation for OCS Activities Permitted by BOEM (AK-19-06)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Contract
Approx. Cost	TBD
Performance Period	FY 2019–2020
Conducting Org.	TBD
Date Revised	November 8, 2018
PICOC Summary	
Problem	Newer, more accurate acoustic harassment criteria for marine mammals requires greater accuracy in NEPA analyses. No standardized source of noise spectra characteristics that links with accompanying datasets is available.
Intervention	This study would collate baseline information regarding noise from sources associated with human activities, especially oil and gas exploration and development. A search will be conducted of white and gray literature produced by government, private sector, non-governmental, and academic entities.
Comparison	The results will support analyses to discriminate anthropogenic noise sources and noise generated by the natural environment and biological sources.
Outcome	The project will produce a dataset of sound metrics for noises from a variety of sources associated with oil and gas exploration and development activities.
Context	The results will be relevant to all Outer Continental Shelf (OCS) Planning Areas.

BOEM Information Need(s): BOEM needs information about noise from sources associated with oil and gas exploration and development activities to inform noise impacts analyses that meet the newer noise impact thresholds criteria issued by NMFS in 2016. Results will support noise impacts analyses at all levels of NEPA, and in Endangered Species Act (ESA) Section 7 consultations.

Background: Newer, more accurate acoustic harassment criteria for marine mammals requires greater accuracy in NEPA analyses. Historically, the sound metric of decibels (dB re 1 µPa) has been used in NEPA analyses, without serious consideration of the frequencies involved, or if marine mammals were capable of detecting such noises. These relationships are now being addressed in newer NEPA documents produced by BOEM; however, no standardized source of noise spectra characteristics is available that links with accompanying datasets.

Objectives: The goal of this study will develop a consolidated source of information that provides BOEM analysts with a basic tool to analyze the effects of anthropogenic noise on marine mammals in the Alaska OCS in support of NEPA.

Methods: Researchers will collect existing noise production data found in journal publications and gray literature reports produced by government, private sector, non-governmental, and academic entities. Efforts will focus on noises from different types of seismic surveys and drilling; anchor handling; vessel, aircraft and hovercraft traffic; on-ice activities; ancillary activities; sub-sea pipeline installation; etc. Specifically, collected data will include the metrics of frequency, dB re 1 µPa, and dB SEL24, etc., and any other relevant metrics to support analysis of potential impacts from noise to marine mammals and other biota. Results will be presented in a final report, with the accompanying datasets in tabular format.

Specific Research Question(s):

1. What information is available regarding noise from sources associated with oil and gas exploration and development activities?
2. Given the existing knowledge on increased vessel traffic, what is the associated increase in anthropogenic noise?
3. What is the associated ecosystem response, in particular marine mammals?

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Title	Model-based Essential Fish Habitat (EFH) Descriptions for Arctic Cod, Saffron Cod and Snow Crab in the Alaskan Arctic (AK-19-07)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Inter-agency agreement or Cooperative Agreement
Approx. Cost	TBD
Performance Period	FY 2019–2020
Conducting Org.	TBD
Date Revised	November 8, 2018
PICOC Summary	
Problem	Current understanding of the Arctic Fisheries Management Plan (FMP) target species habitat distribution is inadequate to define EFH to the level required to fully identify and address potential habitat impacts from anthropogenic disturbances.
Intervention	This project will update EFH descriptions for Arctic FMP species using current, comprehensive data.
Comparison	Modeling strategies and outputs will be compared to the current EFH designations to look for areas of refinement.
Outcome	Model-based EFH designations will be produced with life stage information, where available, to update current habitat distributions.
Context	Beaufort and Chukchi Seas

BOEM Information Need(s): This project will conduct species distribution modeling to improve the descriptions of habitat use by key Arctic species. The resulting refined habitat maps and descriptions by life-stage will strengthen BOEM's impact assessments during EFH and NEPA analyses associated with Arctic resource development activities.

Background: Essential Fish Habitat (EFH) definitions for the three species (Arctic, saffron cod, and snow crab) covered under the Arctic Fisheries Management Plan (FMP) are qualitative and based on presence-absence data. Commercial fishing is prohibited in the Arctic Management Area, but the habitats of these three ecologically important species may be subjected to non-fishing effects, necessitating increased understanding of their current habitat distributions.

Species distribution models can be used to identify important habitat characteristics that influence spatial patterns in abundance and may provide insight into changes in species distribution. Specifically, the species distribution models can be used to link habitat characteristics to species occurrence and catch per unit effort (CPUE) data from surveys (including several BOEM-funded studies). The ultimate goal of this project is to

refine the EFH text and maps for juvenile, adult and possibly larval life stages of Arctic cod, saffron cod and snow crab for the next 5-year EFH revision (target date 2021).

Objectives:

- Identify 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.
- Refine map and text descriptions of EFH for Arctic cod, saffron cod and snow crab based on species distribution models.

Methods: Researchers will use two types of species distribution models that have been used to define EFH for groundfish in the Gulf of Alaska, Bering Sea and Aleutian Islands (Laman et al. 2017, Pirtle et al., 2017, Turner et al. 2017). First, maximum entropy (MaxEnt) models will be applied, incorporating presence-only data and habitat covariates to predict habitat suitability. In cases where data from large-scale surveys are available and CPUE is recorded, generalized additive models (GAMs) will be used to predict abundance.

As most biological surveys have occurred during the ice-free season (i.e., summer) in the Arctic, the proposed models will describe EFH during the summer. Previous survey data from 1972-2015 will be compiled and supplemented with recent survey data from the nearshore Beaufort Sea and the productive Barrow Canyon as it becomes available. When available, researchers will use length data, von Bertalanffy growth curves, and maturity data to separate juveniles from adults and model the life stages separately. Length-based gear selectivity curves may be used to convert CPUE data for Arctic cod between gear-types to create a more comprehensive dataset for modeling abundance. For species distribution models, habitat covariates to be considered include productivity, bathymetry characteristics, sediment types (Jenkins 1997; dbSEABED), currents, temperature, and salinity (Curchitser et al. 2013). Other habitat covariates will be considered, such as bathymetry-derived seafloor terrain metrics, biogenic habitat features, and occurrence of prey. Model fitting procedures will be used to identify the most important habitat characteristics to be used in the best-fit models.

Specific Research Question(s): How can distribution models be used to update maps and text descriptions for Arctic cod, saffron cod, and snow crab EFH?

References:

Curchitser, E.N., Hedstrom, K., Danielson, S., and Weingartner, T., 2013. Adaptation of an Arctic Circulation Model. U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Studies Program, Headquarters, Herndon, VA. OCS Study BOEM 2013-202. 82 p.

Jenkins, C. J., 1997. Building offshore soils databases. Sea Technology, 38, 25-28.

Laman, E. A., Rooper, C. N., Rooney, S. C., Turner, K. A., Cooper, D. W., and Zimmermann, M., 2017. Model-based essential fish habitat definitions for Bering Sea groundfish species. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-357, 265 p

NPFMC (North Pacific Fisheries Management Council), 2009. Fishery management plan for fish resources of the Arctic management area. ⟨http://www.npfmc.org/wp-content/PDFdocuments/fmp/Arctic/ArcticFMP.pdf⟩

Pirtle, J. L., Shotwell, S. K., Zimmermann, M., Reid, J. A., and Golden, N., 2017. Habitat suitability models for groundfish in the Gulf of Alaska: Deep Sea Research Part II: Topical Studies in Oceanography, Gulf of Alaska Special Issue 2, article in press.

Turner, K., Rooper, C. N., Laman, E. A., Rooney, S. C., Cooper, D. W., and Zimmermann, M., 2017. Model-based essential fish habitat definitions for Aleutian Island groundfish species. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-360, 239 p.

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Title	Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbls (AK-19-08)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Contract
Approx. Cost	TBD
Performance Period	FY 2019–2021
Conducting Org.	TBD
Date Revised	November 8, 2018
PICOC Summary	
Problem	BOEM NEPA analysts require reference information regarding the potential effects of moderately-sized spills on the physical, biological, social, or economic resources on the OCS. However, much of the literature regarding smaller spills of 1,000 to 20,000 barrels is buried in the gray literature or conference proceedings and not easily accessible to the analysts.
Intervention	A literature search focusing on small to medium size spills between 1,000 to 20,000 bbl in volume and their impacts on these environments would be very helpful to BOEM analysts for future National Environmental Policy Act (NEPA) analyses of the Outer Continental Shelf (OCS).
Comparison	Scaling of impacts from much larger oil spills may not provide an accurate representation to support analysis of effects from smaller spills.
Outcome	The project will identify available literature that defines the locations and impacts to human, physical, and biological environments of small to medium size spills.
Context	All OCS Planning Areas

BOEM Information Need(s): Bureau of Ocean Energy Management (BOEM) needs information about oil spills, including particular oil types and volumes, and their impacts under specific environmental variables to allow NEPA analysts to make refined evaluations regarding potential impacts from large (≥1,000 bbl) crude and refined oil spills.

Background: The relationship between BOEM Outer Continental Shelf (OCS) activity and oil spills is a common question; and public concern about oil spills is heightened due to the potential impacts on sensitive resources. However, many of the most well studied oil spills (e.g., *Exxon Valdez* and *Deepwater Horizon*) are orders of magnitude larger than the median OCS spill sizes which are used for NEPA impact assessment. Analysts must use these impacts and scale them to spills of much smaller volumes and duration. Much of the literature regarding smaller spills of 1,000 to 20,000 barrels is buried in the gray literature or conference proceedings. Further, as new BOEM analysts

begin their careers, the use of the older literature, although still valuable, is being lost to the archives.

Objectives:

- Synthesize documentation regarding impacts to biological, social, or economic resources from crude and refined oil spills ranging from 1,000–20,000 bbl in volume.
- Provide a systematic synthesis for use in impact assessment.

Methods: Researchers will conduct a careful literature compilation of all relevant information on crude and refined oil spills of 1,000–20,000 bbl in size since approximately 1970. Sources consulted will include not only formally published scientific literature but also so-called "gray literature", information available from the Internet, and information developed through limited appropriate personal contacts. After conducting an extensive and thorough review of the peer-reviewed and gray literature, researchers will prepare an annotated bibliography of information regarding effects and impacts of crude and refined oil spills of 1,000–20,000 bbl in size. Products will include a written synthesis of impacts and degree of recovery from crude and refined spills of 1,000–20,000 bbl in size discussing environmental and physical variables derived through the extensive review.

Specific Research Question(s): What is the range of environmental effects from oil spills of 1,000–20,000 bbl in size?

2.2 Profiles of Studies to be Considered for FY 2020

Table 2. BOEM Alaska OCS Region Studies to be Considered for FY 2020

Page Number	Discipline	Study Title
49	ID	Synthesis of Current Environmental Literature for OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Islands
51	BIO	Red-throated Loons and Their Fish Prey in the Beaufort Sea as a Biomonitor for Ecosystem Health
55	BIO	Arctic Cod Winter Spawning Survey
57	MM	Acoustic Detection of Critically Endangered North Pacific Right Whales off Kodiak, Alaska
59	BIO	Arctic Marine Biodiversity Observing Network (AMBON) on Alaska's Arctic Outer Continental Shelf (OCS)
63	SSE	Subsistence Mapping and Traditional Knowledge Studies for Six Cook Inlet Communities: Nanwalek, Port Graham, Seldovia, Nikiski, Alexander Creek, and Tyonek
65	SSE	Kenai Peninsula Borough Economy, 2007 to Current Year

Discipline Codes	
BIO - Biology	ID = Interdisciplinary & Information Management
PO = Physical Oceanography	MM = Marine Mammals & Protected Species
SSE = Social Science & Economics	

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Title	Synthesis of Current Environmental Literature for OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Islands
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Contract
Approx. Cost	TBD
Performance Period	FY 2020–2022
Date Revised	November 8, 2018
PICOC Summary	
Problem	The *2019–2024 National Outer Continental Shelf (OCS) Oil and Gas Leasing Draft Proposed Program* identifies lease sales in 11 OCS Planning Areas that have not been considered for leasing in decades. Collation of available environmental information is needed to support analyses under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), etc. for these lease sales and other activities regulated by BOEM.
Intervention	This study will complete regionally-based literature searches and syntheses of environmental information for the OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Arc.
Comparison	Results from this award will provide resources to help guide BOEM NEPA analysts in locating the reference information they will need.
Outcome	The project would produce annotated bibliographic information of relevant literature and two or more summary reports documenting the current environment for various resources.
Context	Hope Basin, Norton Basin, St. Matthew-Hall, Navarin Basin, Aleutian Basin, Bowers Basin, St. George Basin, and Aleutian Arc OCS Planning Areas

BOEM Information Need(s): The *2019–2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program* identifies lease sales in 14 Alaska OCS planning areas that will require NEPA analyses of the existing environment and potential impacts from possible future oil and gas exploration and development activities. No lease sales have occurred in Planning Areas within the Bering Sea since the mid-1980s. BOEM requires updated information to support NEPA analysis and documentation for the proposed lease sales in these areas.

Research in the Bering Sea and Aleutian Islands supported by a broad array of organizations—including the National Science Foundation, BOEM, National Oceanic & Atmospheric Administration, Alaska Department of Fish & Game, North Pacific Research Board, and academia—has produced an extensive body of literature that can be synthesized to support NEPA analysis for potential future lease sales in OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Arc.

Background: The region extending from the Aleutian Islands through the Bering Sea to the Bering Strait and Hope Basin is very productive and ecologically diverse. In addition, the Bering Sea is economically and culturally important, supporting some of the largest and most valuable commercial fisheries in the United States as well as sustaining important subsistence harvests for local residents. Physical and biological changes have been observed in these areas in recent years. Marine mammals, birds, and fish are shifting where they eat, bear their young, and make their homes in response to changes in sea ice extent and duration (Ashjian et al. 2012)

Objectives: Describe the current environmental understanding of Hope Basin, the Bering Sea and the Aleutian Islands.

Methods: Researchers will conduct a careful literature search and compilation of all relevant information on the environment and resources of Hope Basin, the Bering Sea, and the Aleutian Islands. Two or more reports and accompanying annotated bibliographies will be produced for subregions of this large area in consideration of ecosystems and planning area boundaries.

Specific Research Question(s): What is the current status of physical, biological, social, and economic resources in the ecosystems of Hope Basin, the Bering Sea and the Aleutian Islands?

References:

Ashjian, C. J., Harvey, H. R., Lomas, M. W., Napp, J. M., Sigler, M. F., Stabeno, P. J., Van Pelt, T. I. (eds.), 2012. *Understanding Ecosystem Processes in the Eastern Bering Sea*. Special Issue of Deep Sea Research Part II: Topical Studies in Oceanography. Volumes 65-70, Pages 1–316.

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Title	Red-throated Loons and their Fish Prey in the Beaufort Sea as a Biomonitor for Ecosystem Health
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Intra-agency Agreement (USGS)
Approx. Cost	TBD
Performance Period	FY 2020-2023
Date Revised	November 8, 2018
PICOC Summary	
Problem	Population declines appear to have been accelerating in marine-fish dependent birds in the Beaufort Sea. Given that existing data has demonstrated that adult red-throated loons have high survival rates, the negative population trend suggests that reproductive success is poor. Their clutch sizes appear stable, implying an inability of red-throated loon parents to acquire sufficient prey resources for their young, either from numerically few prey or from prey of insufficient nutritional quality. Reasons for the lack of sufficient available prey may include changing water temperature regimes or turbidity or distance from the coast (flight costs are high). Presence of existing and proposed energy development activities may also impact fish while further increasing flight costs to gather fish prey, as suggested by evidence of the lack of habituation of loons to related disturbances (Schwemmer et al. 2011; Furness, 2015).
Intervention	This study proposes to build an energy budget for red-throated loons to evaluate how availability of fish prey, quality of fish prey, flight distance, and dive duration required to capture fish prey affect the ability of loons to successfully raise young. The data to build an energy budget would be a combination of new field studies on loon feeding ecology (i.e., data collection on flight paths, fatty acid signatures and nutritional value of fish used by loons, etc.) and collaborative use of ongoing BOEM-sponsored studies examining the local prey fish communities in the same area.
Comparison	This study proposes two study sites – one near the Liberty prospect and a second site distant from Liberty but in a similar ecological setting elsewhere along the Beaufort Sea coastline. Similar data collection would occur concurrently at both sites and within the broad domain of the aforementioned fish studies. If replicated in later years (e.g., after Liberty is in production), then a follow-up study would enable the strongest type of experimental design (e.g., a BACI design: Before-After-Control-Intervention).
Outcome	The study anticipates detecting differences in the nutritional quality of fish prey species available to and consumed by red-throated loons. Further, by using data on relative abundance of forage fishes, will evaluate for effects of any nutritional deficits for the birds on their ability to successfully raise young. Future NEPA analyses of cumulative effects or potential disturbances in the area will consider any identified ecological limit in how far loons will travel to capture sufficient prey for their young.
Context	Nearshore and offshore Beaufort Sea

BOEM Information Need(s): BOEM requires information to assess cumulative impacts on Arctic marine fish-eating species due to disturbance around industrial facilities, ecological changes in in near shore environments, or accumulation of contaminants exposure. Information from this study will support BOEM in assessing whether red-throated loons are behaviorally impacted by industrial activities and assessing if near shore fish communities are sufficiently abundant and of adequate nutrition to enable loons to be reproductively successful. This information will help to monitor for effects from proposed construction at Liberty and inform BOEM analysts and decision-makers in relation to NEPA cumulative effects analyses and documentation for future lease sales, EPs, and DPPs.

Background: The population decline of red-throated loons in northern Alaska has accelerated, suggesting that conditions are changing in the near shore environment. Red-throated loons require marine fish prey to feed both themselves and their chicks. Given their predilection for marine fish of high fat content, populations of red-throated loons are sensitive to the abundance and nutritional value of fish prey. Previous studies from other geographic regions have shown that some keystone fish species are critical to enabling red-throated loon breeding success. Also, the energy density of fish prey varies across time, corresponding with changes in oceanographic conditions and changes in species availability. Flight costs to capture fish are very high, and thus perturbations that impel loons to change their travel routes may have energetic consequences that could be ecologically significant, such as decreased reproductive success.

Objectives:

- Identify whether fish-dependent birds exhibiting recent population declines nesting near the Beaufort Sea coast are able to provision enough food resources from marine waters to enable them to successfully raise young.
- Assess the amount of energetic expenditure red-throated loons require to raise one versus two chicks (loons lay 2 eggs, and often can only raise one chick).
- Assess above information (i.e., reproductive energy budget) for two sites, including the vicinity of planned Liberty development where disturbance to chick-provisioning is anticipated.

Methods: This work will leverage information from and be conducted in the same season and region of the Beaufort Sea coast as the ongoing BOEM-USGS partnership "Nearshore fish surveys in the Beaufort Sea: Examining long-term community change and the role of nearshore habitats." Researchers will attach satellite transmitters to adult loons during nesting or chick rearing to allow tracking of flight patterns and estimation of energetic costs of travel from nests to foraging sites. A sensor will also be attached to the leg that identify if it is in the water and at what depth. Small fat biopsies and fatty acid analysis will provide taxa-specific prey information and fish captured by collaborators will enable analysis of the nutritional value of fish by species and size. Researchers will use a model to integrate how flight costs, diving costs, fish dietary quality, and fish abundance influence breeding success of loons, and how breeding success may in turn affect population changes. Available data from northwest Alaska in 2009-2010 (Rizzolo, Schmutz, and Speakman, 2015) will support comparative analysis.

Specific Research Question(s):

1. What is the current energetic value of various nearshore fish prey in the Beaufort Sea?
2. How do the energetic costs associated with obtaining marine fish for chicks affect the reproductive success of loons?
3. Is reproductive success related to population decline of red-throated loons?

References:

Furness, R.W. 2015. A review of red-throated diver and great skua avoidance rates at onshore wind farms in Scotland. Scottish Natural Heritage Commissioned Report No. 885.

Rizzolo, D.J., Schmutz, J.A., and Speakman, J.R. 2015. Fast and efficient: postnatal growth and energy expenditure in an Arctic-breeding waterbird, the red-throated loon (Gavia stellata). The Auk 132(3):657-670.

Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V. and Garthe, S., 2011. Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. Ecological Applications, 21(5), pp.1851-1860.

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Title	Arctic Cod Winter Spawning Survey
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Cooperative Agreement
Approx. Cost	TBD
Performance Period	FY 2020–2024
Date Revised	November 8, 2018
PICOC Summary	
Problem	Information is unavailable about spawning timing and locations for this keystone Arctic species
Intervention	This project will sample Arctic cod during suspected spawning season using previously unavailable methods.
Comparison	This project will provide baseline information to update and confirm suspected spawning locations for Arctic cod.
Outcome	Identify spawning locations and timing for Arctic cod.
Context	Beaufort and Chukchi Seas

BOEM Information Need(s): Arctic cod are a keystone species in the Arctic food web, and occur in Chukchi Sea and Beaufort Sea Planning Areas. Basic life history information, such as spawning time and locations, is limited due to accessibility issues during ice-covered months. The under-studied winter season and the currently uncertain location of suspected Arctic cod spawning, egg, and larval habitat is of increasing public concern. This information is especially important for NEPA and Essential Fish Habitat (EFH) analyses, including analysis of the potential effects of spilled oil trapped and held for many months under ice.

Background: Thick ice cover during three-fourths of the year restricts access for scientific studies and limits our understanding of Arctic cod ecology. Arctic cod fill an essential ecosystem role by consuming small prey and in turn providing a food resource for larger fishes, birds, marine mammals, and to the Arctic residents subsisting on those animals. Open-water surveys in the Beaufort and Chukchi Seas have found larger cod size and abundance near the continental slope, suggesting that spawning cod may be associated with the slope or the nearby ice edge. Spawning locations and spawning stock size are uncertain, but current research funded by the North Pacific Research Board (NPRB) is attempting to identify possible spawning locations for Arctic and saffron cod through oceanographic currents and specific hatch dates of individual fish. The recent development of nets that can fish directly under the ice simplifies the logistical challenges of capturing fish in winter habitats. It may be possible to leverage existing work through NPRB's Arctic Integrated Ecosystem Research Program (Arctic IERP) to fulfill BOEM information needs about cod early life history traits. The potential overlap of Outer Continental Shelf (OCS) exploration and development areas

with possible Arctic cod spawning and rearing sites is an issue of concern for stakeholders. Oil spills, though unlikely, could have far-reaching effects on the food web should vulnerable areas and life stages of this keystone species be affected.

Objectives:

- Validate survey methods adapted for use in Arctic ice-covered areas.
- Identify spawning times and locations for Arctic cod along the continental shelf and slope in the Beaufort and Chukchi Seas.
- Increase understanding of relationships among winter fish ecology, trophic interactions, and oceanographic conditions in this region.

Methods: This study will conduct under-ice sampling in close collaboration with scientists from the Alfred Wegener Institute (AWI) in Germany who have demonstrated successful use of the Surface and Under-Ice Trawl (SUIT) (van Franeker et al., 2009) to sample zooplankton and fish under sea ice. Initial sampling will be conducted at suspected cod spawning sites in the U.S. identified through literature review and a current NPRB modeling effort. Once survey methods have been validated, subsequent sampling will use a targeted approach based on initial data collection, indigenous knowledge, and NPRB modeling to identify specific spawning locations.
This study would contribute additional ship time to existing research efforts. Planned operations of the ice strengthened R/V *Sikuliaq* in the northern Bering Sea, Chukchi Sea, and western Beaufort Sea during spring 2019, as part of the NPRB's Arctic IERP, may provide an opportunity to add dedicated cruise days for initial U.S. sea trials of the SUIT. Collaboration with other U.S. and Canadian agencies will be pursued for subsequent focused sampling to take advantage of the economy of scale. Ice breaker capability may be required to extend the study to some suspected spawning locations.

Specific Research Question(s):

1. Is it possible to sample cod under the ice in winter from a research vessel using a towed net?
2. Where and when do Arctic cod spawn in the Beaufort and/or Chukchi Seas?
3. How would potential oil spills in ice-covered conditions impact early life stage cod?

References:

van Franeker, J. A., H. Flores, and M. Van Dorssen. 2009. The Surface and Under Ice Trawl (SUIT). In H. Flores, editor. Frozen Dessert Alive—The Role of Sea Ice for Pelagic Macrofauna and its Predators, PhD thesis, University of Groningen. pp. 181–188.

Environmental Studies Program: Alaska Annual Studies Plan

Title	Acoustic Detection of Critically Endangered North Pacific Right Whales off Kodiak, Alaska
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Inter-agency Agreement,
Approx. Cost	TBD
Performance Period	FY 2020–2024
Date Revised	November 8, 2018
PICOC Summary	
Problem	The eastern population of the North Pacific right whale occurs in areas of the Gulf of Alaska potentially affected by oil development activities in Cook Inlet, as well as potential future lease sales in the Cook Inlet, Kodiak , and Gulf of Alaska OCS Planning Areas.
Intervention	The year-round occurrence of right whales will be assessed through detections by passive acoustic recorders deployed in multiple locations off Kodiak Island.
Comparison	The results of this study will be compared to the results of BOEM's oil-spill trajectory modeling efforts, which indicated that North Pacific right whales could be affected by a potential oil spill in Cook Inlet.
Outcome	This project will provide new baseline information regarding the habitat use of North Pacific right whales near Kodiak.
Context	What are the circumstances and/or geographic domain(s)?

BOEM Information Need(s): Information on right whale occurrence is needed to refine our understanding of the overlap with potential future oil and gas exploration and development activities resulting from Cook Inlet Lease Sale 244, as well as potential future oil and gas lease sales in the Cook Inlet, Kodiak and Gulf of Alaska Planning Areas. Results from this study will support decision-making for management of human use conflicts and inform NEPA analyses and ESA Section 7 consultations associated with lease sales in these planning areas.

Background: The eastern population of the North Pacific right whale is critically endangered, with abundance likely only in the tens of whales. Basic information on current abundance, trend and distribution of this stock are needed. While new information on right whale distribution has come from NOAA surveys of the Bering Sea, there has been very little effort in the Cook Inlet, Kodiak and Gulf of Alaska (GOA) Planning Areas. Almost no survey coverage of the offshore waters of the GOA that were habitat for right whales as recently as the 1960s when the Soviet Union was conducting illegal whaling activities. In July 2017, a North Pacific right whale was documented in the GOA between Sand Point and Kodiak at Kilokak Rocks.

The oil-spill trajectory modeling conducted by BOEM for the recent Cook Inlet Lease Sale 244 showed that right whale habitat including Kilokak Rocks could be affected by oil in the event of a spill in Cook Inlet. In addition, vessel traffic and other activity associated with oil and gas development pose threats to right whales in the region through noise, pollution and/or ship collisions. With additional lease sales being considered for Cook Inlet, as well as the Kodiak and Gulf of Alaska Planning Areas, additional information is needed to identify the use of this area by this critically endangered population.

Objectives: This project will evaluate the current occurrence of right whales in the GOA around Kodiak Island. This will provide additional baseline information on this critically endangered species' occurrence in these Planning Areas, which would be needed to develop appropriate mitigation measures should leasing occur in this geographic area.

Methods: In collaboration with NOAA, long-term passive acoustic recorder moorings will be deployed to provide year-round data on right whale spatial and temporal occurrence as well as ambient noise measurements. Density estimation may also be possible from these single-recorder moorings using novel passive acoustic methods. Researchers will analyze acoustic data from these recorders to refine knowledge of the spatial and temporal occurrence of right whales in the GOA around Kodiak Island and near to the species' designated Critical Habitat on Albatross Bank. Recordings may also be analyzed for information related to other species and inclusion of additional sensors on the moorings will be explored. Recorders will be deployed for two or three years, with a scheduled maintenance each year.

Specific Research Question(s): What is the temporal occurrence year-round of critically endangered North Pacific right whales in areas potentially affected by activities associated with oil and gas exploration and development in the Cook Inlet and Kodiak OCS Planning Areas?

Environmental Studies Program: Alaska Annual Studies Plan

Title	Arctic Marine Biodiversity Observing Network (AMBON) on Alaska's Arctic Outer Continental Shelf (OCS)
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Inter-agency agreement or Cooperative Agreement
Approx. Cost	TBD
Performance Period	FY 2020–2025
Date Revised	November 8, 2018
PICOC Summary	
Problem	Present and future oil and gas development on the OCS of the Beaufort and Chukchi seas have potential effects on the marine ecosystem. This could disturb essential ecosystem services in the Arctic, including sustainable subsistence practices of indigenous peoples.
Intervention	Long-term ecological studies that monitor marine ecosystems are needed to help us discern and understand patterns and changes in composition and function, and to separate impacts due to human activities from environmental change. Biodiversity observing at the appropriate scale has proven to be a practical tool to help identify vulnerable and resilient regions within ecosystems of the Arctic.
Comparison	Effects will be evaluated via long-term data that allow an assessment of impacts from development against the backdrop of known natural variability. The range and patterns of natural variability, and relationships to environmental drivers, can only be discerned from long-term data collection.
Outcome	Continuation of existing biodiversity observing programs will provide the necessary information on ecosystem structure and diversity, variability, and resilience to external drivers. Outcomes include provision of publicly accessible data for informing decision-making on development, fishing, and shipping, for assessing climate patterns, and optimizing monitoring strategies.
Context	Beaufort Sea and Chukchi Sea Planning Areas

BOEM Information Need(s): BOEM needs a comprehensive yet rigorous monitoring system for the OCS in the Arctic to help discern and understand patterns and changes in composition and function, and to separate impacts due to human activities from environmental change. Results from this project will inform NEPA analyses and decision-making related to future lease sales in the Beaufort Sea and Chukchi Sea.

