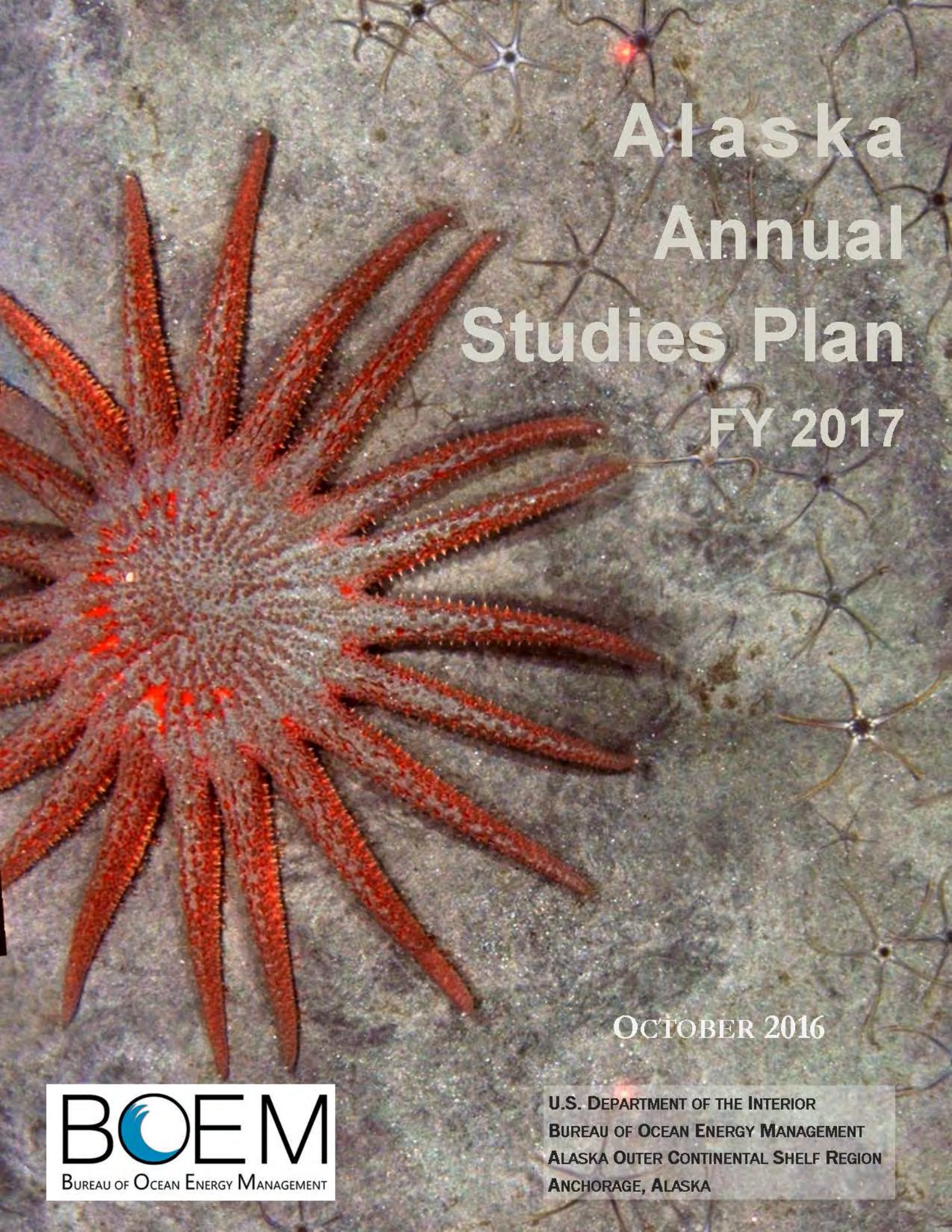


Alaska Annual Studies Plan

FY 2017

OCTOBER 2016

BOEM

BUREAU OF OCEAN ENERGY MANAGEMENT

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT
ALASKA OUTER CONTINENTAL SHELF REGION
ANCHORAGE, ALASKA

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

October 2016

This document may be accessed electronically at http://www.boem.gov/akstudies/. To request a hard copy or 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: Sunflower seastar (*Pycnopodia helianthoides*) and brittle stars (Ophiurida) on a weathervane scallop bed. *Analysis of Benthic Communities on Weathervane Scallop Beds in Shelikof Strait* (OCS Study BOEM 2014-659).

Photo credit: Gregg Rosenkranz, ADF&G. Taken by the ADF&G CamSled

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

October 11, 2016

Dear Stakeholder:

Thank you for your interest in the Environmental Studies Program (ESP) of the Bureau of Ocean Energy Management (BOEM). 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. 5). We are interested to know your perspectives and to receive any suggestions you may have for the BOEM *Alaska Annual Studies Plan, FY 2018*, which we are now beginning to formulate.

For your convenient reference, we are providing the *Alaska Annual Studies Plan FY 2017*, developed from submissions we received over the past year. In particular, we invite your attention to Section 1.4 in the document for a succinct review of notable updates.

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 (see Section 1.3). Suggestions may be submitted via email to Alaska.Studies@boem.gov, and must be received by us no later than November 28, 2016, to ensure consideration for the 2018 fiscal year (October 1, 2017– September 30, 2018). Following revisions to the plan, we will issue a final *Alaska Annual Studies Plan FY 2018* in the fall of 2017.

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 me at (907) 334-5281.

Sincerely,

Heather A Crowley

Heather A. Crowley, Ph.D.
Alaska Region Studies Plan Coordinator

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

Proposed Study for FY 2018

Formatting Guidance: We recommend study profiles be less than 2 pages. Profiles are not a detailed scope of work. If the study is selected for further consideration, BOEM will prepare a detailed scope of work. Please provide the following categories of information.

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

Administered By: Alaska OCS Region

Title: Enter title

BOEM Information Need(s) to be Addressed: Provide brief and conclusive reason(s) why BOEM needs the information. For example, identify how the study relates to analysis under the National Environmental Policy Act and/or specific BOEM decision(s), such as formulation of a mitigation measure to protect the environment. Please be as specific as possible.

Period of Performance: FY 2018-20XX

Description:

Background: Please provide 1 to 2 paragraphs on 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 objective(s) of the study. Explain what hypothesis will be tested or what questions will be answered by this study. We encourage the use of lists (1, 2, 3, etc.) for multiple, related objectives.

Methods: Provide brief detail on what information, techniques or methods are available that could be used. Explain how the objectives of the study will be accomplished.

Date information is required: Provide dates when products would be most useful and for what purpose, such as "Final report is needed by November 2020 to support NEPA analysis for anticipated lease sales under the next five-year program." If the study includes products in addition to the scientific report (e.g. database, model, bibliography), explain in this section.

TABLE OF CONTENTS

LIST OF STUDY PROFILES

Habitat and Ecology

ACRONYMS AND ABBREVIATIONS

ACES	Alaska Coastal Ecosystem Survey
ADCP	Acoustic Doppler Current Profiler
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AMBON	Arctic Marine Biodiversity Observing Network
AMSS	Alaska Marine Science Symposium
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
ARP	Arctic Research Plan
ASP	Alaska Annual Studies Plan (BOEM)
AOOS	Alaska Ocean Observing System
ArcSEES	Arctic Science, Engineering and Education for Sustainability
ARCTREX	Arctic Tracer Release Experiment
AUV	Autonomous Underwater Vehicle
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOWFEST	Bowhead Whale Feeding Ecology Study
BSMP	Beaufort Sea Monitoring Program
BSEE	Bureau of Safety and Environmental Enforcement
BWASP	Bowhead Whale Aerial Survey Project
CAB	Chemistry and Benthos
cANIMIDA	Continuation of Arctic Nearshore Impact Monitoring in Development Area
CESU	Cooperative Ecosystem Studies Unit
CHAOZ	Chukchi Acoustics, Oceanography and Zooplankton study
CIAP	USDOI Coastal Impact Assistance Program
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)
FY	Fiscal Year

G&G	Geological and Geophysical exploration
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
LEO	Local Environmental Observer [Network]
MARES	Marine Arctic Ecosystem Study
MML	Marine Mammal Laboratory
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation 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
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 Environmental Studies Program (ESP) of the Bureau of Ocean Energy Management was established and funded by the United States Congress to support the Outer Continental Shelf (OCS) oil and gas leasing program of the U.S. Department of the Interior (USDOI) in pursuit of national energy policies. The Environmental Studies Program was administered originally by the Bureau of Land Management (BLM) from 1973 until 1982, then by the Minerals Management Service (MMS), and presently by the Bureau of Ocean Energy Management (BOEM) since October 2011. 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. 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.

The Outer Continental Shelf Lands Act (OCSLA) of 1953, as amended (43 U.S.C. 1344 et seq.), provides direction for preparing and implementing an OCS oil and gas leasing program based on the need to balance orderly energy resource development with protection of the human, marine, and coastal environments. The Energy Policy Act of 2005 provides for BOEM to also consider renewable energy projects on the OCS. 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. Federal laws impose additional requirements on the OCS leasing process, these include, but are 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.

The ESP operates on a national scale to assist in projecting, assessing and managing potential effects on the human, marine, and coastal environments of the OCS that may be affected by oil and gas exploration, development, and production, as well as renewable energy exploration and development. Lease-management decisions are enhanced when current, pertinent and timely environmental information is available. Final reports from the ESP are most directly utilized by teams of NEPA analysts within the BOEM Environmental Analysis Sections when they prepare Environmental Impact Statements (EISs) and Environmental Assessments (EAs), and review Geological and Geophysical permit applications, Exploration Plans (EPs) and Development and Production Plans (DPPs). Of course, a wide range of scientists, stakeholders and decision-makers also make use of our study products.

Since the ESP began, the USDOI and BOEM have funded nationally more than $1.1 billion for environmental studies through fiscal year (FY) 2016. Nearly $450 million of that amount has funded studies in Alaska across 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 peer-reviewed publication. The ESP manages ongoing study projects in Alaska (currently about 65) in disciplines such as physical oceanography, air quality, fate and effects of pollutants, protected and endangered species, marine ecology, and the social sciences, including traditional knowledge. Completed study reports are posted on our website at http://www.boem.gov/ESPIS/. An alternate location for browsing Alaska Region study reports by year is http://www.boem.gov/AKpubs.

Early in the development of the program, the focus was on obtaining baseline information on the vast biological resources and physical characteristics of the Alaskan environment for pre-lease decision-making. These studies included biological surveys of marine species, basic oceanography and meteorology, and geologic and sea ice phenomena. As a broader base of information was established, it became possible to focus on more topical studies in smaller areas to answer specific questions and fill identified information needs. In addition, generic studies were initiated to examine the potential effects of oil spills on biological resources and different oil development scenarios were modeled to determine the most likely routes of transport and dispersion of oil that might affect the marine environment. The use of computer modeling techniques has been implemented to aid in the assessment of potential oil spill and other pollutant risks to the environment, and to key species such as fur seals, sea otters and endangered whales. Modeling has also been used in ecosystem studies, especially where extrapolation to other areas provided valid analysis.

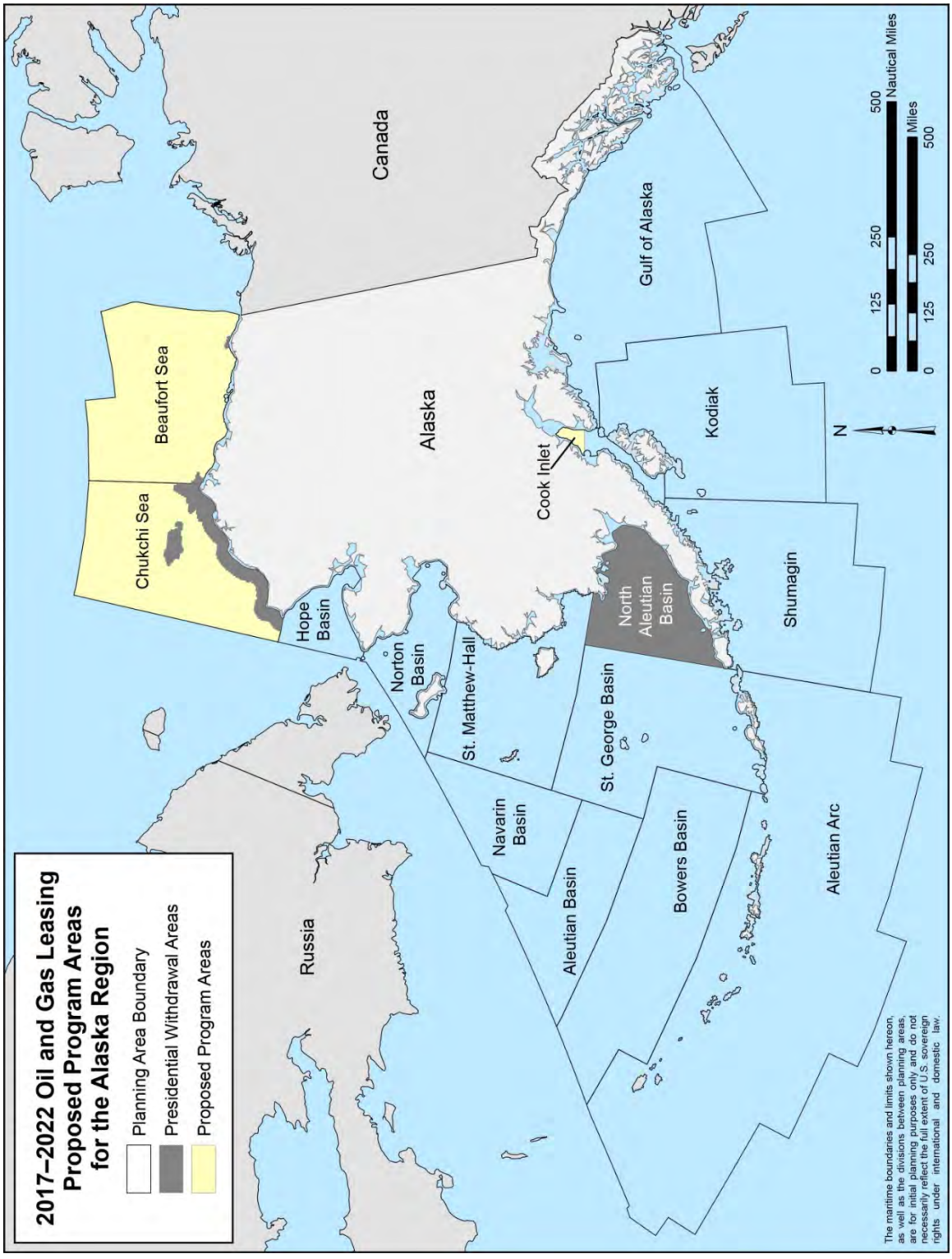
As studies information has been amassed, improved focus has required greater integration of various scientific disciplines. To facilitate this, BOEM co-sponsors the Alaska Marine Science Symposium each year. The ESP also has initiated regional Synthesis Meetings and Information Transfer Meetings (ITMs) to gather maximum expertise and assess the status of existing information, as well as to plan the best possible approach to acquire new data, within the constraints of time and resources. As BOEM and other Federal and State agencies collect more pertinent information, BOEM funds studies to search and evaluate existing literature and data prior to initiation of field efforts. This prevents duplication of effort and saves valuable resources by focusing study efforts on the areas of greatest information need and highest usefulness. Of course, additional research coordination with groups external to BOEM occurs continuously through a variety of institutional mechanisms, as discussed in the following section.

Scientific Studies are Conducted in Partnership

The ESP in Alaska, through its day-to-day operations and studies planning process, works to:

- Coordinate plans and studies with other ongoing programs and research projects, both internal and external to BOEM, to assure optimal studies management and efficient use of funding resources.

Figure 1. Alaska OCS Region Planning Areas



- Enhance utilization of existing information.
- Enhance interdisciplinary approaches to project planning, data collection and data interpretation.
- Implement the *National Strategy for the Arctic Region* (White House, 2013b; White House, 2014).
- Support the work of the Arctic Council and its various working groups.

Currently, a major portion of the ESP in Alaska is conducted on a collaborative basis with an extensive range of bilateral and multilateral partnerships. The ESP in Alaska coordinates routinely on major projects with numerous Federal entities, including: 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) and the Arctic Landscape Conservation Cooperative (LCC); USDOI Coastal Impact Assistance Program (CIAP); the North Slope Science Initiative (NSSI); the National Park Service (NPS); the 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); and the Polar Research Board.

In addition, the ESP works directly on specific projects with the Alaska Ocean Observing System (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); and academic institutions including the University of Alaska Anchorage (UAA), University of Alaska Fairbanks (UAF), Woods Hole Oceanographic Institution (WHOI), University of Washington (UW), Rutgers University, and University of Texas (UT). The ESP also coordinates closely with active industry research and monitoring programs in Alaska conducted by Shell Offshore Inc., ConocoPhillips, and others.

Under the University of Alaska Coastal Marine Institute (CMI) the ESP taps the scientific expertise of regional and local experts through the University of Alaska to collect and disseminate environmental information about resource issues of mutual interest. This arrangement was created in 1993 by a cooperative agreement between the University of Alaska and the ESP to study coastal topics associated with the development of natural gas, oil and minerals in Alaska's OCS. Through the CMI, the ESP stimulates important studies in a cost-saving one-to-one match structure. Since its inception, the CMI has leveraged over $20 million of agency funds into $40 million worth of relevant marine-based research, with matching funds from more than 50 different organizations. During that time, the CMI program has also provided roughly 145 years of student support and completed approximately 85 studies. For this agreement, which extends through 2017, the Alaska OCS Region has planned $1,000,000 per year with a dollar-for-dollar match arrangement. More information about the CMI can be found at http://www.sfos.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, with each unit focusing on a separate biogeographic region. The goal of the CESU network is 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 U.S. and seven other arctic nations voluntarily agreed to cooperate on an Arctic Environmental Protection Strategy, which evolved into the formation of the Arctic Council in 1996. 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.

Since 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.

In ESP field oriented studies, 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 ESP strives to incorporate local, traditional, and indigenous knowledge of Alaska Natives, Alaskan residents, and the permanent participants of the Arctic Council directly in the preparation of its study products and interpretation of results. The process of integrating local, traditional, and indigenous knowledge varies from project to project, but the outcome of better information for decision-making is a common goal.

Alaska OCS Studies Planning Process

In the Alaska OCS Region of BOEM, research planning is a continual process that follows a longstanding annual cycle, beginning with the distribution of the *Alaska Annual Studies Plan* (ASP). The ASP is distributed 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 approved new studies for the coming fiscal year, it also serves to initiate the next planning cycle by circulating a letter that calls for suggestions about new information needs from all interested parties, including scientists, stakeholders, partners and the general public.

In Alaska, we typically receive more than 60 study profiles from external institutions and BOEM staff with suggestions for new research. Correspondence from agencies such as NMFS, USFWS, and the State of Alaska are carefully considered; particularly those that are relevant to interagency consultations under the Endangered Species Act and other processes. Additional ideas for new research derive throughout the year from program reviews and public meetings, including science conferences, multilateral planning sessions, and public hearings. Study profiles also address recommendations from broad programmatic reviews or "data gap" analyses, such as those coming from the National Academy of Sciences, the Interagency Ocean Policy Task Force, and the Arctic Council. Of course, the majority of incoming proposals for new research still originate with BOEM staff and managers in the regular performance of their duties.