Background: Biological and physical measurements that characterize ecosystem status and trends inform decision-making in the context of resource extraction and climate change. Long-term observations of the ecosystem, preferably over decades, and ideally across trophic levels from microbes to marine mammals, are needed to improve understanding of ecosystem dynamics and better assess possible anthropogenic effects against a naturally variable system. A strong focus on biodiversity - including

taxonomic, genetic, and functional diversity is recommended (Duffy et al. 2013). Diversity can be a gauge of system resilience and functional complexity because high levels of biodiversity promote ocean health and secure the multiple functions and services the oceans provide (Palumbi et al. 2009). Thus, managing resources in ways that conserve existing marine biodiversity will support appropriate ocean energy management (Geijzendorffer et al. 2016). This strategy also aligns with broader national and international goals of determining comprehensive, long-term biodiversity measures (e.g., U.N. Convention on Biological Diversity; Anderson et al., 2017; U.S. Arctic Research Commission 2016).

The work proposed here builds on the pilot development of the Arctic Marine Biodiversity Observing Network (AMBON) in the Chukchi Sea (ending in 2019), which is part of a national Marine Biodiversity Observing Network. AMBON also links to the Distributed Biological Observatory (DBO), which coordinates long-term monitoring of biologically productive regions in the Arctic. This observing network concept is tested and ready to expand to the Beaufort Sea as OCS energy development is undertaken.

Objectives:

- Build on the initial AMBON efforts to extend long-term biodiversity observing to the Beaufort Sea OCS.
- Design a strategic biodiversity observing program for the interconnected Chukchi and Beaufort OCS.
- Optimize data management and accessibility through collaboration with the U.S. Integrated Ocean Observing System (IOOS).

Methods: The project will sample biodiversity of all ecosystem components (microbes, plankton, benthos, fishes, seabirds, marine mammals) with concurrent physical-chemical measurements along a fixed station grid with multiple transects crossing the Beaufort shelf. Lines could include the DBO6 line at 152°W, the area of Simpson Lagoon, and the DBO7 line near Camden Bay (west of Mackenzie River outflow). Several transects from the initial AMBON in the Chukchi Sea (e.g., DBO3, ML1, ML4) could be maintained for continuity and to capture the dynamic connection between the Chukchi and the Beaufort Sea. Lines will be occupied every other year with data management through the Alaska Ocean Observing System (AOOS), a regional IOOS node.

Specific Research Question(s):

1. What are the regional patterns of biodiversity on the Alaska Arctic shelves?
2. How do they influence ecosystem complexity and function?
3. How do they inform energy resource management?

References:

Anderson, K., Ryan, B., Sonntag, W., Kavvada, A., and Friedl, L., 2017. Earth observation in service of the 2030 Agenda for Sustainable Development. Geo-spatial Information Science. http://dx.doi.org/10.1080/10095020.2017.1333230.

Duffy, J.E., Amaral-Zettler, L.A., Fautin, D.G., Paulay, G., Rynearson, T.A., Sosik, H.M., and Stachowicz, J.J., 2013. Envisioning a marine biodiversity observation network. Bioscience, 63(5), 350-361.

Geijzendorffer, I.R., Regan, E.C., Pereira, H.M., Brotons, L., Brummitt, N., Gavish, Y., Haase, P., Martin, C.S., Mihoub, J.B., Secades, C., and Schmeller, D.S., 2016. Bridging the gap between biodiversity data and policy reporting needs: an Essential Biodiversity Variables perspective. Journal of Applied Ecology, 53(5), 1341-1350.

Palumbi, S.R., Sandifer, P.A., Allan, J.D., Beck, M.W., Fautin, D.G., Fogarty, M.J., Halpern, B.S., Incze, L.S., Leong, J.A., Norse, E., and Stachowicz, J.J., 2009. Managing for ocean biodiversity to sustain marine ecosystem services. Frontiers in Ecology and the Environment, 7(4), 204-211.

U.N. Council on Biological Diversity. Strategic Plan For Biodiversity 2011-2020 and the Aichi Biodiversity Targets; https://www.cbd.int/decision/cop/?id=12268 (accessed 3/1/2018).

U.S. Arctic Research Commission and Arctic Executive Steering Committee, eds. 2016. Supporting Arctic Science: A Summary of the White House Arctic Science Ministerial Meeting, September 28, 2016, Washington, DC. United States Arctic Research Commission, Arlington, VA, 78 pp.

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Environmental Studies Program: Alaska Annual Studies Plan

Title	Subsistence Mapping and Traditional Knowledge Studies for Five Cook Inlet Communities: Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Contrct
Approx. Cost	TBD
Performance Period	FY 2020-2022
Date Revised	November 8, 2018
PICOC Summary	
Problem	Subsistence communities living along Cook Inlet could be affected by onshore and offshore resource development. The information that is available to address subsistence use areas and associated traditional knowledge (TK) is either limited to one-year snapshots or dates to the 1980s.
Intervention	Subsistence mapping and TK fieldwork in five of the communities along Cook Inlet was collected for the Alaska LNG Project, but the information was never completely analyzed or published due to the stoppage of the project.
Comparison	Subsistence use area information is presented by species for the 10 year time period (2005-2014) and for the most recent year for which data is collected. This design creates a time series which allows comparison of changing harvest patterns over time and also provides a baseline for future comparisons.
Outcome	This study will provide documentation of recent (e.g., 2005-2014) subsistence use areas and associated TK, describing the current status of subsistence availability, harvest amounts, harvest effort, and health and quality of subsistence resources.
Context	Cook Inlet Subsistence communities

BOEM Information Need(s): OCS Lease Sale 244 in 2017 leased 14 blocks in the Cook Inlet Planning Area and exploration activities are contemplated on those blocks. Lease Sale 258 is scheduled for 2021 under Five-Year Program 2017 to 2022 while the recently released 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program anticipates Cook Inlet OCS Sales in 2021 and 2023. This study will provide information for the description of the existing environment and analysis of direct and cumulative effects for the economy, subsistence, social systems, commercial and sport fishing, and tourism and recreation in the NEPA analyses that accompany these OCS actions. A similar study documenting subsistence activities in the North Slope Borough (Stephen R. Braund & Associates 2009) was invaluable in completing similar NEPA analyses for the Beaufort Sea and Chukchi Sea OCS activities.

Background: In 2013, the Alaska LNG Project commenced subsistence and TK baseline studies for communities potentially affected by the proposed natural gas

pipeline from the North Slope to Kenai Peninsula, Alaska. As part of this effort, Stephen R. Braund and Associates (SRB&A) conducted subsistence mapping and TK studies with 735 individuals in 24 communities, including communities along Cook Inlet (Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek) that could be potentially affected by the Alaska LNG Project. In 2016, after fieldwork in these communities had been completed, the Alaska LNG Project halted all studies and the information from these communities was never fully analyzed and published.

Objectives: This study would complete the data analysis and reporting begun for the Alaska LNG Project for the six communities of Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek to provide updated information regarding these communities' subsistence use areas and TK.

Methods: BOEM will engage with SRB&A to reinitiate contact with the six study communities to coordinate the final publication and review of the subsistence mapping and TK efforts from the Alaska LNG Project. Researchers will complete the data analysis and mapping efforts for these communities. After the communities are given an opportunity to review the final results, researchers will produce a final study report and associated maps for each community.

Specific Research Question(s):

- For all subsistence resources, what subsistence use areas, patterns, and intensity of use for Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek have been used in recent years (2005-2014)?
- What are the active harvester and elder TK observations regarding subsistence availability, harvest amounts, harvest effort, and health and quality of subsistence resources?

References:

Stephen R. Braund & Associates, 2009. *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow*. OCS Study MMS 2009-003. Prepared for the U.S. Department of the Interior, Minerals Management Service, Anchorage, Alaska. 349 pp.

USDOI, BOEM, 2016. Alaska Outer Continental Shelf, Cook Inlet Planning Area, Oil and Gas Lease Sale 244 Final EIS. OCS EIS/EA BOEM 2016-069. Alaska OCS Region. Anchorage, AK.

USDOI, MMS, 2003. Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199 Final EIS. OCS EIS/EA MMS 2003-055. Alaska OCS Region. Anchorage, AK.

Environmental Studies Program: Alaska Annual Studies Plan

Title	Kenai Peninsula Borough Economy, 2007 to 2017
Administered by	Alaska OCS Region
BOEM Contact(s)	TBD
Procurement Type(s)	Contract
Approx. Cost	TBD
Performance Period	FY 2020–2022
Date Revised	November 8, 2018
PICOC Summary	
Problem	The Kenai Peninsula Borough is the area that bears the preponderance of costs and benefits of OCS development in the Cook Inlet Planning Area. The diverse communities of the area have been experiencing unprecedented changing economic conditions including an ongoing state-wide recession.
Intervention	The study will provide a qualitative and quantitative profile of the borough and its constituent villages, towns and cities over the study period. Information on the change will come from primary and secondary sources in relation to trends in the State of Alaska. Information on the changes will come from primary and secondary sources such as comprehensive land use and zoning plans, census data, etc. This typology was used to distinguish effects between these types of communities in previous studies (Fall, et al. 2001) and BOEM Environmental Impact Statements for Cook Inlet (USDOI, MMS 2003; USDOI, BOEM 2016).
Comparison	The trend study will provide data to facilitate further comparison of the effects on communities in NEPA analyses.
Outcome	Documentation on the changes in the economic conditions of the Kenai Peninsula Borough and constituent communities during the study period.
Context	The Kenai Peninsula Borough adjacent to the Cook Inlet Planning Area

BOEM Information Need(s): OCS Lease Sale 244 in 2017 leased 14 blocks in the Cook Inlet Planning Area and exploration activities are contemplated on those blocks. Lease Sale 258 is scheduled for 2021 under Five-Year Program 2017 to 2022 while the recently released 2019-2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program anticipates Cook Inlet OCS Sales in 2021 and 2023. This study will provide information for the description of the existing environment and analysis of direct and cumulative effects for the economy, subsistence, social systems, commercial and sport fishing, and tourism and recreation in the NEPA analyses that accompany these OCS actions. A similar study of the North Slope Borough Economy (Northern Economics, Inc. 2006) was invaluable in completing similar NEPA analyses for the Beaufort and Chukchi Sea OCS activities.

Background: Updated baseline information is needed on the economy and institutions of the Kenai Peninsula Borough (KPB) and its constituent communities (villages which are primarily subsistence-based economies, towns which are primarily

commercial-fishing based-economies and cities which have diverse economies that nonetheless are dominated by oil and gas extraction). Existing information is collected and reported by a number of public-sector entities and tends to be aggregated at the borough-level. That level of analysis does not provide the finer detail to analyze community-level effects. The study period captures major changes that have been experienced because of declining oil and gas revenues.

Objectives:

- Describe the structure of the KPB and constituent communities and how it has changed from 2007 to the 2017, including: in- and out-migration, demographic trends, institutional analyses of local and regional entities, revenues and expenditures of the borough
- Evaluate the role of the regional Alaska Native Claims Settlement Act (ANCSA) Regional and Village Corporations in the KPB as a force for economic development and delivery of public services.
- Identify how the KPB and its communities, ANCSA Village Corporations, tribal entities and others used revenues from the oil and gas industry and establish a comparative basis for assessing economic effects of upcoming onshore and offshore oil and gas activity

Methods: Researchers will assemble existing data sources to synthesize a quantitative and qualitative description of KBP economy by sector (for example, recreation and tourism, commercial fishing, oil and gas), borough revenues and expenditures for each year of the study period, classifying local government services by level and department and other major categories. Using the typology of village, town, and city, they will describe how the KPB and local governments have adapted to the decline in revenues and how individuals, households, and communities have responded to changing conditions. Data from KPB, the State of Alaska and other organizations will be used to describe the structure of the economy (private, public, non-profit sectors including the regional and village Alaska Native Corporations) from 2007 to 2017. Results will identify employment by sector of the economy and employer. An analysis of local jobs and the types of jobs and out-migration and in-migration of workers will include description of the flexibility of jobs in relation to subsistence and commercial fishing. Reviews with local industry, fishing, and tribal interests will also be coordinated as needed.

The study will note changes in the structure of the principle components of the economy including oil and gas, commercial fishing, and recreation and tourism. Researchers will make a quantitative and qualitative description of KBP borough revenue and expenditures for each year of the study period, classifying local government services by level and department and other major categories. The study will describe how the KPB and local governments have adapted to the decline in revenues and how individuals, households, communities have responded to changing conditions. Data from KPB, the State of Alaska and other organizations will be used to describe the structure of the KPB economy (private, public, non-profit sectors including the regional and village Alaska Native Corporations) from 2007 to 2017. Results will identify employment by sector of

the economy and employer. An analysis of local jobs and the types of jobs and out-migration and in-migration of workers will include description of the flexibility of jobs in relation to subsistence and commercial fishing. Reviews with local and tribal officials will also be coordinated as needed.

Specific Research Question(s): What is the structure of the economy of the KBP and communities and institutions and how has it changed and adapted during the focus period of the study?

References:

Northern Economics, Inc., 2006. North Slope Economy 1965 to 2005. OCS Study MMS 2006-020. Prepared for U.S. Department of the Interior, Minerals Management Service, Anchorage, AK. 224 pp.

USDOI, BOEM, 2016. Alaska Outer Continental Shelf, Cook Inlet Planning Area, Oil and Gas Lease Sale 244 Final EIS. OCS EIS/EA BOEM 2016-069. Alaska OCS Region. Anchorage, AK.

USDOI, MMS, 2003. Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199 Final EIS. OCS EIS/EA MMS 2003-055. Alaska OCS Region. Anchorage, AK.

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2.3 Profiles of Ongoing Studies

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Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Arctic Air Quality Assessment Modeling (AK-13-01)

BOEM Information Need(s) to be Addressed: BOEM requires information to assess the cumulative air quality impact of OCS Arctic oil and gas activity, including oil-spill response equipment and associated support equipment not already accounted for through State and Federal air permit requirements. This information will support BOEM and various Federal and State agencies in assuring compliance with the Clean Air Act and environmental justice initiatives. In addition, the information will provide public agencies, permit applicants, and the public with a holistic view of the air pollution impact on the people and environment in Northern Alaska. To support regulation of oil and gas emission sources on the Arctic OCS, BOEM also requires information for defining emission exemption thresholds to ensure OCS facilities will not produce significant air quality impacts to a State.

Total BOEM Cost: $1,766,025 **Period of Performance:** FY 2013-2018

Conducting Organization: Eastern Research Group, Inc.

Principal Investigator(s): Paula Fields Simms (Project Manager)

BOEM Contact: Dr. Heather Crowley

Description:
Background: Any Arctic oil and gas exploration and extraction activities that may be proposed for the OCS will require environmental evaluations pursuant to the NEPA and the Clean Air Act, and air quality operating approval will be required under BOEM's Air Quality Regulatory Program. An air quality model capable of conducting an air impact analysis requires various input datasets, including emission sources and meteorology, and a cumulative evaluation requires existing background pollutant concentrations. This project proposes development of these major input datasets, which would be applied to air quality models such as AERMOD, CALPUFF, and the Community Multipurpose Air Quality model (CMAQ) or the Comprehensive Air Quality Model, with extensions (CAMx), to assess the cumulative air quality impact of proposed offshore OCS projects and North Slope support activities.

Various estimates are available for pollutant sources from proposed and existing North Slope and OCS activities, but there is no overall analysis to show the increased pollutant concentration from all aspects of the proposed activities, including increased emissions in towns along the coast, emissions from support vehicles far from the drilling operation, and aircraft and helicopter emissions. This project pulls together existing emissions information available from the Alaska Department of Environmental

Conservation and combines it with estimates of additional emissions from proposed OCS activities. From this comprehensive database, an emission inventory can be calculated and translated to three-dimensional emissions for a time period of interest (i.e., output from the Sparse Matrix Operator Kernel Emissions [SMOKE] processor).

This project includes development of a five-year meteorological modeling dataset (years 2009-2013) that is optimized for performance with air quality dispersion models. The meteorological and emissions datasets will be applied to local area air quality models such as AERMOD and CALPUFF, and a regional air quality model such as CMAQ or CAMx. The results will assist in defining the cumulative impacts of all pollution sources induced by OCS activity, including the formation of secondary fine particulate matter (PM2.5) and ozone chemistry that may be occurring in this environment. This study will be coordinated with work in the Gulf of Mexico OCS Region to avoid duplication of efforts and ensure consistency with similar approaches.

Objectives:

- Test the hypothesis that the cumulative impacts from OCS-related activities, exclusive of permitted sources, would not cause a statistically significant impact on Alaska.
- Test the hypothesis that secondary PM2.5 and ozone are not significant for cumulative impact analyses.
- Evaluate modeling results to assess the cumulative impact of emissions on the OCS and on the North Slope.
- Apply the results to demonstrate compliance under the NEPA and the Clean Air Act for EISs and EAs prepared by BOEM and use the information to evaluate the existing emission exemption equations and, if needed, develop revised exemption equations.

Methods:

1. Build an input database of emission sources typically associated with oil and gas activities on the OCS. Build in a scenario of potential OCS development.
2. Prepare an emission inventory using EPA-approved calculation methods and prepare emissions data sufficient as input to local and regional air quality models.
3. Compile and format a dataset for use in dispersion models approved for the Arctic OCS. To the extent practicable, this should build upon meteorological datasets developed by the BOEM "Beaufort/Chukchi Seas Mesoscale Meteorology Modeling Study" and by industry that reflect climatological conditions of the North Slope, Beaufort Sea, and Chukchi Sea.
4. Conduct air quality modeling by applying the input datasets to EPA-approved models such as AERMOD, CALPUFF, CMAQ, or CAMx.

5. Analyze importance of atmospheric chemistry with tools such as a literature survey, box chemistry models, plume models with chemistry, and regional air quality models.
6. Assess the results to identify the background impact and the cumulative impact of proposed OCS activities to meet the project objectives.

Revised Date: August 9, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea
Administered By:	Alaska OCS Region
Title:	Beaufort Sea Marine Fish Monitoring Survey in the Central Beaufort Sea (AK-10-06)

BOEM Information Need(s) to be Addressed: Fish resources are important to upper trophic levels in the Beaufort Sea ecosystem and to the coastal communities. NEPA analysts need additional species presence and abundance information for assessing potential impacts of OCS development activities. Study information will support NEPA analysis and documentation for Beaufort Sea EPs and DPPs.

Total BOEM Cost: $1,764,252 **Period of Performance:** FY 2010-2018

Conducting Organization: University of Alaska Fairbanks

Principal Investigator(s): Dr. Brenda Norcross

BOEM Contact: Catherine Coon

Description:
Background: Enhanced marine fish information is needed for Beaufort Sea NEPA analyses. Existing data at the most basic level—e.g., fish species presence/absence and distribution data—are spotty and outdated. Fish assemblages and populations in other marine ecosystems off Alaska have undergone observable regime-shifts in diversity and abundance over the last 20-30 years. While the same is likely true of the Beaufort Sea, it is unconfirmed because the scant distribution and abundance data available are pre-regime-shift. Furthermore, important marine mating, spawning, rearing, feeding, and migration habitats (pre or post regime-shift) is yet to be delineated. A baseline of fish species, distribution, relative abundance, and the locations of critical or sensitive life history stage habitats in this central portion of the Beaufort Sea Planning Area remains a very high-priority information need for NEPA analyses.

An under-ice pilot survey is included because the Beaufort Sea Planning Area is under ice for half to three-fourths of the year. Thus, it is important that BOEM obtain a more complete data set that encompasses the under-ice season. The addition of the under-ice pilot survey study will provide a more complete methodology and a baseline data set that encompasses all seasons in the Beaufort Sea, including ice-covered seasons. Such a data set will support environmentally sound OCS oil and gas exploration and development decisions.

The addition of bird and marine mammal observers and zooplankton sampling will provide transect data in offshore areas where data for those species is as sparse as for fish species. The contemporaneous collection will also enable first-time correlations between fish, zooplankton, birds and marine mammal species in this area.

Objectives:

- Identify the fish species that occupy the central OCS Beaufort Sea Planning Area.
- Develop and recommend a methodology adapted to arctic conditions and specific BOEM information needs for use in future surveys.
- Identify the fish species that occupy the central Beaufort Sea Planning Area during the ice-covered season.
- Correlate observation of seabirds and marine mammals to fish and zooplankton for increased understanding of this arctic ecological system.

Methods: The survey will sample fish and zooplankton in the central Beaufort between 147° and 152° west longitude, the area of greatest interest. Due to logistical conflicts encountered in 2008, it will incorporate new strategies for timing surveys to avoid interference from industry seismic surveys. It will include methods adapted to sampling small sized and rare fish thought to inhabit the Beaufort Sea and also assess additional options to effectively sample bottom habitats. Addition of bird and marine mammal observers will provide transect data to those specialties and allow correlations between fish, zooplankton, birds, and marine mammals.

A pilot under-ice marine survey will implement a design outlined in the 2007 MMS "Under-Ice Sampling Workshop." The survey will occur in three stages: 1) assemble local and traditional knowledge with Inupiat residents; 2) under-ice sampling by local residents and time lapse under-ice cameras, 3) test survey of three different and difficult-to-sample Arctic cod habitats at the ice-water interface with DIDSON sonar (dual frequency identification sonar), remotely operated vehicles (ROVs), and shallow-water scuba transects. The pilot study will provide statistical hypothesis testing between the open water, ROV and dive surveys, which will provide a baseline for subsequent surveys and provide sampling statistics, including variance estimators, for future time-series analyses.

The final products will include Geographic Information Systems (GIS) and report formats. Intermediate results will be provided for NEPA analyses.

Revised Date: August 13, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Alaska Monitoring and Assessment Program (AKMAP) Survey of Estuaries within the National Petroleum Reserve-Alaska (AK-13-03-11)

BOEM Information Need(s) to be Addressed: Information is needed on coastal estuarine habitats and baseline contaminants in the Beaufort and Chukchi Seas to refine our understanding of the connections between marine and coastal habitats. Habitats in the ecologically fragile coastal environments are particularly vulnerable to oil spills. Information from this study will support a better understanding of current conditions to improve understanding of changing distributions of habitats and contaminants under different development scenarios and climate change conditions. This project will operate concurrently with and integrate with ANIMIDA III (AK-11-14b) to provide a current baseline of ecological conditions in coastal areas.

Total BOEM Cost: $250,594
plus Joint Funding ($250,594)

Period of Performance: FY 2015-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Doug Dasher

BOEM Contact: Warren Horowitz

Description:
Background: An aquatic resource survey of estuaries within the National Petroleum Reserve-Alaska (NPR-A) is being conducted by the Alaska Department of Environmental Conservation (ADEC) under the Alaska Monitoring Assessment Program (AKMAP). This survey is based on sampling designs developed with an integrated approach that uses multiple indictors to allow for assessment, evaluation, understanding and forecasting at different spatial scales. The AKMAP surveys allow for statistical inferences to be made for the entire population or region, such as NPR-A estuaries, that can be used to support baseline assessments of ecological condition, cumulative impacts, trends over time and for use in probabilistic risk assessments. The funding provided by BOEM will double the number of sites to be surveyed.

The NPR-A survey will assist local, State, and Federal resource managers to identify issues, alternatives and mitigation measures necessary for NEPA documents. For example, it will provide information for identifying critical habitat areas for multiple uses (i.e., marine mammals, benthic organisms, sea birds, fishes, oil spill response and subsistence use), and to inform the selection of appropriate pipeline corridors. The survey will provide information useful in the development of technical tools, such as

regional sediment normalization curves and benthic response indices, which facilitate evaluation of potential environmental effects from human activities.

AKMAP NPR-A Survey Design: The NPR-A estuary target population was mapped with a combination of NOAA's environmental Sensitivity Index coastline for the North Slope with some shorelines modified for erosion based on 2010 SPOT imagery. Estuaries were defined for the NPR-A as any tidally-influenced water with less than 50% of its perimeter adjacent to the ocean. Indicators to be measured include characteristics of the aquatic resource that provide quantitative or semi-quantitative data on the condition of the aquatic resource. Indicators allow AKMAP to evaluate effects of multiple stressors, such as chemical contaminants and other human activities, on the biological communities. AKMAP considers two types of indicators, condition and stressor. Biological or physical characteristics are condition indicators used to evaluate the condition of the aquatic resource to an environmental value. Biodiversity of marine sediment invertebrates is a condition indicator for the environmental quality of the waters. Stressors, such as low dissolved oxygen or petroleum hydrocarbon contamination, may result in measurable changes in condition indicators, such as benthic or fish community structure.

Objectives: The goal of this project is to expand the existing AKMAP surveys to include up to 20 additional sampling stations, allowing for a more robust statistical analysis, and to incorporate a sediment chemistry analysis into the project. The specific objectives of this project include:

- Estimate the areal extent of NPR-A estuaries that meet or do not meet ADEC and Environmental Protection Agency (EPA) water quality criteria in regard to ecological conditions (sediment, water column, biological).
- Assess whether areal extent and magnitude of ecological conditions vary between the NPR-A Chukchi and Beaufort estuaries.
- Evaluate potential connections between biological responses and contaminant exposure, including relationships between diversity and abundance of macroinvertebrates and habitat conditions, such as sediment grain size, at each station, or contaminant concentrations, including sediment trace metals and polycyclic aromatic hydrocarbons.
- Assess potential differences between regional reference conditions established by the entire survey and the same indicators measured temporally at potentially impacted stations, such as areas near oil seeps.

Methods: The survey will follow National Coastal Condition Assessment (NCCA) methods that are prepared nationally by EPA in coordination with the States for teams conducting aquatic resource surveys. AKMAP NPR-A will use four NCCA indices of condition – water quality (pH, dissolved oxygen, temperature, salinity, nutrients, total suspended solids, light transmittance, chlorophyll a), sediment quality (hydrocarbons, trace metals, total organic carbon), benthic community condition, and fish tissue contaminants.

A Generalized Random Tessellation Stratified survey design for an area resource was used to locate the stations, but the targets may be modified based on a final assessment of bathymetry in relation to the draft of the vessel finally contracted. Two strata were created – Beaufort Sea and Chukchi Sea estuaries – with an equal probability of selection of 20 base stations plus 20 oversample stations within each stratum. At each station, water column data will be collected through the use of a CTD and Niskin bottle sampling. Surficial sediment samples (macroinvertebrate and sediment chemistry) also will be collected. A 1-meter beam trawl will used to collect epifauna and fish samples for tissue contaminants. A microbial hydrocarbon degradation study and a sediment core dating pilot project will share the water and sediment samples.

Revised Date: August 8, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Migration Trends for King and Common Eiders and Yellow-billed Loons past Point Barrow in a Rapidly Changing Environment (AK-13-03-14)

BOEM Information Need(s) to be Addressed: This study will provide information to inform decision-making about the management of eiders and loons, including assessing conservation priorities such as potential impacts from climate change, increased shipping, and OCS oil and gas exploration and development in the Beaufort Sea and Chukchi Sea. BOEM analysts and decision-makers can use this information in NEPA analysis and documentation for potential future lease sales, EPs and DPPs.

Total BOEM Cost: $62,977
plus Joint Funding ($62,977)

Period of Performance: FY 2016-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Abby Powell

BOEM Contact: Rick Raymond

Description:
Background: Most of the king (*Somateria spectabilis*) and common eiders (*S. mollissima v-nigra*) and yellowbilled loons (*Gavia adamsii*) nesting in northern Alaska and northwestern Canada migrate twice annually past Point Barrow, Alaska during their northward spring migration and their southward fall migration. In 1996, spring and fall counts indicated both eider species experienced population declines of approximately 50% between 1976 and 1996. The counts were repeated in 2002-2004, at which time it appeared that since 1996 the number of common eiders passing Point Barrow had increased, but only slightly, and that the number of king eiders had remained stable but had not returned to the 1970s levels. Loon species were also counted in the surveys in 2002-2004, but data have not been analyzed.

The North Slope Borough (NSB) and the Wildlife Conservation Society (WCS) successfully completed a spring count of these species in 2015. This project will repeat the spring migration count in 2016 to obtain estimates of king and common eider populations to be analyzed with the current 2015 count. These data can be compared with those from the 1970s, 1996 and the early 2000s to evaluate long-term and current trends, evaluate observer error through photographic and radar techniques, and obtain estimates of yellow-billed loon populations that can be compared to the previous counts. These data will support assessment of conservation needs of these species, both now and in the future.

Objectives:

- Obtain estimates of king and common eiders passing by Point Barrow in spring 2016 and compare with counts from 1996, the early 2000s, and spring 2015.
- Evaluate observer bias through photographic and radar techniques.
- Obtain estimates of yellow-billed loons passing by Point Barrow in spring and fall 2016 and compare with counts from 1996 and the early 2000s.

Methods: Spring counts will be accomplished from an observation site on the shore-fast sea ice approximately 10 km southwest of Point Barrow. Counts will be conducted from approximately 20 April to early June from the same general location as previous year counts. Sex, species, and age-ratio will be determined both visually by ground-based observers and by photographic sampling using a high-resolution camera with 400-mm telephoto lens. For each flock sighted, time, direction of travel, species composition, and number sighted, ratio of males to females will be recorded. Data analysis will be consistent with that used for previous counts in order to compare results with earlier estimates. Study results will be shared through presentations, reports and peer-reviewed publications.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Identifying Sources of Organic Matter to Benthic Organisms in the Beaufort and Chukchi OCS (AK-13-03-15)

BOEM Information Need(s) to be Addressed: This study will track organic matter sources to benthic consumers on the OCS of the Beaufort and Chukchi Seas. NEPA analysts evaluate the potential effects of oil and gas activities both within and along with the cumulative in these two OCS planning areas. NEPA analysts need quantitative information and tools to assess the contribution of various organic matter sources to marine food webs, sources that can be directly contribution of various influenced by oil and gas extraction activities. The baseline data will also allow for comparison to monitor potential future developments on the OCS.

Total BOEM Cost: $246,082
plus Joint Funding ($246,082)

Period of Performance: FY 2016-2019

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Matthew Wooller

BOEM Contact: Warren Horowitz

Description:
Background: Benthic invertebrate communities in the Arctic are an essential ecosystem component in terms of mineralization and energy transfer to higher trophic levels. Understanding the baseline sources of energy flow is essential for management and mitigation in light of the potential for climatic and anthropogenic alterations to the Arctic, many of which are likely to happen through food web links. Development impacts may influence or alter marine environment the way invertebrates process the baseline organic matter sources for marine consumers, potentially changing energy pathways that ultimately support sentinel higher trophic levels of great ecological and subsistence importance. Results from prior BOEM-funded food web work in the Beaufort Sea indicate, terrestrial carbon may have to undergo microbial degradation before it becomes a viable food source. In addition dramatic Arctic climatic changes including melting sea ice cover, increased storm activities, and permafrost and coastal erosion, contribute to changing carbon sources available to marine food webs (e.g., sea ice to phytoplankton production and possibly an increase in microphytobenthos production), likely changing proportions of organic matter sources and perhaps changing the overall marine primary production occurring in Arctic shelf seas.

The essential amino-acid-specific stable carbon isotope approach in this study is a particularly powerful tool to quantify the proportional contribution of microbial,

terrestrial plant, and marine primary producers consumed by benthic organisms. Essential amino acids cannot be synthesized *de novo* by consumers, but rather originated from the organisms that synthesized them (e.g., photosynthetic or microbial organisms). These essential amino acids, with their specific isotope values, are then incorporated into and conserved within a consumer. Essential amino acids within a consumer create a pattern, termed "stable isotope fingerprint," can be statistically compared with the fingerprints of essential amino acids from primary producers. This method has been tested in marine ecosystems, but not yet applied to Arctic marine food webs.

This study will complement much of the bulk isotope research that has been and is being applied in OCS regions by using existing, archived samples from previous BOEM-funded projects provide novel, quantitative baseline food web information by filling a gap identified in previous work on benthic food webs in these Arctic OCS systems and provide an important benchmark for comparison with future samples.

Objectives:

- Identify the stable carbon isotope compositions of essential amino acids from benthic organisms that contribute substantially to benthic biomass and have a variety of feeding types and mobility in the Beaufort Sea OCS and are common prey for higher trophic levels.
- Perform essential amino acid fingerprinting of archived ecological equivalent benthic samples from the Chukchi Sea OCS.
- Quantify the proportional contribution of marine photosynthetic (sea ice, phytoplankton, microphytobenthos), terrestrial photosynthetic, and microbial-derived essential amino acids in Beaufort and Chukchi seas benthic organisms.
- Compare the Beaufort Sea and Chukchi Sea results with published database of production sources (Larsen et al., 2009; Larsen et al.,2013) to identify amino acid sources for the tested benthic organisms.

Methods: This project will measure the stable carbon isotope composition of individual essential amino acids for approximately 400 bivalve, shrimp and echinoderm samples from the Beaufort and Chukchi Seas. The samples are derived from a collection of more than 5,000 samples of benthic marine invertebrates that have been archived from the BOEM-funded *U.S.-Canada Transboundary Fish and Lower Trophic Communities, AMBON*, and *Hanna Shoal Ecosystem Study* projects. Isotope signatures will be compared to a published database of signatures from primary producers using discriminant analyses to determine whether amino acid fingerprints are characteristic of algal, microbial, or terrestrial sources. Researchers will use the normalized isotope values to calculate proportional contributions of essential amino acids from sources to consumers.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Nearshore Food Web Structure on the OCS in Cook Inlet, Alaska (AK-13-03-22)

BOEM Information Need(s) to be Addressed: Updated and readily accessible intertidal and shallow subtidal habitat information will support environmental analyses for future Cook Inlet lease sales and potential future Exploration Plans, and Development and Production Plans in Cook Inlet, as well as for BSEE's ongoing spill response planning. The subtidal and intertidal areas are home to many grazing invertebrates which provide an important source of prey for marine and terrestrial mammals, birds, other invertebrates and humans and are particularly susceptible to oil spills. Updated information from this study will be important to understanding and assessing potential impacts of an oil spill in Cook Inlet.

Total BOEM Cost: $124,402
plus Joint Funding ($124,402)

Period of Performance: FY 2017-2019

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Katrin Iken

BOEM Contact: Catherine Coon

Description:
Background: Nearshore marine habitats are particularly vulnerable to potential impacts of marine oil and gas extraction activities and shipping, as well as to influences from climate change or other anthropogenic activities. In addition to the direct lethal effects that a severe incident such as an oil spill could have on nearshore species of all trophic levels, more subtle effects include the reduction of resilience and health of species and the disruption of the energy flow among the various nearshore ecosystem components.

Food web structure is the representation of how species within the nearshore system are linked through energy flow, thus building a network. Food web interactions are responsive to perturbations from human activities such as oil and gas extraction as well as from climate change, potentially leading to disruptions in energy flow to higher trophic levels.This project will examine food web structure in nearshore, macroalgal-dominated systems in Kachemak Bay and in Kamishak Bay, adjacent to the Cook Inlet 2017-2022 Program Area. These nearshore systems are highly diverse, and current efforts are underway to characterize the community composition and diversity of these systems (AK-15-08; AK-14x-10) partnering with National Park Service, University of Alaska Fairbanks, and the Cook Inlet Regional Citizens Advisory Council. Leveraging off these ongoing BOEM funded studies, this study will add a dynamic, food web oriented characterization of the ecosystem. Adding a food web perspective to

simultaneously ongoing studies of species occurrence and richness provides a more dynamic, interaction-driven view of the ecosystem that can be useful in understanding key species function in an ecosystem.

Objectives: The overarching goal of the study is to identify the food web structure (trophic levels and trophic niche use) of the nearshore macroalgal-based systems in Cook Inlet, to provide an assessment of the potential vulnerability of the nearshore food webs, and to establish a benchmark for monitoring changes in food web characteristics over time. Specific objectives include:

- To quantitatively describe and compare nearshore macroalgal-based food web structure in two regions in Cook Inlet using stable isotope analysis.
- To gauge resilience of nearshore food webs in Cook Inlet based on measures of food web structure and trophic niche space.

Methods: This project will provide quantitative measures of nearshore food webs, such as food web length, trophic level of main taxa, food web niche structure, and carbon sources within the Cook Inlet OCS. Sampling will occur in two regions in Lower Cook Inlet: Kachemak Bay and Kamishak Bay in 2017 and 2018. Lab analysis will use carbon and nitrogen stable isotope of nearshore primary producers (macroalgae, phytoplankton) and abundance consumers (mussels, limpets, whelks, sea stars, and crabs) combined with quantitative abundance data.

Revised Date: August 13, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Benthic Habitat Mapping in Eastern Cook Inlet (AK-13-03-25)

BOEM Information Need(s) to be Addressed: Easily interpretable information about benthic habitats is needed to support environmental analyses for OCS development in Cook Inlet, as well as for BSEE's ongoing oil-spill response planning. Products from this study will support NEPA analyses for future Cook Inlet lease sales and for future EPs and DPPs that may result from Cook Inlet Lease Sale 244 (2017) and others in the future.

Total BOEM Cost: $25,000 plus Joint Funding ($25,000)

Period of Performance: FY 2017-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Jennifer Reynolds

BOEM Contact: Dr. Heather Crowley

Description:

Background: Kachemak Bay is a geologically diverse area of eastern Cook inlet that formed as a glacial fjord. Today it has large inputs of freshwater and sediment from streams and glaciers. The north side of Kachemak Bay is characterized by lowlands of the Peninsular Terrane, composed of weakly lithified marine sediments of the Sterling and Beluga Formations and extensively covered by glacial till. Homer spit is a glacial moraine that extends from the north side across most of the bay. The eastern head of the bay is home of the mud and silt-rich Fox River Flats. Bedrock south of the bay is primarily the McHugh Complex of the Chugach Terrain, composed of basalt, volcanic tuff, and marine sedimentary rocks. This area is mountainous with extensive glaciers.

Bathymetry and geological substrate are the major components of benthic habitat mapping, including seabed relief at multiple scales, sediment grain sizes, identification of current-driven bedforms, and the location and lithology of bedrock outcrops and glacial dropstones. The benthic environment also includes the near-seabed oceanography. This analysis will include characterization of the substrate, oceanographic setting, and bottom water characteristics of temperature, salinity and turbidity.

Objectives: This study will construct a high resolution benthic bathymetry of of the Kachemak Bay area in lower Cook Inlet as a basis for future classification of substrate, bottom water characteristics, and different habitat types.

Methods: This study will develop a very high resolution bathymetry geodatabase for Kachemak Bay. This bathymetry data will facilitate future habitat density mapping efforts.

Revised Date: August 9, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Functional Diversity of Epibenthic Communities on the Chukchi and Beaufort Sea Shelves (AK-13-03-27)

BOEM Information Need(s) to be Addressed: This study will evaluate the functions lower trophic epibenthic organisms have within overall ecosystem processes to better understand the way these Arctic ecosystem operate. Potential disturbance from oil and gas activities to these processes could be identified through changes in the biological trait composition of benthic communities. BOEM NEPA analysts evaluate the potential effects of oil and gas lease sales and the cumulative effects of human activities in areas that may be impacted by OCS oil and gas exploration, development, and production activities. A better understanding of how the lower trophic communities contribute to the local ecosystem will support analysts evaluating potential impacts of development that may cascade through the lower and upper trophic ecosystem. This will directly contribute to implementing BOEM's mission of risk assessment and development of management strategies. Baseline data collected will also facilitate future environmental effects monitoring at Liberty and other potential oil and gas developments on the OCS.

Total BOEM Cost: $23,548
plus Joint Funding ($23,548)

Period of Performance: FY 2017-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Lauren Sutton

BOEM Contact: Lorena Edenfield

Description:
Background: Functional diversity encompasses the role of species within a community through redundancy and similarities of shared traits. For example, high functional redundancy, where many species of a community share similar biological traits, leads to high ecosystem stability and increased resilience because a specific community function would still be maintained even if one species were to disappear due to a disturbance. In contrast, a taxonomy-based community analysis would show the change in species composition, but would not indicate how this change relates to overall ecosystem functioning.

Biological trait analysis (BTA) assesses functional diversity by assigning biological traits to species based on their life history, morphology and behavior, thus identifying their function and role in a specific environment. Functional diversity includes traits related to morphology (body form, fragility, colonial/solitary), behavior (mobility, adult movement, feeding habit, trophic level, bioturbation, depth range), and life history (size,

weight, adult age, reproductive strategy, larval development size). Each trait is further separated into modalities. For example, the feeding habit trait is separated into six modalities: surface deposit feeder, subsurface deposit feeder, suspension feeder, scavenger, predator, and parasite.

Benthic communities are especially suitable for this purpose because they integrate processes over time spans of months to years and are thus excellent indicators of longer-term impacts.

Objectives:

- Establish an epibenthic biological trait analysis (BTA) benchmark of ecosystem functioning for the Beaufort Sea and Chukchi Sea shelf systems
- Compare the functional diversity of the Beaufort Sea and Chukchi Sea shelf communities using biological trait analysis.

Methods: Researchers will select epibenthic invertebrates collected in 10 to 60 meter water depths during previous and ongoing BOEM field studies. A combination of measurable biological traits (e.g., weight, body size, body form) and traits derived from extensive literature research (e.g., life history information, feeding type) will be used to create a database of biological traits from vouchers as well as specimen photographs. Each species' affinity to one or more of the 6 'modalities' (scavenger, predator, etc.) will be evaluated using a multivariate linear ordination method called fuzzy coding analysis. Researchers will calculate modalities over all taxa at each station and compare biological traits between stations along both the Beaufort Sea and Chukchi Sea shelves.

Revised Date: August 16, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Ecological Processes in Lower Cook Inlet and Kachemak Bay: A Partnership in Monitoring (AK-14-x10; AK-14-x11; AK-14-x12)

BOEM Information Need(s) to be Addressed: NEPA analysts require updated information regarding the physical and biological environment, including variability in oceanographic conditions and plankton communities, as well as data related to sensitive species. The results will support NEPA analysis and documentation for lease sales, Explorations Plans (EPs), and Development and Production Plans (DPPs). Collected oceanographic, benthic and seabird data will support validation and sensitivity testing of ocean circulation models used for BOEM's Oil-Spill Risk Analysis efforts.

Total BOEM Cost: $350,000 plus Joint Funding (~$1,000,000) **Period of Performance:** FY 2014-2018

Conducting Organization: NOAA; Dr. Kris Holdereid; USFWS; Dr. Kathy Kuletz (completed); NPS Heather Coletti (completed)

BOEM Contact: Catherine Coon

Description:

Background: Cook Inlet circulation patterns are influenced by intrusions of the Alaska Coastal Current, large seasonal changes in freshwater input, geographically-influenced wind forcing and a large tidal range. The lower Cook Inlet and Kachemak Bay also support rich nearshore and pelagic biological communities. Improving understanding of this complex marine environment will improve understanding of biological variability and potential impacts from oil and gas development activities.

The *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) and State and Federal agencies are currently supporting a five-year, $12 million long-term monitoring program in the Gulf of Alaska region affected by the 1989 *Exxon Valdez* oil spill, including lower Cook Inlet. The multidisciplinary monitoring program, called GulfWatch Alaska, seeks to build upon the extended restoration research and monitoring by providing data to identify and help understand the impacts of multiple ecosystem factors on the recovery of injured resources. This program, headed by the Alaska Ocean Observing System (AOOS), Prince William Sound Science Center, and the NOAA Kasitsna Bay Laboratory, links changes in environmental conditions with population trends in nearshore benthic and pelagic species. In lower Cook Inlet and Kachemak Bay, the program includes seasonal oceanographic and plankton surveys, annual near-shore benthic surveys, and opportunistic seabird and marine mammal surveys.

Data management for the GulfWatch Alaska program is coordinated by AOOS and science synthesis is led by the NOAA Kasitsna Bay Laboratory. Oceanographic data from this study will also support NOAA's ongoing validation efforts for the NOS circulation model to improve model use in environmental assessments and oil-spill response planning. Collaboration with the GulfWatch Alaska program and partner organizations (AOOS, NOAA, USGS, UAF, ADF&G, USFWS, etc.) presents a unique opportunity for BOEM to leverage funds and obtain needed information through support of expanded ecosystem monitoring efforts in lower Cook Inlet.

Objectives:

- Quantify seasonal and inter-annual variability in oceanographic conditions and plankton communities and provide information to assess long-term trends.
- Enhance monitoring of sensitive species (seabirds, sea otters) in conjunction with monitoring of environmental conditions.
- Improve understanding of water mass movement in lower Cook Inlet/Kachemak Bay for use in environmental analysis and circulation model validation.
- Compile existing historical data and literature in regards to intertidal studies and canopy kelps in the subtidal from Cook Inlet. Information will be accessible for use in planning as well as for use in future site selection and recommendation for more extensive evaluations.

Methods: This study will enhance existing oceanographic surveys, plankton surveys, near-shore benthic surveys, and upper trophic level surveys of seabirds and marine mammals to support NEPA analyses. Collected data include: temperature, salinity, phytoplankton and zooplankton samples, water samples for acidification analyses, benthic surveys, and seabird and sea otter observations when possible. Currently, oceanographic and plankton surveys are conducted quarterly along three transects in lower Cook Inlet and two transects in Kachemak Bay. Based upon consideration of results from analysis of data collected in 2012, surveys will be expanded in time and/or space to improve assessment of seasonal conditions. The need for expanded benthic monitoring will be assessed and implemented if appropriate. This study will also provide for addition of seabird and marine mammal observers to all surveys in Cook Inlet. Standard agency protocols are used for intertidal, bivalve and subtidal canopy kelp, at-sea seabird and marine mammal monitoring. A pilot field season occurred in 2015 in the Kamishak Bay Area.

Revised Date: August 13, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring (AK-15-01)

BOEM Information Need(s) to be Addressed: BOEM needs a more rigorous monitoring system to improve information about the health of biodiversity in the Chukchi Sea as a means to enhance environmental impact assessments and develop better metrics for cumulative impact analysis. Biodiversity measures for the marine environment need to be acquired through systematic and comprehensive methodology.

Total BOEM Cost: $1,750,000 plus Joint Funding (~$4,200,000) **Period of Performance:** FY 2015-2020

Conducting Organization: NOPP Partnership with NOAA-IOOS; UAF

Principal Investigator(s): Dr. Katrin Iken

BOEM Contact: Catherine Coon

Description:

Background: Biological diversity is defined as the variety of life, encompassing variation at all levels of complexity – genetic, species, ecosystems, and biomes – and including functional diversity and diversity across ecosystems. A growing body of research demonstrates that: (1) the maintenance of marine biodiversity (including coastal biodiversity) is critical to sustained ecosystem and human health and to resilience in a globally changing environment; and (2) the condition of marine biodiversity offers a proxy for the status of ocean and coastal ecosystem health and the ability to provide ecosystem services. Thus, managing our marine resources in a way that conserves existing marine biodiversity would help address other ocean management objectives. For example, it would provide information to enhance management against threats such as invasive species and infectious agents, enable predictive modeling, better inform decision-making, and allow for adaptive monitoring and Ecosystem-Based Management.

The overarching goal of the AMBON project is to build an operational marine biodiversity observing network from microbes to whales. AMBON is a 5-year research partnership (2015-2020) between university and Federal investigators that integrates with the Alaska Ocean Observing System (AOOS) as the central data node to provide a publicly accessible and user- friendly database. AMBON is funded through the National Ocean Partnership Program, with contributions from the National Oceanographic and Atmospheric Administration (NOAA), the Bureau of Ocean and Energy Management (BOEM), and Shell Exploration and Production Company. AMBON is primarily focused on the continental shelf in the Chukchi Sea, but through these partnerships, AMBON will make biodiversity data available to a broad audience of users and stakeholders,

from local to pan-Arctic to global. The AMBON project samples two of the Distributed Biological Observatory (DBO) lines.

The assessment of possible adverse risk from OCS energy development hinges on being able to differentiate human-induced effects from natural variability. Given the complexity of marine ecosystems and the possible effects of global climate change, this often requires making observations over large ocean areas, seasonally, and over multiple years and even decades to acquire reasonable statistical confidence.

Objectives: The AMBON has four principal objectives to develop a sustainable model of continuous biodiversity observation including all levels of diversity from genetic to organismal to ecosystem:

- To improve taxonomic and spatial coverage in biodiversity observations on the Chukchi shelf.
- To integrate and synthesize past and ongoing research programs on the US Arctic shelf into an Arctic biodiversity observation network with publicly accessible data.
- To demonstrate how a sustainable observing network could be developed for this and other regions and ecosystems.
- To link with international programs on the pan-Arctic level.

Methods: AMBON has had two field seasons – one in 2015 and one in 2017. During those field efforts, AMBON collects ecosystem level biodiversity information along five cross-shelf and one along-shelf transect in the Chukchi Sea. State of the art genetic techniques complement traditional taxonomic approaches to include the small size fractions (microbes, nano- to microplankton, meiofauna) into biodiversity assessments.

Through working with the Alaska Ocean Observing System (AOOS), the program creates open access data and coordinates with other national BON demonstration projects. Outreach is pursued through a website (through AOOS), and interactions with local communities, specifically the Native Alaska communities of the north that are most directly affected by the changes in the Arctic. Various stakeholders are engaged through direct communications (e.g., BOEM, Shell, IOOS), workshops, database, scientific meetings, etc.

Revised Date: August 13, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Subtidal and Intertidal Habitats and Invertebrate Biota in Lower Cook Inlet, Alaska (AK-15-08)

BOEM Information Need(s) to be Addressed: Updated and readily accessible intertidal and shallow subtidal habitat information is needed to conduct environmental analyses for OCS development in Cook Inlet, as well as for BSEE's ongoing oil-spill response planning. The subtidal and intertidal areas are home to many grazing invertebrates which provide an important source of prey for marine and terrestrial mammals, birds, other invertebrates and humans and is particularly susceptible to oil spills. Updated information from this study will be important to understanding and assessing potential impacts of an oil spill in Cook Inlet.

Total BOEM Cost: $600,000 plus Joint Funding (~$150,000) **Period of Performance:** FY 2015-2019

Conducting Organization: National Park Service

Principal Investigator(s): Heather Coletti

BOEM Contact: Catherine Coon

Description:
Background: Benthic invertebrates and their habitats are susceptible to effects from oil and gas exploration and development activities. The subtidal invertebrates and habitats adjacent to the OCS are particularly susceptible to oil spills and updated information is needed to assess impacts from a potential large oil spill in Cook Inlet. Previous research on intertidal and subtidal habitats in Cook Inlet includes the Outer Continental Shelf Environmental Assessment Program (OCSEAP) begun in 1975, as well as work done by the Cook Inlet Regional Citizens Advisory Council (CIRCAC) in 2000.

Subtidal and intertidal communities are also an important conduit of energy, nutrients, and pollutants between terrestrial and marine environments; provide resources for subsistence, sport, and commercial harvests; and are important for recreational activities such as wildlife viewing and fishing. Changes in the structure of the intertidal community serve as valuable indicators of disturbance, both natural and human induced. Further, changes in overall and relative abundance of intertidal species may have serious consequences for the bird and mammal species that forage in nearshore areas.

Marine bivalves (clams, mussels, and chitons [badarkis]) in particular are subsistence species for Alaska Natives and residents. Native communities in Port Graham and Nanwalek have noted a substantial decline in shellfish populations and have expressed

concern over the potential loss or contamination of subsistence resources. Bivalves are ubiquitous and critical components of the nearshore intertidal environment, and have been used widely as sentinels in monitoring programs. Community monitoring for bivalves for potential contaminants would be an important component to address concerns about release of contaminants, most notably polycyclic aromatic hydrocarbons (PAH), into the environment. It is important to improve our understanding of the following: the extent and details of benthic habitat that support subsistence resources, hydrocarbon loads in these resources, as well as the sources and extent of local contamination, particularly those where subsistence harvest continues.

This study will be conducted with a collaborative approach between communities and Federal agencies. The study will provide a better understanding of invertebrate biota including distribution and densities, and will depict the variety of habitat structures. A subset of the species will be used as sentinel species to assess the vulnerability of marine ecosystems to the effects of oil contamination. Hydrocarbon work will also leverage previous surveys by CIRCAC and NOAA-NOS. Potential cooperators include USGS, CIRCAC, NOAA, USFWS, Gulf Watch Alaska, Kenai Peninsula Watershed Forum, and the Port Graham Tribe and Chugach Regional Resources Commission.

Objectives:

- Describe lower Cook Inlet nearshore habitats, including invertebrate and algal communities, using existing ShoreZone data and imagery and the results of prior intertidal and shallow subtidal sampling programs.
- Identify areas and habitats across a range of different habitat strata in Lower Cook Inlet that should be included in a long-term monitoring program to provide baseline conditions.
- Conduct intertidal and shallow subtidal sampling in identified monitoring areas, including appropriate habitats within Kamishak Bay and extending north to Tuxedni Bay.
- Based on evaluation of existing hydrocarbon data, develop and facilitate a plan for a community monitoring program that monitors hydrocarbon concentrations in tissues of potential nearshore sentinel species (e.g. clams, mussels, chitons) for important subsistence areas near Port Graham and Nanwalek in Kachemak Bay.
- Integrate new information collected during the biological monitoring component with existing spatial habitat data in the context of known physical and oceanographic conditions.

Methods: This study will compile and collate important historical and ongoing temporal and geospatial habitat and intertidal and shallow subtidal data into a publically-accessible interactive platform. Data will be compiled in a manner that allows creation of digital and web-based synoptic maps to better portray ecological information and support resource management decisions. Researchers will conduct targeted subtidal surveys across an range of habitat types and areas using protocols from the Census of Marine Life/NaGISA (Natural Geography In-Shore Areas), Exxon Valdez Oil Spill Trustee Council-Gulf Watch Alaska, and National Park Service Inventory programs, as

well as the BOEM-MARINe program where suitable. Researchers will apply an analytical approach to utilize existing habitat data supplemented with newly collected biological data to better document ecological processes in nearshore areas, producing derived geographical datasets and maps to help inform resource managers, stakeholders, and decision-makers.

This project has a multi-phased approach:

Phase I: Historical Database - Compile existing historical intertidal and shallow subtidal data and literature from Lower Cook Inlet (completed).

Phase II. Intertidal and Subtidal Assessments - Conduct rocky intertidal and shallow subtidal (< 15 m water depth) community assessments- completed for 2015, 2016, and 2017.

Phase III. Develop sampling plans and recommendations for more extensive evaluations and potential monitoring based on the historical analyses and field assessments of Phases I and II.

Information about existing nearshore benthic habitat data in the area was summarized prior to the 2015 field season. Relevant biological historical data for this compilation included nearshore macroalgae, eelgrass, and bivalves and a range of geomorphic shore types. The information was compiled into a geo-referenced database to be integrated into an AOOS Cook Inlet on-line data portal and visualization tool, and will be used to help identify research gaps in terms of habitat, species, and geographic areas.

Field seasons occurred in 2015, 2016, 2017 and 2018. Low-angle rocky habitats in Lower Cook Inlet were assessed for intertidal and subtidal community assemblages. During these field seasons six intertidal rocky, macroalgal-dominated sites were randomly selected from the Alaska ShoreZone habitat classification data. A series of subtidal dive sites were also established near each intertidal site where possible. In 2018 opportunistic UAS was also flown over a set number of transects.

Revised Date: August 13, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Arctic Integrated Ecosystem Survey, Phase II (AK-16-07)

BOEM Information Need(s) to be Addressed: BOEM needs a comprehensive assessment of both demersal and pelagic fish communities in the Chukchi and Beaufort Seas to improve benchmark information about the distribution, abundance, and life history of Arctic marine fish species. In particular, systematic surveys of the midwater fish community are currently lacking for the western Beaufort Sea. There is also a need for monitoring fish communities on a regular basis at least every 3-5 years to document variability and long-term changes. This information is needed to enhance environmental impact assessments, particularly with respect to early life history stages of key species such as Arctic cod (*Boreogadus saida*) and forage fishes, to develop indices and benchmarks against which to compare future changes, and to identify the distribution of the vulnerable life stages to facilitate development of effective mitigation measures.

Total BOEM Cost: $2,500,041 plus Joint Funding **Period of Performance:** FY 2017-2022

Conducting Organization: NOAA, USFWS, UAF

Principal Investigator(s): Dr. Ed Farley, Dr. Kathy Kuletz, Dr. Franz Mueter

BOEM Contact: Rick Raymond

Description:
Background: The goal of Arctic IES Phase II is to improve understanding of processes that structure the Arctic ecosystem and influence the distribution, abundance, and life history of lower (phytoplankton, zooplankton) and upper trophic level species (invertebrates, fishes, seabirds, mammals), and their vulnerability to a rapidly changing environment. The lower trophic level component aims to better understand the climatological, physical, chemical, and biological processes that influence energy flow from primary producers to zooplankton and ichthyoplankton, and the upper trophic level component will work to describe and understand how lower trophic processes reverberate through the food web to influence invertebrate, fish, and seabird communities. Additionally BOEM needs a comprehensive assessment of both demersal and pelagic fish communities in the Chukchi and Beaufort Seas to improve benchmark information about the distribution, abundance, and life history of Arctic marine fish species. There is also a need for monitoring fish communities on a regular basis at least every 3-5 years to document variability and long-term changes. This information is needed to enhance environmental impact assessments, particularly with respect to early life history stages of key species such as Arctic cod (*Boreogadus saida*) and forage fishes, their prey and predators and to identify the distribution of the vulnerable life stages to facilitate development of effective mitigation measures.

Objectives:

- Quantify the distribution, abundance, and condition of demersal fishes and shellfishes throughout the U.S. shelf waters of the Chukchi Sea and Western Beaufort Sea.
- Quantify the distribution, abundance, and condition of mid-water marine fishes, in particular young-of-the year Arctic gadids and forage fishes, throughout the U.S. shelf waters of the Chukchi Sea and Western Beaufort Sea.
- Combine results from previous Arctic surveys (Arctic Eis, Phase 1, BASIS) and planned surveys (Arctic IES Phase 2) to assess variability in pelagic and demersal fish ecology over time relative to ocean conditions.
- Establish the relative abundance, size, and condition of juvenile salmonids that utilize the coastal regions of the Pacific Arctic Region and establish whether juvenile salmon utilize the coastal waters of the Beaufort Sea during late summer and determine their likely origin.
- Develop spatially explicit bioenergetics models for Arctic cod and saffron cod as well as juvenile pink and chum salmon and test the impact of warming summer temperatures on their growth and distribution.
- Provide a geodatabase including base maps and attribute tables of marine fish and lower trophic communities.
- Facilitate collaboration for an integrated ecosystem analysis with other researchers including the partnership with the NPRB Arctic Program.
- (Part B)Test the hypothesis that a large under-ice spawning aggregation of Arctic cod in the northern Chukchi Sea serves as a source for Arctic cod in the Beaufort Sea, whereas saffron cod form local populations in the coastal waters of the Chukchi and Beaufort Seas.
- (Part C) Quantify the distribution, abundance, and prey association of seabirds in the PAR in relation to oceanographic conditions, prey abundance, and feeding guilds.