From these multiple sources of input, BOEM subject-matter experts assimilate the various study comments and recommendations and consolidate them into discrete study profiles. Often, this involves merging several related objectives from multiple sources into a single study effort. It also involves revising submissions to enhance mission-focus or to provide more conclusive results. Consistent with our mission, the Environmental Studies Program funds studies that have strong applicability to pending pre- and post-lease decisions under the Five-Year OCS Oil and Gas Leasing Program. The most important considerations for establishing priorities within the national context include: program relevance; timing in relation to assessment needs; feasibility and likelihood of conclusive findings; and availability of information from other sources.

After evaluation of incoming proposals and extensive internal discussions, we prepare a short-list of the high priority study profiles to be considered by regional and national senior managers. In late January, the short-list of proposed profiles, as defined by priority of information need and consideration of budgetary constraints, is shared and coordinated with all regions within BOEM. 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, as well as the technical aspects of proposed study methods. During this period, the short-list is coordinated with other agencies through multilateral partnerships such as NSSI and the Arctic LCC. The proposed profiles are again revised and reprioritized as needed, and finalized by August for funding allocation in the new fiscal year. The Annual Studies Plan is then finalized and circulated to the public in autumn, when the cycle starts all over again.

Once a research project achieves funding and gets underway, interim reports and project websites facilitate data sharing and report dissemination. When a project is complete, final study reports are posted to the BOEM website and a number of other scientific web portals to facilitate distribution. Project data are typically delivered to the National Centers for Environmental Information (NCEI) and to customized project websites. The ESP is also developing new platforms for enhanced data sharing with all

stakeholders. Thus, from start to finish, the entire planning, procurement, and dissemination process involves constant coordination with multiple organizations and scientific entities.

Issues To Be Addressed

The *Alaska Annual Studies Plan FY 2017* complements and reinforces the goals of the Environmental Studies Program. The ESP is guided by several broad themes, which include:

- Monitoring Marine Environments
- Conducting Oil-Spill Fate and Effects Research
- Minimizing Impacts to Marine Mammals and Other Biota
- Understanding Social and Economic Impacts
- Maintaining Efficient and Effective Information Management
- Integrating Scientific Results with Local and Traditional Ecological Knowledge

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. 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.

At each step of the OCS leasing, exploration, development and production, and decommissioning process, a variety of potential issues or resource-use conflicts may be encountered. Two questions are fundamental:

- What are the expected effects to the human, marine, and coastal environments due to offshore activity?
- Can negative effects be minimized through mitigation measures?

Environmental studies are the primary means by which information on these questions is acquired for use by decision-makers. Currently the ESP in Alaska is focused primarily on future lease sales, proposed development of the Liberty Prospect, and potential exploration activities in the Beaufort and Chukchi Sea Planning Areas. OCS oil and gas-related issues addressed by ongoing and proposed studies in the Beaufort and Chukchi Seas include, but are not limited to:

- What refinements can we make to our knowledge of major oceanographic, cryospheric, and meteorological processes and how they influence the human, marine, and coastal environments?
- What role will ocean currents and sea ice play in distribution of anthropogenic pollutants near exploration and development prospects?

- What long-term changes in heavy metal and hydrocarbon levels may occur near exploration and development prospects, or regionally along the Beaufort and Chukchi Sea coasts?
- How do we improve our model analyses of the distribution and fate of potential oil spills?
- If oil is spilled in sea ice, what will its fate be?
- What effects might artificial island or pipeline construction have on nearby marine communities or organisms?
- What changes might occur in sensitive benthic communities such as the Stefansson Sound Boulder Patch?
- What are the current spatial and temporal use patterns of these planning areas by potentially sensitive species such as bowhead whales, polar bears, other marine mammals, birds, or fish?
- What is the extent of feeding by endangered whales in areas of the OCS that could be affected by potential future oil and gas exploration, development and production activities?
- What changes might occur in habitat use, distribution, abundance, movement or health of potentially sensitive key species such as bowhead whales, polar bears, other marine mammals, birds, or fish?
- What interactions between human activities and the physical environment potentially affect sensitive species?
- How can we better quantify anthropogenic sound in the marine environment, its effects on the well-being and behavior of marine species, and the resulting impacts to subsistence practices?
- What changes might occur in socioeconomics and the subsistence way of life in coastal Alaska communities?
- What are current patterns of subsistence harvest, distribution, and consumption, and what changes might occur in key social indicators as a result of OCS exploration and development and production?
- To what extent can changes in subsistence practices and patterns be attributed to perceptions related to oil and gas exploration and development and production activities?
- How can we continue to integrate local and/or traditional knowledge into studies related to the ESP in Alaska?

Many of these same issues are also relevant to the Cook Inlet Planning Area. Some additional concerns in Cook Inlet include:

- What are the potential effects of oil exploration and development on key economic activities such as commercial fishing, sport fishing, and tourism?

- How do we improve our model analyses of the fate of potential oil spills in locations with extensive intertidal areas?
- What are the current spatial and temporal use patterns of this planning area by potentially sensitive species such as beluga whales, fin whales, Steller sea lions, sea otters, other marine mammals, birds, or fish?

1.2 Projected OCS Activities

This *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. 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.

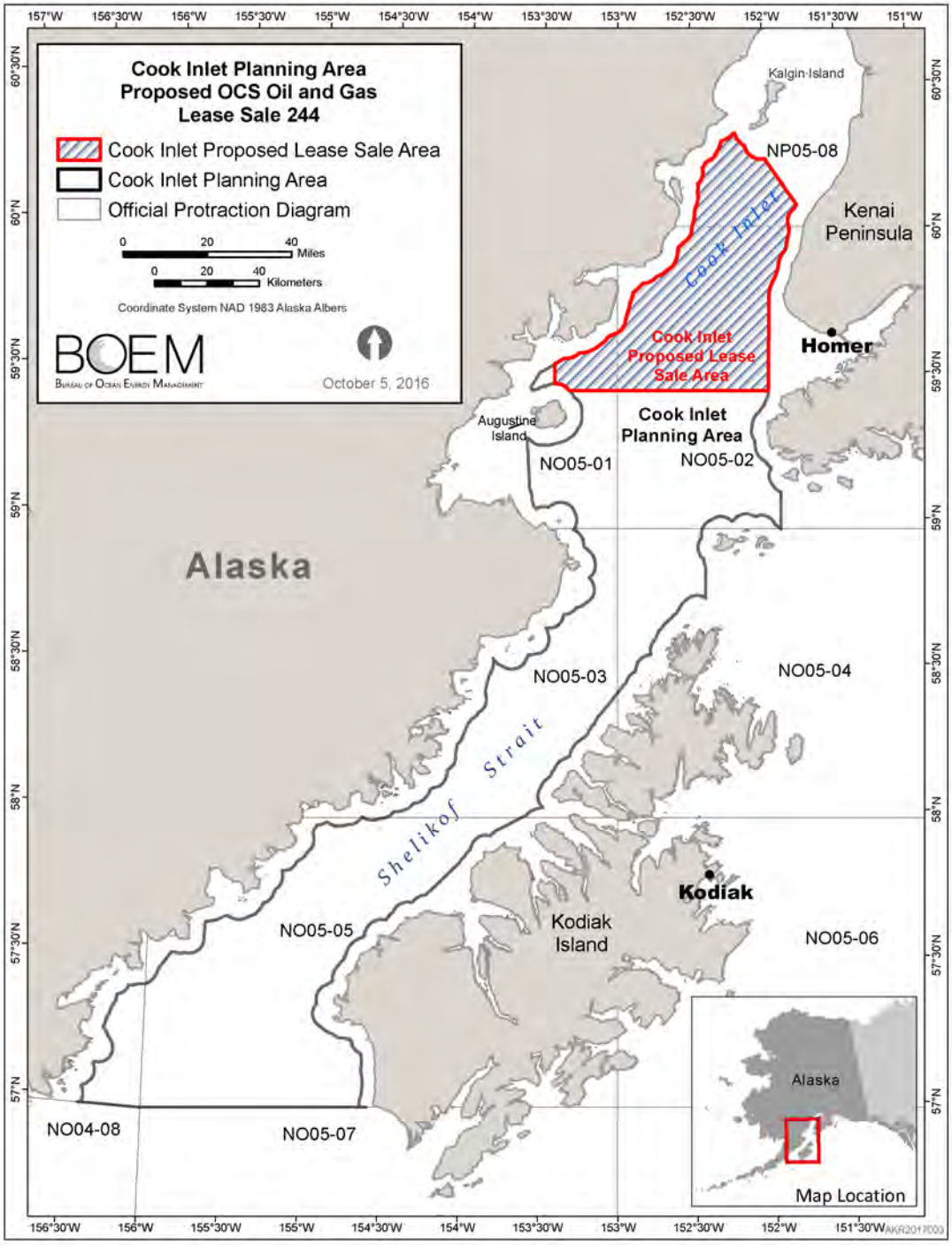
Considerations at the Lease Sale Stage

Preparation of an environmental document pursuant to NEPA based on the best available information 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. This introduces an additional time-sensitivity to the information need. Although much relevant information exists for certain 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.

On December 16, 2014, President Obama signed a memorandum withdrawing the North Aleutian Basin Planning Area from consideration for future leasing. On January 27, 2015, the President signed a second memorandum withdrawing certain areas of the OCS offshore Alaska from leasing disposition. Areas in the Chukchi Sea include a pre-existing 25-mile nearshore buffer, the area surrounding Hanna Shoal, and an area to the north of Barrow that will not be considered for leasing due to its documented importance for subsistence use. In addition, two subsistence whaling areas near Barrow and Kaktovik are withdrawn from consideration in the Beaufort Sea.

In the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program 2012-2017* (USDOI, BOEM, 2012) BOEM established a targeted leasing strategy in Alaska, aiming to take a balanced approach to development. A lease sale is scheduled for June 2017 in the northern portion of the Cook Inlet Planning Area (Figure 2). A EIS for Cook Inlet Lease Sale 244 was issued on July 15, 2016. This release was followed by a 45-day public comment period, which ended September 6, 2016. BOEM anticipates release of a Final EIS in the coming months.

Figure 2. Cook Inlet Planning Area



On March 15, 2016, BOEM released the 2017-2022 *Outer Continental Shelf Oil & Gas Leasing Proposed Program* (USDOI, BOEM, 2016). This *Proposed Program* identifies three potential lease sales in the Alaska OCS: one in the Beaufort Sea Planning Area (Figure 3) in 2020, one in the Cook Inlet Planning Area in 2021, and one in the Chukchi Sea Planning Area (Figure 4) in 2022. These potential lease sales are deliberately scheduled later in the Proposed Program to provide additional opportunity to evaluate and obtain information regarding environmental issues, subsistence use needs, and infrastructure capabilities, as well as results from any exploration or development activity associated with existing leases.

Considerations at the Exploration and Development and Production Stages

Prior to FY 1982, most studies offshore of Alaska were planned, conducted, and concluded before a lease sale was held for the purpose of providing information to support environmental review and decision-making. However, not all information can be obtained prior to a lease sale. In accordance with mandates of Section 20 of the OCSLA (43 U.S.C. 1346), the need for studies continues into the post-lease period to address environmental concerns and monitoring related to specific areas of interest.

The ESP acquires additional information for environmental analyses related to exploration, development and production. Accordingly, an increasing number of studies have become more closely related to proposed exploration and development schedules and related monitoring in addition to those broader studies related to the pre-lease stage. As with the Lease Sale stage, the wide range of environmental conditions from Cook Inlet to the Arctic is considered during the process of formulating new studies. OCS activities that require may environmental data and assessment include:

- Review of Exploration Plans (EPs)
- Monitoring of exploration drilling
- Review of Development and Production Plans (DPPs)
- Monitoring of development, construction and production activities
- Oil and gas transportation
- Platform decommissioning
- Oil spill detection, containment, clean-up and damage assessment

Data related to these activities are limited in offshore areas of the U.S. Arctic, due to the limited oil and gas activities on the OCS in the Beaufort and Chukchi Seas. However, environmental analyses 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. In addition, the first commercial oil production within the National Petroleum Reserve-Alaska began in 2015 at the CD-5 site in the Alpine field, and production of natural gas condensate at the high-pressure Point Thomson reservoir started in April 2016.

Figure 3. Beaufort Sea Planning Area

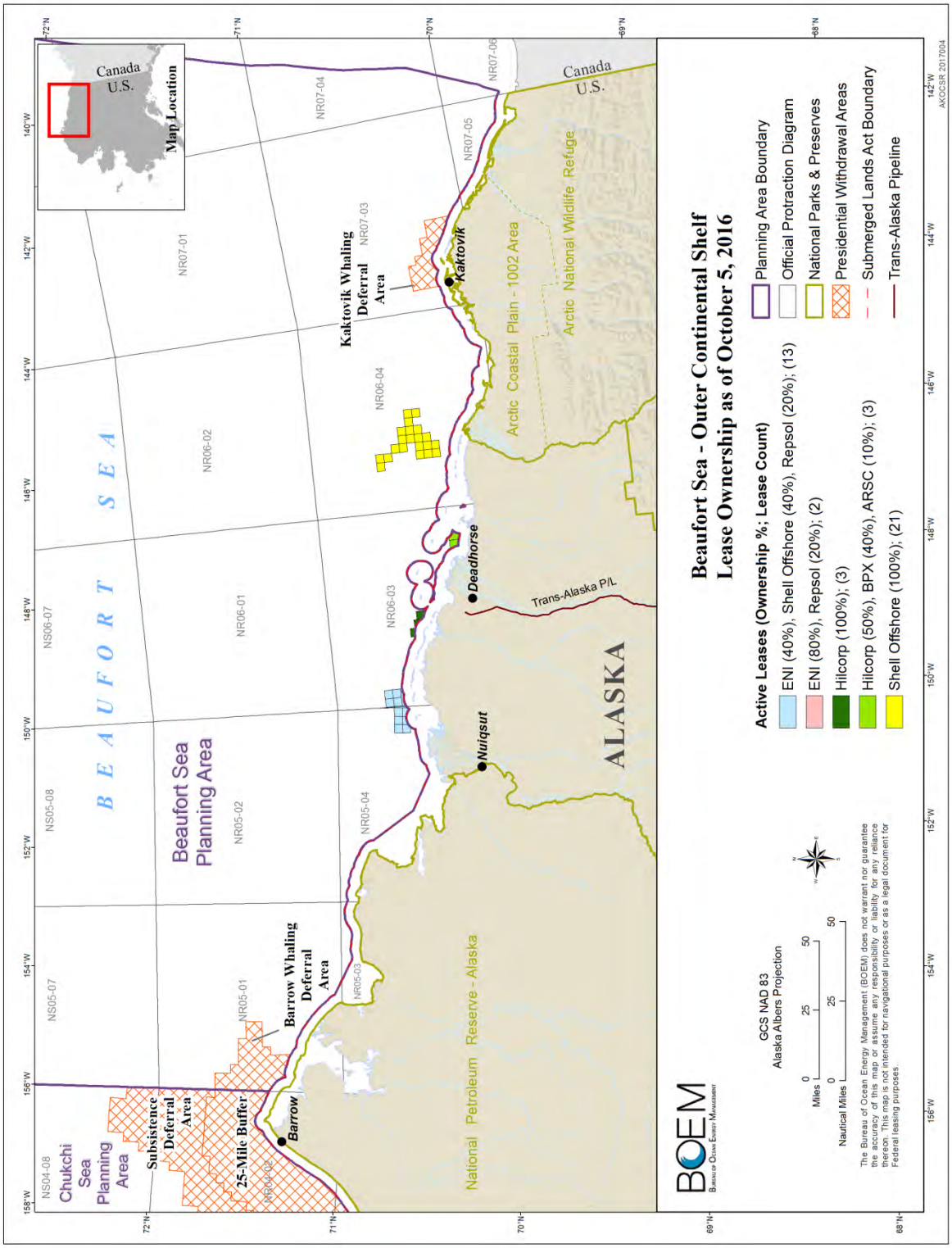
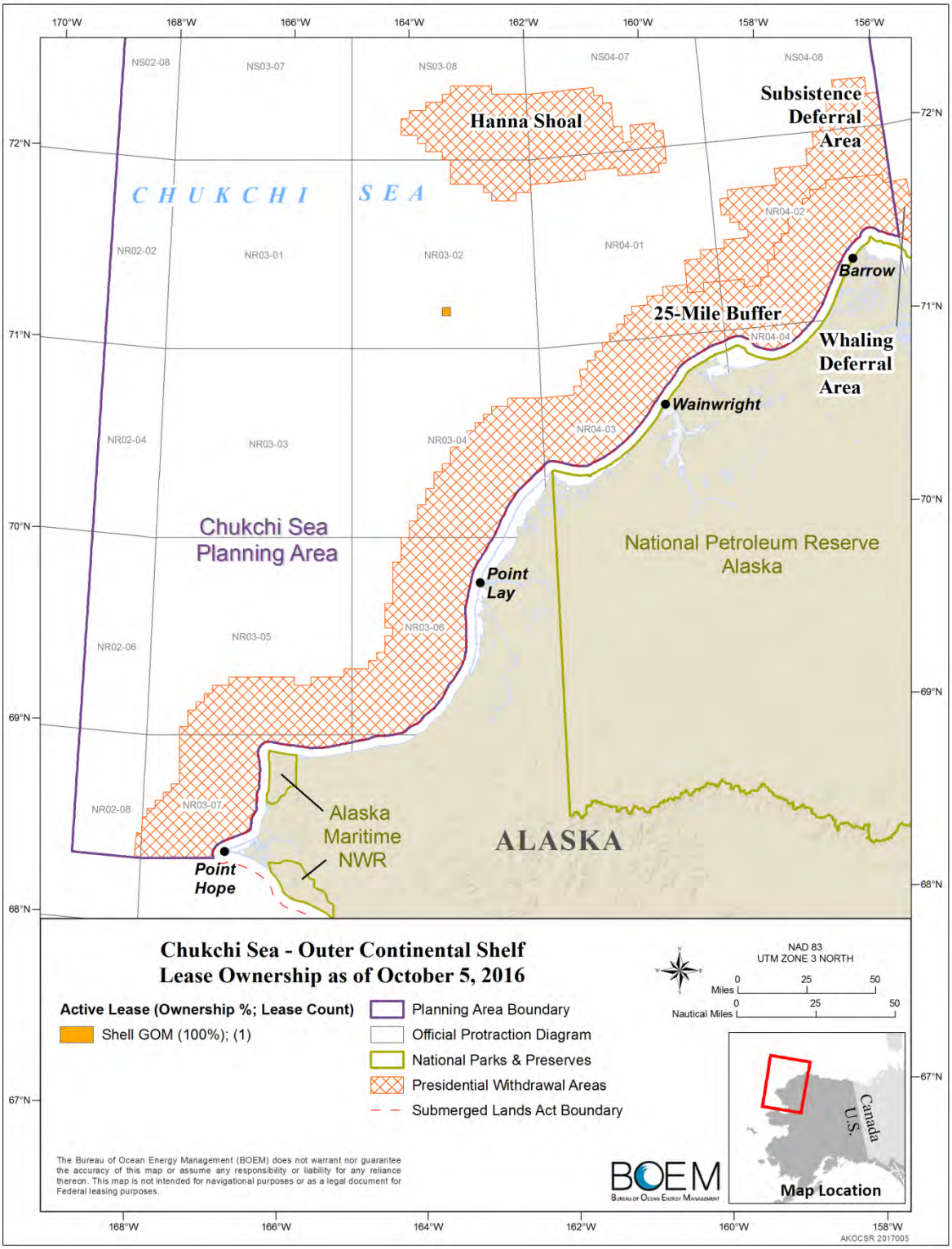


Figure 4. Chukchi Sea Planning Area



A total of 2,351 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. Lease Sale 193, held in February 2008, resulted in 487 leases being issued in the Chukchi Sea Planning Area. As of September 2016, there are 42 active leases in the Beaufort Federal offshore area and one active lease in the Chukchi Sea. There are no active leases from previous lease sales in the Chukchi Sea, Bering Sea, Cook Inlet, or Gulf of Alaska Subregions.

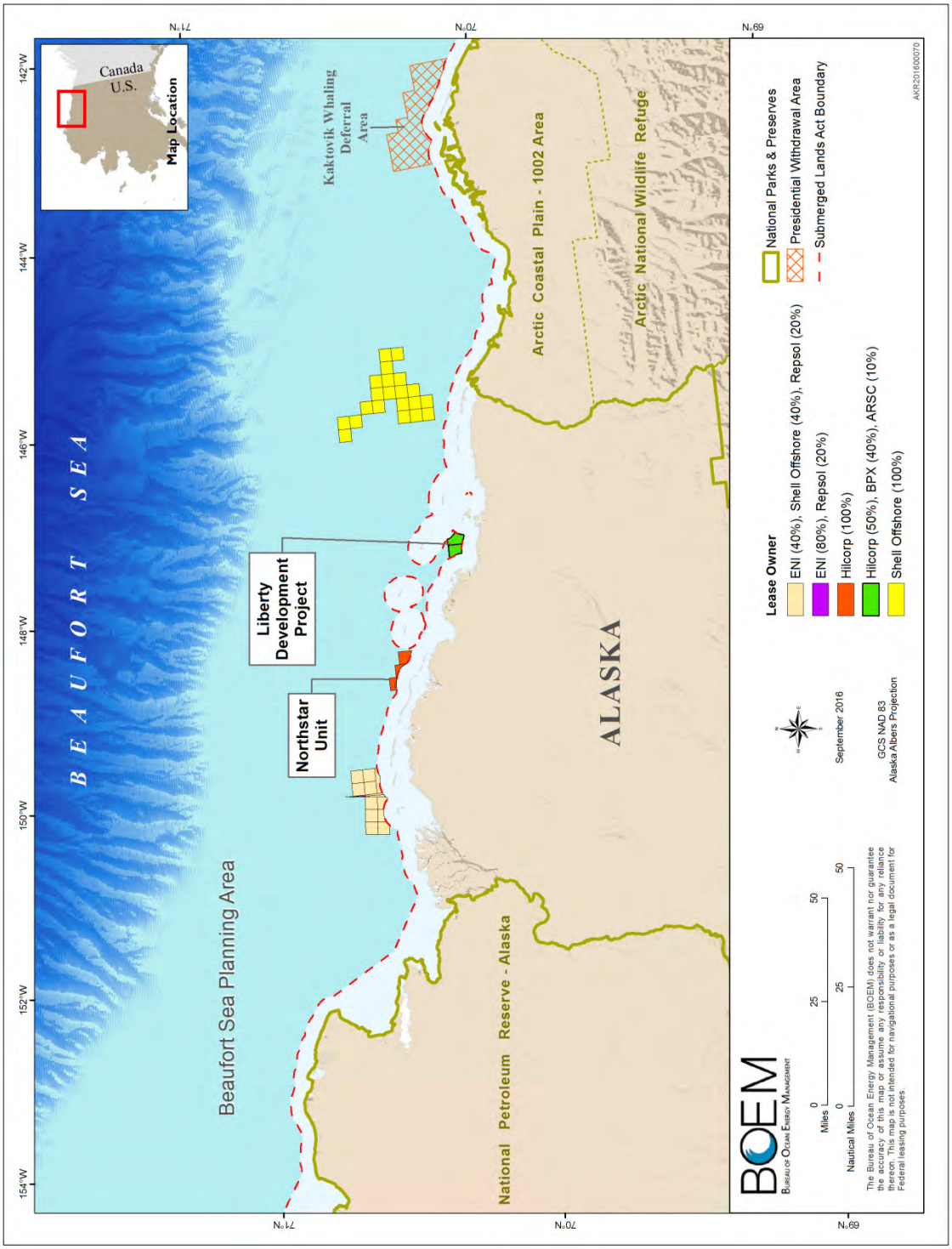
Production:
Northstar – Northstar is a joint Federal/State of Alaska unit located in state waters in the Beaufort Sea about 6 miles northwest of Prudhoe Bay. The six producing Federal wells fall under Bureau of Safety and Environmental Enforcement (BSEE) regulatory authority, the State wells fall under the State's oversight. Production started in 2001 and peaked in 2004. Total production of crude oil through July 2016 is more than 166 million barrels, with the Federal portion comprising more than 29.6 million barrels.

Development:
Liberty – The Liberty prospect (Figure 5) is located in the central Beaufort Sea to the east of the existing Endicott Satellite Drilling Island. 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, 2014), 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. Review of Hilcorp's DPP is ongoing, and BOEM is preparing an EIS for the project.

Exploration:
At this time, BOEM does not have any exploration plans.

Air Quality:
The Consolidated Appropriations Act of 2012 transferred jurisdiction to regulate air emissions associated with oil and gas activities on portions of the Alaska OCS adjacent to the North Slope Borough from EPA to BOEM. Companies seeking to operate facilities in this area no longer require an air quality permit from the EPA. Rather, their proposed facilities' emissions will be evaluated by BOEM as a prerequisite to approval of the operator's exploration plan or development and production plan.

Figure 5. Location of the planned Liberty Development Project



1.3 Identification of Information Needs

Beaufort and Chukchi Seas General Information Needs

Both offshore and onshore oil and gas development and production activities are continuing across Alaska's North Slope. Residents of Nuiqsut, Kaktovik and Barrow are particularly concerned about long-term effects of OCS developments at Northstar, Liberty, and other possible developments, as well as long-term and cumulative effects from onshore and OCS activities. Key constituents have identified the need to monitor potential effects from development at Liberty on circulation patterns and resulting impacts to behavior of marine mammals and anadromous fish, changes in sedimentation and related effects on water quality and Boulder Patch biological communities, and potential effects on social systems and subsistence activities in the vicinity of Northstar, Liberty, and other potential OCS activities. Related questions that be addressed include the characteristics of major oceanographic and meteorological processes and how they influence the human, marine, and coastal environments.

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 within the Beaufort Sea. In recognition of industry interest at the time, USDOI placed less emphasis on studying the Chukchi Sea than the Beaufort Sea beginning in the mid-1990s. Beginning in 2007, the Alaska OCS Region increased its efforts in the Chukchi Sea, leveraging more than $70 million (through FY 2016) 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. The Chukchi Sea remains an important area for continued research due both to its high oil and gas resource potential and its location 'upstream' of 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.

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 Development Area" (ANIMIDA) program and its continuation (cANIMIDA) began 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" and "ANIMIDA III: Contaminants, Sources, and Bioaccumulation," which has been expanded to include Camden Bay.

Figure 6 shows the ANIMIDA sampling locations in 2015, along with some of the sampling activities through the years of the ANIMIDA program, which have included: measuring hydrocarbon and trace metal concentrations in benthic biota, examining turbidity and suspended sediment in the water column, productivity of kelp in the Stefansson Sound Boulder Patch, assessing subsistence whaling at Cross Island, and characterizing anthropogenic chemicals in biota.

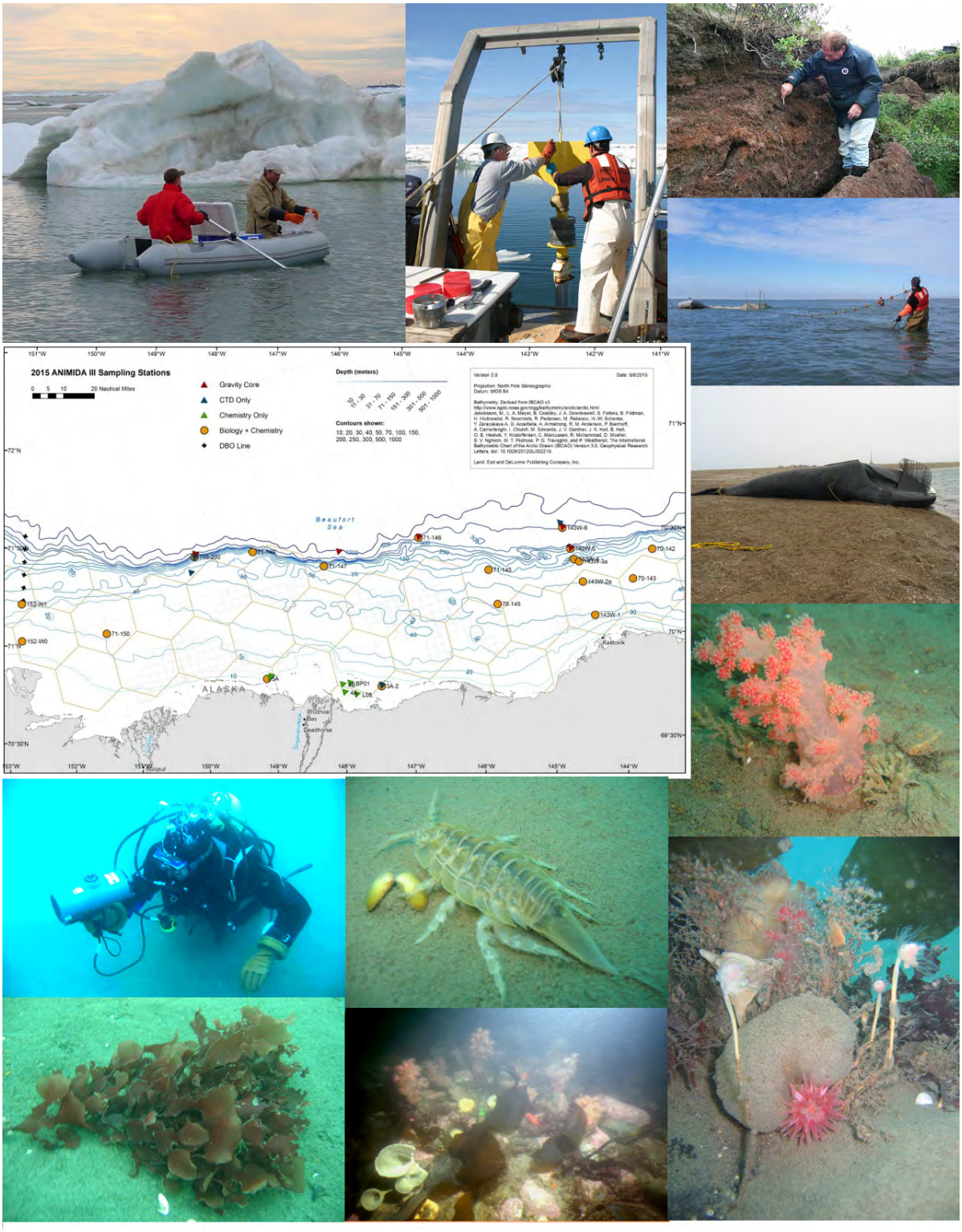
In addition to the ongoing need for integrated research programs, there is also a need for synthesis of results from multiple studies to facilitate interpretation of data across disciplines. The ongoing "Synthesis of Arctic Research" (SOAR) study brings together a multidisciplinary group of Arctic scientists and Alaskan coastal community representatives to explore and integrate information from completed and ongoing marine research in the northern Bering, Chukchi and Beaufort Seas. The goal of SOAR is 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. Highlights of these and other important research projects are provided in Section 1.4.

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 in this region and the potential impacts on biota associated with these systems. 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. It becomes very 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. Figure 7 shows researchers deploying an ice drifter on a multiyear ice floe north of Point Barrow. Information about ice gouge characteristics and recurrence rates is also needed to assess 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. Information will be used to assess the cumulative air quality impact of Arctic OCS oil and gas activity, including oil spill response equipment and associated support equipment not already accounted for through State and Federal air quality permit requirements.

Pollutants: North Slope residents are concerned about potential contamination of their food supply. In the Beaufort Sea such foods include bowhead whales, seals, waterfowl and fish. Of particular concern are environmental effects of development on these biota, including effects from potential oil spills. 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. More information about the fate (weathering) of spilled oil under arctic conditions is also needed.

Figure 6. The ANIMIDA Program, 1999 – Present



Photos by ANIMIDA and cANIMIDA Project Teams.

Figure 7. Deploying an ice drifter on a multiyear ice floe north of Point Barrow, April 2015 (Kasper and Mahoney, 2015)

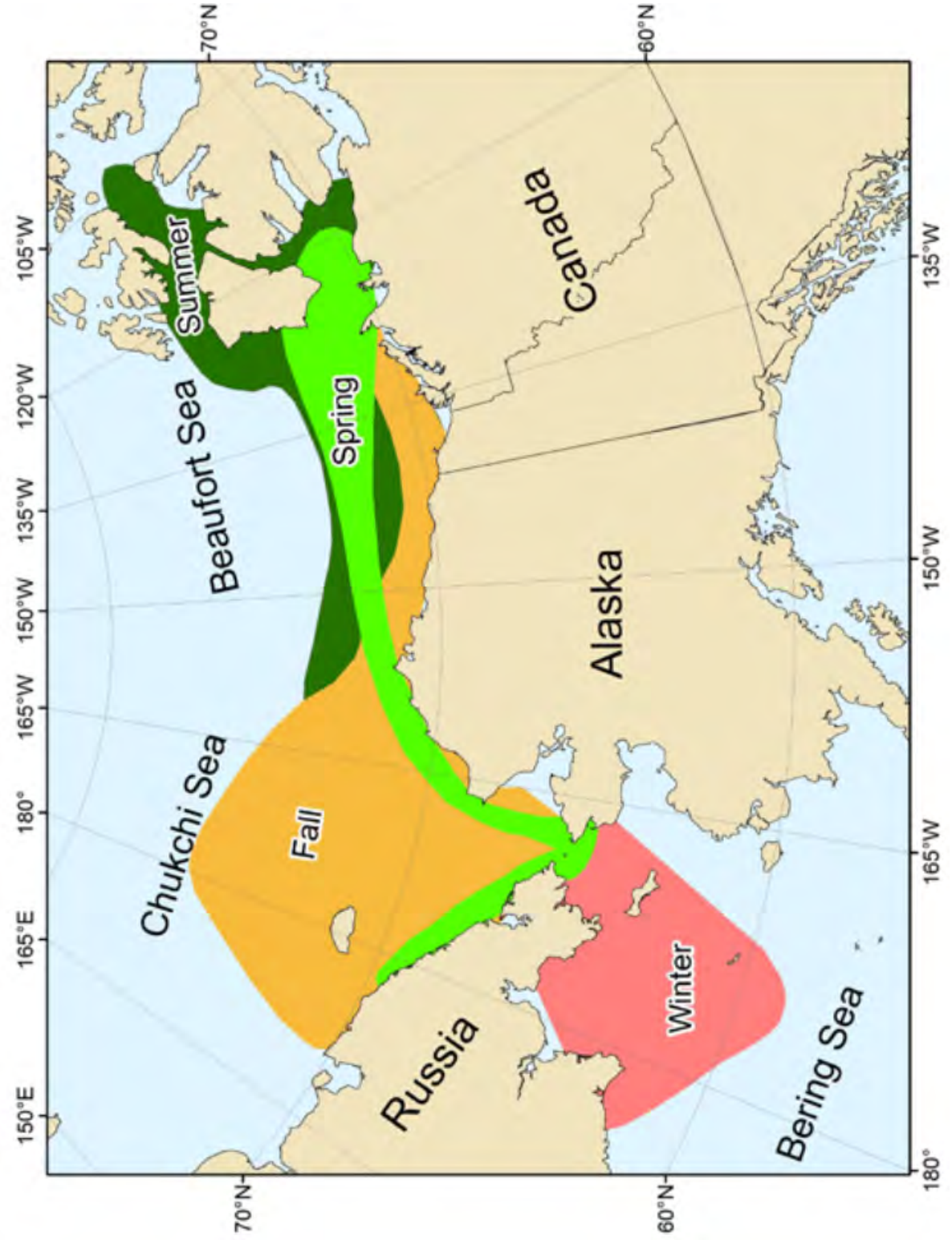
Information on Bowhead Whales and Other Wildlife: The bowhead whale is central to Alaska Native cultural and spiritual life and the Iñupiat rely heavily on bowhead whales for subsistence. A central concern is the effect of noise on the well-being and the behavior of the whales. Whale hunters have reported 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. Figure 8 depicts the generalized range of bowhead whales in the Beaufort, Chukchi, and Bering Seas, as inferred from a synthesis of tracks from satellite-tagged bowhead whales. Information about bowhead feeding and habitat use is also needed, and it is important to assess the factors that may be affecting the habitat use, health, population status and migration routes of bowhead whales. Noise from industrial activity is a central concern. Additionally, Iñupiat whale hunters as well as the scientific community have raised concerns about potential cumulative impacts on bowhead whales.

The populations of bowhead whales, polar bears, spectacled eiders, spotted and ringed seals, and other threatened and endangered species, as well as candidate species such as walruses and some ice seals, are an ongoing concern. Potential effects from loss of sea ice are a particular concern. 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. 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 in the Beaufort and Chukchi Seas fill an essential role in the Arctic 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 these areas 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.

Figure 8. Map of the seasonal occurrence and migration corridors of bowhead whales from the Bering-Chukchi-Beaufort stock (Quakenbush et al., 2013)



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)
- Employment changes (potential effects on subsistence way of life by a cash economy)
- 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 western 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. Figure 9 provides an example of a synthesis map depicting tracks from Wainwright for subsistence harvest, including whales, seals, walrus, and caribou. We continue to seek and include firsthand knowledge of local subsistence hunters to enhance the scientific knowledge base.