Methods: Survey protocols will follow established methods such as those employed during the Arctic Ecosystem Integrated Survey (Arctic Eis) with sampling conducted from at least two platforms (bottom trawl survey, mid-water/acoustic survey and surface trawl survey). Sampling will be adapted based on Arctic Eis results and experience. In particular, mid-water/acoustic surveys will be the primary surveys in the northern Chukchi Sea and Beaufort Sea for assessing young-of-the-year and forage fish, while surface trawl sampling for juvenile salmon will be adaptive and exploratory as it is unknown if juvenile salmon utilize the Beaufort Sea. Oceanographic and plankton sampling in the Chukchi Sea will be coordinated with the recently funded Arctic Marine Biodiversity Observation Network (AMBON) project. However, the sampling design in the Chukchi Sea will likely differ from the transect-based AMBON design to more closely match the 2012 bottom trawl survey and 2012/13 oceanographic and fisheries

surveys. The appropriate sampling design for the Beaufort Sea remains to be determined, but may proceed either along a grid or along a series of onshore-offshore transects. If resources permit, acoustic transects will be extended offshore to detect possible aggregations of Arctic cod along the slope and into the basin, based on similar surveys conducted in the Canadian Beaufort Sea.

Seabird surveys will be conducted using visual observations and standardized strip transects, with adjustments used for previous Alaska surveys . Surveys will be conducted during daylight hours while transiting between sample stations. The observer records all marine bird and mammal sightings within 300m and a 90° arc forward from the 'center line' (line of travel). Standard transect width will be 300m, with individual sightings recorded in distance bins (0-50m, 50-100m, 100-200m, 200-300m, >300m), and angle from the observer in 5 degree increments. Birds in the water or actively foraging are recorded continuously, while flying birds are recorded during quick 'scans' of the transect window at intervals of approximately 1• min-1 (depending on vessel speed) to avoid overestimating. The observer records observations directly into a laptop computer using survey software DLog3 (A.G. Ford, Inc., Portland, OR), recording species, number of individuals, behavior (on water, in air, on ice, foraging), distance bin, and angle. Environmental variables such as sea state (Beaufort scale), glare, weather, and sea ice cover (proportion in tenths) are recorded at first entry and automatically thereafter unless updated as necessary.

Survey data will be combined with recent laboratory results on the growth of Arctic gadids and results from modeling possible transport pathways of particles from the Chukchi Sea to resolve the connectivity of Arctic cod and saffron cod between the Chukchi Sea and the Beaufort Sea. In addition, specimens collected during the surveys may be shared with a variety of researchers to further improve understanding of the biology of Arctic fishes (age & growth, genetic structure, energetics, trophic dynamics). Integration will occur from the benthos to the pelagic and the near surface waters, and will include fish, oceanography, and plankton sampling, coupled with seabird observations. All components will provide inputs into an Integrated Ecosystem Assessment.

Revised Date: August 8, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Updating Status and Trends of Seabirds and Forage Fish in Lower Cook Inlet (AK-16-09)

BOEM Information Need(s) to be Addressed: Seabird densities in lower Cook Inlet are among the highest in Alaska—one reason why the greatest damage to marine bird populations from the Exxon Valdez oil spill occurred there. Resident and migratory seabirds are supported by abundant local stocks of key forage fish species such as herring, sand lance and juvenile pollock. Monitoring of seabird populations and forage fish stocks in potential oil and gas lease areas has been a BOEM priority for decades, both to mitigate impacts of development and to assess the impact of potential oil spills. Both tasks are compromised when population estimates are outdated, and prediction of resilience to development or spills is enhanced by knowledge of population dynamics and current trends. Following intensive investigations of seabirds and forage fish in lower Cook Inlet during 1995-2000, collection of such data in lower Cook Inlet has been limited. The information collected in this new study will be used to support environmental analyses for potential future lease sales and exploration, development and production activities in Cook Inlet.

Total BOEM Cost: $300,000 **Period of Performance:** FY 2018-2020

Conducting Organization: USGS

Principal Investigator(s): Dr. John Piatt

BOEM Contact: Rick Raymond

Description:

Background: USGS led seabird and forage fish studies in lower Cook Inlet during 1995-1999 to assess the recovery of seabird populations following the 1989 Exxon Valdez oil spill. The original project was designed to measure the foraging and population responses of six seabird species to fluctuating forage fish densities around three seabird colonies in lower Cook Inlet (Barren, Chisik and Gull islands). These studies included at-sea surveys for forage fish (hydroacoustics, trawling, seining and associated oceanographic measurements) while measuring aspects of seabird breeding biology (egg and chick production, chick growth, population status and trends) and foraging behavior (diets, feeding rates, foraging time) at the three colonies. The most detailed data were collected on Common Murres (*Uria aalge*) and Black-legged Kittiwakes (*Rissa tridactyla*), the most commonly monitored species in Alaska. The breeding biology and population trend of seabirds differed markedly between colonies relative to persistent geographic differences in forage fish abundance, which were in turn related to persistent oceanographic structuring of habitat in lower Cook Inlet.

Fifteen years have passed since these studies were completed, and little comparable work has been conducted during the interim. Anecdotal reports suggest that major ecosystem changes have occurred, including rather large changes in ocean temperature from warm to cold and back to warm that may influence the timing of breeding and reproductive success of birds on Gull and Chisik Islands. Whether these changes have resulted in changes to the population trajectories observed in the 1990s remains unknown. Additionally, in the winter of 2015/2016 there has been a massive die-off of Common Murres, possibly due to starvation. Murre die-offs have occurred in previous winters, but not in the numbers Alaska is seeing. A return to lower Cook Inlet to gather new data on seabird demography and forage fish communities will help establish the range of natural variability in population parameters in relation to environmental factors and provide an updated baseline of ecosystem condition in advance of new oil and gas leasing.

Objectives: This study will conduct a pilot year of field surveys which will focus on assessing the prey base around seabird colonies (Chisnik and Gull Island) in lower Cook Inlet, while also gathering basic demographic data on seabirds at the colonies. This pilot year may broaden into a larger planned study, which has the following overarching objectives:

- Assess the current abundance, distribution and species composition of forage fish near the three main seabird colonies in lower Cook Inlet over four years.
- Assess foraging behavior (diets, feeding rates, foraging time) at the three colonies
- Census current populations of murres and kittiwakes at their colonies in lower Cook Inlet, and assess average levels of annual production over four years.
- Compare findings for fish and seabirds with data collected in 1995-1999, and relate trends to long-term environmental changes in ocean climate.

Methods: To facilitate comparisons with data from the prior studies, similar protocols for measuring food availability and seabird population biology will be employed, with some refinements. Forage fish abundance will be assessed using mid-water trawls (CPUE, catch composition) and acoustic surveys (biomass in MT/km^2) around each colony. Densities of seabirds and marine mammals, and sea surface temperature/ salinity will also be recorded continuously on transects. A CTD profiler will measure temperature, salinity, chlorophyll, and turbidity at depth on selected stations. USGS researchers will coordinate and collaborate with the NOAA Kasitsna Bay Laboratory in collection of oceanographic data, and provide all data to the NOAA Kachemak Bay National Estuarine Research Reserve data archives.

At the colonies researchers will census kittiwakes and murres on established monitoring plots, measure reproductive success of adult birds, and collect data on diet composition of adults and chicks. If USGS researchers obtain supplementary funding from other sources (e.g., EVOSTC, NPRB) the work may be expanded to monitor foraging time budgets at colonies, and resume banding studies to measure annual adult survival rates of murres and kittiwakes. Researchers will coordinate and collaborate with the USFWS Alaska Maritime National Wildlife Refuge on studies of seabirds at Chisik and Barrens islands, and with the Seldovia Native Corporation for studies on Gull Island.

Methods of data analysis will center on contrasting the functional responses of seabirds to prey fluctuations within and between decades of study, and relating trends in birds and fish to directly measured local changes in the environment (e.g., temperature, salinity) and to larger scale indices of climate change (e.g., ENSO, Pacific Decadal Oscillation, Global Warming Trend). It will be important to quantify these sources of natural variability to evaluate possible future trends under different climate scenarios, and distinguish these from potential direct human impacts of OCS oil and gas exploration and development or oil spills in Cook Inlet.

Revised Date: August 8, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s): Gulf of Alaska

Administered By: Alaska OCS Region

Title: Alaska Wave Energy Converter Impact Assessment (AK-17-02)

BOEM Information Need(s) to be Addressed: The Energy Policy Act of 2005 delegated regulatory authority to BOEM over renewable energy resources on the OCS. For hydrokinetic energy development, FERC manages permit authority for licensing while BOEM retains regulatory responsibilities for leasing and compliance requirements. To achieve complete assessment of the feasibility of a wave energy conversion demonstration project already underway off the coast of Yakutat, Alaska, additional environmental data is needed in specific topical areas, including: subsea hazards, seabed sediment dynamics, ambient noise, and local distribution of marine mammals and fish. BOEM and other regulatory authorities will use this newly acquired information to make immediate decisions about the viability and planning of commercial interests in offshore renewable energy projects in Yakutat and other promising locations, including on the OCS.

Total BOEM Cost: $780,000 **Period of Performance:** FY 2017-2020

Conducting Organization: University of Alaska Fairbanks

Principal Investigator(s): Dr. Jeremy Kasper

BOEM Contact: Dr. Heather Crowley

Description:
Background: Since Alaska has thousands of miles of coastline, the state holds vast potential for tidal and wave energy development. With emerging technologies, these energy resources are becoming more attractive to coastal communities as a potential energy source to diminish reliance on costly diesel fuel. In 2013, FERC approved a preliminary permit application to Resolute Marine Energy to undertake an offshore wave energy feasibility study beyond the surf zone near the City of Yakutat. State and local sources have already funded initial wave energy feasibility studies to determine that the project site does afford excellent deep and shallow water wave resources that can be harnessed by "Surge Wave Energy Converter"™ technology.

Yakutat is a remote community located along the northeastern Gulf of Alaska. Their current power generation is 100% from diesel fuel, which must be barged in, resulting in a high cost of electricity that averages $.60 per kilowatt hour. The City and Borough of Yakutat, along with tribal leaders, have identified other options to meet their energy needs, including wave energy. Their interest led to an effort in 2009 to launch initial research intended to assess both available wave energy and local environmental factors that would establish the feasibility of advancing a development project using emergent "wave energy converter" (WEC) technology available from the Boston-based company, Resolute Marine Energy. FERC approved a preliminary permit for the project in

January 2013 to initiate such feasibility studies. The preliminary project design envisions an array of nine wave converters positioned beyond the surf zone on the seabed in State waters running parallel to shore.

The first phase of the assessment evaluated Yakutat's wave energy resource. The City and Borough of Yakutat funded the UAF Alaska Center for Energy and Power to deploy a bottom-mounted mooring offshore of Yakutat to measure key parameters relevant to the placement of an array of wave energy converters. An Acoustic Doppler Current Profiler recorded surface wave statistics such as wave height, time between wave crests, direction, and speed. Another sensor measuring conductivity, temperature and depth provided data necessary to inform environmental conditions that accompany different wave and current patterns, as well as concurrent studies of local marine mammal populations and fisheries. The second phase of the assessment involved a modeling effort, funded by the Alaska Energy Authority (AEA), to support the installation and operation of the WEC units. AEA funding also supported the development of wave climatology for the greater Yakutat area in order to assess the proper size of the WEC array.

Study results from these two phases indicate that Yakutat wave resources provide "excellent" energy source potential in both deep and shallow water. However, additional data on environmental factors is necessary to assess the viability of undertaking the development. In particular, comprehensive assessments are still needed in three specific topical areas: subsea hazards, seabed dynamics, and marine mammals. In 2016, bathymetry and seabed depth work will be funded by the Department of Energy. But information needs are still pressing to characterize seabed dynamics, including areas prone to sediment movement and their implications for benthic habitat. Information needs are also still pressing to characterize ambient underwater noise, as well as presence and habitat implications for local fish and marine mammals. Without BOEM engagement, this demonstration project will remain incomplete and inconclusive, inhibiting renewable energy momentum in Alaska.

Objectives:

- Collect scientific and technical data sufficient to complete assessment of the feasibility of the Yakutat Wave Energy Project.
- Establish firm scientific understanding of seabed dynamics, ambient underwater noise, and fish and marine mammal presence and habitat requirements in the project area offshore of Yakutat.
- Evaluate implications of findings from the Yakutat Wave Energy Project for feasibility studies in other coastal regions of Alaska, including extensions onto the OCS.

Methods: Work with UAF Alaska Center for Energy and Power, Alaska Energy Authority, DOE, FERC, NOAA, and USFWS to integrate and extend offshore environmental feasibility studies sufficient to fully assess the viability of wave energy projects in Yakutat and other areas of coastal Alaska.

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea, Cook Inlet
Administered By:	Alaska OCS Region
Title:	Marine Bird Distribution and Abundance in Offshore Waters (AK-17-03)

BOEM Information Need(s) to be Addressed: This project will provide basic information on distribution, abundance, and habitat requirements of marine birds, necessary to assess potential effects of oil and gas exploration, development and production in the Chukchi Sea, Beaufort Sea, and Cook Inlet Planning Areas. Results from the project will support ESA Section 7 consultations and NEPA analyses for potential future lease sales and DPPs. The information obtained from these surveys may assist in development of mitigation measures and strategies to reduce potential impacts on listed and candidate species under the ESA (Spectacled Eider, Steller's Eider, Short-Tailed Albatross, Yellow-billed Loon) as well as Priority Species identified by the USFWS (11 Tier-1 species and 14 Tier-2 species). By collaborating with multi-disciplinary vessel-based projects, it will be possible to make linkages between physical and biological factors that influence the distribution of marine birds.

Total BOEM Cost: $500,000 **Period of Performance:** FY 2017-2021

Conducting Organization: USFWS

Principal Investigator(s): Dr. Kathy Kuletz

BOEM Contact: Rick Raymond

Description:

Background: Seabirds are wide-ranging apex predators and good indicators of changes in marine ecosystems. Seabirds spend most of the year offshore, yet our information needs are greatest for the pelagic aspect of their lives. To address these needs, an At-sea Seabird Observer Program was initiated by the U.S. Fish and Wildlife Service with a grant from the North Pacific Research Board (Project 637; 2006-2008) and continued as part of the Bering Sea Study (B64; 2008-2010) and by an inter-agency agreement with BOEM (AK-10-10; 2010-2015) to provide marine bird data for areas of oil and gas activity. In total these surveys provided > 200,000 km of survey effort to the North Pacific Pelagic Seabird Database and resulted in marine bird distribution files and multiple publications relevant to BOEM requirements for NEPA and other Environmental Assessments in offshore waters. Among the published findings: seabird and marine mammal 'hotspots' in the Chukchi Sea; evidence of shifts in distribution and species composition in the Bering and Chukchi Seas; new information was also obtained on seasonal changes in seabird distribution and on locations of molt areas for several alcid species. Additionally, BOEM has partnered with USFWS in Cook Inlet as part of the GulfWatch Alaska program in 2014-2015. Because of observed and on-going climate change, it will be important to document shifts in species distribution, particularly

following the exceptionally warm 2014 and 2015 years, with predicted warm conditions in 2016-2017.

Basic information on timing and duration of use within designated Alaska OCS planning areas is necessary to better define the impacts of perturbations and ultimately population effects. Breeding seabirds are generally monitored at colonies, yet they spend most of the year dispersed offshore. Additionally, one half or more of all seabirds do not breed in a given year, thus management of marine birds requires knowledge of spatial and temporal patterns of seabird distribution at sea.

Objectives:

- Estimate the spatial distribution, species composition and seasonal changes in species and estimate abundances for marine birds in designated Alaska OCS planning areas.
- Process the data for entry into the North Pacific Pelagic Seabird Database for future accessibility and facilitate management decisions for marine bird use of planning areas.
- Examine trends in abundance of key species by comparison to 1993 and 1995-99 for Cook Inlet, and for Kachemak Bay, relative to 2005-2007 and 2011. These historic data and the newly collected observations will be used to determine if there have been changes in marine bird distribution.
- Examine the effects of environmental drivers (climate and oceanographic conditions) as well as biological drivers (prey availability) on seabird distribution by collaborating with researchers who collected oceanographic and biological data during the same research cruises.

Methods: This project will build off of established methods for an at-sea survey program, to opportunistically collect distribution data on seabirds via partnership and collaboration among the USFWS, NOAA-Fisheries and other vessel-based monitoring or research programs. Observers will conduct visual surveys using established protocol (strip transect or modified distance sampling) to identify all marine birds and mammals while a vessel is in transit. Data is entered directly into a computer with location data (latitude and longitude) along with associated environmental conditions. Data is processed and submitted to the North Pacific Pelagic Seabird Database by converting counts into densities (birds/km^2). Five data sets (time series) will be compared for abundance trends and analyzed for changes. The report will discuss how environmental drivers relate to spatial distribution and abundance of key species and discuss whether climate change is affecting listed species or document other potential causes (reduced breeding habitat, etc.).

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Title	Environmental Resource Areas: Developing Products to Support Oil-Spill Risk Analysis (OSRA) and National Environmental Policy Act (NEPA) (AK-18-01)
Administered by	Alaska OCS Region
BOEM Contact(s)	Dr. Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Intra-agency Agreement
Approx. Cost	$400,000
Performance Period	FY 2019–2022
Conducting Org.	USGS
Date Revised	November 8, 2018
PICOC Summary	
Problem	Tools or methods for analyses are needed to identify environmental resource areas (ERAs) for consideration in the assessment of potential impacts to marine mammals, cetaceans, seabirds, and other resources from Outer Continental Shelf (OCS) oil- and gas-related activities.
Intervention	Synthesis of available information about individual species or other resources to facilitate development of methods for identifying ERAs.
Comparison	This study will provide improved efficiency defining ERAs over existing approaches that are individualized for various resources. This will also allow for better continuity to update the information when staffing changes.
Outcome	A consistent approach that can be applied to multiple resources and planning areas to produce a collection of ERAs in support of OSRA.
Context	All Alaska Planning Areas

BOEM Information Need(s): Refined information of the density distribution and temporal timing of resources susceptible to effects from potential oil spills will inform better decisions when developing inputs to BOEM's OSRA. Results from this project will help refine ERAs used in OSRA and will assist BOEM in National Environmental Policy Act (NEPA) analyses for potential future lease sales, for Exploration Plans (EPs), Development and Production Plans (DPPs), Endangered Species Act (ESA) Section 7 consultations, and decision-making on the Outer Continental Shelf (OCS) in Alaska by helping to identify the resources and geographic areas most susceptible to potential impacts from OCS activities.

Background: Having a good understanding of the seasonal distribution, relative abundance, and habitat use of marine mammals, birds, and other species on the OCS is fundamentally important to evaluating the potential environmental impacts associated with oil and gas exploration and development, as well as cumulative impacts related to other activities. Whales, walrus, polar bears, seals, sea lions, and birds have differing temporal and spatial distributions. Moreover, all of these species are used for

subsistence and form an important part of the diet and cultural base for people in communities along the Alaska coast.

BOEM and others have amassed extensive datasets documenting spatial presence and other information for a wide range of species. The distributions of many species are temporally and spatially structured, showing seasonal or interannual changes in response to various mechanisms. These factors affect the vulnerability of a species to contact from a potential oil spill that BOEM considers as part of its OSRA through identification of ERAs, which are areas of concern relating to social, environmental, or economic resources, including critical habitat or use areas for different species of concern. Each ERA has a spatial and temporal attribute and its vulnerability may vary according to the time of year. Various methods are used to define the location and geographical extent of ERAs, depending on the availability of data.

Satellite telemetry data available from previous and ongoing BOEM-funded studies on many species including bowhead whales, walruses, and ringed, bearded, and spotted seals can be used for identifying core use areas, identifying feeding areas, and other analyses for the development of ERAs. For example, bowhead whale telemetry data have been used to prepare kernel densities of bowhead locations (Quakenbush and Citta 2013). Using an alternative approach, Roberts et al. (2016) integrated data from aerial and shipboard cetacean surveys with environmental information from remote sensing and ocean models to develop habitat-based density models for a variety of cetacean species in the U.S. Atlantic and Gulf of Mexico. Using these models, the researchers were able to simulate seasonal movement patterns resembling those suggested in the literature and produce monthly mean density maps for the species considered.

Objectives: This study will establish a consistent foundation for developing and refining ERAs used for OSRA. Specifically it will:

- Assess the utility of different modeling techniques or other analyses to evaluate distribution, abundance and temporal timing of marine mammals or birds;
- Identify a small number of pilot species/population(s) for assessing methodologies or metrics;
- Investigate seasonal patterns of movement of the identified species in the Cook Inlet, the Beaufort Sea, or Chukchi Sea;
- Evaluate spatial variations in seasonal density of identified species in Cook Inlet, the Beaufort Sea, or Chukchi Sea.

Methods: Initially, this project will focus on pilot species/population(s) in one or more of the Cook Inlet, Beaufort Sea or Chukchi Sea Planning Areas to develop a methodology that can then be applied to other areas. This study will assimilate available monitoring information about biological resources, habitat, and oceanographic parameters in Cook Inlet or the U.S. Arctic. These data will be derived from a range of sources, including aerial and ship surveys, satellite tags, monitoring buoys, remote sensing, ocean models, etc. Researchers will then identify a methodology such as habitat-based models, following Roberts et al. (2016), or other type of analysis of biological resource densities,

for example that used by Citta et al. (2015), to develop a documented method for refining ERAs to support the OSRA process.

Specific Research Question(s): What consistent method or methods can be identified to define a set of ERAs to facilitate the OSRA process in an efficient manner?

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Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Marine Arctic Ecosystems Study (MARES): A Multi-Agency NOPP Partnership (NT-13-05)

BOEM Information Need(s) to be Addressed: Through this multi-agency agreement under the National Oceanographic Partnership Program (NOPP) BOEM expects to enhance multi-lateral arctic research coordination and to improve regulatory decisions and NEPA analyses pertinent to lease sales, EPs, and DPPs in the Beaufort Sea. The partnership will lead to specific task orders and objectives that will be developed and procured as discrete study profiles. Final reports will be available to inform NEPA analyses and decision-making; interim data products and inputs may also be used to address information needs.

Total BOEM Cost: $5,323,338 plus Joint Funding ($547,583) **Period of Performance:** FY 2015-2020

Conducting Organization: Stantec Consulting Services Inc.

Principal Investigator(s): Dr. Francis Wiese

BOEM Contact: Dr. Heather Crowley

Description:
Background: BOEM needs additional comprehensive and integrated information in the Arctic on the spatio-temporal distribution of fundamental physical, biological and chemical variables, their associated interactions and regulating mechanisms, as well as the distribution of cultural and subsistence resources which sustain local communities. This information will be used to better understand and assess arctic ecosystem sensitivities and vulnerabilities as a function of space and time to aid decision-makers in minimizing the impact of the oil & gas activities on the Outer Continental Shelf. The resulting information will support NEPA analyses, in validating models, and in Oil-Spill Risk Analysis. Additionally, these observations and improved description and understanding of biogeochemical and physical interactions will aid to improve the accuracy of model simulations and forecasts. Coordinated observational and modeling efforts will produce information that will be analyzed from different perspectives: a) ecosystem understanding and environmental protection, b) climate change and monitoring, and c) Oil-Spill Risk Analysis.

This partnership between BOEM, ONR, Shell, and USARC takes an integrated ecosystem approach to monitoring environmental change in the Arctic while coordinating the efforts of several Federal agencies. It is also responsive to the Interagency Arctic Research & Policy Committee (IARPC) 5-year plan (2017-2021) and research priorities, as well as recommendations from earlier MMS/BOEM studies.

Objectives:

- Identify and delineate areas of high biological productivity, as well as relative sensitivities and resiliencies to changes in environmental conditions within ecosystem components. This includes a detailed description of different trophic levels and their composition in terms of species abundance, distribution, and behavior in both ice free and ice covered habitat.
- Provide a qualitative and quantitative description of the biogeochemical-physical interactions and feedback processes in ice free and ice covered areas.
- Provide a detailed spatio-temporal description of ocean currents at different depths along the Beaufort continental shelf, including ice covered areas.

Methods: Proposed studies will emphasize an integrated, or ecosystems approach to data collection or synthesis. Each study will be based on the application of appropriate scientific methodologies, coordinating observational and modeling efforts, while focused on essential processes, functions and interactions among organisms and their environment. Proposed studies will recognize that humans, with their cultural diversity, are an integral component of ecosystems, and will accommodate appropriate methods of integration where possible, including access to traditional knowledge with active involvement of Alaska Natives in research planning and execution. Proposed studies will also seek to advance, where appropriate, the use of technology and instrumentation in monitoring and understanding complex ecosystem processes.

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea
Administered By:	Alaska OCS Region
Title:	ANIMIDA III: Boulder Patch and Other Kelp Communities in the Development Area (AK-11-14a)

BOEM Information Need(s) to be Addressed: The Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) and continuation of ANIMIDA (cANIMIDA) have monitored the Boulder Patch Area of Special Biological Concern in the Beaufort Sea OCS. There is a continuing, ongoing need for this monitoring in the development area within the Beaufort Sea during the performance period of the study, which will coincide with continued production from Northstar, development and production from Liberty, and potential future delineation and development in Camden Bay. The information will support NEPA analysis and documentation for Beaufort Sea lease sales, EPs, and DPPs.

Total BOEM Cost: $647,661 **Period of Performance:** FY 2012-2020

Conducting Organization: CESU-University of Texas at Austin

Principal Investigator(s): Dr. Ken Dunton

BOEM Contact: Catherine Coon

Description:
Background: The ANIMIDA project started monitoring of the Boulder Patch in 2000. This and multiple other research projects on the Boulder Patch by BOEM, the National Science Foundation, and industry have allowed one of very few long-term monitoring records in the Arctic to be cobbled together, stretching from the late 1970s through the current decade.

The Liberty prospect adjoins the Boulder Patch. BOEM is currently reviewing a DPP submitted by Hilcorp Alaska LLC that proposes construction of a gravel island and production facility at Liberty. In addition, there is potential for exploration activity at active leases in the vicinity of Camden Bay, an area with known but poorly mapped kelp beds. Ongoing industry activities necessitate ongoing monitoring projects.

Objectives:

- Evaluate the potential impact from additional activities at the Liberty prospect on the Boulder Patch kelp community.
- Monitor the impact to the Boulder Patch community from increased summer turbidity and other oceanographic changes occurring with climate change.
- Estimate the importance of and extent of Camden Bay kelp patches.

Methods: The Boulder Patch kelp bed surveys and monitoring will be conducted using small vessel support in the open water season. Kelp production will be measured using established or comparable techniques. Oceanographic measurements shall include ambient light intensity and total suspended solids using established or comparable techniques. Data will be combined with the existing long-term dataset. The extent of kelp in Camden Bay will be surveyed and GIS maps constructed of kelp and implied (boulder and or hard bottom) kelp beds in the study area.

Revised Date: August 13, 2018

Environmental Studies Program: Ongoing Studies

Region:	Alaska
Planning Area(s):	Beaufort Sea, Chukchi Sea
Title:	Fate and Persistence of Oil Spill Response Chemicals in Arctic Seawater (AK-13-03-13)

BOEM Information Need(s) to be Addressed: This study will provide information regarding the fate and effects of oil spills, and of oil spill response methods, on the arctic marine environment. Timely information regarding the fate, persistence, biodegradation, and effects of chemical dispersants (e.g. Corexit 9500) in the arctic marine environment will be valuable to regulators, industry, stakeholders, the scientific community, and the public. BOEM analysts and decision-makers can use this information in NEPA analysis and documentation for potential future lease sales, EPs and DPPs.

Total BOEM Cost: $216,290 plus Joint Funding ($211,289)

Period of Performance: FY 2015-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Mary Beth Leigh

BOEM Contact: Rick Raymond

Description:

Background: In the event of an oil spill in the arctic marine environment, the use of chemical dispersants is one potential option for oil spill response. Upon regulatory approval, Corexit 9500 will likely be the principal stockpiled chemical dispersant for application to an oil spill in the Arctic. Before the risks of dispersant use can be fully assessed, there is a critical need to determine the fate and persistence of the chemical components of dispersants in the marine environment. This study will quantify biodegradation rates of the chemical dispersant (Corexit 9500) under laboratory conditions using arctic seawater collected under different seasonal conditions. Collected open and ice-covered seawater will be used to determine how the presence of crude oil alongside dispersants affects the biodegradation of both dispersants and oil. Using advanced molecular tools, microbe activity will be identified in dispersant biodegradation in arctic seawater. Shifts in the microbial community in response to dispersants will be examined and potential effects on microbially-mediated ecological processes will be evaluated. Novel, timely and urgently needed protocols for evaluating the fate of dispersants, as well as oil, in the arctic marine environment and their potential effects on ecological function will be developed.