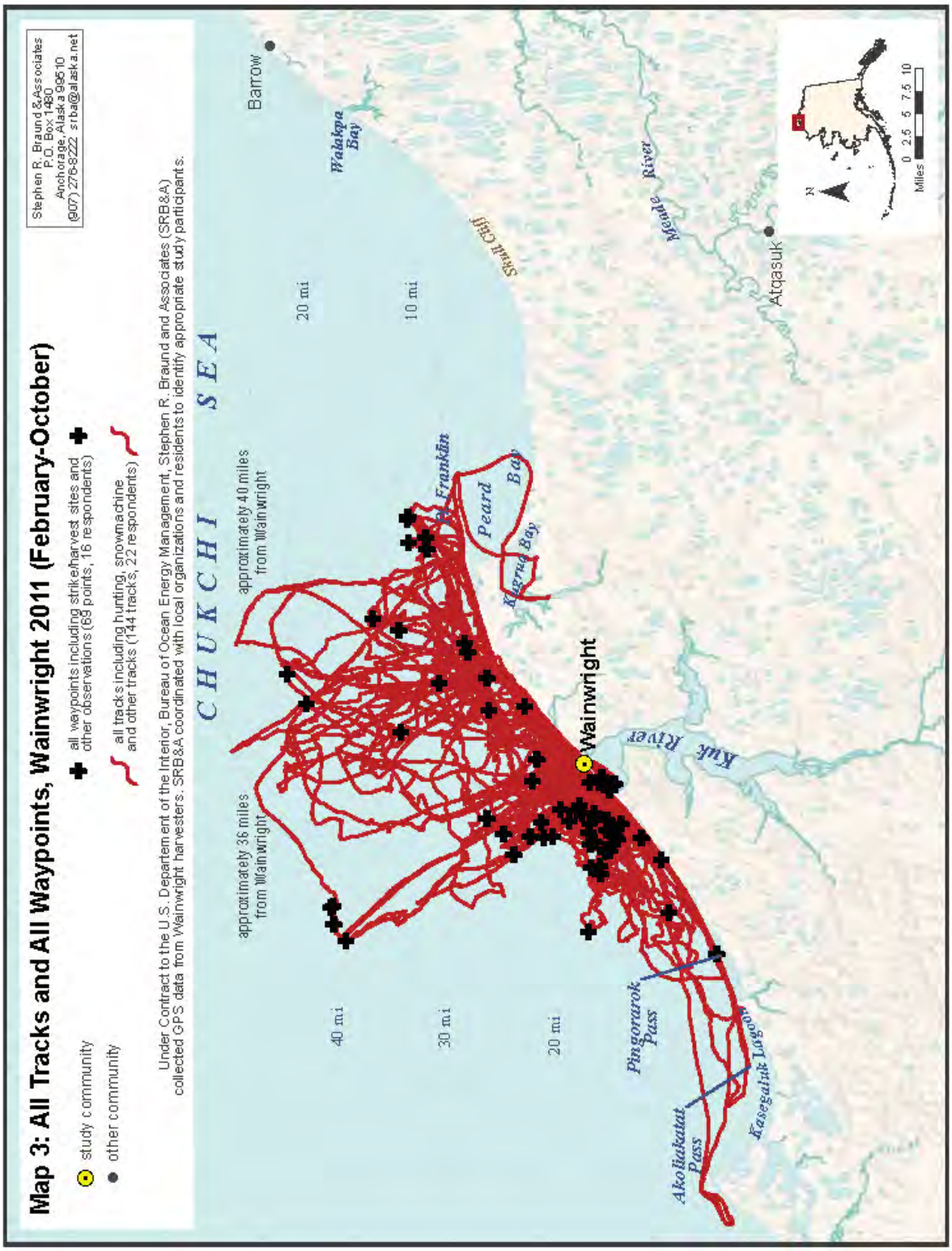
Archaeological Resources: The archaeological significance of offshore areas has been recognized in recent years and marine archaeological studies have been showing the presence of prehistoric sites on the shelves beneath the modern ocean. Basic information and analysis is needed for assessments of archaeology potential in the Beaufort and Chukchi Seas to support the National Historic Preservation Act and NEPA review. Data are very limited in the Chukchi Sea, and the last baseline study in the Beaufort Sea should be updated.

Cook Inlet General Information Needs

There is an ongoing need for updated information about the physical and biological environment in Cook Inlet and Shelikof Strait to support NEPA analysis for potential future lease sales in this area. Specific information needs in Cook Inlet include, but are not limited to:

- An improved understanding of circulation and water mass movement in lower Cook Inlet
- Assessment of variability and long-term trends in oceanographic conditions and biological communities

Figure 9. A synthesis map depicting tracks from Wainwright for subsistence harvest, including whales, seals, walrus, and caribou (Stephen R. Braund & Associates, 2013)



- Use of the area by sensitive species including cetaceans, sea otters, pinnipeds, and seabirds
- Evaluation of the potential effects of OCS oil and gas exploration, development, and production on commercial fishing, recreational, and subsistence activities in Cook Inlet

Renewable Energy General Information Needs

Section 388 of the Energy Policy Act of 2005 amended the OCSLA to give discretionary authority to BOEM to issue leases, easements or rights-of-way on the OCS for alternative energy projects, such as wind, wave, or ocean current facilities. Under this authority, the areas that BOEM makes available for alternative energy leasing are likely to be determined through a process that assesses different types of alternative energy resources, anticipated and potential environmental impacts, and other relevant information on a national, regional, or local basis. No lease sales for renewable energy are currently planned for the Alaska OCS Region, but the need exists for information about the resource potential and feasibility for development of alternative energy projects off Alaska.

Mineral Resources General Information Needs

The OCSLA gives discretionary authority to BOEM to issue leases for mineral resources. No lease sales for mineral resources are currently planned for the Alaska OCS Region.

1.4 Notable FY 2016 Programmatic Highlights

IARPC support (update): The Arctic is a region of considerable and growing interest to the U.S. Government. In 2013, the White House released the *Arctic Research Plan: FY 2013 –2017* (White House, 2013a), as developed by the Inter-agency Arctic Research Policy Committee (IARPC). In 2013, the White House released the *National Strategy for the Arctic Region* (White House, 2013b), followed in 2014 by *Implementation Plan for the National Strategy for the Arctic Region* (White House, 2014), which incorporated the IARPC five-year research plan as part of the strategy to ensure responsible stewardship of the Arctic environment. These documents advocate ecosystem-based research and management approaches to support sound decisions about resource development. As an active IARPC participant, the BOEM Environmental Studies Program has played a lead role in implementing national research priorities in the Arctic. Appendix 1 (see pages 207-218) 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. IARPC is currently preparing the *Arctic Research Plan: 2017-2021,* which is targeted for release in December 2016.

Synthesis of Arctic Research (update): The Synthesis of Arctic Research (SOAR) project aims to create a platform for collaboration among scientists and U.S. Arctic residents with the overarching goal of increasing our knowledge of the ecosystem in the western Arctic, which is currently undergoing substantial environmental changes. The specific objective of SOAR is to identify and test hypotheses that cross scientific disciplines

through synthesis and analysis of extensive data available from decades of research in the region, including more than $50 million in BOEM-funded marine mammal and oceanographic studies over the past 10 years. The SOAR study began in 2011, and the first of two phases was completed with publication in July 2015 of a special issue of the journal Progress in Oceanography, comprised of 17 articles resulting from the SOAR project. The second phase of SOAR is underway, with publication of another special peer-review journal issue anticipated in the coming months.

Biodiversity Monitoring: As the Arctic continues to experience intense and accelerating changes, it is increasingly important to observe and document trend lines in biodiversity and ecosystem health. Toward that end, BOEM is partnering with Shell, NOAA, and the University of Alaska Fairbanks to initiate the Arctic Marine Biodiversity Observing Network (AMBON) project in the Chukchi Sea. The AMBON project is designed to provide needed information about taxonomic and spatial coverage in biodiversity observation on the Chukchi shelf. Notably, AMBON adds a significant new molecular component to previous biodiversity observations, thus fully capturing for the first time the microbial fraction of the ecosystem biota, which likely are among the first responders to ecosystem stress. The project also builds upon recent efforts to extend time-series monitoring data, and integrate synthesized data with past and ongoing research programs on the U.S. Arctic shelf.

Marine Arctic Ecosystems Study: In 2014, BOEM initiated the Marine Arctic Ecosystems Study (MARES) through NOPP. The primary geographical scope of the project is the continental shelf and slope of the Beaufort Sea between Barrow Canyon and the Mackenzie River delta (including the Tuktoyaktuk Peninsula). The extensive coverage follows from requirements for understanding regional ecosystem dynamics and the broad science missions of multiple NOPP partners. The MARES project involves several core planning and research components, including: conceptual hypotheses; fieldwork and data sampling through remote sensing, autonomous gliders, and scientific cruises; syntheses and integration of previous, concurrent, and new observational data.

Collaboration with the North Pacific Research Board (NPRB) “Arctic Marine Integrated Ecosystem Research Program”: 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 Arctic research. In 2015, BOEM extended that collaboration to join NPRB as formal co-sponsor of the Arctic Integrated Ecosystem Research Program, which will invest approximately $16 million in studying marine processes in the U.S. Arctic in 2017-2021.

Current Keystone Studies

Integrated Multidisciplinary Studies

Traditional Knowledge Implementation: In collaboration with the North Slope Borough, this project aims to identify and organize panels of Local and Traditional Knowledge (TK) subject matter experts from North Slope communities to facilitate integration of TK into scientific research and decision-making processes. This effort will

enhance the authority of TK and its integration with science by promoting dissemination to external scientists through consistent methods and directly involving local subject matter experts

Arctic Marine Biodiversity Observing Network (AMBON): This study collaborates with the emerging Distributed Biological Observatory (DBO) Network and IOOS to develop a prototype ecosystem-based marine biodiversity network on the OCS in the Chukchi Sea monitoring multiple trophic levels and species, while optimizing data management and modeling capabilities.

Chukchi Acoustic, Oceanography and Zooplankton Study Extension: Hanna Shoal: This study, known as CHAOZ, continues the acoustic and biophysical monitoring begun under the study "COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales" with focus on the region of Hanna Shoal. The general presence of marine mammals, including bowhead and other baleen whales, near Hanna Shoal will be documented to assess the importance of this area of very high biological productivity. The study includes deployment of arrays of long-term acoustic recorders that are capable of continuous year-round recording.

Arctic Whale Ecology Study (ARCWEST): In collaboration with NMFS and the Pacific Marine Environmental Laboratory (PMEL), this study assesses patterns of spatial and temporal use of the Chukchi Sea by endangered bowhead, fin and humpback whales, as well as beluga and gray whales, and evaluates ecological relationships that affect critical habitat for these species. This effort combines targeted oceanographic sampling with biological sampling and satellite tagging of individual humpback, fin and gray whales to expand scientific understanding of whale behavior and to improve evaluations of where and when aggregations of feeding whales are likely to occur. This study extends the research of the "Bowhead Whale Feeding Ecology Study" (also known as BOWFEST) into the Chukchi Sea and expands the scope to include other cetacean species.

U.S.-Canada Transboundary Fish and Lower Trophic Communities: In collaboration with the Department of Fisheries and Oceans Canada, this partnership with UAF will document baseline fish and invertebrate species presence, abundance, distribution and biomass in the U.S. and Canadian Beaufort Sea. The hydrographic structure of the eastern Beaufort shelf also will be documented to provide enhanced understanding of the effects of habitat variables such as temperature and salinity on species distributions under different climate conditions.

ANIMIDA III: This pair of companion studies continues long-term Beaufort Sea monitoring efforts begun in 1999. Sediment and benthic biota samples are collected throughout the Beaufort Sea development area and into Camden Bay. Measured concentrations of hydrocarbons and trace metals will provide additional baseline information and monitoring results to evaluate for chemical contamination and turbidity. Additionally, kelp beds in the Boulder Patch Area of Special Biological Concern, as well as Camden Bay, are monitored to evaluate potential impact from oil and gas exploration and development activities.

Synthesis of Arctic Research (SOAR): This study is conducting 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. The overarching goals of the project are to increase scientific understanding of the biophysical environment, enhance capability to forecast future conditions, and effectively transmit findings to stakeholders.

Marine Arctic Ecosystems Study (MARES): In partnership with numerous government agencies and other entities through the National Oceanographic Partnership Program, the goal of this study is to conduct coordinated observational and modeling efforts to produce information that will be analyzed from different perspectives, including: ecosystem understanding and environmental protection, climate change and monitoring, and Oil-Spill Risk Analysis. Component projects will emphasize an integrated, or ecosystems approach to data collection and synthesis, while focusing on essential processes, functions and interactions among organisms and their environment.

Air Quality and Meteorology

Arctic Air Quality Modeling: This study will conduct air quality modeling using existing dispersion models to reasonably assess the potential cumulative air quality effects associated with onshore and offshore emission sources. The study will evaluate existing methods for establishing emissions exemption thresholds and, if necessary, suggest improved methods.

Physical Oceanography

High-Resolution Circulation Model of the Beaufort Sea: This collaboration with Rutgers University and UAF will develop a high-resolution model simulation to accurately represent the ocean circulation processes associated with barrier islands and coastal features of the U.S. Beaufort Sea.

Characterization of Circulation in the Northeast Chukchi and Western Beaufort Sea: In collaboration with UAF, ocean current circulation fields are being mapped and analyzed along the coast of the northeastern Chukchi and western Beaufort Seas through the deployment of coastal High Frequency radar systems, offshore bottom mounted Acoustic Doppler Current Profilers (ADCPs), gliders and surface drifters. Such direct circulation measurements improve understanding of the ocean currents that drive oceanographic processes and influence the transport and fate of spilled oil.

Arctic Tracer Release Experiment (ARCTREX): In collaboration with UAF, this study performs targeted dye release experiments at both the surface and bottom of the Northeast Chukchi Sea to examine applications for mapping spilled oil in Arctic waters. These experiments are designed to test available observational technologies and their capability to map a dye plume both temporally and spatially (simulating an oil spill) and to potentially deliver real time data to response agencies, including data for ingestion into numerical oil spill trajectory models.

Marine Mammals

Field Evaluation of an Unmanned Aircraft System (UAS) for Studying Whales in the Arctic: This partnership with NMML and the Naval Surface Warfare Center Dahlgren Division conducts aerial surveys using UAS technology concurrently with conventional manned aircraft surveys to 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.

Village-based Satellite Tracking of Ringed and Bearded Seals: This partnership with ADF&G trains seal hunters in villages along the Beaufort, Chukchi and northern Bering Seas in seal capture and tag deployment. The resulting data will be analyzed relative to ice edge, ice concentration, bathymetry, and residence times to better understand movements and habitat use of ice seals in the region.

Satellite Tracking of Bowhead Whales: In collaboration with the Alaska Department of Fish and Game, this study tracks the movements and document the behavior and habitat utilization of bowhead whales using satellite telemetry. Tags equipped with environmental sensors will be deployed to monitor, collect, and transmit ambient oceanographic conditions during bowhead whale migrations. Acoustic tags document vocalization rates and ambient noise levels to develop analysis of call rates relative to behavior and disturbance. Data will be used to examine inter-annual variation in bowhead feeding concentrations and vocalizations. Other large cetacean species (Gray whale, Humpback whale and Fin whale) may be opportunistically tagged and tracked as a pilot study for future research.

Abundance and Demographic Rates of Pacific Walruses: This partnership with USFWS will conduct genetics testing on walrus biopsy samples collected over multiple years. 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. 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.

Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea: In partnership with MML, this study merges the Bowhead Whale Aerial Survey Project (BWASP) and the Chukchi Sea aerial surveys of marine mammals. This combined effort, also known as the "Aerial Survey of Arctic Marine Mammals" or ASAMM, collects aerial survey data on seasonal distribution, relative abundance, and habitat use of marine mammals in the Beaufort and Chukchi Seas. Observations are focused on bowhead whales, but also help to monitor gray whales, beluga whales, Pacific walrus, polar bears, bearded seals, and several other species of ice seals. All of these species are exposed to changes in environmental variables such as oceanographic currents, sea temperature, sea ice cover, prey availability, and anthropogenic impacts. MMS and BOEM have conducted aerial surveys of the fall migration of bowhead whales each year since 1987. Methods are comparable from year to year and based on similar monitoring dating to 1979.

Habitat and Ecology

Ecological Processes in Lower Cook Inlet and Kachemak Bay: This collaborative effort with NOAA, USFWS, and NPS enhances existing oceanographic surveys, plankton surveys, near-shore benthic surveys, and upper trophic level surveys of seabirds and marine mammals in lower Cook Inlet and Kachemak Bay. Improving understanding of this complex marine environment will improve understanding of biological variability and potential impacts from oil and gas development activities.

Distribution and Habitat Use of Fish in the Nearshore Ecosystem of the Beaufort and Chukchi Seas: In partnership with NOAA, this study will inventory the distribution and diversity of nearshore fish, their habitat and prey along high priority sites in the Beaufort and Chukchi Seas. The age and diet of the fish, as well as ambient oceanographic conditions, will be assessed to improve understanding about the effect of habitat variables like temperature and salinity on fish species distributions.

Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area: This partnership with NOAA and UAF documents and characterizes the distribution of pelagic and demersal fish and invertebrate communities in the Chukchi Sea lease area. The study includes 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. This project is a component of the "Arctic Ecosystem Integrated Survey" or Arctic EIS, a collaborative effort involving scientists from UAF, NOAA's Alaska Fisheries Science Center, USFWS and ADF&G.

Social Systems

Community Based Monitoring: This partnership with the Alaska Native Tribal Health Consortium will enhance the existing Local Environmental Observer (LEO) Network and expand it to reach a broader public in the North Slope and Kenai Peninsula areas. The LEO Network is a volunteer program of mostly tribal environmental professionals who share information about environmental events where they live. The Arctic Council Ministerial has expressed interest in expanding the network into a Circumpolar LEO program.

Social Indicators in Coastal Alaska: Arctic Communities: This study updates key socio-cultural and economic baseline data for analysis of potential local and regional impacts from offshore exploration and development activities. It will evaluate the pace, direction and magnitude of regional socio-economic changes experienced by residents in select Arctic coastal communities including: Point Lay, Wainwright, Barrow, Nuiqsut and Kaktovik.

This page left blank intentionally.

SECTION 2.0 STUDY PROFILES

2.1 Profiles of Ongoing Studies

Information about ongoing studies can be found at:
http://www.boem.gov/AKstudies

This website is updated three times each year and includes:

1. An updated status of each study.
2. Report due dates.
3. Related publications.
4. Affiliated websites.

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

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Arctic Air Quality Impact 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 Cost: $1,766,025 **Period of Performance:** FY 2013-2018

Conducting Organization: Eastern Research Group, Inc.

BOEM Contact: Dr. Heather Crowley

Description:
Background: Arctic oil and gas exploration and extraction activities proposed for the OCS require environmental evaluations pursuant to the NEPA and the Clean Air Act, and air quality operating approval is 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.

The completed BOEM project, "Chukchi/Beaufort Seas Mesoscale Meteorology Modeling Study" (MMM), developed a long-term dataset of meteorological model data. While useful in air quality modeling, the MMM dataset configuration is designed to support modeling of an oil-spill response. The data was not evaluated and optimized for air pollutant dispersion and transport. This project included development of a five-year meteorological modeling dataset (years 2009-2013) that is optimized for performance with air quality dispersion models.

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 would pull together all existing emissions information available from the Alaska Department of Environmental Conservation, which would be combined with estimates of additional emissions from proposed OCS activity. From this comprehensive database, an emission inventory could 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).

The meteorological and emissions datasets would 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 would 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. This should utilize and 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 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Changes in Beaufort-Chukchi Seas Intense Storm Activity and Impacts on Surface Climate and Ocean Properties (AK-13-03-18)

BOEM Information Need(s) to be Addressed: BOEM needs a better understanding of seasonal and regional changes in storm activities and their impacts on sea ice and the ocean to support environmental analyses associated with offshore oil and gas exploration and development activities. Assessments of these changes using high-resolution models and observational data are needed for evaluating the potential ecological and socioeconomic effects of possible OCS activities. Results from this study may be used for NEPA analysis for future lease sales, EPs, and DPPs.

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

Period of Performance: FY 2016-2017

Conducting Organization: CMI, UAF

BOEM Contact: Warren Horowitz

Description:

Background: BOEM completed two regional modeling study efforts for the Chukchi and Beaufort seas over the past few years. The *Beaufort and Chukchi Seas Mesoscale Meteorology Modeling Study* (OCS Study BOEM 2013-0119) produced thirty years (1979-2009) of atmospheric model data output whereas second study entitled *Adaptation of the Arctic Circulation Model* BOEM (OCS Study BOEM 2013-202) produced a coupled sea ice-ocean model for the Beaufort and Chukchi Seas. This study will analyze outputs from the Chukchi-Beaufort Seas High resolution Atmospheric Reanalysis (CBHAR) and the coupled Arctic Regional Atmospheric-Ocean-Sea ice model to identify the distribution of storm tracks and intensities for the Chukchi and Beaufort Seas and document how these storm tracks impacted changes to surface wind stress, ice coverage, and ocean conditions. Observational data from moored Acoustic Doppler Current Profilers (ADCP) from the BOEM funded study *Circulation and Water Property Variations in the Nearshore Alaska Beaufort Sea (1999-2007)* (OCS Study MMS 2009-035) will be used to compare storm tracks and intensities from the model data to changes in ocean conditions as measured from these moorings. Satellite data will also be used to examine the impact that these storm tracks had on known breakout events along the Beaufort and Chukchi coasts.