Objectives:

- Quantify the fate and persistence of the chemical dispersant, Corexit 9500, including its individual chemical constituents, in arctic seawater

- Compare rates of dispersant biodegradation under summer vs. winter conditions
- Determine if dispersant biodegradation is slowed or accelerated by the presence of crude oil
- Assess the effects of dispersants on crude oil biodegradation rates
- Identify microorganisms important to biodegradation of dispersant chemical components in arctic seawater
- Evaluate shifts in microbial communities in response to dispersants in the context of potential changes in ecological function

Methods: This study will apply established laboratory incubation protocols for assessing the biodegradation of dispersants in fresh arctic seawater (including incubations with and without crude oil present), using replicate 1-L incubation vessels temperature controlled cold room held at relevant temperatures determined at the time of seawater sampling. Open water season seawater samples (Aug-Sept) will be collected from the Chukchi Sea and transported by air to UAF for laboratory studies. Summer and winter (under-ice) seawater will be collected from ~1km offshore of Barrow, Alaska. Three incubation series will be conducted and analyzed:

7. Summer 2014 offshore seawater + Corexit (already completed and samples in storage)
8. Winter 2015 under-ice seawater + Corexit
9. Summer 2015 seawater with Corexit +/- ANS crude oil

Replicate incubations will be harvested over a time course for comprehensive dispersant and petroleum chemical analyses (when oil is present). A series of sterile control incubations will be run in parallel to quantify abiotic losses. The chemical components of Corexit 9500 require advanced analytical methods (LC-MS-MS), and will be quantified using methods already optimized in a laboratory setting. Petroleum biodegradation (in oil incubations) will be assessed using extraction and GC-MS analyses in the UAF IAB Core Laboratory. Additional replicate microcosms will be filtered to collect microbial cells for DNA extraction and molecular biological analyses of microbial communities.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Microbial Biodegradation of Alaska North Slope Crude Oil in Arctic Marine Sediments (AK-13-03-24)

BOEM Information Need(s) to be Addressed: BOEM needs additional information to facilitate evaluation of the fate of oil spilled in the Arctic marine environment. To better assess the fate of oil spilled in the Arctic marine environment, there is a need to understand the oil biodegradation potential in Arctic sediments. BOEM analysts and decision-makers can use this information in NEPA analysis and documentation for potential EPs and DPPs in the Beaufort Sea.

Total BOEM Cost: $174,931 plus Joint Funding ($174,930)

Period of Performance: FY 2017-2019

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Mary Beth Leigh

BOEM Contact: Rick Raymond

Description:

Background: Ice-covered waters are becoming more accessible to human activities, increasing the likelihood of anthropogenic disturbance and contaminant exposure through oil and gas development as well as increased commercial shipping and other activities. Because microbial biodegradation is the primary means through which petroleum is removed from the marine environment following a spill, knowing the oil biodegradation potential for each ecosystem compartment (i.e. shoreline, sea ice, sea surface, water column, and benthos) is important to evaluating the fate and effects of oil contamination and to developing cleanup strategies such as bioremediation. To date, relatively little is known about the oil biodegradation potential of the Arctic marine environment, particularly in the benthos (sediment).

Oil in the benthos, although less visible than that on the surface or shoreline, can greatly impact the health of the marine system immediately following an oil spill for up to a decade or more, and can result in adverse effects on both benthic and pelagic food webs. Oil can be toxic or fatal to a multitude of demersal fishes and invertebrates and is persistent in the environment and the tissues of exposed organisms years after a spill event. Ten years following the *Exxon-Valdez* oil spill (EVOS), researchers discovered oil compounds both within marine sediments and at toxic levels within the tissues of organisms such as Pacific Halibut, mussels, and clams. In Arctic marine sediments, benthic fishes and invertebrates compose all or some of the diets of marine mammals including walruses, seals, and bowhead whales, which are also important for Alaska Native subsistence hunting. Thus, understanding the fate of oil in Arctic marine

sediments is important to assessing the potential environmental and human health impacts of an oil spill in this ecosystem.

This study proposes to perform laboratory incubation studies to investigate the biodegradation of fresh and weathered crude oil in sediments under both aerobic and anaerobic conditions in order to assess biodegradation rates and to identify oil-degrading microbes, which can help to formulate projections regarding the fate of spilled oil in sediments.

Objectives:

- Assess the capacity for biodegradation of Alaska North Slope crude oil by indigenous microorganisms in subtidal Arctic marine sediments under aerobic and anaerobic conditions.
- Compare the biodegradation of fresh oil versus moderately weathered oil in Arctic sediments.
- Identify microorganisms involved in biodegradation of oil in Arctic marine sediments.
- Utilize taxonomic information from incubation studies to assess the distribution of putative oil-degrading microbes

Methods: Marine sediment samples will be collected approximately one km offshore on the Chukchi Sea, directly north and west of Point Barrow, AK in late summer (August-October) 2017. Laboratory incubation studies will be performed to investigate the biodegradation of fresh and weathered crude oil in sediments under both aerobic and anaerobic conditions to assess biodegradation rates and to identify oil-degrading microbes, which can facilitate evaluation of the fate of spilled oil in sediments. Following the identification of putative oil-degrading bacteria in incubation tests, queries will be conducted to existing microbial community datasets from sediments across the Beaufort Sea to assess the biodegradation potential present in indigenous sediment microbial communities across the region. Together, the findings will provide an in-depth analysis of the crude oil biodegradation potential of Arctic marine sediments at growing risk of contamination.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Oil-Spill Occurrence Estimators for the Outer Continental Shelf in the Arctic (AK-16-04)

BOEM Information Need(s) to be Addressed: The Oil-Spill-Risk Analysis (OSRA) is a cornerstone to regional EISes, EAs, and oil-spill contingency planning. Oil-spill issues constitute a substantial portion of public comments submitted on sale or development EISs in the Alaska OCS Region. This study is necessary to develop oil spill occurrence estimators for NEPA analyses for oil and gas lease sales or development projects.

Total BOEM Cost: $262,821* (*task orders to-date) **Period of Performance:** FY 2017-2022

Conducting Organization: ABS Group

Principal Investigator(s): David Stalfort (Project Manager)

BOEM Contact: Dr. Heather Crowley

Description:
Background: The OCS spill occurrence rates used in non-Arctic BOEM NEPA analyses are based on historical platform, pipeline or tanker crude oil-spill rates, almost entirely from the Gulf of Mexico and Pacific OCS. For analyses in the Arctic since 2002, the BOEM Alaska OCS Region has incorporated a fault-tree approach, which considers 1) differences in oil-spill occurrence factors between the Arctic and Gulf of Mexico OCS and 2) Arctic-specific factors. Recent examples of such analyses include:

Bercha Group, Inc. 2014. Updates to Fault Tree Methodology and Technology for Risk Analysis Chukchi Sea Sale 193 Leased Area. OCS Study BOEM 2014 -774. Anchorage, AK: USDOI, BOEM, Alaska OCS Region. 109 pp.

Bercha Group Inc. 2013. Updates to Fault Tree for Oil Spill Occurrence Estimators, Update of GOM and PAC OCS Statistics to 2012. OCS Study BOEM 2013-0116. Anchorage, AK: Prepared by Bercha International Inc. for USDOI, BOEM, Alaska OCS Region. 35 pp. http://www.boem.gov/2013-0116/.

Bercha, F.G. 2011. Summary Final Report Alternative Oil Spill Occurrence Estimators for the Beaufort and Chukchi Seas - Fault Tree Method. OCS Study BOEMRE 2011-030. Anchorage, AK: Prepared by Bercha Group, Calgary, Alberta, for USDOI, BOEMRE, Alaska OCS Region. 48 pp. http://www.boem.gov/BOEM-Newsroom/Library/Publications/2011/2011-030.aspx.

Objectives:

- Update Gulf of Mexico and Pacific OCS historical oil spill statistics.
- Provide analyses on topics relevant to oil-spill occurrence rates, spill sizes, oil-spill frequency distribution, and other parameters.
- Obtain fault tree spill occurrence rates and confidence intervals for NEPA analyses for any Arctic OCS Lease Sales or for OCS offshore oil and gas developments.

Methods: Task orders from this study will: 1) review and assimilate oil-spill occurrence reports, data and geohazard data from alternative sources and locations as needed to update Gulf of Mexico and Pacific OCS historical data; 2) conduct literature searches and analyses on relevant topics, such as potential causal factors of oil spills in Arctic regions and differences in oil-spill occurrence factors between the Arctic and Gulf of Mexico and Pacific OCS, assessing the relative importance of various causal factors and conducting sensitivity analyses, evaluating whether oil-spill sizes and frequency distributions vary as a function of annual oil production rates; 3) use these data together with measures of spill size and frequency variance to run the Monte Carlo fault tree model with these measures of variance; 4) provide fault tree analyses as needed for Arctic oil and gas lease sales based on BOEM-supplied exploration and development scenarios, generating life-of-field oil spill occurrence rates and indicators; 5) provide fault-tree analyses as needed for site-specific oil and gas developments in the Arctic, taking into account site-specific geohazards and generating life-of-field occurrence indicators; 6) provide a formal report documenting each analysis, and 7) provide professional support to BOEM in regard to statistical issues of occurrence rates and estimator(s) related to this study and its results.

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Title	Hydrocarbon Seeps in the Lower Cook Inlet, Gulf of Alaska, Chukchi Sea and Beaufort Sea OCS Planning Areas (AK-18-x11)
Administered by	Alaska OCS Region
BOEM Contact(s)	Dr. Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	TBD
Performance Period	FY 2019–2021
Conducting Org.	UAF
Date Revised	November 8, 2018
PICOC Summary	
Problem	Information regarding location and extent of natural hydrocarbon seeps on the OCS off Alaska is limited. Information that does exist is dispersed throughout the body of scientific literature, or held by government agencies and other entities.
Intervention	Currently available information about the locations, volumes, and chemical and weathering characteristics of hydrocarbon seeps on the Alaska OCS, as well as information regarding hydrocarbon-consuming organisms in the area will be identified, gathered, and analyzed. Recommendations for collection of additional field data will also be developed.
Comparison	This study will provide baseline information regarding natural hydrocarbon seeps on the OCS.
Outcome	Data about seeps will assist BOEM geoscientists in identifying locations of undiscovered oil and gas resources on the Alaska OCS and determining the fair market value of leased OCS blocks. Results from this project will also support analyses under NEPA by helping to quantify the associated contributions of hydrocarbons to the environment.
Context	The Lower Cook Inlet, Gulf of Alaska, Beaufort and Chukchi Planning Areas are listed for potential lease sales in the 2019-2024 Proposed National Program

BOEM Information Need(s): Hydrocarbon seep composition, location and volume is needed to address multiple aspects of BOEM's mission: 1) Hydrocarbon surface seeps can be a direct indicator of subsurface hydrocarbon prospects. Information about area seeps will inform BOEM geoscientists in estimating the undiscovered oil and gas resources of the Alaska OCS and determining the fair market value of leased OCS blocks. 2) Natural seeps represent a large portion of the petroleum input to the sea, providing natural background concentrations of hydrocarbons in the environment. Better knowledge of area seeps will provide insight into consideration of cumulative effects in agency NEPA analyses of exploration and development of hydrocarbon prospects in the Alaskan OCS. 3) Chemosynthetic communities have been shown to populate near hydrocarbon seeps. Evaluating these communities will provide further inform NEPA analyses on the effects of exploration and development activities in the Alaska OCS.

Background: Hydrocarbon seep locations and compositions have been used in prospecting for oil and gas fields. It has been observed that the compositions of hydrocarbon seeps can be a direct indicator of hydrocarbons filling a subsurface prospect. It has also been shown that the composition of gas seeps can be used to determine whether a hydrocarbon prospect is filled with oil or gas (Jones and Drozd, 1983). Whether a prospect is filled with oil or with gas has important implications for estimating undiscovered technically and economically recoverable oil and gas.

Limited information is available about the spatial extent or volume of release from natural hydrocarbon seeps on the Alaska OCS, or the disposition and residence time of the hydrocarbons in the environment. Some information about the location and extent of natural hydrocarbon seeps in the Chukchi and Beaufort OCS exists in the form of sniffer and shallow core surveys, but there is little data available for seeps in the Lower Cook Inlet and Gulf of Alaska.

We have little knowledge of the chemical properties of Alaska OCS hydrocarbon seeps, how seeped hydrocarbons are affected by weathering, or how they compare to known hydrocarbon types in other development areas. The presence of natural hydrocarbon seeps is indicative of organisms adapted to metabolize the hydrocarbons. These organisms in turn indicate the capacity for microbial remediation of hydrocarbons in the environment, or natural bioremediation through the means of reducing pollutants by way of resident oil-eating bacteria. Oil-eating, cold-water bacteria in the Gulf of Mexico waters were a major factor contributing to removal of spilled oil from the Macondo spill in 2010.

Objectives:

- Identify available geological, geophysical, and geochemical data that can provide insight into the location and extent of likely oil seeps in the Lower Cook Inlet, Gulf of Alaska, Chukchi and Beaufort OCS Program Areas
- Provide recommendations for future field-sampling efforts to augment the results and to facilitate estimation of seep volume, chemical characterization of oil (water column and/or sediment) samples, and identification of communities of hydrocarbon-associated organisms.

Methods: Researchers will search the available literature, including the large volume of information from the OCSEAP program of the 1980s and 1990s, to identify and gather any available information about the locations, volumes, and chemical and weathering characteristics of hydrocarbon seeps on the Alaska OCS, as well as information regarding hydrocarbon-consuming organisms in the area. A map of known seeps will be produced. Researchers and BOEM scientists will convene two to three meetings to discuss results of these efforts and develop plans for future field-sampling endeavors. Topics of discussion shall include, but not necessarily be limited to: additional geophysical survey data (e.g. multibeam echosounder and sub-bottom profiler data) needed to expand the spatial coverage; identification of prospective sites for coring and geochemical analysis; methodologies for evaluation of seep volume, chemical composition of oil, and microbial communities.

Specific Research Question(s): 1) What information is available regarding natural hydrocarbon seeps in the Lower Cook Inlet, Gulf of Alaska, Beaufort, and Chukchi Program Areas? 2) What is best approach for evaluating the volume of the natural hydrocarbon seeps and the variations in chemical composition? 3) What sampling is required to evaluate the type of microbes or other organisms populate the vicinity of the hydrocarbon seeps?

References:

Jones, V.T., and Drozd, R.J., 1983, *Predictions of oil or gas potential by near-surface geochemistry*. AAPG, V.67, no. 6, p. 932-952.

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Environmental Studies Program: Ongoing Studies

Title	Oil Spill Occurrence Estimators for Onshore and Offshore Crude and Refined Oil Spills on the Alaska North Slope and Cook Inlet, Alaska (AK-18-x12)
Administered by	Alaska OCS Region
BOEM Contact(s)	Dr. Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$224,658
Performance Period	FY 2019–2021
Conducting Org.	Nuka Research and Planning Group, LLC
Date Revised	November 8, 2018
PICOC Summary	
Problem	Petroleum hydrocarbon spill data for analyses, including the number, volume, and likelihood of such petroleum hydrocarbon spills, is needed to support the assessment of potential impacts under the National Environmental Policy Act (NEPA).
Intervention	Disparate petroleum hydrocarbon spill data will be collected into a systematic collation of data for mathematical analyses.
Comparison	A suite of objective methodologies will provide estimates of petroleum hydrocarbon spills needed for NEPA analyses.
Outcome	This project will deliver regionally-specific estimates of the occurrence of small oil spills for the Beaufort and Chukchi Seas and Cook Inlet.
Context	Beaufort Sea, Chukchi Sea, Cook Inlet

BOEM Information Need(s): The oil-spill risk analysis is a cornerstone to regional Environmental Impact Statements (EISs), environmental assessments (EAs), and oil-spill-contingency planning. Oil-spill issues constitute a substantial portion of public comments submitted on lease sale or development and production EISes and exploration plan (EP) or geophysical and geological EAs in the Alaska Outer Continental Shelf (OCS) Region. Oil spill occurrence rates specific to Alaska derived from this study will be used by Alaska Outer Continental Shelf (OCS) Region staff to estimate small oil spill occurrence (<1,000 bbl) in preparing NEPA documents for future Beaufort Sea, Chukchi Sea, or Cook Inlet lease sales, Exploration Plans (EPs), Development and Production Plans, and in reviewing oil-spill-contingency plans for OCS and coastal facilities.

Background: The Bureau of Ocean Energy Management (BOEM), Alaska OCS Region uses various datasets and models to estimate the number, volume and likelihood of large (≥1,000 bbl) and small (<1,000 bbl) spills occurring. These estimates are used to evaluate potential oil spills from a proposed OCS action and derive an impact determination for NEPA analyses. The OCS spill occurrence rates used in non-Arctic BOEM NEPA analyses are based on historical Gulf of Mexico and Pacific OCS platform, pipeline, or worldwide tanker crude oil-spill rates (ABS Consulting Inc., 2016). Since

2000, the Alaska OCS Region has incorporated Alaska North Slope spills (Robertson et al., 2013) in the analyses.

Objectives:

1. Develop relative spill occurrence estimator(s) suitable for use for onshore and offshore small oil spills on the Alaska North Slope using an appropriate exposure variable.
2. Develop relative spill occurrence estimator(s) suitable for use for onshore and State offshore for small and large oil spills in and adjacent to Cook Inlet using an appropriate exposure variable.

Methods: Investigators will conduct a preliminary meeting to discuss acceptable statistical methods in consideration of historical statistical approaches, BOEM rationales for estimating oil spill occurrence rates, and possible sources of variance. The discussion will include: methods for deriving historical spill frequencies from Alaska North Slope and Cook Inlet spill records; exposure variables for spill frequency such as pipeline miles, volume of throughput, age, and well years; implications for using different exposure variables; limitations of the spill records; and recommended standard data format for exposure variables and accident data.

The investigators will update oil spill occurrence estimates previously calculated for the North Slope (Robertson et al., 2013). They will collect, examine, and reconcile crude and refined oil spill records and cleanup reports for the North Slope for spills ≥1 bbl from industry, U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), U.S. Department of the Interior (DOI), Bureau of Land Management (BLM), BOEM, Bureau of Safety & Environmental Enforcement (BSEE), U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (USDOT, PHMSA), and Alaska Department of Environmental Conservation (ADEC) datasets through 2019. Exposure data for Alaska North Slope will be collected and the number of wells, flow, and pipeline miles by year provided when available. The investigators will also calculate accident frequencies for small spills and perform appropriate statistical analyses, including trend analysis. Results will be collated into an electronic database in a standard format.

Similarly, the investigators will collect, examine, and reconcile crude and refined oil spill records and cleanup reports for the onshore and offshore Cook Inlet region for spills ≥1 bbl from industry, USCG, EPA, DOI, BLM, BOEM, BSEE, U.S. Fish & Wildlife Service, USDOT PHMSA, and ADEC data sets through 2019.into an electronic database in a standard format. Exposure data for Cook Inlet region will be collected and the number of wells, flow, and pipeline miles by year provided when available. The investigators will also calculate accident frequencies for small spills and perform appropriate statistical analyses, including trend analysis. Results will be collated into an electronic database in a standard format.

Specific Research Question(s): What are the respective frequencies of oil spills on the Alaska North Slope and Cook Inlet?

References:

ABS Consulting Inc., 2016. 2016 Update of Occurrence Rates for Offshore Oil Spills. Arlington VA: Prepared by ABS Consulting Inc. for USDOI, BOEM/BSEE. 95 pp.

Robertson, T. L., Campbell, L. K., Pearson, L., and Higman, B., 2013. Oil spill occurrence rates for Alaska North Slope crude and refined oil spills. Report to Bureau of Ocean and Energy Management. OCS Study BOEM 2013-205.

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Environmental Studies Program: Ongoing Studies

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Development and Testing of a Low-Cost Satellite-Tracked Ice Drifter for Arctic Waters (AK-13-03-07)

BOEM Information Need(s) to be Addressed: The products of this study will respond to BOEM's and the State of Alaska's needs to better understand ocean currents within the water column underlying sea ice and to better estimate oil and contaminant trajectories in the nearshore in the event of a spill during the winter months. These low-cost ice drifters will be able to be easily deployed in ice-infested waters. The results from the ice drift study will provide new information on the stability of landfast ice, including in those areas that are heavily used by subsistence hunters. The capability to monitor large fragments of detached coastal sea ice in real-time would allow local communities, the State of Alaska, and Federal Agencies to track the movement of large ridges of ice that have the potential to be offshore marine mammal habitat or potential maritime hazards to shipping operations or subsistence hunting. Information from this study will support NEPA analyses for future lease sales, EPs, and DPPs.

Total BOEM Cost: $243,286 plus Joint Funding ($215,123)

Period of Performance: FY 2014-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Jeremy Kasper

BOEM Contact: Warren Horowitz

Description:

Background: This study will develop and test a limited number of ice drifters to measure small scale ice motion within the nearshore and offshore sea ice off Barrow. Sea ice movement is an important concern with respect to offshore oil and gas operations, the shipment of goods to the villages, scientific research activities, and the safety of subsistence hunting activities. Through the use of satellite-tracked buoys and satellite imagery, our understanding of large-scale ice motion within the deep ocean has improved significantly over the past few decades, although our knowledge of the impacts of small scale ice motions are limited, especially in the nearshore and offshore areas of the shallow shelf areas of the Chukchi Sea. Recent scientific investigations described in OCS Study BOEM 2012-079, *Application of High Frequency Radar to Potential Hydrocarbon Development Areas in the Northeast Chukchi Sea,* have shown a complex set of ocean currents within this area of the shelf during the open water season. Other investigations have shown large breakout events of landfast ice along the northeast Chukchi coast. In one of these breakout events on April 9, 2012, a large mass of ice over 40 km in length broke off the coast seaward of Wainwright and drifted into offshore areas of the Chukchi Shelf.

Objectives:

- Design, develop, test, and deploy low-cost satellite-tracked ice drifters that will collect position data during winter conditions in the northeast Chukchi Sea. The drifters should be easily deployed by local residents using snow-machines or walking on ice; survive low altitude deployments from helicopters; transmit real-time position data via Iridium Satellite; and float and continue sending position data after the ice flow has melted.
- Obtain ice motion information from the collection and analysis of sub-daily position data from clusters of deployed drifters within the coastal ice and within offshore ice flows.
- Obtain ice thickness and velocity data from the tagged ice floes, when possible, as they pass over co-located Ice Profiler and Acoustic Doppler Current Profiler situated beneath the coastal ice and at offshore locations.

Methods: The proposal plans to design, develop, and test a new type of satellite-tracked ice drifter that can be deployed on coastal landfast ice by local hunters or on top of freely drifting mobile pack ice by helicopter to track the movement of sea ice in the northeast Chukchi Sea. The movement and velocity data from the ice-drifters will compliment other data collection efforts currently underway that measures nearshore ice movements, current velocities, and ice thickness from X-Band Coastal Radar, moored Acoustic Doppler Current Profilers (ADCP), and Ice Profiling Sonars (IPS), respectively. Sub-daily position data from the clusters of drifters and X-Band Coastal Radar will improve our understanding of small scale ice dynamics of the coastal attached sea ice. As the fragments of ice detach from the landfast ice during the spring and early summer months, the co-located ADCP and IPS, and the coastal meteorological station in Barrow will provide additional information on potential forces driving the detachment process and movements of sea ice within the nearshore area. Farther offshore large ice floes will be tagged with clusters of ice drifters to track their movements. Twenty (20) prototype ice drifters will be deployed in stages to ensure that any design flaws may be corrected with later deployments. Improvements to the design of the drifters will be made as needed to ensure success.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Measuring Wave Forces along Alaska's Coastal Sea Ice (AK-13-03-17)

BOEM Information Need(s) to be Addressed: This study will provide a better understanding of the stresses that cause breakout events associated with landfast ice along the Chukchi and Beaufort coasts from wind, waves, coastal waves, and storm surges. The results from the sensor measurements will be used to better understand the mechanical properties of sea ice within the landsfast ice zone. Information will provide supporting data to improve our understanding of ice safety and marine navigation during the spring months. Information could also be utilized in NEPA documents to assess the risk of landfast ice to proposed exploration and production activities.

Total BOEM Cost: $311,392 plus Joint Funding ($311,392) **Period of Performance:** FY 2016-2019

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Mark Johnson

BOEM Contact: Warren Horowitz

Description:
Background: Landfast ice stability is extremely important to the Alaska Native subsistence hunters along the Chukchi coast. During the spring hunt for bowhead whales the subsistence hunters use landfast ice as a stable hunting platform. Breakout events occur when there is a sudden detachment of the landfast ice platform from the coast. In some years, large breakout events have stranded subsistence hunters offshore on drifting sea ice. Climate change may cause earlier and more frequent breakout events due to longer periods of open water causing greater exposure of the ice edge to the forces of waves and storm surges. A set of inertial motion units (IMUs) sensors will be designed and deployed to measure ice acceleration due to waves propagating through the landfast ice off Barrow, Alaska. These types of measurements will improve ice safety by understanding how propagating waves impacts landfast ice stability and fragmentation along the coast. These measurements will also help to achieve a better understanding on the processes associated with larger breakout events that occur on an annual basis along the Chukchi coast. The experiment of measuring wave propagation into the landfast ice has been tested in Norway with success. This study plans to reproduce a similar experiment along the coast of the Chukchi Sea to measure those wave forces in the landfast ice near Barrow, Alaska.

Objectives: The overall goal of this project is to improve ice safety by understanding wave energy propagation into sea ice, and determine its effect on landfast ice stability along the Chukchi coast. Specific objectives include:

- Improving the ability to detect infragravity waves at the fast ice edge and directly measuring ice acceleration, wave period and arrival time.
- Developing estimates of wave velocity and amplitude and propagation direction.
- Gaining a better understanding of wave origin, propagation path and attenuation and their relationship to the mechanical properties of ice.
- Estimating the stresses imparted into landfast ice.
- Evaluating the relationship between infragravity and landfast ice destabilization events.
- Assessing the effect of ice topography and heterogeneity of wave propagation.

Methods: This project will design, fabricate, and field test portable sensors that measure the 3D acceleration of the landfast ice. Year one field testing will be conducted in Fairbanks, Alaska. During year two, the researchers will build three IMU wave sensors for full deployment during the spring months on the landfast ice edge off of Barrow, Alaska. In year three, the IMU wave sensors will be deployed away from the landfast ice edge to test the feasibility of measuring wave attenuation and estimate along path ice thickness.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: High-frequency Characterization of the Physicochemical Parameters of Cook Inlet, Alaska (AK-13-03-23)

BOEM Information Need(s) to be Addressed: Results from this study will support analysis of cumulative effects in NEPA documents for future Cook Inlet lease sales, and for future EPs and DPPs that may result from Cook Inlet Lease Sale 244 (2017) or future Cook Inlet lease sales.

Total BOEM Cost: $120,094
plus Joint Funding ($120,094)

Period of Performance: FY 2017-2020

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Amanda Kelley

BOEM Contact: Dr. Heather Crowley

Description:
Background: Measuring ocean acidification (OA), the addition of anthropogenic atmospheric CO_2 to the surface oceans, is increasingly important to aid understanding of how marine ecosystems will respond to global ocean change. With few long-term and baseline ocean pH records in place, it is difficult to determine the natural and anthropogenic influences on ocean pH variability. With recent developments in pH sensor technology, monitoring networks are growing along the west coast of the United States. This study will deploy two sensors capable of measuring pH, temperature, conductivity (to calculate salinity) and oxygen concentration along the freshwater gradient in Cook Inlet, Alaska. Utilizing this new technology can vastly improve understanding of nearshore carbonate chemistry and help tease apart the source of current pH variability. Conductivity measurements will facilitate identification of the intensity of freshwater input as well as improve calculations of pCO_2 levels. Due to oxygen's role in photosynthesis and respiration, oxygen concentration measurements will provide insight to the relative impact that biological processes have on the carbonate system, although it does not directly impact pH or pCO_2. Verification of a pH gradient across Cook Inlet will provide a unique framework for biological studies investigating aspects of OA tolerance and local adaptation. Including temperature, conductivity and oxygen concentration measurements will further our understanding of complex, near-shore OA dynamics.

Objectives:

- Establish baseline high-frequency pH, temperature, conductivity (salinity) and dissolved oxygen time-series measurements from two near-shore sites in Cook Inlet, AK.
- Quantify the sources of pH variability, including those associated with biological processes, tides and currents, and freshwater (riverine) input.

Methods: This project will deploy oceanographic SeapHOx sensors at two sites along the freshwater gradient found in Cook Inlet, Alaska. Sensors will be deployed in summer 2017 via scuba in lower Cook Inlet and Kachemak Bay. Sensor maintenance will be conducted and calibration samples collected at six-month intervals over two years. Descriptive statistics and basic time-series analyses will be used to describe the range, frequencies, and mean conditions measured at each site. Site-specific correlation and regression analyses will be employed to explore variation between sites and among measured parameters. Spectral analyses will be used to identify periodicities and correlation among parameters across different frequencies. Low pass and high pass filters will identify sources of short-term, event-scale and seasonal pH variability (if present) will be investigated and described through simultaneous analysis of oxygen, salinity, and temperature

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea
Administered By:	Alaska OCS Region
Title:	Wave and Hydrodynamic Observations and Modeling in the Nearshore Beaufort Sea (AK-17-01)

BOEM Information Need(s) to be Addressed: BOEM needs a validated high-resolution wave model and hydrodynamic model outputs to assess current and future wave conditions and their impacts on offshore oil and gas structures, and potential changes in sedimentation patterns and coastal erosion within Stefansson Sound and the nearshore areas of the Beaufort Sea. Specifically, BOEM requires information on the impacts that climate change may have on sea ice, wind and wave conditions, changes in sedimentation rates, and ice pile up events during the expected timeframe of the Liberty Development Project (~2020-2050). Coordinated field observations are needed for model validation since wave observations are quite limited in the central Beaufort Sea. Results from this study will support NEPA analyses for future lease sales, EPs and DPPs, and inform monitoring activities associated with the planned Liberty Development Project.