Objectives:

- Develop an improved meteorological modeling storm tracking algorithm.

- Develop a climatology of storm tracks and storm intensities from the CBHAR and Regional Ocean model data sets for the Beaufort and Chukchi Seas.
- Document interannual and decadal storm climatologies based on outputs from the model simulations.
- Document how storms impact surface wind direction, wind speed, temperature and heat budgets.
- Document how the storm tracks and associated climate variables impact sea ice and ocean conditions based upon observational data.

Methods: This study will document the climatology and changes in storm tracks and storm intensities for the Beaufort and Chukchi Seas from 1979-2009, including their impacts on surface wind stress, sea ice and ocean conditions from the outputs of the Chukchi-Beaufort Seas High resolution Atmospheric Reanalysis CBHAR and the Coupled Arctic Regional Atmospheric-Ocean-Sea ice models, and from observations measured from oceanographic moorings. Researchers will improve the storm tracking algorithm by optimizing the output for the Beaufort and Chukchi Seas. They will construct the storm track climatology for the Beaufort and Chukchi Seas through the use of data outputs from the CBHAR and HIRHAM-NAOSIM models. Study products will include regional climatological means for spatial distribution and spatial average for storm count duration, lifetime, and intensity for each month. Climatological results between the CBHAR and HIRHAM-NAOSIM data outputs will be compared and their inherent biases assessed.

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas (AK-12-03a)

BOEM Information Need(s) to be Addressed: The BOEM needs information on several aspects of the temporal and spatial structure of ocean currents in the northeastern Chukchi and western Beaufort Seas. This characterization encompasses a description of the mean circulation under different wind and sea ice coverage conditions. This knowledge will be valuable for (a) improving the quality of information used in the Oil-Spill Risk Analysis conducted by BOEM, (b) inferring the transport of zooplankton, contaminants and other quantities in key areas, (c) providing insight into the flow-related feeding aggregations of bowhead whales near Barrow, (d) providing important information for the preparation of NEPA documents, (e) providing information for ocean modeling efforts (including validation and skill assessment), and (f) complementing ongoing social research on offshore subsistence hunting.

Total Cost: $5,056,252
plus Joint Funding (~$1,000,000)

Period of Performance: FY 2012-2017

Conducting Organization: CESU-UAF

BOEM Contact: Warren Horowitz

Description:
Background: The circulation in the region of the junction between the Chukchi and Beaufort continental shelves is likely complex given the abrupt change in the orientation of the isobaths, change in shelf width, and the convergence of the mean westward wind-driven flow over the U.S. Beaufort Sea with the mean northeastward flow along the eastern flank of Barrow Canyon. The nature of this junction varies with the winds and ice environment. The regional circulation is such that contaminants introduced on either the Chukchi or Beaufort shelf will likely have a variety of fates. These include being advected from one shelf to the other, being flushed offshore into the Arctic basin, or perhaps accumulating within the vicinity of the western Beaufort Sea due to flow convergence from currents on both shelves. The conditions under which these various scenarios occur are not well known.

This proposed study is a continuation and expansion of the existing surface circulation study within the northeast Chukchi Sea. Prior to 2009, surface current observations on the Chukchi shelf were extremely limited. Through a joint Industry/BOEM supported study, the University of Alaska Fairbanks (UAF), Coastal Marine Institute began measuring surface currents during the open water period on the Chukchi shelf beginning in September 2009 with the deployment of long range (180 km), High

Frequency (HF) radar systems located at the villages of Barrow and Wainwright. In 2010, coverage was expanded to the southwest to include additional OCS lease areas. The surface current data was supplemented by water column profile data collected by Slocum Gliders. Acoustic Doppler current profilers (ADCPs) were also deployed across the Alaska Coastal Current at the head of Barrow Canyon to assess the annual flow regime, the connectivity between surface and subsurface currents during the open water season, and the changes in subsurface currents beneath the mobile pack ice and lead system during the winter months. This new study will expand our present efforts to improve understanding of the flow regime and shelf dynamics between the inner and outer Chukchi shelf, the exchange of waters between the Chukchi Sea and western Beaufort shelf through Barrow Canyon, and the upwelling of Atlantic Waters.

Objectives:

- Extend the present Chukchi Sea HF radar, mooring and glider study to include the western Beaufort shelf slope and Barrow Canyon to investigate the spatial and temporal structure of ocean currents within the western Beaufort and northeast Chukchi shelves and the exchange of waters between these areas.
- Characterize 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.
- Describe the oceanic response, at different levels in the vertical, using all available wind observations, as well as those generated by atmospheric and/or coupled models.

Methods: The above objectives will be pursued using a suite of instrumentation including: ADCPs, CTDs, Ice Profiling Sonar (IPS5), gliders, surface drifters and HF radars. Long Range HF radar systems presently deployed along the Chukchi coast at Point Lay, Wainwright and Pt. Barrow will be modified to increase the maximum observable range to approximately 250 km to capture the summer surface current flow over a larger area of the Chukchi shelf and around Hanna Shoal. A planned HF radar deployment at Cape Simpson (CIAP funds) will capture surface current flow along the western Beaufort shelf and slope and within Barrow Canyon. Gliders, surface drifters, moored ADCPs and towed CTDs will collect data on depth and time dependent current, temperature and salinity structure. Ice Profiling Sonar and moored ADCPs will be used to calculate ice drift and velocity. Sea ice extent will be obtained from satellite information, while drifting buoys will be crucial for computing flow trajectories and diffusivities. Data from the ADCPs, CTDs, glider deployments, HF radars, planned drifter measurements and available industry data will be synthesized to acquire a comprehensive characterization of the circulation in the study area. This project will coordinate and collaborate with other research projects in the area (BOEM, WHOI, AOOS/IOOS, industry, etc.) to synthesize and integrate all available data.

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Arctic Tracer Release Experiment (ARCTREX): Applications for Mapping Spilled Oil in Arctic Waters (AK-12-03b)

BOEM Information Need(s) to be Addressed: The results from this study could inform BOEM Oil-Spill Risk Analysis (OSRA) and oil-spill fate modeling efforts, and may improve detection and cleanup operations in the event of a large oil spill. Outputs could be used to verify oil-spill contingency plans. Results will support environmental assessments and decisions associated with exploration plans. The BOEM/BSEE analysts and decision-makers may use the results to improve NEPA analyses and documentation for any future exploration and development activities.

Total Cost: $624,977 plus Joint Funding (~$625,000) **Period of Performance:** FY 2013-2016

Conducting Organization: University of Alaska Fairbanks

BOEM Contact: Warren Horowitz

Description:

Background: There is a need in the Arctic OCS to test, develop, and implement the observational platforms, mapping software, and oil-spill models that could track and assess the fate of spilled hydrocarbons. This study will field test environmental response and mapping software in cooperation with NOAA's Office of Spill Response and Restoration, and other parties who would be willing to share resources and incorporate real-time observational data into this tracking and mapping software system. We will develop and test the instrumentation for AUV gliders and other observational technologies that can map the surface and subsurface dispersion of a dye release. The BOEM will jointly work with other interested parties to field test the capability of the environmental response and mapping software to track a planned release of inert dye within the Chukchi Sea. Protocols will be developed and tested over multiple field experiments to assess applications for tracking a potential pollutant release in the OCS during the open water season.

Objectives:

- Develop a better understanding of small scale transport processes important to fate and effects modeling used in oil impact analysis.
- Assess the effectiveness of HF Radar surface current mapping system and drogue drifters for providing near-surface current input data to oil-spill models.

- Develop, test, and deploy instrumentation for Autonomous Underwater Vehicles (AUV) that can be customized for use in the Arctic to detect the spatial and temporal locations of subsurface dye plumes.
- Conduct at least two field tests of the dispersal and tracking of a non-toxic inert dye off the Chukchi coast.
- Track the dispersed dye plume by incorporating input from the AUVs and other real time data collection sensors in the Chukchi Sea (e.g., surface currents from HF Radar, drifters, modeled wind fields, data from meteorological buoys and other offshore instruments) to assess the fate and transport of the dye plume.
- Develop algorithms quantifying small scale transport processes based on measurable oceanographic and meteorological data (i.e., advection, Langmuir circulation, wind drift, vertical and horizontal dispersion coefficients, etc.)

Methods: This study will perform targeted dye release experiments at both the surface and bottom of the Northeast Chukchi Sea to examine applications for mapping spilled oil in Arctic waters. These experiments are designed to test available observational technologies and their capability to map a dye plume both temporally and spatially (simulating an oil spill) and to potentially deliver real time data to response agencies, including data for ingestion into numerical oil spill trajectory models. Two planned field experiments will be conducted during the August-September time frame, in 2014 and 2015. The research team will use the same suite of instruments currently used in the Chukchi Sea on other projects (CTDs, fluorometers, gliders and towed vehicles). Using large dynamic-range fluorometers, the research team will undertake a field experiment to map a dye plume and its evolution in time and space over a 3-6 day period over two field seasons and multiple dye injections. Part of the planned activities includes evaluating the effectiveness of instruments to track the released dye under diverse environmental conditions. The team will coordinate our field effort with NOAA's Environmental Response Management Application ERMA (Arctic ERMA) and the Bureau of Environmental Enforcement (BSEE), and work towards real time data ingestion into NOAA's oil-spill response system. The first field experiment was successfully conducted in 2014.

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas (AK-15-02)

BOEM Information Need(s) to be Addressed: BOEM uses coupled ice-ocean circulation model results as input to oil-spill trajectory analysis. Results with higher spatial resolution are needed to more fully represent nearshore circulation processes, particularly those near rivers, barrier islands and coastal lagoons within the nearshore Beaufort Sea. Development and application of state-of the-art circulation models are essential to future OSRA-based NEPA analyses for Development and Production Plans within Stefansson Sound and the nearshore Beaufort Sea.

Total Cost: $489,735 **Period of Performance:** FY 2015-2017

Conducting Organization: Rutgers University

BOEM Contact: Dr. Heather Crowley

Description:

Background: Offshore barrier islands, coastal features, and freshwater river outflow are known to affect the fine-scale ocean circulation in nearshore areas. Previous oil spill trajectory analyses, conducted by BOEM, in Stefansson Sound used both nearshore 2-D circulation and offshore 3-D coupled ice-ocean circulation model results. The spatial resolution of the current Arctic Circulation Model study is too coarse to adequately resolve the barrier islands within Stefansson Sound and the lagoons and other coastal features along the Beaufort Sea coast and produce high-quality simulations of the associated fine-scale circulation processes.

Objectives:

- Adapt and maximize the utility of an existing regional 3-D coupled ice-ocean circulation hindcast model to obtain high-resolution model fields that represent fine-scale processes associated with barrier islands and coastal features in the Beaufort Sea nearshore areas.
- Provide BOEM with ten to twenty years of relevant modeled fields, such as gridded wind, surface water and ice velocity, ice cover, and limited other modeled fields as agreed to between the contractor and BOEM.
- Evaluate the modeled under-ice currents in consideration of information derived from the study Idealized Process Model Studies of Circulation in the Landfast Ice Zone of the Alaskan Beaufort Sea (OCS Study BOEMRE 2011-056).

Methods: A coupled ice-ocean model will be modified to maximize utility in the Beaufort Sea nearshore areas. The model will possess sufficient spatial resolution to accurately represent circulation processes associated with barrier islands and coastal features. Conduct the standard suite of sensitivity testing and validation of the model and results.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Development of an Accurate Model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response (AK-13-03-03)

BOEM Information Need(s) to be Addressed: In the event of an oil spill, sea ice complicates the tracking of ice/oil trajectories and can hinder clean-up operations. There is a need for a sea ice model that can accurately simulate ice pack deformation and failure to improve ability to track ice/oil trajectories and support oil response operations. This information may be used by BOEM analysts and decision-makers in NEPA analysis and documentation for lease sales, EPs and DPPs.

Total Cost: $359,078
plus Joint Funding ($358,221)

Period of Performance: FY 2013-2017

Conducting Organization: CMI, UAF

BOEM Contact: Dr. Heather Crowley

Description:

Background: OCS oil and gas exploration and production activities in the Beaufort and Chukchi Seas can be significantly and adversely affected by sea ice. For example, in the event of an oil spill, the presence of sea ice vastly complicates the issues of tracking ice/oil trajectories and conducting clean-up operations. It becomes important to forecast the trajectory and dispersion of contaminated ice and to simulate the location of pressured ice, which can hinder transportation. Of particular interest is simulating realistic lead distributions (opening and closing rates), ice deformation, ice velocity, ice stress, ice flow trajectory, and the location of ice divergence and convergence zones.

The current state-of-the-art for coupled ocean-ice-atmosphere modeling makes use of a continuum model of sea ice kinematics originally developed by Hibler. Ice-ocean modeling of the Beaufort and Chukchi Sea areas is under development for BOEM using ROMS, which includes an ice model with elastic viscous-plastic (EVP) ice dynamics. This type of coupled ice-ocean models has difficulty in reproducing observed sea ice strain-rates. The representation of sea ice in the regional, pan-Arctic and global models currently used for simulating the coupled ice-ocean system or for ice forecasting does not represent the brittle failure behavior of the ice pack on the spatial scales these models attempt to resolve. The difficulty is that the continuum EVP models used to describe ice constitutive properties do not represent observed internal ice stresses and strain rates (opening and shearing), and they do not reproduce realistic patterns of localized shear zones. Hence these models cannot simulate the dispersion of sea ice well, which limits their utility in forecasting or hindcasting the trajectories of contaminated ice.

A discrete element method (DEM) sea ice model can simulate fracture patterns with intersection angles and spacing characteristics similar to those observed in Arctic pack ice. Although, to date, no regional model of sea ice has reproduced realistic deformation patterns, the DEM approach has been successful in simulating the density of fractures expected in the Beaufort Sea. The DEM approach directly accounts for discontinuities in the ice pack at which failure can occur and stresses concentrate to form cracks, unlike continuum approaches that use an isotropic rheology (such as CICE which uses the EVP model) and require artificial seeding of stress discontinuities in order to simulate cracks. As the DEM approach specifies the failure stress of weaknesses (defined as joints or contacts between grains or unit cell floes), control of fracture characteristics is more physically based in a DEM model.

Objectives: This project will build upon previous work funded by MMS and BOEM (OCS Study MMS 2005-068, OCS Study MMS 2008-020, OCS Study BOEM 2012-067) and NSF to:

- Develop a DEM model that accurately simulates ice velocity, kinematics and dispersion in the Beaufort and Chukchi Seas.
- Optimize the model to simulate realistic lead distributions (opening rate) and the location of pressured ice that hinders transportation.
- Build validation metrics appropriate for confining parameters in pack ice constitutive relations.
- Produce an open-source well-documented DEM sea ice model usable by the general sea ice community and readily incorporated into coupled sea ice/wind/ocean models

Methods: This study will build a model of sea ice interaction, simulating drift and deformation of the ice pack, with the DEM. The researchers will work to improve model parameters over previous DEM models by tuning the model to field data and investigate the effects on model simulations of varying the failure process from a gradual weakening ice strength during failure to a sudden rupture upon reaching failure criteria. In developing the model, they will identify appropriate representation of tensile, compressive and shear failure of pack ice.

The model domain will encompass the Beaufort and Chukchi Seas with zero velocity and stress gradients across the open ocean boundaries. This will ensure no artificial shear is imparted at the open boundaries that would manifest as unrealistic kinematic features. External forcing will be developed from available products. The validation metrics developed in the study will provide insight into the mechanical properties of pack ice. Sensitivity experiments will be conducted to tune the model.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $218,286
plus Joint Funding ($215,123)

Period of Performance: FY 2014-2017

Conducting Organization: CMI, UAF

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 40Km 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: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts (AK-13-03-09)

BOEM Information Need(s) to be Addressed: This study will deploy a network of tide gauges that will provide information to examine the relationships between ocean processes and sea level along the entire Chukchi-Beaufort coast in a systematic manner. A better understanding of local sea levels in this region and their relationship to both local and remote wind forcing will aid with improving the ocean circulation models that support BOEM's oil-spill trajectory modeling for lease sales, EPs and DPPs.

Total Cost: $72,178
plus Joint Funding ($72,222)

Period of Performance: FY 2014-2017

Conducting Organization: CMI, UAF

BOEM Contact: Dr. Heather Crowley

Description:
Background: Changes in coastal sea level are caused by ocean currents, storm surges, winds, and tides. Local observations and recent measurements acquired by current meters in the northern Chukchi Sea and western Beaufort Sea indicate that sea level and coastal currents sometimes change rapidly even if local winds are calm. These changes are responses to wind forcing in the southern Chukchi/northern Bering Sea. These remote winds initiate sea level changes that propagate northward along the Chukchi coast toward Barrow and then eastward along the Beaufort coast.

Presently, there are NOAA tide gauges (sea level recorders) at Red Dog dock and at Prudhoe Bay. These two monitoring sites are too few and too distant from one another to investigate relationships between sea level and ocean processes along the entire Chukchi-Beaufort coast in a systematic manner.

Objectives: The overall goal of this study is to improve understanding of ocean circulation and improving computer models of ocean circulation in the Chukchi and Beaufort Seas. Specific objectives include:

- Investigating relationships between landfast ice breakout events and sea level changes;
- Assessing the sea level responses to local and remote wind forcing during open water and ice covered seasons; and
- Computing tidal harmonics and other relevant statistics for each location.

Methods: This project will deploy tide gauges (water level recorders) to acquire year-long (summer 2014 – summer 2015) records of local sea level at five locations in Alaska: Pt. Hope, Pt. Lay, Wainwright, Barrow, and Kaktovik. Local boats and crews will be chartered in each community and provided with necessary instruction to deploy and recover the moorings. The moorings will be deployed in lagoons or protected waters near the sentinel communities at locations and depths, identified by local crews, where the potential for instrument loss and/or damage associated with ice scouring is minimized. Sea level signals in lagoons are typically comprised of signals associated with large-scale processes occurring external to the lagoons and small-scale processes occurring within the lagoons. Accordingly, three (one primary and two secondary) moorings will be deployed near each community.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Development of an Autonomous Carbon Glider to Monitor Sea-Air CO_2 Fluxes in the Chukchi Sea (AK-13-03-12)

BOEM Information Need(s) to be Addressed: The Chukchi Sea is thought to be an important sink for excess atmospheric carbon dioxide (CO_2). A more accurate assessment of CO_2 flux within this region could improve future projections of CO_2 concentrations and climate change. Results from this study will inform NEPA analyses for potential future lease sales, EPs, and DPPs in the Chukchi Sea.

Total Cost: $124,696
plus Joint Funding ($124,696)

Period of Performance: FY 2015-2017

Conducting Organization: CMI, UAF

BOEM Contact: Warren Horowitz

Description:

Background: One of the concerns relating to human activities is the effects on the carbon-dioxide exchange and relationship to climate change within the Arctic Ocean. Since the Chukchi Sea is thought to be a very important carbon sink, and acts as a biogeochemical pathway to the Arctic Ocean, it is very important to better understand how to most efficiently measure carbon fluxes within the water column, and between the atmosphere and the ocean. Our present understanding of the carbon cycling within the Chukchi Sea is based upon sparse data obtained from fixed moorings and ship based measurements. Therefore it is important to develop a platform that can provide continuous measurements of CO_2 within the water column.

The integration of a carbon sensor into a Slocum glider may provide more accurate measurements of the spatial and temporal variability of sea-air CO_2 fluxes within the Chukchi Sea. Measurements from such autonomous platforms could provide future times series of the physical and biogeochemical observations within the Arctic at unparalleled spatial and temporal scales. The "Carbon Glider" could provide insights in the physical mechanisms that drive the changes in CO_2 throughout the water column and obtain a better understanding of the physical processes that lead to a buildup of CO_2 in subsurface waters associated with benthic and water column remineralization.

Objectives:

- Develop a carbon glider that will measure pCO_2, temperature, and salinity at very high spatial and temporal scales within the water column.
- Evaluate the glider's ability to autonomously map the vertical and horizontal variability in oceanic pCO_2

Methods: This study will integrate a custom made-MiniPro CO2 sensor with a Slocum glider. Laboratory testing will be conducted to optimize the new sensor's performance and initial field tests will be conducted in from UAF's Seward Marine Center. Once the carbon glider operation and performance is shown to be robust during test deployments in Seward, a week-long demonstration mission to assess carbon distributions will be conducted in Resurrection Bay during the spring of 2016. If successful and additional funding is obtained, a second trial may occur in the Arctic.

The calibration samples taken during the glider deployment and retrieval will be used to evaluate the accuracy and precision of the sensor. Glider-measured pCO2 will be calibrated directly with respect to water column measurements of total alkalinity and dissolved inorganic carbon from bottle samples. These data will be used to create a calibration curve for the measured values, as well as to assess the uncertainties in the sensor data.

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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: Obtain 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 Cost: $311,392
plus Joint Funding ($311,392)

Period of Performance: FY 2016-2019

Conducting Organization: CMI, UAF

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: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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, with last Boulder Patch survey in 2007. 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 Camden Bay delineation and potential development. The information will support NEPA analysis and documentation for Beaufort Sea lease sales, EPs, and DPPs.

Total Cost: $647,661 **Period of Performance:** FY 2012-2019

Conducting Organization: CESU-University of Texas at Austin

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 1970's 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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: ANIMIDA III: Contaminants, Sources, and Bioaccumulation (AK-11-14b)

BOEM Information Need(s) to be Addressed: This project has last monitored the development area in the Beaufort Sea OCS, with last sampling of contaminants, sources, and bioaccumulation in 2006. 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 Camden Bay delineation and potential development. The information will support NEPA analysis and documentation for Beaufort Sea lease sales and DPPs.

Total Cost: $2,975,190 **Period of Performance:** FY 2013-2017

Conducting Organization: Olgoonik/Fairweather, LLC

BOEM Contact: Catherine Coon

Description:
Background: The Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) and continuation of ANIMIDA (cANIMIDA) started in 1999 and has provided baseline data and monitoring results for chemical contamination, turbidity, Boulder Patch productivity, and subsistence whaling in the vicinity of oil industry development in the Beaufort Sea OCS. Northstar and Liberty prospects were monitored prior to development and Northstar throughout development and production. A second continuation of the subsistence whaling task was completed during cANIMIDA and the Boulder Patch monitoring began in FY 2012.

In 2015, Hilcorp Alaska LLC submitted a DPP to BOEM proposing 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. Ongoing industry activities necessitate ongoing monitoring projects. The last contaminant sampling under cANIMIDA occurred in 2006 and did not include the deeper Camden Bay area of interest.

Objectives:

- Continue the ANIMIDA/cANIMIDA sediment chemistry monitoring emphasizing hydrocarbon and priority metal concentrations.
- Improve the cANIMIDA conceptual model of suspended sediment interactions, loading, and export from the ANIMIDA area, continue to delineate and quantify the offshore dispersion of river runoff and suspended sediments during the spring melt, trace the dispersion of suspended sediments into deeper, outer shelf

water, continue to refine sourcing techniques for suspended sediments particularly in the expanded eastern ANIMIDA area, expand the chemical analyses of suspended sediments to include hydrocarbon composition, estimate the contribution of shoreline erosion, Mackenzie River, and offshore waters to suspended sediment load and composition.

- Continue development of a conceptual model of bioaccumulation and trophic interaction in ANIMIDA biota, monitor bioaccumulation of contaminants in selected species, and continue ANIMIDA/cANIMIDA contaminant monitoring program for amphipod and bivalve samples.
- Develop and initiate a contaminant monitoring program for deeper water benthic biota found in this expanded ANIMIDA study area. Include mid-Beaufort Distributed Biological Observatory stations as part of the monitoring program.

Methods: Larger vessel support has been provided in offshore Camden Bay for the biological/contaminant effort. Primary biological/contaminant field surveys will likely occur in the open-water period, with some effort during breakup with high river flow, and at least once during the ice-covered season.

Sediment and biota sampling were scheduled such that stations sampled in eastern, central, and western Beaufort in ANIMIDA/cANIMIDA were resampled at least once and that new deeper eastern Beaufort Region stations around Sivulliq and Torpedo would sampled at least twice (to form a baseline). Focus will be on potential oil and gas development areas and contaminants in sediments and benthic biota, as well as distribution and abundance of benthic biota.

Chemical fingerprinting and ratio techniques developed in ANIMIDA/cANIMIDA will be used to characterize sources of suspended sediments. Profiles for turbidity, salinity, temperature and current would be obtained from numerous sites around the pertinent project area at the time of sampling. The choice of elemental and isotope parameters to be analyzed for suspended sediment will be designed to maximize the potential for discriminating among different sources of particles. A variety of dispersion models and predictive tools should be considered.

The study will use the cANIMIDA conceptual food web model to help guide development of specific objectives for this task, increase statistical viability of the results with the goal of longer-term strategy for biological contaminant monitoring, and will make improvements to this conceptual model based on study findings.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Distribution and Abundance of Select Trace Metals in Chukchi and Beaufort Sea Ice (AK-13-03-04)

BOEM Information Need(s) to be Addressed: Anthropogenic contaminants from local, regional, or global sources can contribute to the abundance and distribution of trace metals in sea ice and therefore could significantly affect the distribution of dissolved trace metals in surface waters. Offshore exploration and development products (e.g. drilling muds, produced water or oil) are potential local and regional sources, while atmospheric emissions from industrialized regions captured in winter snow are potential regional and global sources. Results from this project will improve understanding of trace metal distribution and abundance in the Arctic sea ice environment, and on its role as a source of trace metals in the water column. BOEM analysts and decision-makers will use this information in NEPA analysis and documentation for lease sales, EPs and DPPs.

Total Cost: $262,073
plus Joint Funding ($262,073)

Period of Performance: FY 2013-2017

Conducting Organization: CMI, UAF

BOEM Contact: Dr. Heather Crowley

Description:
Background: Increased oil and gas activities in the offshore U.S. Arctic can potentially lead to changes in the natural environment. Offshore exploration and extraction of mineral resources in the U.S. Arctic under a changing sea ice environment emphasizes the need to better understand the role of natural environmental processes in the retention, transport, and subsequent release of trace metals in sea ice. Concentrations of trace elements in seawater and sediments in the nearshore Beaufort Sea development area have been well constrained by numerous studies during the last 20 years, including the ANIMIDA and cANIMIDA projects. In contrast, there are no data for dissolved trace metals in U.S. Arctic sea ice and a very limited number of unpublished data points for particulate metals. Sea ice samples were collected during the cANIMIDA projects, but contamination issues stemming from the type of corer used precluded the measurement of dissolved trace elements.

The concentrations of certain trace metals are significantly elevated in sea ice relative to seawater, as indicated by results of previous studies in Antarctica and the Bering Sea. Consequently, sea ice melt has been shown to increase concentrations of some elements in surface waters, but the processes controlling the retention and subsequent release of trace metals in sea ice are not well understood. Possible mechanisms include: 1) trace metals mobilized into the dissolved phase from suspended sediments that were trapped

during sea ice formation; 2) trace metals mobilized from aerosols deposited onto the sea ice as snow begins to melt; 3) trace metals that vary only as a function of salinity and have limited particle reactivity (i.e. Barium and Aluminum); or 4) trace metals concentrated within brine channels during ice formation, and as the base of the sea ice interacts with the upper water column during the growing season. Understanding the relative importance of these mechanisms will provide the basis for understanding how trace metals (naturally occurring and anthropogenic) are retained, transported, and released by sea ice.

Objectives:

- Manufacture and test a trace metal clean ice corer.
- Conduct laboratory-based experiments on sea ice retention and release of trace metals.
- Collect aerosols and surface seawater samples in the Chukchi Sea and near ice floes.
- Quantify dissolved and particulate trace metals in laboratory grown sea ice and the resulting brine/seawater mixture.
- Quantify dissolved and particulate trace element concentrations in offshore surface seawater samples.
- Quantify particulate trace element concentrations and ratios in offshore atmospheric deposition (aerosol/snow) samples.
- Quantify dissolved and particulate trace metal concentrations and ratios in ice cores and snow samples collected in Camden Bay.

Methods: The researchers will build a new corer using commercially pure titanium battery powered drill head to minimize potential contamination. Laboratory experiments to investigate the cycling of trace elements in sea ice will focus on 1) the effect of sediment inclusion and brine rejection during ice formation and growth and 2) the effects of sea ice degradation on the characteristics of material exported from sea ice. These experiments will be conducted under temperature-controlled conditions in plastic tanks, and the resultant concentration of the trace metals in the sea ice and underlying waters will be monitored. Changes in the dissolved and particulate fractions will be monitored as ice grows in both the ice and remaining seawater. The ice will be allowed to grow slowly and a time series of trace metal concentrations in both seawater and ice obtained.

Offshore surface seawater and aerosols samples will be collected on board the *R/V Mirai* in collaboration with the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC). Snow will be collected onboard the ship opportunistically during snow events using wide mouth plastic bottles mounted on a polyethylene pole positioned as high and forward as possible on the ship. A total of ~80-100 cores samples will be collected from 10 stations during the sea ice sampling effort in Camden Bay. Specially designed sampling techniques will be employed to minimize contamination.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Crude Oil Infiltration and Movement in First-year Sea Ice: Impacts on Ice-associated Biota and Physical Constraints (AK-13-03-06)

BOEM Information Need(s) to be Addressed: This project will address some of the questions related to infiltration of oil into sea ice and its biological impacts. This is much needed information with regard to the analysis of potential oil spills in the Arctic, particularly during winter months when ice cover is unavoidable. BOEM analysts and decision-makers will use this information in NEPA analysis and documentation for lease sales, EPs, and DPPs.

Total Cost: $298,214
plus Joint Funding ($298,214)

Period of Performance: FY 2014-2017

Conducting Organization: CMI, UAF

BOEM Contact: Dr. Heather Crowley

Description:

Background: Sea ice plays a critical role in the physics, chemistry and biology of polar seas. Increased oil and gas exploration and development, along with increased shipping in Arctic seas, are increasing the likelihood of oil spill events during periods of ice cover in these areas. Oil spilled under sea ice will initially accumulate under the ice but will then be redistributed through various physical processes, including entrainment into the brine channel system of the sea ice. The extent to which this movement occurs depends on the porosity of the ice, which is temperature and salinity dependent. In addition, the highly variable abundances of biota can substantially alter the characteristics of the brine channel network.

Sea ice provides a habitat for a wide range of biota that inhabit the surface, interior, and bottom ice layers including single-celled organisms such as diatom algae as well as multi-cellular taxa such as nematode round worms, various crustaceans and Arctic cod. These ice biota fuel Arctic food webs by providing an early and, for some taxa, nutritiously superior food pulse to pelagic and benthic fauna before the onset of pelagic production. Depressed sea-ice derived production caused by toxic or mechanical effects of oil would cascade up the food chain both in the pelagic and benthic realms.

Objectives:

- Adapt and apply potentially suitable, simple analytical and fluid dynamics numerical models to the small-scale movement of oil in ice.

- Compare results from mesocosm experiments conducted in nearly sterile versus highly populated biomass of sea ice to assess the effects on oil migration.
- Assess changes in sea ice flora and fauna composition in association with exposure to oil.
- Analyze the dependence of the volume fraction of ice impacted by oil on the small scale, as well as the mobilization of oil, on the evolution of ice microstructure during spring warming.

Methods: Field work will be conducted off Barrow, Alaska, during the sea ice-covered season in 2014 and 2015. Geophysical and biological measurements, as well samples of ice biota will be collected during different seasons, spring (April 2014) and early spring (Feb/March 2015), because physical and biological properties of sea ice change with increasing temperature and irradiance. Sections from at least three ice cores per sampling period and site will be melted directly in the dark and divided for measurements of algal pigment concentrations and measurement of particulate organic carbon (POC) and nitrogen (PON). Sea-ice geophysics data obtained in the field will include continuous measurements of ice temperature, thickness and snow-depth evolution with automated sensor. During field visits, ice cores will be extracted for analysis of ice stratigraphy, salinity, temperature and oxygen stable-isotope composition. On-ice thickness surveys will provide information on spatial variability of ice and snow thickness.

Ice tank experiments will be conducted at UAF. Two tanks each will be dedicated for each of three treatments: 1) an abiotic control (-biota, +oil); 2) a biotic control (+biota, –oil); and 3) an experimental treatment (+biota, +oil). Prior to collection of sea ice biota, the experimental design will be tested with an abiotic control to compare microstructure of artificial and natural sea ice. Natural sea ice biota collected from Barrow (see above) will be concentrated in biomass and inserted into treatments 2 and 3 after the initial sea ice cover has reached a thickness of ~5 cm. Crude oil will be released into treatments 1 and 3 under the ice, and after incubation for 2, 10 and 20 days after the oil release, small ice cores (5 cm diameter) will be taken to quantify biological parameters. Biological parameters to be quantified include ice algal pigment concentration, mass of particulate organic carbon and nitrogen, abundance of ice meiofauna, and extracellular polymeric substances as well as bulk salinity, porosity, and oil concentration.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

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, biodegradation, persistence, 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 Cost: $216,290
plus Joint Funding ($211,289)

Period of Performance: FY 2015-2017

Conducting Organization: CMI, UAF

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:

1. Summer 2014 offshore seawater + Corexit (already completed and samples in storage)
2. Winter 2015 under-ice seawater + Corexit
3. 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: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 lease sales, EPs, and DPPs.

Total Cost: $1,764,252 **Period of Performance:** FY 2010-2016

Conducting Organization: University of Alaska Fairbanks

BOEM Contact: Kate Wedemeyer

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): All Alaska Planning Areas

Administered By: Alaska OCS Region

Title: Seabird Distribution and Abundance in the Offshore Environment (AK-10-10)

BOEM Information Need(s) to be Addressed: More information on the distribution and timing of use by marine birds, including listed and candidate species under the ESA (Spectacled Eider, Steller's Eider, Short-Tailed Albatross, Kittlitz's Murrelet) is necessary to assess potential impacts of oil and gas exploration and development in the Chukchi Sea Planning Area. Data on the distribution of marine birds may be used for ESA Section 7 consultations, NEPA analyses, and other documentation. The information obtained from these surveys may assist in development of mitigation measures and strategies to reduce potential impacts related to OCS oil and gas activities.

Total Cost: $320,000
plus Joint Funding (~$30,000)

Period of Performance: FY 2010-2017

Conducting Organization: USFWS

BOEM Contact: Catherine Coon

Description:
Background: Basic information on timing and duration of use within the Chukchi Sea and Beaufort Sea 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. The North Pacific Pelagic Seabird Database (NPPSD) is used to consolidate marine bird survey data, but most of these data were collected in the 1970s-80s. Since then, many seabird species have declined and changes have occurred in ocean ecosystems. These changes may have affected the foraging patterns of seabirds. Further changes due to predicted Arctic climate change are anticipated. To address these needs, this project will build off of a recently established at-sea survey program, to collect distribution data on seabirds via partnership and collaboration among the USFWS, NOAA-Fisheries and other vessel-based programs.

Species composition of marine birds varies tremendously by season. For example, in the Bering Sea, shearwaters (*Puffinus* spp.) are the dominant species in summer and fall, accounting for 40-60 % of total marine bird density (birds/km2). When shearwaters return to their southern breeding grounds in winter and spring, seaducks (*Anatidae* spp.) and Murres (*Uria* spp.) dominate. These species groups have very different dispersal patterns and foraging behaviors, thus seasonal changes should be integrated

into management schemes. Furthermore, there is little information on seabird distribution during the migration and winter phases, and filling these information needs will be valuable for mitigating impacts from oil and gas exploration.

The results of this study will complement recent and on-going surveys of marine birds which are partially funded by the North Pacific Research Board (NPRB) and the USFWS. In 2006-2007, NPRB project placed 637 seabird observers on NOAA and NSF-funded vessel-based projects. During those two years, USFWS seabird observers joined 27 cruises and surveyed in excess of 42,000 km. Data on more than 547,000 birds were added to the NPPSD. However, only two of those cruises covered waters in the Chukchi or NAB areas. The at-sea survey program recently received additional funding from NPRB for 2008-2011, as part of the Bering Sea Ecosystem Integrated Research Program. Again, the funded surveys do not adequately provide coverage of the Chukchi or Beaufort areas. With minimal additional funding, the USFWS at-sea survey program could expand to other research cruises that will provide coverage of the lease sale areas. In combination, these surveys will provide a more complete and current data set on marine bird use of the region.

Objectives:

- Estimate the spatial distribution, species composition and seasonal changes in species and abundance for marine birds in the Chukchi Sea and Beaufort Sea 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 the Chukchi Sea and Beaufort Sea Planning Areas.

Methods: Seabird observers will be placed on ships of opportunity, primarily NOAA, BOEM, and NSF-funded research vessels. Based on on-going BOEM, NOAA and NSF programs, we anticipate availability of at least five additional cruises per year in the Chukchi Sea and Beaufort Sea Planning Areas or within the Bering Sea. Observers use standardized protocols for marine bird surveys and data is entered directly into a laptop computer with a GPS interface. The presence of marine mammals is also recorded, although the seabird protocol differs from those used exclusively for marine mammal surveys. Data will be processed for entry into the NPPSD, providing access to multiple users.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Hanna Shoal Ecosystem Study (AK-11-03)

BOEM Information Need(s) to be Addressed: This study will constitute a key component of Chukchi Sea environmental studies pertinent to Chukchi Sea oil and gas activity. The highest oil industry interest is in the area just to the south of Hanna Shoal. The BOEM analysts and decision makers will use the information in NEPA analysis and documentation for lease sales, EPs and DPPs decision-making in the Chukchi Sea.

Total Cost: $5,692,571
plus Joint Funding (~$750,000)

Period of Performance: FY 2011-2017

Conducting Organization: CESU-University of Texas at Austin

BOEM Contact: Dr. Heather Crowley

Description:
Background: The recently COMIDA CAB study highlighted the importance of Hanna Shoal in the NE Chukchi Sea as a biological oasis bordering the boundary between Chukchi and Arctic Ocean waters. The reason for the high productivity in this area is poorly understood, however. The shallower waters of the shoal have long been known as traps for grounding of bergy bits and deep-keeled sea ice, and a reoccurring polynya is created down current of the grounded ice.

Bering Sea water entering the Chukchi Sea and flowing north is thought to flow both to the east and west of the shoal. Historically, the transport of this warmer Bering Sea water past Hanna Shoal has resulted in melt out of open water "bays" in the ice cover on either side of Hanna Shoal. In most recent years with global warming, floating pack ice in summer persists in this area longer than elsewhere in the Chukchi, often surrounded by open water even to the north. This persistence strengthens the vertical stratification over Hanna Shoal as this residual summer ice melts and freshens the surface layer. Taylor columns may be responsible for maintaining ice in the regions of Herald and Hanna shoals. Circulation processes around Hanna Shoal are poorly understood, but the circulation here is part of a broader circulation field that connects the Chukchi and Beaufort. Waters draining through Herald Valley to the western Chukchi shelf and slope regions are carried to the eastern Chukchi, where outer shelf and slope waters are very likely brought back onto the shelf.