Total BOEM Cost: $2,123,903 **Period of Performance:** FY 2017-2022

Conducting Organization: University of Alaska Fairbanks; USGS Western Region

Principal Investigator(s): Dr. Jeremy Kasper; Dr. Li Erikson

BOEM Contact: Warren Horowitz

Description:
Background: The shallow shelf area in Stefansson Sound is capable of modifying large wave events as they propagate shoreward. Depth refraction, shoaling, and dissipation processes due to shallow water bathymetric effects are difficult to represent in shallow water wave models. The area within Stefansson Sound and Foggy Island Bay are difficult to model due to the scarcity of wind and wave information, the complex shallow bathymetry, coastal topography and the highly variable and mobile sea ice conditions. The 100-year return wave height and period are important considerations for the design of offshore fixed structures to support the topside oil and gas facilities. Likewise, rapidly changing climate conditions such as warmer temperatures, stronger winds, and reduced ice cover can adversely impact those shore based facilities through larger, more persistent waves and thawing of permafrost and increased coastal erosion.

This study will produce high resolution wave output in the nearshore region to assess the impacts of waves on sea ice and offshore structures. A coordinated field effort will collect offshore observations using fixed moorings and buoys for validation of the proposed wave model for the Beaufort Sea. Additional field effort will be conducted to map ice pile-up events within Stefansson Sound.

Objectives:

- Obtain a better understanding of the physical processes related to wave simulations within Stefansson Sound, Beaufort Sea, the bottom conditions and depth-induced wave breaking conditions and their effects.
- Assess offshore wave and meteorological conditions within Stefansson Sound and compare those measurements to model results.
- Produce a 20-year wind and wave hindcast reanalysis dataset and document the minimum, mean, and maximum wind-wave events.
- Characterize wave conditions in Stefansson Sound over a 2, 5, 10, 20, and 30 year period based upon the model results and potential reduced sea ice conditions due to climate change.
- Develop a coupled wave-hydrodynamic-sediment transport model to document current sediment transport conditions; forecast changes due to higher waves, stronger currents and diminished sea ice.
- Through field observations, document wave, ice, and erosional conditions within Stefansson Sound and their impacts on offshore and coastal oil and gas facilities during the two years of field effort and compare to past assessments since the 1970s.

Methods: This study will develop a new wave model or enhance an existing wave model (e.g., the Simulating Waves Nearshore or SWAN model) to better simulate near shore wave conditions within the Beaufort Sea. Researchers will validate the model against field-deployed moorings that measure site-specific wave conditions over a two-year field season. The developed wave model will be coupled to a hydrodynamic model to evaluate potential nearshore impacts or changes in sedimentation rates or sites of deposition or erosion related to changes in current and wave energy resulting from construction of a gravel island for oil and gas production on the OCS. This work intends to be coordinated with ongoing and future research funded by BSEE and BOEM to investigate the dynamics of sea ice freeze-up.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Synthesis of Arctic Research (SOAR) Physics to Marine Mammals in the Pacific Arctic (AK-11-05)

BOEM Information Need(s) to be Addressed: The changing physical environment of the U.S. Arctic OCS is hypothesized to drive a rapid tempo of change in the distribution and behavior of a number of protected marine mammals that inhabit those waters. The same species may be affected by oil and gas activities within BOEM planning areas, with strong potential for deleterious interactions between natural and human induced phenomena. Under NEPA and the ESA, BOEM is required to evaluate whether and how Federal actions associated with oil and gas development may affect these protected populations. Information on ocean circulation and hydrography is useful for those evaluations as well as for input into various models used to forecast the outcome of oil spills and other physical phenomena. Given recent high investment in interdisciplinary biological and oceanographic research by the Governments in the region, a synthesis of results of completed and ongoing studies would be useful to inform management decision-makers and may be useful in determining needs of future research activities.

Total BOEM Cost: $1,798,459 plus Joint Funding (~$490,000) **Period of Performance:** FY 2011-2018

Conducting Organization: NOAA-Pacific Marine Environmental Laboratory

Principal Investigator(s): Dr. Phyllis Stabeno, Dr. Sue Moore

BOEM Contact: Dr. Heather Crowley

Description:

Background: The physical climate of the western Arctic appears to be rapidly changing. The summer minimum sea ice extent in 2007 and 2008 covered an area which was 37% less than the areal coverage of two decades ago and 20% less than the previous minimum coverage in 2005. High water temperatures and dense concentrations of zooplankton have been observed near Barrow. The rapidity of these changes was unexpected, as the consensus of the climate research community just a few years ago was that such changes would not be seen for another 30 years, as expected from the CO2 anthropogenic contribution alone.

During the same period, several marine mammals have exhibited unusual movements or behaviors that may be related to these environmental changes. The range of humpback whales has moved northward to include the northern Chukchi and western Beaufort Seas. Fin whales have expanded their range northward to include waters north of Icy Cape in the Chukchi. In 2009, bowhead whales fed extensively in the northern Chukchi Sea, a phenomenon not observed since the end of commercial whaling one

hundred years ago. In recent years, gray whales have fed in increasing numbers along the coastline between Wainwright and Barrow. In 2007 and 2009, walrus formed large aggregations on shore between Norton Sound and Barrow. This behavior appears to be related to the summer retreat of sea ice well northward of traditional walrus feeding areas on the shelf break.

Given the continuing retreat of sea ice and the known high-latitude range of these species in other oceans, it is likely that the recent sightings represent a climate-related range expansion that will continue in future years. Other changes in behavior and/or expansion of feeding areas also may accelerate as ice continues to degrade and water temperatures rise.

Between the years 2005 and 2015 MMS and BOEM will have invested more than $50,000,000 in marine mammal and related oceanographic studies in the western Arctic. These data will increase our body of knowledge about the region considerably, but interpretation will be complicated by concurrent environmental changes. This study proposes a synthesis of research from the ongoing studies in the Region. These studies include, but are not limited to:

- Bowhead Whale Feeding Variability in the Western Alaskan Beaufort Sea: Satellite Tracking of Bowhead Whales & Oceanography and Feeding
- Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic
- Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling
- Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea
- Walrus Habitat Use in the Potential Drilling Area
- Pinniped Movements and Foraging: Bearded Seals
- Arctic marine research studies supported through NOPP
- Studies conducted by the State of Alaska and the North Slope Borough under the USDOI Coastal Impact Assistance Program (CIAP)

Objectives:

- Increase scientific understanding of the inter- and intra-relationships of oceanographic conditions, lower trophic prey species, such as small fish and krill, and marine mammal distribution and behavior in the Chukchi Sea Planning Area, and adjacent waters.
- Enhance capability to estimate future changes in oceanographic features such as currents, upwellings, and ice leads and associated changes in the behavior of marine mammals and their prey.

Methods: Using a synthesis approach, PIs will analyze data available from BOEM supported, and related, studies in the Chukchi Sea Planning Area and adjacent waters, using available statistical and other models to identify and test hypotheses that cross scientific disciplines. This study will be guided by an oversight committee formed of senior scientists and accomplished through annual, or more frequent, meetings (with significant data preparation and analysis beforehand). In the first meeting participants

will inventory available data and deem its sufficiency for use to address specific hypotheses and questions identified by the participants in facilitated sessions. Recommendations for further analyses and publication development will be provided in a report to BOEM summarizing that meeting. After BOEM review and approval, subgroups of interdisciplinary scientists will work together to prepare data for integration and conduct appropriate statistical analyses or modeling to identify interdisciplinary relationships and/or test hypotheses previously identified. If useful, PIs may integrate data with on-going oceanographic programs (e.g. RUSALCA and the Distributed Biological Observatory) to inform ecosystem models and enhance their predictive capability. After analyses are completed, sub-groups will prepare multi-authored manuscripts for publication in appropriate peer-review literature. Topics for synthesis include, but are not limited to, inter- and intra-relationships of oceanographic circulation, sea ice, hydrography, lower-trophic abundance and distribution, and marine mammal distributions and behavior. Deliverables from this study will include multiple workshop proceedings and summary recommendation reports, as well as multiple peer-review journal publications.

Revised Date: August 9, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring (AK-12-02)

BOEM Information Need(s) to be Addressed: This project will extend ongoing research to provide more information on the locations and use of bowhead whale feeding areas, the variability of those locations from year to year, and the environmental factors that can be used to project where bowhead whales will concentrate. This information can be used for developing mitigation options for OCS oil and gas activities in the Beaufort and Chukchi Seas. Information on the vocal behavior of bowhead whales under various environmental conditions is needed to interpret the habitat use and call behavior being collected on many passive acoustic recorders currently in use. Information from this study will support ESA Section 7 consultations and NEPA documentation.

Total BOEM Cost: $2,699,857 **Period of Performance:** FY 2012-2019

Conducting Organization: ADF&G

Principal Investigator(s): Dr. Lori Quakenbush

BOEM Contact: Carol Fairfield

Description:

Background: A previous BOEM study using satellite telemetry has greatly added to the knowledge of bowhead whale movements, concentration areas, and the timing of both. Multiple years of tracking during this study has begun to provide information regarding the inter-annual variability in movements and concentration areas. Continued tracking will provide a better understanding of this variability and will allow us to estimate the timing and location of bowhead concentration areas making mitigation measures more directly applicable and useful.

Satellite-linked transmitters are a valuable tool for tracking bowhead whales and they have been effective at documenting movements of large and small whales of both sexes, and the timing and locations of concentration areas. Another tool, of increasing use, is the passive acoustic recorder deployed near areas of interest to record marine mammal vocalizations. Recorded bowhead vocalizations indicate that a bowhead was present at the time of vocalization, but an absence of calls could mean bowheads are present but not vocalizing. Bowhead whale vocalization rates related to various behaviors (e.g., feeding and travelling) or potential disturbances (e.g., boat traffic, seismic operations, and drilling) are needed to interpret the information being collected by passive acoustic recorders. Sensors for monitoring environmental conditions such as temperature and

salinity have been developed and are in use on large whales, including bowheads in Greenland.

Objectives: To better understand interannual variation in bowhead whale feeding concentrations and to interpret call counts and calling rates collected by passive acoustic recorders.

Methods: This study will track the movements and document the behavior of bowhead whales using satellite telemetry to compare among years emphasizing new tagging locations such as St. Lawrence, Island, Pt. Hope and Canada. Bowhead whale vocalization rates and ambient noise levels will be documented using an acoustic tag to develop analysis of call rates relative to behavior and disturbance. Tags equipped with environmental sensors will be deployed to monitor, summarize, and transmit ambient oceanographic conditions as bowheads migrate. Limited numbers of individuals of other species of large whales (Gray, Humpback, Fin) may be tagged and tracked as opportunities arise as a pilot study for future work.

This study also will continue collaborations between individual whaling captains, AEWC, NSB, ADF&G, NMFS, BOEM, DFO-Canada, and Natural Resources Greenland and develop additional collaborations with oil companies and consultants collecting acoustic data to accomplish this project. Satellite transmitters with environmental and passive acoustic monitoring capabilities will be deployed on bowhead whales near Native communities in the Beaufort, Chukchi, and Bering Seas. Plots of whale tracks will be made available weekly and location data compared among years to determine inter-annual variability of movements and concentrations. Acoustic data will be analyzed to determine individual whale calling rates relative to whale behavior and disturbance factors. This study will be coordinated with AEWC and local whaling captains' associations go prevent any interference with subsistence whaling and hunting. All necessary research and access permits will be obtained by the PI.

Revised Date: August 14, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea, Northern Bering Sea
Administered By:	Alaska OCS Region
Title:	Ice Seal Movements and Foraging: Village-based Satellite Tracking of Ringed and Bearded Seals (AK-12-05)

BOEM Information Need(s) to be Addressed: More information is needed on seal movements and feeding areas relative to areas of interest for oil and gas leasing, exploration and development. Additional information would be particularly useful to evaluate potential interaction between industrial development and anticipated effects of diminished summer sea ice in much of their habitat. Data can be used to design monitoring and mitigation measures and will support NEPA environmental analyses. Since ice seals have been petitioned for listing under the ESA, information from this study may be useful for future ESA Section 7 consultations.

Total BOEM Cost: $1,174,994 **Period of Performance:** FY 2013-2019

Conducting Organization: ADF&G

Principal Investigator(s): Dr. Lori Quakenbush

BOEM Contact: Carol Fairfield

Description:
Background: Considerable effort has been expended since the 1980s to document the distribution, abundance and behavior of ice seals in the Beaufort and Chukchi Seas. However, most of that effort involved aircraft surveys and analysis of prey from stomachs collected by biologists or in subsistence harvests. Some satellite telemetry studies of ringed, bearded, and spotted seals movements have been conducted (funded by MMS and others) showing large scale movements by all species and age classes. One highly successful project was conducted from 2004-2010 near Kotzebue in which local hunters were trained for capture and tagging. Seals tagged near Kotzebue ranged farther north than Barrow and south to Bristol Bay. Overall, because of the proximity to the tagging most of the locations are in the southern Chukchi Sea near Kotzebue. Additional tagging locations are needed to better understand the range of movements and use patterns. Tagging near Pt. Lay, Wainwright, and Barrow may show a greater use of the Chukchi Sea and the Beaufort Sea than use by seals tagged near Kotzebue. On the other hand, if seals tagged near Kotzebue go to the Yukon-Kuskokwim area and Bristol Bay, seals tagged in the Bering Sea may also use the Chukchi and Beaufort Seas.

Adult ringed seals are the most ice adapted and are known to use the heaviest ice concentrations throughout winter and spring, and it was assumed that juveniles occupied similar habitats in winter. Movements of adult and juvenile ringed seals tagged near Kotzebue, however, showed juveniles travelling to and wintering near the ice edge in the Bering Sea while adults wintered in heavy ice in the northern Bering and

Chukchi Seas. It is likely that other similar patterns of use by species or sex/age classes will be documented during this tagging study.

Objectives: To better understand movements and habitat use of ice seals in the Beaufort, Chukchi, and northern Bering Seas.

Methods: Using the tagging project conducted in Kotzebue Sound by the Native Village of Kotzebue (Kotzebue IRA) as a model, develop similar collaborations between local Village Councils, seal hunters, the Ice Seal Committee, NSB, ADF&G, NMFS, BOEM, to establish seal tagging projects near several Native communities selected for their importance in provided missing seal movement information. Biologists have trained hunters in seal capture and tag deployment and provide weekly maps of seal tracks to the hunters and their communities. Movement data will be analyzed relative to ice edge, ice concentration, bathymetry, and residence times.

Revised Date: August 14, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Arctic Whale Ecology Study (ARCWEST): Use of the Chukchi Sea by Endangered Baleen and Other Whales (AK-12-07)

BOEM Information Need(s) to be Addressed: Whale species listed as threatened and/or endangered are known to, or potentially could, occur in areas that may be affected by oil and gas activities within the Chukchi Sea Planning Area. These include, but are not limited to the humpback (*Megaptera novaeangliae*), the fin (*Balaenoptera physalus*), and the bowhead (*Balaena mysticetus*), all of which are listed as endangered. Recent sightings of both humpback and fin whales in the Chukchi and/or Beaufort Seas, indicate a range expansion by one or both species. Gray (*Eschrichtius robustus*) and beluga (*Delphinapterus leucas)* whales also use these waters in large numbers. Under NEPA and the ESA, BOEM will be required to evaluate if and how Federal actions associated with oil and gas development may affect these whales. The occurrence, distribution and habitat use of these species in the areas concerned may play an important role in determining which areas are to be offered for lease, and the timing of potential exploration and development activities in certain areas.

Total BOEM Cost: $4,602,000 plus Joint Funding (~$4,024,000) **Period of Performance:** FY 2012-2017

Conducting Organization: NOAA-MML

Principal Investigator(s): Dr. Catherine Berchok

BOEM Contact: Carol Fairfield

Description:

Background: Research under the Bowhead Whale Feeding Ecology Study (BOWFEST) indicated that large concentrations of bowhead whales feeding in the Barrow arch (Wainwright to Smith Bay) are attracted by prey and nutrients transported from the Bering Sea through Barrow Canyon and upwelled onto the Beaufort shelf near Barrow. Other large concentrations of whales, pinnipeds and water birds are also found in the area and may be attracted by elements of the same mechanism. However, it is not clear exactly how this transport mechanism operates as these resources could be transported through the Chukchi Sea on the Alaska Coastal Current or by other sources of Bering Sea waters. This study will undertake to determine relationships between dominant currents passing through the Chukchi Sea and resources delivered to the Barrow Arch area and will provide information about the dynamic nature of those relationships relative to whale distribution and habitat utilization in the eastern-Chukchi and extreme western-Beaufort Seas.

The relationships between Chukchi Sea currents and the transport of nutrients and prey may be more dynamic than formerly appreciated and may be changing as a result of the warming of the surface waters and increasing retreat of summer sea ice in the Chukchi. Recent observations of humpback and fin whales in the Chukchi Sea are likely a climate change-related range expansion that will continue in future years. Even as the range of these cetaceans appears to be expanding, with the exception of the bowhead whale, little is known about the population identities of any of the whales observed there. In the case of the humpback whales, it is possible that they are part of the relatively small western North Pacific stock. Information about the extent to which the region is important for humpback or fin whales is extremely limited. Gray whales make extensive use of the Chukchi for feeding and at least some gray whales have been documented in the area during every calendar month. Gray whales potentially could belong to stocks associated with either North America or Asia; the latter is considered to be critically endangered, with fewer than 150 animals remaining. Although gray whales have been documented in the Chukchi Sea by surveys over the past three decades, the ecology of the species has not been studied in the area. Over 10% of the Eastern Pacific Stock may use the Chukchi Sea for summer feeding. They are known to make extensive summer use of waters near the leased area and Peard Bay, areas of significant interest for industrial development. Beluga whales are frequent visitors to lagoons and coastal waters along the eastern Chukchi Sea coast. They are prized as a traditional species taken for subsistence and ceremonial purposes by Alaska Natives resident along that coastline. Beluga stock associations are not well known but belugas in the region are probably from a mixture of several stocks inhabiting the Chukchi Sea and Arctic Ocean.

Since all five species winter in, or south of, the Bering Sea, large numbers must pass through the Bering Strait during seasonal migrations to feeding grounds further north. Beginning at the Bering Strait, this research will investigate the currents and nutrient/prey transport process using methods and equipment developed for physical and biological oceanography. Additional work on the distribution, stock identity, and ecological relationships is needed for all five whale species and this all will be accomplished in a cooperative, highly-integrated study involving scientists supported by BOEM, the NSB DWM, and the NSF.

Objectives:

- Assess spatial and temporal patterns of use of the Chukchi Sea by endangered bowhead, fin and humpback whales, and beluga and gray whales.
- Assess population structure and origin of animals.
- Evaluate ecological relationships for the species, including physical and biological oceanography.
- Extend existing studies of bowhead whale foraging ecology into the Chukchi Sea to further understand the sources, transport and advection of krill from the Bering Strait.

Methods: This study requires technologies including satellite tracking, passive acoustic monitoring, genetic analyses, and oceanographic and biological methodologies and technologies.

Northern Bering Sea: Satellite tags will be attached to humpback and fin whales, and their movements through the Chukchi Sea will be monitored through the Argos system. No fin whales have been satellite tagged in this region. Up to 20 tags per species would be deployed in each of 4 years. Population structure and origin will be assessed by genetic analysis of biopsy samples. Areas where aggregations of whales occur will be targeted to increase the probability of successful tagging. For example, an aggregation of humpback whales tends to occur in the northern Bering Seas southwest of St. Lawrence Island (around the M8 oceanographic mooring). Sonobuoys will be used to target fin whales which use a triplet call that occurs in both the Bering and Chukchi Seas. An array of listening devices will be deployed through the Bering Sea to monitor occurrence and movement of large whales transiting through the area to facilitate tagging efforts and target whales that move into the Chukchi Sea.

Chukchi Sea/Bering Strait: In the Chukchi Sea, arrays of listening devices will be deployed in the Bering Strait and near Wainwright, Alaska, with the intention of monitoring the occurrence and movements of large whales transiting through the area. This study will also permit a full visual and acoustic survey to be conducted between Dutch Harbor and the Bering Strait/Wainwright. In addition, photo-id, biopsy sampling and satellite tagging will be attempted if humpback, fin and gray whales are found en route. Humpback, fin, and gray whales will be tagged in the region as practical. Cruises will be organized to extend similar research activities to those areas during years 3-4 of the study. Oceanographic surveys, including prey sampling, will be conducted in association with cruises, and will include studies of foraging ecology of bowheads using similar methods to those employed in the Beaufort Sea. Instrumented moorings may be deployed for year-around monitoring of oceanography and sound. The study will be integrated with other ongoing studies in the region including aerial surveys, passive acoustic monitoring and oceanography. Analysis of acoustic data from new and existing recording packages will investigate the occurrence of gray, humpback, fin and bowhead whales on a year-round basis.

Revised Date: August 14, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ) (AK-13-02)

BOEM Information Need(s) to be Addressed: Information from this study will document the physical and biological dynamics in the Hanna Shoal region, including the temporal and spatial distribution of marine mammals. Findings may be used for evaluating potential deferral areas and other potential limitations on OCS leasing, exploration, and development, such as the January 2015 Presidential Withdrawal of Hanna Shoal. This study will provide useful information to support NEPA analysis and documentation for Beaufort and Chukchi Sea lease sales, exploration plans, development and production plans, consultations under the ESA, supporting authorizations by other Federal agencies under MMPA, and monitoring protocols for adaptive management.

Total BOEM Cost: $3,933,671 plus Joint Funding (~$2,000,000) **Period of Performance:** FY 2013-2019

Conducting Organization: NOAA-MML

Principal Investigator(s): Catherine Bechok

BOEM Contact: Dr. Heather Crowley

Description:

Background: The western Arctic physical climate is rapidly changing. The summer minimum sea ice extent in 2007, 2008 and 2011 covered an area which was 37% less than the areal coverage of two decades ago and 20% less than the previous minimum coverage in 2005. The reduction in sea ice coverage also opens up vast new regions of the Arctic Ocean to increased absorption of sunlight and storage of heat. The rapidity of these changes was unexpected, as the consensus of the climate research community just a few years ago was that such changes would not be seen for another 30 years. The observed northward retreat of the minimum extent of summer sea ice has the potential to allow expansion of oil and gas-related exploration and development into previously closed seasons and localities in the U.S. Arctic.

Baleen whales (bowheads [*Balaena mysticetus*], gray whales [*Eschrichtius robustus*], fin whales [*Balaenoptera physalus*], humpbacks [*Megaptera novaeangliae*], and minke [*Balaenoptera acutorostrata*]) are subject to changes in environmental variables such as oceanographic currents, sea temperature, sea ice cover, prey availability, and anthropogenic impacts. Furthermore, extreme ice-retreat and climate warming in the western Arctic over the last decade are expected to lead to changes in species

composition and distribution, evidenced already through local knowledge and opportunistic observations.

Hanna Shoal in the northeast Chukchi Sea is an area of special biological concern bordering the boundary between Chukchi Sea and Arctic Ocean waters. The reason for this, however, is poorly understood. The shallower waters of the shoal have long been known as traps for grounding of sea ice, and a reoccurring polynya is created down current of the grounded ice. In most recent years, floating pack ice in summer persists in this area longer than elsewhere in the Chukchi, often surrounded by open water even to the north. Biological "hot spots" in the Chukchi Sea are thought to be related to coupled pelagic and benthic productivity. The importance of the Hanna Shoal region to bowhead, gray and other whales, as well as walruses and ice seals, is not well known.

The study "COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales" combines passive acoustic detection and tracking of whales, active acoustic detection of zooplankton, and biophysical measurements from long-term moorings on the Chukchi Shelf to examine relationships between primary production, zooplankton biovolume and the presence/absence of whales. Passive acoustic detection and tracking is a proven tool for assessment of large whales in U.S. seas. Specifically, acoustic detection has proven a key addition to the census of bowhead whales (*Balaena mysticetus*) during their spring migration past Barrow, and in relation to oil and gas development activities offshore Prudhoe Bay. The proposed study will refocus this monitoring to the region of Hanna Shoal. These measurements will complement the biological, oceanographic and contaminant data collected by the "Hanna Shoal Ecosystem Study."

Objectives: This study will refocus the acoustic and biophysical monitoring begun under the study "COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales" to the region of Hanna Shoal. Specific objectives include:

- Assess the spatial and temporal distribution of marine mammals near Hanna Shoal.
- Implement a tonal detector/classifier for all marine mammal species of interest to BOEM in the Arctic.
- Describe patterns of current flow, hydrography, ice thickness, light penetration, and concentrations of nutrients, chlorophyll and large crustacean zooplankton.
- Evaluate the extent to which variability in environmental conditions such as sea ice, oceanic currents, water temperature and salinity, and prey abundance influence whale distribution and relative abundance.
- Develop a quantitative description of the Chukchi Sea's noise budget, as contributed by biotic and abiotic sound sources, and continuous, time-varying metrics of acoustic habitat loss for a suite of arctic marine mammal species.

Methods: This study will deploy long-term passive acoustic recorder moorings in the vicinity of Hanna Shoal to provide information on marine mammal distribution. Researchers will also opportunistically deploy sonobuoys to monitor vocalizing marine

mammals while the ship is underway. Annual data will be analyzed for whale calls to estimate: seasonal occurrence by species, inter-annual differences in occurrence by species, variation in occurrence due to changes in ice extent, and types and strengths of anthropogenic noise in the study area. Biophysical moorings and active acoustic moorings for zooplankton deployed on the flanks of Hanna Shoal will collect information on currents, hydrography, ice, nutrient and chlorophyll concentrations, etc. These instruments will be refurbished and redeployed annually.

The study will also use autonomous and real-time passive acoustic recording systems to monitor the Chukchi acoustic ecosystem and quantify changes in its acoustic habitat as a function of natural and man-made noise contributors. The systems will automatically collect, detect and report via satellite species-specific sounds from a broad suite of marine mammals in the Chukchi Sea, including: beluga, bowhead, fin, humpback and killer whales; bearded, ribbon and ringed seals; walrus; and fishes. These data will populate models of the acoustic environment that are currently under development.

Revised Date: January 29, 2018

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Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Using Trace Elements in Pacific Walrus Teeth to Track the Impacts of Petroleum Production in the Alaskan Arctic (AK-13-03-26)

BOEM Information Need(s) to be Addressed: BOEM NEPA analysts evaluate the potential environmental effects of OCS oil and gas exploration, development, and production activities. Trace element concentrations have been found to be an effective measure of the degree and spatial extent of environmental contaminants related to oil and gas activities. This study will provide information about variations of trace metal concentrations in relation to oil and gas activities and will improve understanding of the potential impacts of these contaminants to biota at multiple trophic levels. Results from this study will inform NEPA analyses for EPs or DPPs that may be submitted in the Beaufort Sea and for potential future lease sales.

Total BOEM Cost: $25,000
plus Joint Funding ($25,000)

Period of Performance: FY 2017-2018

Conducting Organization: CMI, UAF

Principal Investigator(s): Casey Clark

BOEM Contact: Carol Fairfield

Description:
Background: During the extraction of petroleum resources, there is the potential for the discharge of contaminants from drilling muds to the environment. Typical contaminants associated with sediments include concentrations of As, Ba, Cd, Cr, Cu, Fe, Mn, Pb, Ni, V, and Zn), which may impact the benthic ecosystem. Pacific walruses (*Odobenus rosmarus divergens*) are an ideal species for monitoring the impact of petroleum exploration and extraction on benthic environments in this region due to their geographic overlap with historic oil and gas exploration areas, and their broad diet of benthic invertebrates. Walrus teeth act as biological archives of trace element exposure, from which one can measure the concentrations of trace elements in the teeth of walruses from historic museum collections and present-day Alaska Native subsistence harvests. As a result, these animals may serve as a valuable means of monitoring the impacts of oil and gas activities on benthic communities as well as other predators foraging in this area (e.g., bearded seals, *Erignathus barbatus*, and gray whales, *Eschrichtius robustus*).

Walrus teeth contain an unusually large cementum layer, which is laid down seasonally in dark and light bands. Trace elements are included in the matrix of the tooth cementum in concentrations that reflect those of the environment in which the animal lives and feeds. By measuring these trace element concentrations, the lifetime history of

an animal's exposure to specific trace elements may be reconstructed. This method has the potential to capture seasonal or annual exposure events, as well as increases in element exposure within an individual's lifetime. Walrus teeth are relatively abundant in museum collections, allowing a time series of element concentrations to be generated that spans many decades, and are available through the Alaska Native subsistence harvests. Natural variation in trace element concentrations can be established by measuring element concentrations in walrus teeth from historic and modern walruses. This baseline will allow for examination of walrus contact with trace elements associated with petroleum exploration, as well as potential changes since the discovery of oil reserves in the Alaskan Arctic.

Objectives: The objectives of this study are to:

- Quantify natural variability of trace elements commonly associated with oil and gas activities (As, Ba, Cd, Cr, Cu, Fe, Mn, Pb, Ni, V, and Zn) in teeth of female walruses killed prior to the era of petroleum exploration and extraction in the Alaskan Arctic (pre-1970s)
- Assess differences/similarities in trace element concentrations before and after the beginning of petroleum extraction in the Alaskan Arctic
- Analyze lifetime changes in trace element concentrations in the teeth of individual female walruses to identify seasonal or annual exposure events as well as lifetime trends in trace element exposure.