Biological "hot spots" in the Chukchi Sea are thought to be related to coupled pelagic and benthic productivity. A high abundance of bottom fauna is correlated with high pelagic primary production, possibly associated with the ice edge that reached the seabed mostly ungrazed. However, the mechanisms that must explain the productivity at Hanna Shoal are relatively poorly understood. With the retreat of the summer ice-

edge to deeper, more northern waters in recent years, this pelagic/benthic coupling may be weakening at Hanna Shoal. The ongoing productivity of this region depends on the timing and position of the ice edge. Other BOEM projects in the Chukchi are showing sustained benthic productivity in the area of Hanna Shoal accompanied by high concentrations of water birds, walrus, and whales. Ongoing BOEM studies looking at ocean heat transport across the central U.S. Chukchi Sea, to the south and at circulation to the east, toward Barrow Canyon will provide context to this study.

Objectives:

- Refocus the ecological monitoring started under COMIDA CAB to the region of Hanna Shoal, including nearby biological "hot spots."
- Verify and enhance the food web/contaminant bioaccumulation structure developed in the COMIDA CAB study.
- Measure water column and benthic primary and secondary productivity and biomass, and determine the relation to oceanographic processes.
- Document annual circulation and density fields, as well as ice conditions, at Hanna Shoal throughout the year and examine important chemical, physical and biological interactions with the unique ecological regime in this highly productive area.
- Better understand the physical processes controlling circulation patterns in the region through analyses of numerical ocean process model results.
- Integrate effort and findings with recent and ongoing BOEM and other NE Chukchi Sea studies of higher trophic levels.
- Participate in the Distributed Biological Observatory for the Northeast Chukchi Sea

Methods: This project will continue COMIDA CAB benthic sampling, food web analysis, and contaminant measurements, focusing on the Hanna Shoal region. Water column primary and secondary production and biomass also will be measured. Cruise zooplankton data will be supplemented by data from moored zooplankton-sensing ADCP units capable of distinguishing copepod and euphausiid biomass signatures. Appropriate moored and shipboard measurements of currents, sea ice drift, and hydrography (including geochemistry) will examine circulation and density fields. Moorings will be used for long term profiling of temperature and salinity, including under ice measurements in winter. Additional oceanographic data may be obtained from other projects in the Chukchi, these data include: HF radar, moored acoustic Doppler current profilers (ADCP), meteorological buoys, gliders and moored zooplankton-sensing ADCP units capable of distinguishing copepod and euphausiid biomass signatures. Taxonomic information and vouchers for newly identified species will be provided to the National Museum at the Smithsonian Institution.

This study will use numerical ocean circulation model results for the Chukchi Sea to better understand the physical processes controlling circulation patterns in the region. Analyses will be performed on the model results to examine interactions of the flow field

and density structure with the topography and their relation to productivity and biomass distribution. Formal integration with other BOEM projects will be made through the "Marine Mammal/Physical Oceanography Synthesis." Coordination will occur with other international, NSF, NOAA, ADEC, and industry research in the Chukchi Sea.

Revised Date: August 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area (AK-11-08a; AK-11-08b)

BOEM Information Need(s) to be Addressed: This project continues collection of marine fish baseline in the Chukchi Sea, and will provide information on the abundance and distribution of fish, crab, and lower trophic communities in the Chukchi Sea lease area. The study will provide the basis for a better understanding of distribution and relative importance of fish communities. The Alaska OCS Region identified a need for continued fish and invertebrate baseline monitoring during the 2007 MMS-sponsored "Chukchi Sea Information Status and Research Planning Meeting" to support NEPA analyses for lease sales, EPs, and DPPs.

Total Cost: $2,695,000 plus Joint Funding (~$6,000,000)

Period of Performance: FY 2012-2017

Conducting Organization: University of Alaska Fairbanks; NOAA

BOEM Contact: Catherine Coon

Description:

Background: This study proposes to develop a broader understanding of abundance and distribution of demersal and pelagic fish, crab, and lower trophic communities needed to evaluate and mitigate the effects of OCS oil and gas development. Interim results from a current BOEM funded Coastal Marine Institute (CMI) project, "Current and Historic Distribution and Ecology of Demersal Fish in the Chukchi Sea Planning Area," have identified temporal, seasonal, and spatial gaps in data on fish in the Chukchi Sea in particular to sampling on or near the lease areas. This proposal was designed specifically to fill these information needs. It will build upon recent information on invertebrate communities in the Chukchi offshore lease area obtained by the 2009 study "Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Chemistry and Benthos (CAB)." This will also complement the 2010 LGL component of COMIDA CAB that undertook midwater and benthic fishery samples at 20 sites within the COMIDA CAB sample design. This study would utilize these data and create a similar survey design such that data sets were compatible, comparable, and extend the time series. This study would contribute to further knowledge of pelagic fishes in the northeast Chukchi Sea. Data from this study will provide abundance and distribution information for NEPA analysis on fish and invertebrate species.

In the well-studied Bering Sea, it is apparent that the distribution and community composition of fish has changed in recent decades and many species are shifting their distributions northward. A MMS Beaufort Sea fish survey in 2008 indicated presence of

common Bering Sea species, such as walleye pollock and dense aggregations of snow crab in the western Beaufort Sea. These species are also likely to be present in the adjacent Chukchi Sea. This study will increase the extent of fisheries information within the lease area and extend a baseline for further studies linking species distributions between the Bering and Beaufort Seas.

The demersal fish and invertebrate community of the Chukchi Sea is thought to be less dense and diverse than in the Bering Sea and does not support major commercial fisheries at this time. The Chukchi Sea, however, is critical to the existence of many protected species of marine mammals and birds. Alaskans living in coastal Chukchi villages depend on the sea for many of the subsistence foods critical to their way of life. Although the Chukchi has historically been considered a benthic dominated system, available data indicate that there is a large biomass of pelagic fish in the area that has not been adequately sampled. This pelagic fish community seems to be dominated by forage fish, including Arctic cod, sand lance and capelin. These species serve as an important mechanism of energy transfer to top predators such as birds, ice-dependent seals, and cetaceans.

Objectives:

- Document, characterize and understand the distribution of pelagic and demersal fish and invertebrate communities in the Chukchi Sea lease area for the open water season.
- Estimate the geographic range of fish, invertebrates, and lower trophic biomass in the lease area by comparing recent and historic fishery databases.
- Provide a comparison of these communities with that of prior studies, as well as adjacent regions (Beaufort and Bering Seas) and relate the data to oceanographic fronts.
- Provide an updated mass-balance food web model of the eastern Chukchi Sea with collected diet information from the bottom trawl and surface trawl surveys, and sensitivity analyses of the model using ranges of uncertainty measured in the data.
- Collect tissue samples of fish, crab, and zooplankton for genetic, energetic, isotopic, and other biological analyses.
- Collect information on ichthyoplankton and juvenile fish, including ecological and life history information, to support Essential Fish Habitat analysis.
- Provide GIS based maps and attribute tables of marine fish and lower trophics for NEPA and other analyses into the AOOS Arctic Portal.

Methods: Conduct a two year field study with fisheries and lower trophic survey in the Chukchi Sea region to obtain baseline data on the structure and function of these ecosystems and on the ecology of important fish species. Samples locations will be determined such that it compliments and extends recent work in the COMIDA CAB. The abundance of pelagic fish, jellyfish, and large zooplankton (e.g., euphausiids) will be estimated with a multi-frequency echo-sounder and ground-truthed using pelagic gear.

The results will be directly comparable to historic surveys conducted by COMIDA CAB, RUSALCA, Conoco/Shell, and Beaufort surveys which will allow them to be placed into a broader latitudinal context. A series of coordinated bottom trawls would use the same survey methodology used by in the 1990/1991 Chukchi Sea Survey, and the RUSALCA surveys 2004-2008. The results will extend the time series (2004-2008) and build upon the earlier surveys (1990, 1991) of demersal fish and invertebrate communities. To interpret the distribution of fishes and their importance as prey, water column properties (temperature, salinity, light level, chlorophyll fluorescence) will be measured at all trawl stations. This study will coordinate with other ongoing BOEM or other agency or university studies in oceanography and biology to maximize data needs and study design. Food web model will be based on the Ecosim modeling framework as extended by NOAA and UAF PIs to include perturbation analysis and statistical analysis of uncertainty. This study is also known as the Arctic Ecosystem Integrated Survey (Arctic EIS).

Revised Date: August 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: U.S.-Canada Transboundary Fish and Lower Trophic Communities (AK-12-04)

BOEM Information Need(s) to be Addressed: Interest in the Arctic OCS has intensified in the eastern Beaufort Sea, accelerating the need to collect ecological baseline data for fish and lower trophic organisms in transboundary marine waters. Information needs include documentation of fish species presence, abundance and distribution in the lease area as well as their ecological interactions with habitat and other trophic levels (prey species and plankton). This project extends recent marine fish and lower trophic surveys in the Beaufort Sea to assess potential effects of OCS development on lower trophic food webs and essential fish habitat (EFH). Study information will support NEPA and other environmental analyses for future lease sales, exploration plans, and potential development and production plans and possible use by Canada on their oil and gas activities.

Total Cost: $5,191,125
plus Joint Funding (~$5,000,000)

Period of Performance: FY 2012-2017

Conducting Organization: UAF; Department of Fisheries and Oceans, Canada

BOEM Contact: Kate Wedemeyer

Description:
Background: Information needs in the eastern Beaufort Sea are growing, especially in light of new emphasis on marine spatial planning, EFH consultation, food web modeling and Arctic climate change issues. Currently, NEPA analysts must rely on limited historical data and extrapolation to analyze potential development impacts on eastern Beaufort Sea marine fish and lower trophic communities. A 2008 MMS fish survey in the western Beaufort documented unexpected diversity, including several commercial fish species (cod, pollock, crab) previously unknown in the region. We need better information in the eastern Beaufort about what fish species inhabit the area, as well as baseline information about abundance, distribution, habitat, and seasonal and inter-annual variability of fish and invertebrates in the understudied lower foodweb. An under-ice fish and invertebrate baseline, while challenging to obtain, is needed because Beaufort species live under ice three-fourths of the year. Additional oceanographic information about currents, upwelling, and hydrographic structure through fine-scale CTD resolution is needed to document biological habitats. Data from the study will support NEPA analysis to support Essential Fish Habitat (EFH) ecological analyses of fish, their prey and their habitat established for three additional Beaufort fish species (Arctic cod, saffron cod, and snow crab).

This transboundary survey effort, jointly-funded with the Canadian Department of Fisheries and Oceans (DFO), Central and Arctic Region, will share a research vessel, as well as expertise and methods. Costs will be shared in proportion to area surveyed. The collaboration will advance our knowledge of the Beaufort Sea shelf ecosystem, transboundary fish stocks, essential fish habitat, life stage history, and oceanographic variability. Inclusion of invertebrate and primary production sampling will address lower trophic food webs and ecological relationships to bird and marine mammal populations. This work will also contribute to other studies including long-term monitoring efforts near Camden Bay and future international Arctic cod studies.

Objectives:

- Document baseline fish and invertebrate species presence, abundance, distribution and biomass.
- Analyze dietary habits, age and growth patterns of the most abundant species to support Canadian development of a Beaufort shelf fish and marine mammal food web model.
- Test under-ice methods and provide baseline information for the ice-covered season.
- Estimate seasonal variability of fish and habitats.
- Document the hydrographic structure of the eastern Beaufort shelf.
- Enhance understanding of how habitat variables (such as temperature and salinity) affect distributions under different climate conditions.

Methods: The survey will sample fish, invertebrates, and related biological and oceanographic habitat characteristics between longitudes 141° and 147° in the U.S. and into Canadian waters to ~138° (across the Canadian border to Herschel Island and the Mackenzie canyon). Field surveys will be performed every other year in order to reduce autocorrelation of climate conditions and to refine sampling strategy based on analysis of first year data. Field sampling will occur in years 1 and 3. Additional funds will be sought for a third survey in year 4 to better evaluate inter-annual variability.

This survey will expand the scope and reach of a Beaufort Sea Pilot Fish Survey conducted in 2008. Methodologies will follow those from the 2008 survey and the ongoing BOEM Central Beaufort Sea Fish Survey, modified in consideration of lessons learned from the earlier work. Sampling will deploy gear types such as beam trawl (10m wide), otter trawl, Isaacs-Kidd, and bongo nets. This study will include additional field surveys in both the under-ice and open water seasons to provide a better understanding of variability and collect additional habitat characteristics; collect invertebrates in both the water column and benthos; collect CTD data to document hydrographic structure; and collect and analyze ecological (e.g. energetics, isotope, genetic and otolith) samples for a foodweb model. This contemporaneous collection of integrated data over the lower food chain and physical environment supports an ecosystem management approach.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Distribution and Habitat Use of Fish in the Nearshore Ecosystem of the Beaufort and Chukchi Seas (AK-12-06)

BOEM Information Need(s) to be Addressed: Information is needed on nearshore habitats and fish abundance in the Beaufort and Chukchi Seas to refine areas designated as Essential Fish Habitat (EFH) as presented in the Arctic FMP, adopted by NOAA in 2009. Fish in the ecologically fragile nearshore environments are particularly vulnerable to oil spills. Information from this study will support better identification and description of EFH in NEPA analyses and a better understanding of how fish species respond to habitat variables to improve estimates of distributions under different climate conditions. This project will operate concurrently with other fish sampling efforts (AK-10-06 and AK-11-08) to provide a seamless baseline of forage fish data from the beach to the offshore environment.

Total Cost: $164,000
plus Joint Funding (~$500,000)

Period of Performance: FY 2012-2016

Conducting Organization: NOAA

BOEM Contact: Catherine Coon

Description:
Background: The Arctic is one of the most rapidly changing ecosystems in the world, yet information on EFH and what species and life stages use these habitats is very limited. Specific information is very sparse for fishes in the Arctic, especially in shallow, nearshore waters (shoreline out to 8 m depth). Nearshore habitats are some of the most productive habitats in Alaska and the most at risk to development and oil spills. Many species included in the Arctic Fisheries Management Plan for the Arctic, such as capelin and rainbow smelt, use nearshore habitats at some time in their life but estimates of their abundance and habitat use are poorly documented. Nearshore habitats differ from offshore (>30 m depth) habitats, as do fish assemblages in each area. Recent nearshore research in the Arctic has been limited to the Barrow area, which represents only a small fraction of the nearly 1,700 km of the U.S. Arctic coastline. As development and transportation activities begin to increase in the Arctic, more information is needed on fish distribution and habitat use, life history characteristics, food webs, and species at risk to make informed management decisions regarding potential effects from global climate change and human disturbance. In addition, warming conditions in the Arctic will likely result in a reorganization of community structure; new fish species are expected to migrate to the Arctic with unknown consequences to existing stocks and food webs.

Many Arctic fish species are important in the diet of higher-level predators and in Inupiat subsistence fisheries. For example, in the Bering, Beaufort, and Chukchi Seas,

Arctic cod and saffron cod occur in the diets of 13 marine mammal species and 20 seabird species. Availability of prey is critical to some Arctic marine mammals such as ice seals, which themselves are important in the diet of polar bears. Larger predators are already under stress by reduced ice cover. The distribution, diversity, and habitat use of nearshore fishes is largely unknown in other areas of the Arctic, especially in the Chukchi Sea. The proposed study would expand fish distribution and habitat use information to the eastern Beaufort Sea and western Chukchi Sea.

Objectives:

- Inventory the distribution and diversity of nearshore fish, their habitat and prey along high priority sites in the Beaufort and Chukchi Seas
- Assess age and diet of fish important as prey species
- Describe oceanographic features of areas with nearshore fish
- Understand how habitat variables like temperature and salinity affect fish species distributions
- Develop a public outreach document entitled Arctic Coastal Impressions with photographs of the US Arctic Coastline.

Methods: Beach and small otter trawl sampling will occur in areas of high importance, defined as locations near oil and gas production, or close to foraging areas for birds or marine mammals, followed by areas with opportunities for research platforms for three sampling seasons. In the summer and fall 2013/2014 two primary areas will be at sites between Barrow and Peard Bay to establish a baseline of fish and habitat use and as reference sites to the Chukchi Lease area.

A random sample of key fish species (e.g., Arctic cod, saffron cod, and capelin) will be collected for age and diet analyses. A sample of select fish species will also be collected, frozen, and archived for later fatty acid and genetic analyses. Habitat will be measured at each sampling site. At seine sites each beach will be profiled according to ShoreZone protocols. Intertidal invertebrates and macroalgae will also be recorded. Additionally, a drop camera will be deployed, depending on water visibility, to search for and identify unusual habitat types and other fish species that may not be captured by seine or trawl. Models will be generated to assess habitat use by fishes according to habitat variables. Maps will be generated to describe species distribution relative to multiple habitat variables. Information that may lead to NOAA's EFH general distribution will be shared. Relational databases will be built that contain data on species presence and abundance that will expand the current BOEM fish database, be suitable for use in GIS, and complement ShoreZone mapping efforts.

This project collaborates with staff and funding with the Alaska Coastal Ecosystem Survey (ACES) with joint funding from NPRB. The public outreach document entitled Arctic Coastal Impressions shows photographs of the U.S. Arctic Coastline from the ShoreZone project along the North Slope and Western Alaska.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Genomics of Arctic Cod: A Sentinel Species in a Changing Environment (AK-14-03)

BOEM Information Need(s) to be Addressed: To evaluate potential development effects in NEPA documents BOEM needs to understand whether Arctic cod on the OCS are part of a single pan-mictic population or part of more vulnerable sub-populations, and whether or not they exhibit genetic characteristics that will enable them to adapt to retreating sea ice and continue to feed their upper trophic predators. Thus, Arctic cod dynamics are an important consideration for NEPA analyses related to EFH.

Total Cost: $300,000
plus Joint Funding (~$320,000)

Period of Performance: FY 2014-2017

Conducting Organization: USGS

BOEM Contact: Kate Wedemeyer

Description:
Background: Arctic cod (*Boreogadus saida*) are estimated to funnel 93% of lower trophic energy to upper trophic predators including birds, seals, polar bears, beluga whales, and eventually to humans. Although Arctic cod are considered a sentinel species in the U.S. Arctic marine ecosystem, information about them is limited because of the difficulty of studying this ice-associated species. Despite the recognized importance of Arctic cod it is unknown whether there is a single pan-mictic population or whether there are sub-populations. This is an important distinction with respect to potential impact assessment because a sub-population limited to a smaller geographic location or a specialized habitat in the OCS would likely be more vulnerable to impact from an OCS development than a pan-mictic population spread across the circumpolar Arctic. BOEM needs a greater understanding of the ecological role this sentinel species plays as the primary pathway funneling lower trophic production to many marine mammals, birds and fish.

In 2012, a successful BOEM-funded pilot study conducted by USGS in collaboration with a Canadian genetics lab demonstrated that there is in fact a genetic break somewhere between the Chukchi/Western U.S. Beaufort and far eastern Canadian waters. This genetic break indicates that, rather than a single pan-mictic Arctic cod population, there may indeed be sup-populations. The pilot study relied on samples collected in 3 separate BOEM surveys in the northeast Chukchi and the western and central Beaufort Seas. Now that a genetic break has been identified, it is important to fill in the large spatial area between the Central U.S. Beaufort and the far eastern Canadian Beaufort with additional genetic samples and analyses to delineate sub-populations.