Methods: Female walrus teeth from museum collections (n = 65) and recent Alaska Native subsistence harvests (n = 25) have been compiled and are awaiting processing. This study will focus on female walruses because their summer habitat overlaps with past oil and gas exploration areas, whereas most male walruses remain in the Bering Sea all year. Each tooth will be cut longitudinally to create a 3 mm thick cross-section of each tooth. Concentrations of As, Ba, Cd, Cr, Cu, Fe, Mn, Pb, Ni, V, and Zn will be measured and compared to the USGS microanalytical phosphate standard (MAPS-4), as well as the National Institute of Standards and Technology Standard Reference Material (NIST 610) to obtain trace element concentrations in parts per million (ppm). Changes in trace element exposure throughout the life of individual walruses will be investigated by examining increases and/or decreases of element concentrations in a given transect of the tooth. Variability of element concentrations among walruses will be quantified by comparing mean values for the entire transect, allowing comparisons to be made across time periods. In this way, natural variability in trace element concentrations will be established for the era before oil and gas exploration activities occurred in the U.S. Arctic (pre-1968), providing a baseline for comparison with values in teeth of modern walruses.

Revised Date: August 14, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Walrus Seasonal Distribution and Habitat Use in the Eastern Chukchi Sea (AK-13-06)

BOEM Information Need(s) to be Addressed: Data on the seasonal distribution, abundance, and habitat use of Pacific walruses (*Odobenus rosmarus*) are an integral part of assessing and managing anthropogenic risks from Chukchi Sea OCS development. Information on these ecological parameters in the Chukchi Sea are coming to light from current USGS walrus studies, but require further research and monitoring, especially in light of the loss of sea ice habitat and ongoing ecological changes. This study will provide information for NEPA analyses of proposed OCS oil and gas activities, MMPA authorizations by other Federal agencies, and ESA consultations. This study will contribute information useful for developing mitigation strategies to reduce impacts to walruses from proposed oil and gas development activities. In addition, walruses in the Chukchi Sea are an important subsistence resource to Russian and Alaska Natives.

Total BOEM Cost: $1,685,000 plus Joint Funding (~$300,000)

Period of Performance: FY 2013-2018

Conducting Organization: USGS

Principal Investigator(s): Dr. Chad Jay

BOEM Contact: Rick Raymond

Description:

Background: Joint US-Russia aerial surveys to estimate total walrus abundance were conducted in the Chukchi Sea in the fall of 1975, 1980, 1985, 1990, and 1995. Another joint US - Russia walrus abundance aerial survey was conducted in spring of 2006 in the Bering Sea. Recent declines in summer/fall sea ice in the Chukchi Sea have resulted in walruses hauling out at coastal sites in Alaska in fall when sea ice completely disappears over the eastern continental shelf. This situation may provide an opportunity to estimate walrus abundance in the eastern Chukchi Sea in fall by using an aerial survey along the coast of Alaska. The BOEM-funded COMIDA program has conducted opportunistic surveys of the coast to enumerate walruses over the past few years.

The USGS initiated a study in 2007, and expanded the study in subsequent years, to determine the seasonal distribution and habitat use of walruses in the Chukchi Sea. A report on walrus utilization areas in 2008-2011 was published in 2012. However, patterns of utilization are still being established by walruses in response to continued reductions in sea ice habitats in the Chukchi Sea.

Exploration drilling activities in the Chukchi were conducted in 2012 and 2015, and may occur at some time in the future. Therefore, walrus monitoring needs to continue without interruption through at least the next five years to provide pre-development information and describe changes in walrus distribution and abundance associated with changing sea ice habitats. Information regarding the seasonal distribution, abundance, habitat use, and diet of walruses across the planning area will assist in assessing potential impacts and mitigating disturbances associated with proposed exploration and development scenarios. The monitoring activities described in this study profile follow recommendations of the national Ocean Research Priorities Plan (ORPP).

Objectives: The overarching objective of the study is to obtain information on the seasonal abundance, distribution, and habitat use of walruses in the Chukchi Sea. Specific objectives of this study include:

- Determine seasonal distribution and movements of walruses in the Chukchi Sea Planning Area.
- Identify habitats of importance to walruses (e.g., feeding and resting).
- Determine whether prey selection and/or foraging areas are changing over time with increased use of nearshore habitats.
- Assess the feasibility of approaches for estimating the abundance of walruses in the eastern Chukchi Sea in late summer/fall.

Methods:

10. Deploy radio-tag instruments on a sufficient sample of walruses.
11. Use GIS and spatial analysis methods to define important habitats, identify migration pathways, walrus foraging behaviors and activity budgets.
12. Collect appropriate walrus tissue, fecal and/or biopsy samples and perform molecular analysis to identify prey taxa and trends in dietary taxa composition over time.
13. An estimate of walrus abundance in the eastern Chukchi Sea in summer/fall will likely require a combination of coastal aerial surveys to count walruses on land and deployment of satellite radio-tags on walruses to provide data to estimate the availability of walruses for sighting during the survey. Method development will be assessed after the first survey attempt and revised as needed.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Field Evaluation of an Unmanned Aircraft System (UAS) for Studying Cetacean Distribution, Density, and Habitat Use in the Arctic (AK-15-07)

BOEM Information Need(s) to be Addressed: Gray whale, bowhead whales, and belugas are seasonal residents of the northeastern Chukchi Sea and western Beaufort Sea, regions that provide important feeding grounds and migration pathways for all three species. While all three species are protected under MMPA, the bowhead whale is given added protection as an endangered species under ESA, and bowhead whales and belugas are granted additional management consideration as the targets of subsistence hunts by Alaska Natives. Under NEPA and ESA, BOEM is required to evaluate if and how Federal actions associated with oil and gas exploration and development may affect these species. Aerial surveys are one standard methodology for conducting studies of cetacean distribution. In recent years, there has been increasing interest in using Unmanned Aircraft Systems (UAS) to survey cetaceans in the Arctic to decrease risk to personnel, increase survey efficiency, reduce survey costs, and minimize disturbance of marine wildlife. The performance of UAS relative to human observers in manned aircraft is not well understood and must be more thoroughly investigated prior to accepting UAS as an alternative to manned aircraft for conducting these investigations.

Total BOEM Cost: $1,000,000 plus Joint Funding (~$1,235,000) **Period of Performance:** FY 2015-2018

Conducting Organization: NOAA-MML; Naval Surface Warfare Center Dahlgren Division

BOEM Contact: Carol Fairfield

Description:

Background: Manned aircraft are a common platform for studying wildlife because they are relatively cost-effective for surveying large geographic areas and take advantage of humans' ability to quickly integrate sensory information on the biological and physical environment in order to detect, identify, and count species of interest. In recent years, there has been increasing interest in using UAS to study wildlife populations. In particular, UAS have been suggested as an alternate survey platform for studying the distribution and density of the Bering-Chukchi-Beaufort stock of bowhead whales in the western Arctic, which has been investigated using manned aircraft since 1979. The primary advantage of using UAS to survey marine wildlife in the Arctic is the elimination of the risks associated with sending humans far from shore on small aircraft in areas prone to extreme weather. Furthermore, UAS have the potential to be cheaper to operate than conventional aircraft, and some have the advantage of prolonged flight times. Finally, field work conducted by NMML in the Arctic has shown that UAS are less likely to disturb pinnipeds than conventional aircraft.

The FAA's Reauthorization Act of 2012 designated airspace for UAS operations in the Arctic, making UAS a more viable platform for use in marine mammal monitoring. For surveying cetaceans, the ability of UAS methodology to detect cetaceans, identify individuals to species, estimate group size, identify sensitive age classes, and estimate density must be understood relative to the proven capabilities of human observers in conventional aircraft. A small number of limited field tests have been conducted to assess the effectiveness of UAS for surveying cetaceans in the Arctic, the results of which warrant further investigation. Additional insight will be gained only through direct comparisons of UAS and human observers in the field, with cetaceans (bowhead whales, gray whales, and belugas) as the primary targets.

Objectives:

- Evaluate the ability of UAS methodology to detect cetaceans and compare encounter rates, identify individuals to species, estimate group size, identify calves, and estimate density in arctic waters relative to conventional aerial surveys.
- Describe improvements needed in UAS technology (e.g., payloads, cameras, environmental sensors) to operate in arctic conditions for a large-scale survey program.
- Provide recommendations for the types of monitoring or mitigation requirements that can likely be met using UAS.

Methods: Planning and permit application will occur during the first year. Fine-scale aerial line-transect surveys will occur in the second year in the northeastern Chukchi and western Beaufort Seas during the open water season, when bowhead whales, gray whales, and belugas have reliably been found feeding in and migrating through the region. Marine mammal observers will conduct a line-transect survey from an aircraft flying between 1000-1500 ft. A ship-based or land-based UAS will operate concurrently in the same area, with a marine mammal observer on the UAS team, viewing digital video in real-time to detect, identify, and count cetaceans visible in the video feed. Because the effective strip width for the UAS will be narrower than that of human observers in the aircraft, UAS transects will be placed closer together than those for the conventional aircraft. Digital video footage and digital photographs from the UAS will be archived to enable post-flight analyses into UAS performance. Metrics that will be used to compare performance between platforms may include: 1) encounter rates made by each platform; 2) precision of the resulting density estimates; 3) relative efficiency of each platform, measured by length of trackline and duration of survey effort required to achieve a target precision in the density estimate; 4) cost to conduct the survey; and 5) fuel consumption. This study will be integrated with other ongoing BOEM studies in the region, including the "Aerial Surveys of Arctic Marine Mammals (ASAMM)" (AK-16-01) studying the distribution, density, and behavior of marine mammals. Joint-funding opportunities may be available for this project (e.g. ONR and NSB).

Revised Date: August 14, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Aerial Surveys of Arctic Marine Mammals (ASAMM) – Personnel and Aircraft Needs (AK-16-01)

BOEM Information Need(s) to be Addressed: This study will maintain long-term monitoring information about potential impacts to marine mammals from OCS oil and gas-related activities and subsequent leasing in the Chukchi and Beaufort Seas. The information will assist BOEM in NEPA analyses for lease sales, EPs, and DPPs, ESA Section 7 consultations, and decision-making in the Beaufort and Chukchi Seas.

Total BOEM Cost: **$**11,437,309 plus Joint Funding (~$420,000) **Period of Performance:** FY 2016-2019

Conducting Organization: NOAA-MML; USDOI National Business Center

BOEM Contact: Carol Fairfield

Description:

Background: Bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), beluga whales (*Delphinapterus leucas*), Pacific walrus (*Odobenus rosmarus divergens*), polar bears (*Ursus maritimus*), bearded seals (*Phoca fasciata*), and several other species of ice seals are known to occupy the Chukchi Sea, at least during some seasons. All of these species are subject to changes in environmental variables such as oceanographic currents, sea temperature, sea ice cover, prey availability, and anthropogenic impacts. Moreover all of these species are used for subsistence both in Russia and the U.S. and form an important part of the diet and cultural base for most people in communities along the Beaufort and Chukchi coasts. Having a good understanding of the seasonal distribution, relative abundance, and habitat use of marine mammals in the Beaufort and Chukchi Seas is fundamentally important to evaluating the potential environmental impacts associated with oil and gas exploration and development and other anthropogenic activities. Reliable, up-to-date information of this type is needed for marine mammal populations. Aerial surveys of marine mammals are an efficient tool because they offer quick coverage of large marine areas. Past surveys are available for comparison with new data to assess whether changes in distribution or abundance have occurred since the earlier surveys were completed.

A BOEM-funded investigation of the seasonal migration of the bowhead whales using satellite-tracked animal tags revealed that they are resident in the Bering Sea during the winter and return to the Beaufort Sea in the summer when opening spring leads allow for passage along the Alaskan and Canadian coasts. The bowheads leave the Beaufort Sea in the fall and cross the Chukchi Sea before moving back into the Bering Sea for the winter.

Aerial surveys of the fall migration of the bowheads have been conducted annually since 1979, initially by the Bureau of Land Management and subsequently by MMS, now BOEM. This is one of the longest-maintained monitoring programs of a biological phenomenon and has produced an invaluable baseline of the distribution and habitat use of the bowheads. The baseline can be used to observe changes in distribution and habitat use that may occur due to changing atmospheric and oceanic climates and to OCS oil and gas development activities. This investigation will continue the aerial observations of the fall migration for evidence of these changes. Since the beluga whales and other marine mammals seasonally or otherwise resident in the Beaufort and Chukchi Seas are often sighted during the bowhead whale aerial surveys, their occurrence will also be part of the acquired data.

Objectives:

- Document the distributions and relative densities of marine mammals in the Chukchi Sea and Beaufort Sea Planning Areas.
- To the extent possible, delineate the areas that are most important to marine mammals during critical seasons of their annual life history cycles such as calving and feeding.
- Define the annual fall migration of bowhead whales, significant inter-year differences, and long-term trends in the distances from shore and water depths at which whales migrate.
- Monitor temporal and spatial trends in the distribution, relative abundance, habitat, and behaviors (especially feeding) of whales in arctic waters.
- Provide real-time data to BOEM and NMFS on the general progress of the fall migration of bowhead whales across the U.S. Beaufort and Chukchi Seas for use in protection of this Endangered Species, if needed.
- Provide an objective wide-area context for management understanding of the overall fall migration of bowhead whales and site-specific study results.
- Document the spatial and temporal distribution of beluga and gray whales, and other marine mammal species as sighted.

Methods: This partnership between NMFS and BOEM conducts aerial line-transect surveys in the Chukchi Sea and Beaufort Sea Planning Areas from mid-July to the end of October to observe the fall migration of the bowhead whales, continuing the decades-long set of observations. For surveys in both seas, the observational and data recording methodology follows protocols used by the BOEM in past surveys of the bowhead fall migration.

The necessary aircraft services (planes, fuel, maintenance, pilots, etc.) to pursue the science objectives will be supported via Interagency Agreement between the National Business Center's Office of Aviation Services and BOEM.

Revised Date: August 14, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Estimation of Abundance and Demographic Rates of Pacific Walruses Using a Genetics-based Mark-Recapture Approach (AK-16-06)

BOEM Information Need(s) to be Addressed: Large numbers of Pacific walruses (*Odobenus rosmarus divergens)* utilize areas of high oil and gas resource potential in OCS waters of the northeast Chukchi Sea. BOEM needs reliable estimates of abundance and demographic rates of Pacific walruses for use in sound planning, management, and mitigation of potential environmental impacts from oil and gas activities and climate change. Abundance and demographic rates of walruses are also important for NEPA analyses, stock assessments under the Marine Mammal Protection Act (MMPA) and for extinction risk assessment under the Endangered Species Act (ESA). Results from this study may be used for future Chukchi Sea lease sales, as well as in BOEM decision-making and mitigation.

Total BOEM Cost: **$**250,000 plus Joint Funding (~$1,000,000) **Period of Performance:** FY 2016-2019

Conducting Organization: USFWS

Principal Investigator(s): Dr. Patrick Lemons

BOEM Contact: Carol Fairfield

Description:

Background: Walruses are a protected species under the MMPA and are listed as warranted but precluded under the ESA. As part of a 2011 Joint Motion for Approval of Settlement Agreement (Misc. Action No. 10-377-EGS, MDL Docket No. 2165), the U.S. Fish and Wildlife Service must make a decision by September 2017 on whether to propose the walrus for listing under the Endangered Species Act or remove it as a candidate species. Information on abundance and demographic rates will be an important contribution to the relisting decision, which will impact how BOEM manages overlap between oil and gas exploration and development and walrus activity.

Furthermore, decision-making regarding oil and gas-related activities in the OCS areas of the Chukchi Sea relies on a small numbers determination and combining estimates of regional abundance. Current BOEM-funded walrus studies examine distribution and habitat patterns in the Chukchi Sea, as outlined in the studies *Walrus Seasonal Distribution and Habitat Use in the Eastern Chukchi Sea* (AK-13-06), and *Walrus Habitat Use in Drilling Area* (AK-09-01). The results from these studies, combined with a better population estimate of Pacific walrus, would allow managers at BOEM and U.S. Fish and Wildlife Service (USFWS) to determine the proportion of the population

that could potentially interact with these activities. Therefore, comprehensive estimates of global abundance and demographic rates for walruses are important for regulatory and mitigation activities associated with oil and gas development in the northeast Chukchi Sea.

Past efforts to estimate abundance of walruses were based on aerial surveys. The study *Development of Airborne Remote Sensing Methods for Surveys of Pacific Walrus* (OCS Study MMS 2006-003) identified a number of drawbacks to the use of this technique for measuring abundance with sufficient precision to monitor population trends. Therefore, the USFWS, in collaboration with the Alaska Department of Fish and Game, ChukotTINRO, the Association of Traditional Marine Mammal Hunters of Chukotka, and the Eskimo Walrus Commission, secured funds to initiate a genetics-based mark-recapture project for estimation of abundance and demographic rates of walruses in FY 2013.

Objectives: The objective of this study is to partner with USFWS to support the laboratory testing component of a project that uses a genetics-based mark-recapture approach to achieve the following goals:

- Estimate annual abundance of walruses for evaluation of population status and trends by applying mark-recapture analytical techniques to biopsy samples.
- Assess demographic rates of walruses including age and sex specific survival and fecundity for validation and parameterization of population models.
- Compare the estimates of abundance produced from this study with those produced from the BOEM study *Walrus Seasonal Distribution and Habitat Use in the Eastern Chukchi Sea* (AK-13-06) that estimates the abundance of walruses in the OCS areas of the northeast Chukchi Sea for assessment of the proportion of the population potentially exposed to oil and gas activities in the region.

Methods: Genetics testing will be conducted on up to 2000 walrus biopsy samples per year (different age/sex classes). In addition to existing samples, skin biopsy samples will be collected from live walruses hauled out on sea ice during their northward migration from 2016 through 2018. Researchers will utilize the expertise of subsistence hunting communities in both the U.S. and Russia for sample collection. Individual walruses will be identified using single-nucleotide polymorphism markers, which are currently being developed by the USFWS. Mark-recapture models will use the resultant genetic information to estimate abundance. Interim results will be made available to the USFWS to help inform decisions regarding listing of walrus. Results of mark-recapture analyses will be used to estimate population size, population growth rate, age and sex specific survival rates, and recruitment of walruses starting in 2016 and continuing through 2018.

Revised Date: August 14, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Coastal Community Vulnerability Index and Visualizations of Change in Cook Inlet, Alaska (AK-13-03-21)

BOEM Information Need(s) to be Addressed: This project aims to create a GIS platform for a coastal vulnerability index that will include layers depicting the geomorphology, sea level rise, contaminant areas, and coastal erosion mapping overlain by subsistence harvest areas data, and will be specific to the Cook Inlet region. Through entering this data in the AOOS portal, the project will actively advance a better understanding and prospects for using an integrated approach to assess multiple physical variables affecting subsistence. Importantly, this project will also seek local knowledge from up to nine experts from three Alaska Native villages in the Cook Inlet region to confirm subsistence data and provide a broader overview of processes affecting coastal vulnerability and specific examples thereof. The results of this study will be available for use by State of Alaska and local governmental entities as well as by BOEM in any future NEPA planning, production, or development in the Cook Inlet region.

Total BOEM Cost: $50,000 plus Joint Funding ($50,000)

Period of Performance: FY 2017-2019

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Davin Holen

BOEM Contact: Dr. James Lima

Description:

Background: There has been increased effort in recent years to collect data in Cook Inlet related to coastal change. Natural processes coupled with potential climate change impacts are a concern for residents who harvest and use wild resources for commercial, sport, and personal use. This includes erosion along coasts and rivers, the possibility of sea level rise, ocean acidification affecting the areas shellfish species, and changes in salmon abundance due to marine conditions. This project will work within the Coastal Marine Institute framework issue that seeks to model the environmental, social, economic, and cultural processes related to outer continental shelf (OCS) oil & gas activities to provide operators and managers with data necessary to understand oil and gas development activities within the broader scope of activities and environmental changes occurring within Cook Inlet. The goal is to provide operators, managers, and communities with a synthesis of past activities, as well as possible future scenarios for coastal communities in Cook Inlet in combination with subsistence harvest data and local knowledge.

Objectives:

- Produce maps or visualizations of Cook Inlet including geomorphology, shoreline erosion or accretion rates, land motion estimates, sea level trends, and spatial harvest data.
- Document long-term trends through meetings and key respondent interviews.
- Develop a model of a coastal vulnerability index for the Alaska Ocean Observing System (AOOS) Cook Inlet Response Tool module.

Methods: Researchers will assemble available data including: GIS data subsistence harvest data that was collected by ADF&G for a single year with variables such as resource, search area, harvest location, harvest amount, month of search or harvest, and access. Data will also be collected from DGGS, the Kachemak Bay National Estuarine Research Reserve, NOAA, and others as needed. Researchers will also conduct a total of 9 interviews in three key coastal communities, Tyonek, Ninilchik, and Nanwalek in the Cook Inlet region to provide a broader synthesis of activities and meeting participants and informants will review preliminary maps. These maps will document coastal change as well as change in major harvest categories that residents attribute to categories as climate, development, or natural change processes. Qualitative interview data will be included in the overall synthesis to provide an understanding of additional data needs. The final version of the portal will be reviewed by interviewees as well as interested agencies and organizations prior to publishing on the AOOS data portal.

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts (AK-15-05)

BOEM Information Need(s) to be Addressed: This project aims to identify and organize Local and Traditional Ecological Knowledge (TK) subject matter experts from Arctic communities into recognized panels of paid consultants so they may become more widely accessible to function with authority on TK domains. By facilitating the creation of these institutional arrangements, this project will actively advance prospects for TK integration into scientific research sponsored by BOEM and other Federal agencies. The full range of BOEM-funded studies, including physical oceanography, biology, and social systems would benefit from more direct consultation and collaboration with local TK subject matter experts.

Total BOEM Cost: $359,470 **Period of Performance:** FY 2016-2020

Conducting Organization: Dept. of Wildlife Management, North Slope Borough

Principal Investigator(s): Dr. Robert Suydam, Qaiyaan Harcharuk

BOEM Contact: Chris Campbell

Description:

Background: Government dialogue about TK is often preoccupied with integration of TK data rather than with integration of TK experts into a meaningful resource management process. This study will identify key individuals in North Slope communities who are locally recognized for subject matter expertise on specific resources and available to serve on one or more "community of practice" TK panels. The TK panels would be consulted by external scientists working on BOEM-funded projects and would be pre-authorized locally to speak with authority on specific resource management topics of interest including: (1) ocean currents; (2) ice movement and behavior; (3) subsistence harvest of marine mammals; (4) subsistence harvest of seabirds and waterfowl; (5) subsistence sea-run fish; and (6) subsistence terrestrial species and nearshore use. With the exception of some active commissions already in place, formalized local panels do not yet exist to serve in this capacity. TK interaction will meet mutual concerns of all involved parties.

Objectives: The successful integration of TK into decision-making processes requires intensive collaboration between scientists and local communities. This will be achieved by the following:

- Enhance TK authority and integration of TK with science by promoting its dissemination to external scientists through consistent methods and directly involving local subject matter experts.
- Provide a roster and orientation information for use by external scientists about how to access and integrate TK on a more systematic basis for projects undertaken on the North Slope. This information would be accessible to scientists of all disciplines, from physical oceanography to sociocultural studies, and funded by a variety of sources, including Federal and State agencies, National Science Foundation (NSF), and academia.
- Enhance dialogue about science through exchange of information between external scientists and the communities.
- Integrate the traditional Iñupiat model of linking youth with elders.
- Achieve more efficient research project timelines. Currently, studies may be delayed as long as a year so that a community can achieve review consensus.

Methods: All eight North Slope communities would be involved, and panels in each would augment local capacity building. Up to three TK panels may be created in each North Slope coastal community, depending upon the primary interests of each village. For example, the inland communities of Atqusuk and Anaktuvak would likely have no need for a panel on marine processes. Social network methods will be used to identify knowledgeable subject matter experts to participate on each panel through a reliable and credible process using referral techniques. Village tribal leaders will be asked to review the generated list of nominees to recommend finalists who might serve on each TK panel. It is possible that one individual could be a member of more than one TK panel, depending upon community referrals. Panel members will receive honoraria stipends in recognition of their service. Barrow will be the lead community to develop a charter that could serve as a template for other communities. The process will likely replicate social network methodology as described in *Variation in the Abundance of Arctic Cisco in the Colville River* (OCS Study MMS 2007-0042).

The study will develop protocols to facilitate engagement of pre-authorized TK panels and promote dissemination of TK to external scientists with consistent methods. Scientists would initiate dialogue through describing information about their project goals, methods, objectives and findings with the TK panel. Panel engagement and comprehension may lead to suggestions, guidance, and other forms of support, such as annual observations of ongoing environmental change. Scientists will be informed about the use of TK and panel involvement in decision-making to encourage a respectful dialogue between the local experts and external scientists. The study will also explore ways to engage the North Slope Borough School District or other appropriate entity to collaborate with youth involvement on TK panels as ex-officio delegates. Involvement of youth would facilitate cross-generational transfer of TK and promote local institutional capacity. BOEM will seek to establish partnerships in this work with other organizations and agencies, including NSF, the North Slope Borough Department of Wildlife Management, and NSSI.

Revised Date: August 17, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea, Chukchi Sea, Cook Inlet

Administered By: Alaska OCS Region

Title: Community Based Monitoring: LEO Network (AK-16-05)

BOEM Information Need(s) to be Addressed: BOEM needs information on a variety of environmental variables to effectively conduct environmental analyses against a backdrop of changing environmental conditions. The Arctic is undergoing changes that affect subsistence harvests on the land and at sea. Frontline observations are made by residents of rural communities including Alaska Native subsistence harvesters, who can readily identify abnormalities in local habitat, prey availability, species composition, and seasonal timing of ecological processes. In an effort to capture and document such observational data, the Alaska Native Tribal Health Consortium (ANTHC) Center for Climate and Health has developed the Local Environmental Observer (LEO) Network. BOEM is collaborating on this established observation network to enhance its utility for scientific decision-making. The data will be used to support NEPA analyses both to document changing environmental conditions and to assess the range of implications for human communities.

Total BOEM Cost: $400,000 plus Joint Funding ($75,560) **Period of Performance:** FY 2016-2021

Conducting Organization: Alaska Native Tribal Health Consortium

Principal Investigator(s): Michael Brubaker

BOEM Contact: Chris Campbell

Description:

Background: LEO is a volunteer program of mostly tribal environmental professionals who share information about environmental events where they live, post observations on public Google maps, and coordinate with technical experts to identify appropriate actions. The purpose is to increase understanding about climate change and other drivers of environmental conditions to facilitate development of appropriate adaptation strategies. To achieve this, LEO strives to integrate science, traditional knowledge, and modern technology to achieve a robust and effective observation system.

Members self-enroll via the LEO Network website. Since the program was initiated in January 2012, over 250 individuals in 120 communities have enrolled across Alaska and in western Canada. They receive training on how to be effective observers and use of the tools available through the LEO Network. Posted observations are reviewed in monthly webinars and annual conferences and updates are communicated through social media and a weekly e-news to network members and a list-serve of over 1500 subscribers. Dozens of State, Tribal and Federal agencies and academic institutions provide technical consultation support to LEO based on their topical expertise. Most of these

communities are coastal, but there is growing participation in interior Alaska as well. The Network maintains a database of community based observations on a wide range of topics including extreme weather, floods, erosion, ice changes, permafrost thaw, invasive species, infrastructure damage, environmental contamination, and changes in the health, range, and behavior of fish, insects, birds and wildlife.

LEO was originally developed by the ANTHC Center for Climate and Health, with supplemental funding from the Environmental Protection Agency and the Western Alaska Landscape Conservation Cooperative, a partnership of Federal agencies addressing climate change impacts on the nation's landscapes. ANTHC serves as the hub for the LEO Network.

Objectives: This study would identify and promote pathways for incorporating observations and real time documentation in the coastal northern and Cook Inlet regions for the following variables:

- Sea ice formation, significant ice events, and transitions to open water;
- Subsistence activities in the marine environment for sea mammals, fishes, and birds, and observations regarding variations attributable to changing environmental conditions;
- Loss of permafrost and its effects on habitat, health, behavior, and infrastructure;
- Coastal erosion and its effects on habitat, health, cultural resources, and infrastructure;
- Changes in migratory patterns and its effects on abundance, phenology, etc.
- Changes in habitat range that may be indicative of regime shifts.

Further institutional objectives include:

- Increase understanding about environmental change;
- Enhance tools available at the community and regional level to assess impacts;
- Improve communication and collaboration among communities, State of Alaska and Federal government, and other institutions;
- Facilitate development of healthy and effective adaptation strategies.
- Document community-based valuations of environmental resources.

Methods: The following processes are maintained by LEO Network managers in order to sustain the program systems: enrollment and training of new members; management of observation posts and consultations; transfer of observation content to data systems; connecting observers with technical experts in partner organizations; publishing new observations on Google maps; outreach on observations to the Network, social media, and the website; weekly publication of Climate and Health E-News; planning and hosting monthly webinars and annual conferences; synthesize data for education, policy development and management decision through the Alaska One Health Working Group.

Revised Date: August 17, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	National Program
Title:	WALRUS - Walrus Adaptability and Long-term Responses; Using multi-proxy data to project Sustainability (ArcSEES; NT-13-x11)

BOEM Information Need(s) to be Addressed: BOEM needs reliable estimation of long-term trends in walrus feeding ecology, foraging location, and population demographics. NSF's Arctic Science, Engineering and Education for Sustainability (ArcSEES) program is an is a multi-year, interdisciplinary program, supported by an international partnership among BOEM, NSF, USGS, USFWS, EPA, and a consortium of French agencies, that seeks to evaluate the sustainability of the Arctic's human-environmental system and to provide community-relevant sustainability pathways and engineering solutions. BOEM's participation in the ArcSEES program will facilitate a better understanding the complex feedbacks that control the overall evolution of the Arctic system for timescales ranging from a few days to several years. Findings from this and other ArcSEES projects will support NEPA analyses for potential future lease sales, review of EPs, DPPs and other reviews for BOEM decision-making and mitigation.

BOEM Contribution: $200,000 plus Joint Funding

Period of Performance: FY 2013-2019

Conducting Organization: NSF, ArcSEES

BOEM Contact: Dr. John Primo

Description:

Background: In the last seven years there has been a rapid decline in spatial extent of summer sea-ice in the Arctic Ocean. At the same time, striking changes in Pacific walrus (*Odobenus rosmarus divergens*) foraging and haul-out locations have been observed. Marine mammals are considered sentinels of climate change in the Arctic as they are long-lived, occupy higher trophic levels, and many depend on sea-ice habitat. Walruses are also a significant component of the Alaska Native subsistence way of life, so information exchange based on traditional ecological knowledge (TEK) and scientific findings is pivotal to communities relying on these iconic animals. A substantial threat to walruses is the current warming and associated loss of sea-ice during the summer months, which can result in increased mortality due to decreases in prey within range of coastal haulouts and an increase in disturbance events. Despite impressive data from in-depth studies of Pacific walruses over the last 40-50 years, that timeframe is too short to capture adaptation to large-scale warming and change, making sustainability projections difficult. Management decisions are currently based on numerical population assessments, which can be somewhat unreliable, and instead advocated for decision-making processes based on ecological needs and observed ecological change.

Objectives: The goal of this study is to correlate changes in genetic diversity and effective population size (DNA), foraging locations (element analyses) and accessibility (TEK), and changes in overall diet (stable isotope analysis) and health (steroid hormones) of walrus populations in Alaska with known periods of climate change and differing anthropogenic pressures (TEK, published records).

Methods: This study will track changes in walrus trophic position, foraging location, and genetic structure and diversity over the past 2500 years using multi-proxy datasets. The researchers will test correlations between these changes and large-scale climate and anthropogenic forces and will develop projections about how walruses would respond to or perceive varied stresses. The project will involve students from high school to graduate levels to promote sustainability education within affected communities. The results will be compiled and disseminated to assist communities currently planning for a sustainable walrus subsistence harvest within the parameters of a rapidly changing Arctic.

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Beaufort Sea

Administered By: National Program

Title: Cumulative Effects of Arctic Oil Development – Planning and Designing for Sustainability (ArcSEES; NT-13-x11)

BOEM Information Need(s) to be Addressed: BOEM needs information on the effects of oil and gas infrastructure and climate change to support future planning and decision-making. NSF's Arctic Science, Engineering and Education for Sustainability (ArcSEES) program is an is a multi-year, interdisciplinary program, supported by an international partnership among BOEM, NSF, USGS, USFWS, EPA, and a consortium of French agencies, that seeks to evaluate the sustainability of the Arctic's human-environmental system and to provide community-relevant sustainability pathways and engineering solutions. BOEM's participation in the ArcSEES program will facilitate a better understanding the complex feedbacks that control the overall evolution of the Arctic system for timescales ranging from a few days to several years. Findings from this and other ArcSEES projects will support NEPA analyses for potential future lease sales, review of EPs, DPPs and other reviews for BOEM decision-making and mitigation.

BOEM Contribution: $300,000 plus Joint Funding

Period of Performance: FY 2013-2018

Conducting Organization: NSF, ArcSEES

BOEM Contact: Dr. John Primo

Description:

Background: Further development of oil and gas resources and associated infrastructure in the Arctic is possible, and BOEM, other agencies, and the private sector need more information on the infrastructural effects of such activity, and particularly on the thawing of permafrost. This vital component of the arctic ecosystem plays a substantial role in supporting system processes; including subsistence activities in the region.

Additional information is needed so that current international initiatives related to the Arctic may better address cumulative effects of extensive networks of infrastructure needed for resource development. This is important as local people are directly impacted by the effects of oil and gas development and associated infrastructure. The opening of arctic lands and seas to transportation and development is occurring against a backdrop of sea-ice loss, dwindling resources elsewhere in the world, and competing geopolitical interests. It is inevitable that considerably more infrastructure than presently exists will be required to develop these areas.

Objectives: The overarching goal of this study is to better understand the cumulative environmental and social effects of developing oil and gas resources in the Arctic, and to support the creation of a comprehensive adaptive planning approach toward

infrastructural development. In doing so, the study aims to meet the following objectives:

- An enhanced understanding of the infrastructure-related permafrost/landform/ vegetation succession in terrain undergoing thermokarst formation
- The creation of an arctic infrastructure action group to develop adaptive management strategies that address the unique issues related to networks of infrastructure in arctic permafrost environments
- The development of future arctic scientists with an understanding of the effects of industrial development and the potential for adaptive management

Methods: This study will include an examination of infrastructure and landscape change at multiple scales, an evaluation of adaptive management planning for infrastructure in northern Alaska and cumulative effects studies associated with the Iñupiat village of Nuiqsut. The study will also support several workshops bringing a diversity of scientists and local people together to develop adaptive management strategies that address issues related to the effects of infrastructure development in arctic permafrost environments. Lastly, training for students on arctic systems and on issues related to industrial development and adaptive management will be administered through a college course.

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): All Alaska Planning Areas

Administered By: Alaska OCS Region

Title: Coastal Marine Institute (AK-13-03)

BOEM Information Need(s) to be Addressed: This cooperative agreement supports improved leasing decisions and NEPA analyses pertinent to lease sales in the Beaufort Sea, Cook Inlet, and Chukchi Sea. 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 have been identified through the Alaska Annual Studies Plan and a set of identified Framework Issues. The study also will develop information and public products for various audiences that address public concerns raised during outreach efforts.

Total BOEM Cost: $501,500 plus Joint Funding ($497,424) **Period of Performance:** FY 2013-2020

Conducting Organization: CMI, UAF

Principal Investigator(s): Dr. Brenda Konar (Director), Ruth Post

BOEM Contact: Dr. Heather Crowley

Description:

Background: This study provides management of a large ongoing program of scientific research into framework issues related to potential future lease sales in the Alaska OCS Region. It is a cooperative program between BOEM and the University of Alaska, with State of Alaska participation. The Coastal Marine Institute (CMI) is expected to leverage additional scientific results and logistics capability at levels comparable to the BOEM contribution of $1,000,000 per year. The Coastal Marine Institute will update and expand our understanding of OCS environmental information and address future needs related to the offshore oil and gas program in Alaska.

Objectives: The purpose of the CMI is to support BOEM's commitment to environmental stewardship and generate scientific information for BOEM and State of Alaska decision-makers that is consistent with the needs outlined by the Framework Issues. The Framework Issues 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 oil, gas and marine mineral resources.
- Synthesis studies of scientific environmental or socioeconomic background information relevant to the OCS oil and gas program.

Methods: A proposal process is initiated each year with a request for letters of intent to address one or more of the Framework Issues. The proposals are requested from university researchers and other scientific researchers in State agencies. A Technical Steering Committee, made up of scientific representatives of the cooperators, reviews letters of intent and proposals to be evaluated for possible funding. External peer reviews may be requested for new projects. Principal investigators give presentations at ITMs, scientific conferences and various public meetings.

Revised Date: August 9, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: ShoreZone along the Alaska Peninsula (AK-15-03)

BOEM Information Need(s) to be Addressed: ShoreZone mapping is a technique that will provide BOEM with the most comprehensive biological, physical, and geomorphologic data of the Alaska coastal areas. The BOEM analysts and decision-makers will use shoreline mapping information for identifying high priority fish and wildlife habitats in NEPA and ESA analyses and documentation for lease sales, EPs and DPPs, and in BOEM decision-making.

Total BOEM Cost: $450,000 plus Joint Funding (~$200,000)

Period of Performance: FY 2015-2018

Conducting Organization: Moran Environmental Recovery LCC

Principal Investigator(s): Sarah Cook

BOEM Contact: Rick Raymond

Description:

Background: The spatial distribution of nearshore habitats is important information for land and resource managers and decision-makers, and numerous shoreline classification methods have been applied to our coasts. Recent efforts, however, have focused on a partnership of numerous scientists, GIS and web specialists, non-government organizations, and local, State, and Federal agencies. This partnership is applying ShoreZone protocols to build a contiguous, integrated dataset of coastal habitats and imagery for Alaska's coast.

In 2001, the Cook Inlet Regional Citizens' Advisory Council (CIRCAC) began a program to apply the ShoreZone mapping protocols to Cook Inlet and led the development of the first web-based access to the data and imagery. This program was later expanded to include the outer Kenai Peninsula coast, Kodiak Island, and the Alaska Peninsula. CIRCAC also initiated an Alaska ground-station program that has now expanded to include hundreds of stations throughout the Gulf of Alaska and North Slope. By 2005, NOAA's National Marine Fisheries Service stepped forward to provide web-site and data support and currently provides the necessary personnel to manage, update, and serve the data to the public and has also led efforts to map southeast Alaska and develop a larger statewide partnership. By 2012, the program had expanded to the U.S. Arctic with BOEM-sponsored aerial and on-the-ground surveys.

Despite the successful expansion of the ShoreZone program to include much of Alaska's coast, there are still several significant spatial gaps, including portions of the coastline within or adjacent to the Cook Inlet Planning Area. These areas include the Alaska

Peninsula coastline from the Katmai National Park boundary to the Cold Bay area. Also, the Barren Islands were not attempted during earlier surveys in the Cook Inlet area and are an obvious spatial gap to the contiguous, continuous habitat data and imagery for the Gulf of Alaska. A survey along these coastlines would also provide the opportunity to re-survey sections of the Katmai National Park coastline to conduct a project for assessing ShoreZone's applicability for detecting large-scale changes to some biological or geomorphic classifications. Recent studies by the NPS along this coast have shown large-scale loss of mussel bed habitats along portions of the coast. Since ShoreZone maps mussel beds as an along-shore and across-shore bioband, it would be an opportunity to assess whether ShoreZone data (and imagery) can provide a baseline for detecting or illustrating significant changes between periodic surveys in areas determined to be of high interest or sensitivity.

These proposed surveys would close a spatial gap in the Gulf of Alaska ShoreZone data and imagery that has precluded queries of coastal habitat data in areas downstream of existing and potential future oil exploration, development, and production activities in Cook Inlet. Field survey is expected to occur in May 2016.

Objectives:

- Map the along-shore and across-shore geomorphic and biological habitat features using the aerial survey imagery and narration by a biologist and a geomorphologist utilizing the most recent ShoreZone protocols.
- Ground-truth aerial survey results through shore-station surveys along this coast to verify geomorphic features and to describe invertebrate and seaweed assemblages.
- Publicly disseminate all data and imagery via the ShoreZone website, and Cook Inlet Response Tool.
- Assess whether ShoreZone imagery and mapped data can capture some of the larger-scale changes that have been observed in some areas along the Katmai National Park shoreline since the original ShoreZone surveys were conducted in the area in 2003.

Methods: Conduct ShoreZone aerial surveys of the Barren Islands and along the Alaska Peninsula coastline from the northern border of the Katmai National Park coastline to the Cold Bay area where the 2011 Alaska Peninsula surveys ended. The aerial surveys and mapping would take place according to the ShoreZone Coastal Habitat Mapping Protocol for Alaska. Shore-stations surveys should take place at a series of stations over a range of habitat types known to occur along these shorelines (e.g. exposed rocky, rock platforms, exposed boulder beaches, semi-exposed and semi-protected cobble beaches, salt marshes, eelgrass beds). The compiled data and imagery will be posted to the existing ShoreZone website and shore-station data would be collected and disseminated in the same manner as for other locations in Alaska. Data would be also archived at NODC.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s): All Alaska Planning Areas

Administered By: Alaska OCS Region

Title: Alaska Marine Science Symposium (AK-15-x10)

BOEM Information Need(s) to be Addressed: This annual Symposium provides technical analysts and Principal Investigators for BOEM Alaska OCS Region studies a unique forum to share their research findings on the Alaska marine environment and to network with other scientists from around Alaska, the Pacific Northwest, and the nation. Since it is impossible for any single agency or group to conduct all of the needed research within the Alaska OCS Region, this forum provides marine scientists with the opportunity to gather information on other areas of similar research and foster important future collaborative efforts.

Total BOEM Cost: $100,000 **Period of Performance:** FY 2015-2019

Conducting Organization: North Pacific Research Board; Alaska SeaLife Center

Principal Investigator(s): Danielle Dickson

BOEM Contact: Warren Horowitz

Description:
Background: The Alaska Marine Science Symposium (AMSS) is the largest and most comprehensive annual marine science conference within the State of Alaska (http://www.alaskamarinescience.org/). The AMSS is unique since it brings together government and non-government sponsored marine scientists within the State of Alaska, from around the nation, and from other nations in a forum to discuss their common interests in the dynamic and ever changing Alaska marine ecosystem. The Symposium is organized into three large marine ecosystems of Alaska which includes the Arctic (U.S. Beaufort and Chukchi Seas), the Bering Sea, and the Gulf of Alaska. The presentations, poster sessions, and workshops showcase the ocean research within these areas. Daily sessions are focused on the main components of the marine ecosystem including climate and oceanography, lower trophic level productivity, fish and fish habitat, seabirds, marine mammals, and human dimensions.

Over 800 people attended the most recent Symposium in 2018, and many organizations pitched in to make it a success. The BOEM project investigators attended the Symposium and provided important information on the Arctic and the Bering Sea from information collected under the Environmental Studies Program. The BOEM staff and sponsored scientists connected with other scientists that were conducting concurrent research in the Arctic, Bering Sea, Cook Inlet and Gulf of Alaska regions.

In the recently completed Symposium in 2018, there were separate workshops on a recently completed BOEM funded study, Characterization of the Circulation on the

Continental Shelf Areas of the Northeastern Chukchi and Western Beaufort Seas, numerous updates of ongoing and nearly completed studies funded jointly through the Coastal Marine Institute at the University of Alaska, Fairbanks, discussions on marine mammals, fish, and bird distribution, and workshops on community involvement. In addition, there were other workshops on Arctic Research Planning and on communicating ocean science. The Symposium also encourages presentations on the Alaska marine environment from graduate students from local universities and from universities within the lower 48. The Symposium presents awards to the best student poster and oral presentation at the meeting.

Objectives:

- Produce a successful Alaska Marine Science Symposium, which provides a forum for marine scientists and local communities to present their information on the changing marine environment in Alaska.
- Provide a venue for BOEM Alaska OCS Region environmental studies research for the Arctic, Bering Sea, Cook Inlet, and Gulf of Alaska
- Provide a forum for Alaska OCS Region scientists and Principal Investigators to comingle with other researchers that are conducting similar scientific studies within the Alaska OCS or adjoining areas of the Alaska marine ecosystem.

Methods: As a member of the AMSS organizing committee with other scientists and officials from Federal and State agencies, assist in producing a forum for BOEM staff and marine and coastal scientists, and local communities to present their findings on the changing marine environment in Alaska. Provide monetary support for scientists from within the State of Alaska and from around the nation to present their findings at the meeting. Provide abstracts and workshop discussions from the Symposium to the general public for distribution.

Revised Date: August 8, 2018

Environmental Studies Program: Ongoing Studies

Study Area(s):	Beaufort Sea, Chukchi Sea
Administered By:	Alaska OCS Region
Title:	Collaboration with North Pacific Research Board (NPRB) Arctic Marine Research Program (AK-16-02)

BOEM Information Need(s) to be Addressed: BOEM needs to leverage funding for updated environmental data collection as significant opportunities arise. The National Science Foundation and the North Pacific Research Board have worked together programmatically and scientifically through the Bering Sea Project since 2007 (http://bsierp.nprb.org). Based on this successful collaboration, BOEM and NPRB plan to partner on new collaborative research in the Arctic, leveraging expertise across several partners and funding sources, including BOEM, NSF, NPRB, NOAA, Alaska Ocean Observing System (AOOS), USGS, ONR, NASA, North Slope Borough, Northwest Arctic Borough, industry and others, specifically in the Chukchi and Beaufort seas. Research from this collaboration will support mutually identified information needs on the physical, biological and social processes in the Arctic marine environment.

Total BOEM Cost: $1,000,000 **Period of Performance:** FY 2016-2021

Conducting Organization: NPRB

Principal Investigator(s): Danielle Dickson (Project Manager)

BOEM Contact: Rick Raymond

Description:
Background: The Alaska OCS Region 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* 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 Northstar and Liberty development sites. This work continues today with the studies *ANIMIDA III: Boulder Patch and Other Kelp Communities in the Development Area,* begun in 2012, and the recently awarded *ANIMIDA III: Contaminants, Sources, and Bioaccumulation,* which has been expanded to include Camden Bay.

Since 2007, the Alaska OCS Region has also developed a new suite of studies in the Chukchi Sea, leveraging more than $70 million (through FY 2015) to conduct 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 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. Most of them pursue multi-year data collection efforts on a regional scale, with careful attention to inter-annual variability and ecosystem processes. The newly funded *Arctic Marine Biodiversity Observation Network* (AMBON) in the Chukchi Sea is a prime example.

Objectives: BOEM seeks to build upon existing working relationships with NPRB, NOAA, USGS, AOOS, industry and others by establishing financial cooperation, coordinated Request for Proposals, data sharing agreements, and logistical support agreements. The foundation for such partnerships will be based on BOEMs Annual Studies Planning Process.

Methods: BOEM, NPRB and other funding partners will build upon newly available synthesis projects (such as Synthesis of Arctic Research [SOAR] and the Pacific Marine Arctic Regional Synthesis [PacMARS] to examine areas where collaborative studies could help enhance informed decision-making on the sustainable use of resources. This collaborative study will be guided by an oversight committee formed of senior scientists and accomplished through an annual request for proposals (RFP). Recommendations for select studies would be based on program development goals. After BOEM review of RFP responses, subgroups of interdisciplinary scientists will work together with NPRB to select specific task orders for BOEM funding. Targeted areas for new research in the Chukchi Sea would include, but are not limited to: influence of sea ice dynamics and advection on the phenology, magnitude and location of primary and secondary production; 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. Deliverables from this study will include final reports, published papers, and synthesis workshops to integrate multi-disciplinary datasets that will include participation of several BOEM-funded PIs.

Revised Date: August 8, 2018

SECTION 3.0 TOPICAL AREAS FOR FUTURE RESEARCH

This section presents a general forecast of significant topical issues and concerns to be addressed by studies for FY 2021 and beyond. In general, these topics conform with the research themes of the ESP. Due to the great differences existing between Alaskan environments and other OCS areas, the uniqueness of issues in Alaska has dictated the need to anticipate new topical areas for implementation. These projects will focus on BOEM mission needs within the context of varying industry interest in OCS exploration, development and production, as well as potential trends in a changing environment.

In addition to the ongoing information needs relating to existing leases in the Beaufort Sea and Cook Inlet, the *2019-2024 National Outer Continental Shelf Oil and Gas Leasing Program* currently under development could lead to increased levels of oil and gas activities in the Beaufort Sea, the Chukchi Sea, and Cook Inlet. This would expand BOEM's information needs in these areas, as well as in other Alaska OCS Planning Areas that could be impacted by the additional actions.

3.1 Environmental Change

In recent years, the extent, duration, and thickness of summer ice cover in the Arctic region have decreased to record historical lows. The 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 that are now occurring 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 socio-economic 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.

3.2 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 EPA to BOEM. While implementing this authority, 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.

3.3 Physical Oceanography

An ongoing challenge in the Alaska OCS Region 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. Continued development and application of state-of the-art circulation models is important for future OSRA-based EIS analyses.

Improvements are also needed in sea ice aspects of the modeling. The resolution of ice models and ice data needs to be increased 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.

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, would 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.

3.4 Fate and Effects

The Alaska Region 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 in the Alaska Region 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 initiating a study to collate and synthesis currently available data regarding seeps offshore of Alaska, and to develop

recommendations for future field research. Identification of the location and extent of these seeps, as well as information on the chemical composition and weathering characteristics of these oils, would provide additional insight for analysis of potential effects from oil spills. The presence of natural oil seeps is indicative of organisms adapted to metabolize the hydrocarbons. More information is needed about hydrocarbon-consuming organisms resident in the Arctic.

3.5 Marine Mammals and Protected Species

Oil and gas-related activities, including development and production at the Liberty site and other potential sites, may lead to risks of oil spills from buried pipelines, other discharges, noise from various industrial and support activities, and increased human interaction with arctic offshore species. Species protected under the ESA, MMPA and the Migratory Bird Treaty Act are of particular concern if impacted by such factors. Study of the effects of oil and gas-related activities on protected mammals and the need for monitoring of endangered species are expected to continue. Related to this is the need for assessment of how any changes in the bowhead whale migration's distance from shore could relate to subsistence success (see below). Future bowhead whale studies are expected to continue to explore use of satellite tagging for information on bowhead whale residence times in development areas and advancement of UAS technologies also will lead to expanded research opportunities for bowhead whales.

As benthic feeders with a preference for bivalves, walruses are especially vulnerable to climate change or ecosystem shifts (Berchok et al. 2015). Walruses characteristically will haul out onto sea ice to rest, with the advantage that the ice can carry them to new feeding grounds. The summer distribution of walruses has been changing as a result of changes in summer pack ice, however, with large numbers of walruses observed to haul out on land along the Chukchi coast during most years in the past decade. A notable exception is 2012, when some ice persisted over the shelf. Information is needed to more fully understand how this shift to land-based haulouts affects walrus foraging behavior, diet, and energetic needs.

Other key subsistence species for which behavioral or monitoring studies may be needed include polar bears, beluga whales, ringed seals, ribbon seals and bearded seals. The impacts of sea ice loss and other environmental change on both ice seals and polar bears are high priority information needs. The status of the critically endangered Cook Inlet population of beluga whales and potential effects from future oil and gas activity is also of ongoing concern. Furthermore, 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.

3.6 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 oil and gas 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. As a result of the Magnuson-Stevens Fishery Conservation and Management Act, effects on Essential Fish Habitat must also be evaluated. More information is needed to evaluate Essential Fish Habitats 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.

A need for more information on the forage fish resources and their relation to apex predators on the OCS is also indicated. A good understanding of the seasonal distribution, abundance and habitat use of forage fish, including key spawning and migration events that quickly transfer large amounts of energy to upper trophic levels, is fundamentally important to monitoring the potential environmental impacts associated with OCS development.

3.7 Subsistence and Socio-economics

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 also 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. Social indicators should be maintained to serve as a basis for estimating long-term aggregate impacts.

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

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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.

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.
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).				
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	UAF-CMI	$311,392	2016-2019	Improve understanding of wave energy propagation into sea ice, and determine its effect on landfast ice stability along the Chukchi coast.
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.				

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
AK-19-03 Landfast Ice in the Beaufort and Chukchi Seas			2019-2023	This new study will develop protocols to analyze satellite data and develop and maintain a landfast ice climatology database for the Beaufort and Chukchi seas.
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	UAF-CMI	$311,392	2016-2019	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			2019-2023	This new study will develop protocols to analyze satellite data and develop and maintain a landfast ice climatology database for the Beaufort and Chukchi seas.
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	NOPP	$5.32M	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.
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-19-03 Landfast Ice in the Beaufort and Chukchi Seas			2019-2023	This new study will evaluate how changes in landfast ice relate to local and regional changes in temperature, pressure, and major storms.
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			2019-2023	This new study will produce data that will support verification and validation of sea ice models.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
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.
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	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 project included development of 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-12-04 U.S.-Canada Transboundary Fish and Lower Trophic Communities OCS Study BOEM 2017-034	UAF; DFO Canada	$5.19M	2012-2018	Documented baseline fish and invertebrate species presence, abundance, distribution and biomass.
AK-12-07 Arctic Whale Ecology Study (ARCWEST): Use of the Chukchi Sea by Endangered Baleen and Other Whales OCS Study BOEM 2018-022	MML	$4.60M	2012-2017	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	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.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
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)	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	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.
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	NOPP; NOAA; UAF	$1.75M	2015-2020	Examining 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; 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.
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	MML	$4.60M	2012-2017	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.

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
AK-13-02 Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ) OCS Study BOEM 2018-008	MML	$3.93M	2013-2019	Used passive acoustic monitoring to assess spatial and temporal distribution of marine mammals near Hanna Shoal.
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	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.
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	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	This study will conduct a monitoring program to examine long-term drivers of community variability during activities at the Liberty Development.
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.				

BOEM Study	BOEM Partner(s)	BOEM Funding	Study Duration	Relationship to IARPC Performance Element
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.
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.
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-19-04 Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty DPP			2019-2024	
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 9.4: 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: 2014—2018

BOEM 2018-037	ShoreZone Imaging and Mapping along the Alaska Peninsula
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 2018-021	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 2017-077	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 2017-066	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 2017-032	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 2017-017	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
BOEM 2016-079	Distribution and Abundance of Select Trace Metals in Chukchi and Beaufort Sea Ice
BOEM 2016-078	Evaluating Chukchi Sea Trace Metals and Hydrocarbons in the Yukon River Delta, Alaska
BOEM 2016-077	Abundance Estimates of Ice-Associated Seals: Bering Sea Populations that Inhabit the Chukchi Sea During the Open-Water Period
BOEM 2016-076	Arctic Air Quality Modeling Study - Final Photochemical Modeling Report

BOEM 2016-075	Sea Level Measurements Along the Alaskan Chukchi and Beaufort Coasts
BOEM 2016-066	Distribution and Habitat Use of Fish in the Nearshore Ecosystem in the Beaufort and Chukchi Seas
BOEM 2016-064	Sensitivity to Hydrocarbons and Baselines of Exposure in Marine Birds on the Chukchi and Beaufort Seas
BOEM 2016-062	Physical and Chemical Analyses of Crude and Refined Oils: Laboratory and Mesoscale Oil Weathering
BOEM 2016-053	Pinniped Movements and Foraging: Village Based Walrus Habitat Use Studies in the Chukchi Sea
BOEM 2016-052	Final Report: Updates to Fault Tree Methodology and Technology for Risk Analysis -- Liberty Project
BOEM 2016-051	Testing the Use of Unmanned Aircraft Systems for Intertidal Surveys
BOEM 2016-048	Alaska Arctic Marine Fish Ecology Catalog
BOEM 2016-047	Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Hanna Shoal Ecosystem Study
BOEM 2016-037	Technical Manual for a Coupled Sea-Ice/Ocean Circulation Model (Version 4)
BOEM 2015-050	Cook Inlet Circulation Model Calculations.
BOEM 2015-049	Arctic Air Quality Modeling Study Meteorological Model Performance Evaluation: 2009-2013 BOEM Arctic WRF Dataset
BOEM 2015-045	Sediment Characteristics and Infauna of Deltaic Mudflats Along the Alaskan Beaufort Sea
BOEM 2015-041	Biodegradation and Transport of Crude Oil in Sand and Gravel Beaches of Arctic Alaska
BOEM 2015-040	Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2014 - Annual Report
BOEM 2015-039	Arctic Currents: A Year in the Life of a Bowhead Whale
BOEM 2015-034	Final Report of the Chukchi Sea Acoustics, Oceanography and Zooplankton Study

BOEM 2015-029	Population Assessment of Snow Crab, Chionoecetes Opilio, in the Chukchi and Beaufort Seas Including Oil and Gas Lease Areas
BOEM 2015-023	Subsistence Sharing Networks and Cooperation: Kaktovik, Wainwright, and Venetie, Alaska
BOEM 2015-022	Satellite-tracked Drifter Measurements in the Chukchi and Beaufort Seas
BOEM 2014-1001	Arctic Air Quality Modeling Study: Emissions Inventory -- Final Report
BOEM 2014-774	Updates to Fault Tree Methodology and Technology for Risk Analysis -- Chukchi Sea Sale 193 Leased Area
BOEM 2014-772	Loss of Well Control Occurrence and Size Estimators for Alaska OCS
BOEM 2014-668	Biogeochemical Assessment of the OCS Arctic Waters: Current Status and Vulnerability to Climate Change
BOEM 2014-665	Spatiotemporal Distribution and Migratory Patterns of Spectacled Eiders
BOEM 2014-663	Dispersal Patterns and Summer Ocean Distribution of Adult Dolly Varden From the Wulik River, Alaska, Evaluated Using Satellite Telemetry
BOEM 2014-659	Analysis of Benthic Communities on WeathervaneScallop Beds in Shelikof Strait
BOEM 2014-657	ShoreZone Mapping of the North Slope of Alaska
BOEM 2014-050	Arctic Cod Pilot Genomics Study: Preliminary Results from Analyses of Mitochondrial DNA
BOEM 2014-020	Molecular and Otolith Tools Investigate Population of Origin and Migration of Arctic Cisco found in the Colville River, Alaska
BOEM 2014-018	Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2013 Annual Report

APPENDIX 3: RECENT PUBLICATIONS AND PRESENTATIONS DERIVED FROM OCS STUDIES: 2014—2018

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