Additionally, a greater understanding of the ability of Arctic cod to survive and adapt as the ice retreats is needed to separate potential effects of oil and gas development on Arctic cod and its predators from the cumulative effects of climate change. Recent climate-change modeling suggests that as the arctic ice retreats Arctic cod may be at risk of extirpation in the OCS by 2030. Genetics, transcriptomes and genomics can provide insight into whether any Arctic cod lifestages are truly ice-obligate or whether they are simply ice-associated or ice-dependent and can potentially adapt to retreating ice conditions. Identifying whether there are genetically separated sub-populations, particularly near-shore and offshore populations, could provide a clue that there may be differential adaptability due to differential gene expression rather than different genes. Transcriptomes can identify differential expression of the single 'antifreeze' gene that may confer adaptability to loss of ice habitat. Genomics can facilitate transcriptomics by identifying additional genes associated with possible ice-obligation.

The large spatial gap from the eastern U.S. Beaufort Sea across the Mackenzie River Canyon into the Western Canadian Beaufort coincides with the footprint of the current field study "US-Canada Transboundary Fish and Lower Communities." That field study will collect the genetic samples needed for the work described here. The USGS Alaska genetics lab, which recently published similar groundbreaking Polar Bear genetics research, will lead the Arctic cod lab research.

Objectives:

- Identify genetic differences that would change the BOEM approach to Arctic cod effects analyses from evaluating Arctic cod as a single pan-mictic population to evaluating several geographic sub-populations of Arctic cod.
- Test hypotheses that onshore/offshore differences in the extent of ice-obligation genes may be related to differences in either genes (genetics) or gene expression (transcriptomics).
- Test hypothesis that ability to survive loss of Arctic ice may be related to differences in gene expression (transcriptomes).
- Test the ice-obligate hypothesis by identifying both differential genetic ('deep' genomic) and differential gene expression (targeted transcriptomic) pathways.
- Archive genetic specimens for future use in new hypothesis tests or with new technologies and methods.

Methods: The USGS genetics lab will analyze the field samples (supplied by the US-Canada Transboundary survey) for both mitochondrial and microsatellite DNA to identify sub-populations. Genetics results will direct how the next year's samples should be spaced to test the hypothesized dichotomies of coastal vs. continental slope populations; eastern vs. western; warm freshwater inputs vs. cold saline marine waters populations. Laboratory analyses of samples collected during 2012 and 2013 fieldwork will be used to identify optimal sampling locations for the 2014 field season. Initial profiles of the 'antifreeze' gene transcriptome will be analyzed for variation in gene expression across and within hypothesized sub-populations. A complete genomic sequence of a single

individual will be constructed to identify additional genes that may provide adaptive expression to climate change. The investigators will continue to coordinate and collaborate with a parallel Canadian collection and genetic analysis effort.

Revised Date: August 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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: The BOEM *2017-2022 Outer Continental Shelf Oil & Gas Leasing Proposed Program* includes a lease sale in the Cook Inlet Planning Area. 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 Cost: $350,000 plus Joint Funding (~$1,000,000) **Period of Performance:** FY 2014-2017

Conducting Organization: NOAA; USFWS; NPS

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.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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

Conducting Organization: NOPP Partnership with NOAA-IOOS

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 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 close current gaps in 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.

The AMBON aims to develop a sustainable model of continuous biodiversity observation including all levels of diversity from genetic to organismal to ecosystem.

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

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

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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: The BOEM *2017-2022 Outer Continental Shelf Oil & Gas Leasing Proposed Program* includes a lease sale in the Cook Inlet Planning Area. 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 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 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 Cost: $600,000 plus Joint Funding (~$150,000) **Period of Performance:** FY 2015-2019

Conducting Organization: National Park Service

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 will also coordinate with existing efforts to compile historical hydrocarbon data and provide online public access. The data will include appropriate concomitant parameters (e.g. organic carbon, sediment grain size) and associated metadata. Based on this information, areas with accessible marine bivalves will be selected near two communities in Kachemak Bay for community monitoring of PAHs.

Revised Date: August 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Sensitivity to Hydrocarbons and Baselines of Exposure in Marine Birds on the Chukchi and Beaufort Seas (AK-13-03-02)

BOEM Information Need(s) to be Addressed: Baselines of exposure levels on avian species in the U.S. Arctic would provide invaluable reference information for monitoring population status and restoration efforts. Identification of sensitive species and populations will assist in assessments of new development activities, and development of long term monitoring strategies. BOEM analysts and decision-makers will use this information in NEPA analysis and documentation for lease sales, EPs and DPPs.

Total Cost: $247,908
plus Joint Funding ($248,595)

Period of Performance: FY 2013-2016

Conducting Organization: CMI, UAF

BOEM Contact: Rick Raymond

Description:
Background: With the potential of increasing development of oil and gas resources in the Chukchi and Beaufort Seas, establishment of baselines and assessment of sensitivity of arctic biota to hydrocarbon exposure would provide vital information needs for management and conservation of natural resources potentially impacted by development. Evaluating baselines of hydrocarbon exposure in selected avian species of subsistence importance [king eider (*Somateria spectabilis*), common eider (*Somateria mollissima*), and greater white-fronted goose (*Anser albifrons*)] in the Chukchi and Beaufort Seas will provide measurements of liver cytochrome P450 (CYP1A) enzyme activity. Study results will provide a first assessment of baselines for hydrocarbon exposure by forming a basis for further development of field programs for monitoring of exposure levels in marine birds in the Chukchi and Beaufort Sea region. In addition, results will provide information for assessment of current and future safety of subsistence caught food.

Bird sensitivity to hydrocarbons will be evaluated in a broader suite of marine bird species using species-specific cell culture methods. This longer list of species includes spectacled eider, Steller's eider (*Polysticta stelleri*), king eider, common eider, long-tailed duck (*Clangula hyemali*), greater white-fronted goose, black brant (*Branta bernicla*), and three species of alcids. These species represent a broader spectrum of candidate bioindicators of exposure and additional species of conservation and subsistence importance. Results from this study will provide guidance on further selection of suitable bioindicator species, based on their responses and sensitivity to

hydrocarbon exposure will provide information for assessment of relative risks of hydrocarbon exposure to the arctic biota.

Objectives:

- Measure baselines of hydrocarbon exposure in selected species of marine bird indicator species (species of subsistence importance) liver cytochrome (p450) activity.
- Assess and measure comparative sensitivity to hydrocarbon exposure in selected marine bird indicator species (larger suite of marine birds).
- Coordinate and collaborate field work with the North Slope Borough, Department of Wildlife.
- Coordinate with North Slope subsistence hunters to gather cell samples (spring, summer and fall).
- Conduct cell culture assays in laboratory.
- Share study findings to local communities through public outreach programs, produce poster and flyer and present at scientific conferences.

Methods: This study will utilize multiple criteria to select and identify suitable avian species as candidates for ecological monitoring programs. Measurement of liver 7-ethoxyresorufin-O-deethylase (EROD) activity in liver cultures allows for species specific assessment of magnitude and duration of cytochrome P450 (CYP1A) induction. EROD is widely used as an indicator of CYP1A induction and EROD results can be combined with other measurements to determine cellular or genetic effects, allowing evaluation of potential cellular or genetic pathology associated with hydrocarbon exposure. Liver samples to measure hydrocarbon-inducible CYP1A activity will be collected in collaboration with the North Slope Borough, Department of Wildlife Management and local hunters. Ultimately, this study will help in the development of guidelines and field sampling protocols by refining techniques for sample collection.

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 (AK11-14b) to provide a current baseline of ecological conditions in coastal areas.

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

Period of Performance: FY 2015-2017

Conducting Organization: CMI, UAF

BOEM Contact: Kate Wedemeyer

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 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 and Chukchi seas. BOEM analysts and decision-makers can use this information in NEPA analysis and documentation for potential future lease sales, EPs and DPPs.

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

Period of Performance: FY 2016-2018

Conducting Organization: CMI, UAF

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: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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

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 is also needed for future comparison to monitor actively developed OCS areas.

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

Period of Performance: FY 2016-2019

Conducting Organization: CMI, UAF

BOEM Contact: Kate Wedemeyer

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Characterizing Bacterial Communities in Beaufort Sea Sediments in a Changing Arctic (AK-13-03-19)

BOEM Information Need(s) to be Addressed: This study will characterize sediment bacteria in and around oil and gas lease areas on the Beaufort Sea OCS. Applied next-generation DNA sequencing (NGS) will be used to determine bacterial biogeochemical functions to forecast ecosystem functions in benthic communities in response to a changing Arctic. This information will support NEPA analyses and documentation for potential future lease sales, EPs, and DPPs.

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

Period of Performance: FY 2016-2018

Conducting Organization: CMI, UAF

BOEM Contact: Rick Raymond

Description:
Background: Benthic bacteria play an integral role in nutrient cycling and organic matter (OM) degradation in marine sediments. In the Arctic, changing climate conditions have reduced sea ice cover resulting in shifts in marine primary productivity patterns, which affects the quality of OM deposited to the seafloor. Bacterial diversity and community composition can reflect local biogeochemical processes, exposure to contaminants, and nutrients/OM availability to the benthic food web. Bacteria can also indicate the presence of contaminants such as heavy metals and hydrocarbon in crude oil in the environment. Some bacterial genera are known obligate oil-degraders and can "bloom" following oil exposure and rapidly breakdown chemical components of oil *in situ*. Establishing the presence and distribution of known oil-degrading taxa and associated community diversity can provide valuable insights into how microbial communities respond to oil exposure in a given location.

Providing links between bacterial community composition and community function is a growing area of research aimed at identifying ecologically significant bacterial groups. Arctic benthic bacterial communities have only been explored in a few studies, primarily conducted in Greenland and Norwegian deep-sea sediments. Preliminary analysis of benthic bacterial communities from a limited subset of sites in the western Beaufort Sea supports predictions that these communities will reflect the heterogeneity of this system. These data are expected to provide high but varying levels of diversity, indicating that the majority of benthic bacterial diversity in Beaufort Sea sediments has yet to be discovered.

Objectives:

- Assess the diversity and community structure of sediment bacteria at 70 locations distributed across the Beaufort Sea continental shelf and slope, including locations in the vicinity of the oil and gas lease sale areas.
- Examine correlations between environmental parameters and corresponding bacterial diversity and community composition.

Methods: 16S ribosomal (rRNA) marker gene surveys will be conducted on sediments according to published protocols to assess the diversity and community structure of bacterial populations in the Beaufort Sea benthos. Samples will be sequenced from total genomic DNA extracted from sediment samples. Primers from the Earth Microbiome standard protocol will be used to amplify the V4 region of the 16S rRNA gene. Operational Taxonomic Units (OTUs) will be used to characterize bacterial assemblages at each study site and provide estimates of species richness and relative abundance. Sequence data will be analyzed the using the QIIME toolkit with associated taxonomic identification matched against the Green Genes 16S reference database. Patterns in community structure among locations will be examined by evaluating the species matrix based on OTU data in standard morphological species matrices using multivariate statistics. Relationships between community structure and environmental parameters will be evaluated using Bray-Curtis Distances with Canonical Correspondence Analysis (CCA) and non-metric multidimensional scaling (nMDS).

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Using Genotyping-by-Sequencing (GBS) population genetics approaches to determine the population structure of Tanner crab (*Chionoecetes bairdi*) in Alaska (AK-13-03-20)

BOEM Information Need(s) to be Addressed: BOEM needs population level information about species that could be affected by oil and gas exploration, development and production. Information from this study will inform NEPA analyses for future lease sales, EPs, and DPPs.

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

Period of Performance: FY 2016-2018

Conducting Organization: CMI, UAF

BOEM Contact: Catherine Coon

Description:
Background: Genetic tools are increasingly being applied to assess population structure and connectivity in marine species, and are in many cases identifying much greater spatial structure then previously assumed by other tools. Understanding the population structure of tanner crabs (*Chionoecetes bairdi*) in the Cook Inlet Planning Area using genetic tools will be important for determining effective management areas and stock boundaries. It is still unknown whether the stocks around Cook Inlet and Shelikof Strait are isolated and distinct or the populations are substantially connected to other populations throughout Alaska. If the former is the case, OCS activities in this area would need to be concerned with the potential of impacting an isolated stock that would not be supplemented by other populations. If the latter is the case, any potential impacts from OCS activities might be lessened by recruits entering affected areas from elsewhere.

Tanner crab were historically an important commercial species in Alaska, but declines in recent decades led to several fishery closures. The causes of these declines and the lack of substantial recovery are still poorly understood. Improved understanding of the genetic stock structure and exchange between regions may help to inform management practices for this species. Genetic studies of a closely related species, snow crab (*Chionoecetes opilio*), show substantial population connectivity throughout its distribution. However, tanner crab tend to inhabit warmer, nearshore waters and larvae may not be as exposed to potential agents of dispersal such as ocean currents.

Objectives:

- Test the null hypothesis of genetic homogeneity across all sampled populations using a massively multi-locus genotype dataset generated through the GBS approach. If genetic heterogeneity is detected, test alternative models of population structure.
- Assess whether populations in BOEM special project areas of Cook Inlet and Shelikof Strait are distinct or contiguous with nearby populations and evaluate the extent of their natural genetic variability.
- Test for evidence of extreme population size changes in the extent and nature of observed standing genetic variation.

Methods: Samples of hemolymph (a fluid analogous to vertebrate blood) were collected from approximately 800 tanner crabs caught in trawl and crab pots during ADF&G and NMFS summer surveys. Researchers will conduct genetic analysis by the Genotyping by Sequencing (GBS) technique. Total genomic DNA will be extracted from hemolymph samples using established protocols. The DNA quality will be checked by gel electrophoresis and fluorometry. GBS requires high quality DNA, so only samples that yield large, unbroken molecules will be used. Briefly, genomic DNA from each sample is fragmented using a combination of restriction enzymes to generate pools of variable length fragments flanked by restriction enzyme recognition sites. The restriction enzyme digested pools from each sample are then linked to individual identifying tags as well as other tags specific to the sequencing platform. The tagged genomic fragment pools are then stringently size selected to focus sequencing effort on a well---defined subset of restriction digest fragments. This ensures that the same genomic regions or loci are sequenced from the different individuals being genotyped. The size-selected pools are then sequenced on a platform that generates several million sequences reads for each individual analyzed. Using bioinformatic tools, sequence output is quality controlled and manipulated to generate high quality multi- locus genotype datasets.

Collection data associated with the samples examined in this study will be archived in the ARCTOS database at the University of Alaska Museum. Sequencing output will be deposited in the sequence reads archive (SRA) of the National Center for Biotechnology Information. These sequence reads will be made freely available for public dissemination and use in further studies. Finally, a full dataset consisting of quality filtered multi-locus genotypes from all specimens examined in the study will be published as supplementary information for any research publications resulting from this work.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $5,470,500 plus Joint Funding

Period of Performance: FY 2015-2019

Conducting Organization: Stantec Consulting Services Inc.

BOEM Contact: Carol Fairfield; Kate Wedemeyer

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 responds to the National Ocean Policy in addressing Arctic, climate change & acidification, and monitoring through an integrated ecosystem approach while coordinating the efforts of several Federal agencies. It is also responsive to the Interagency Arctic Research & Policy Committee (IARPC) 5-year plan (2014-2018) and research priorities. In addition this study will also address MMS study recommendations: 2010-018 (Beaufort Sea Physical Oceanography) and 2010-032 (cANIMIDA synthesis), and the recommendations of the

White House's Council for Environmental Quality (CEQ) of 2010. By entering into a NOPP partnership, BOEM anticipates that all participating agencies will leverage funds and resources and thus avoid redundant efforts while contributing their complementary expertise.

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Demography and Behavior of Polar Bears Summering on Shore in Alaska (AK-09-05a; AK-09-05b)

BOEM Information Need(s) to be Addressed: A jointly-funded study could address information needs identified in a 2005 MMS funded workshop hosted by the USFWS, "Beaufort Sea Polar Bear Monitoring Workshop." It would provide useful information on the sub-population of polar bears summering in areas of oil and gas-related activities along the Arctic coastline. New information will support NEPA analysis and documentation for lease sales, EPs, DPPs, ESA consultations, MMPA permitting by USFWS, and development of related mitigation.

Total Cost: $1,480,767
plus Joint Funding (~$1,490,000)

Period of Performance: FY 2009-2017

Conducting Organization: USGS Alaska Science Center; USFWS Marine Mammals Management

BOEM Contact: Carol Fairfield

Description:

Background: Polar bear use of terrestrial habitat along the Beaufort and Chukchi Sea coastlines of Alaska has increased in recent years, with up to 10% of the polar bears inhabiting the southern Beaufort Sea remaining on land during the open water period. The remaining bears continue to summer on the pack ice, but now find themselves far north of the productive waters over the continental shelf. Neither situation seems favorable for polar bear foraging, and recent observations of starvation, cannibalism, drowning, and poor survival of young, suggest that polar bears in this region are increasingly subject to nutritional stresses. Although future survival of polar bears will depend on the strategies adopted in the diminishing ice environment; relative advantages and consequences of summering on land or Arctic sea ice over deep waters are unknown. Simultaneously, long-term expansion of oil and gas-related development is being contemplated in the southern Beaufort Sea. Polar bear-human interactions may increase because areas of importance to polar bears for resting, feeding, and traveling are becoming coincident with areas of high interest for oil and gas-related development.

Results from aerial surveys as well as a recent study monitoring polar bears feeding on bowhead whale carcasses at Barter Island and Cross Island indicates that all age/sex classes of polar bears are present along shore during the fall open water period and that approximately 50 percent of the bears are represented by family groups. Large numbers of bears have been observed near Barter Island, Cross Island, and Barrow. Industrial operators in the Prudhoe Bay area report an increasing trend in the numbers, frequency, and duration of polar bear use during the open water period.

Objectives:

- Estimate the demographic composition and inter-annual patterns of use of coastal areas by the sub-population of polar bears summering on land in Alaska.
- Evaluate the implications of extended use of land during the open water period to polar bear health, behavior, and population status.
- Estimate the potential for the health and behavior of polar bears summering along the Beaufort Sea and Chukchi Sea coastlines to be influenced by oil- and gas-related activities.
- Develop draft conservation recommendations to reduce the possibility that industrial activity and changing environmental conditions will interact to the detriment of the polar bear population.

Methods: The investigator will conduct a thorough literature review and develop hypotheses about implications 1) to the management and stability of the polar bear population, and 2) to the health and behavior of individual bears in specific demographic groups of increasing numbers of polar bears remaining on land for extended periods during the open water period. Behavioral observations supported by application of appropriate technology (e.g. satellite tags, radio-frequency tags, and similar tags) will be used to monitor representative polar bears in Alaska that show a tendency to remain on land during the open water period. Movements, site fidelity, and limited life history data will be used to test specific hypotheses. Physical exams will be used to evaluate the health and physical condition of representative bears to test specific hypotheses. Hypotheses and observations will be reconciled and a plan developed to reduce the possibility of negative interactions between polar bears and oil and gas-related activities in a changing physical environment.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $1,798,459
plus Joint Funding (~$490,000)

Period of Performance: FY 2011-2017

Conducting Organization: NOAA- Pacific Marine Environmental Laboratory

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 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $2,699,857 **Period of Performance:** FY 2012-2017

Conducting Organization: ADF&G

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $1,174,994 **Period of Performance:** FY 2013-2017

Conducting Organization: ADF&G

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $4,502,000
plus Joint Funding (~$4,024,000)

Period of Performance: FY 2012-2017

Conducting Organization: NOAA-MML

BOEM Contact: Carol Fairfield

Description:

Background: Research underway on the Bowhead Whale Feeding Ecology Study (BOWFEST) indicates 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 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 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $3,933,671
plus Joint Funding (~$1,644,000)

Period of Performance: FY 2013-2017

Conducting Organization: NOAA-MML

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 to 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: August 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $1,750,000
plus Joint Funding (~$300,000)

Period of Performance: FY 2013-2018

Conducting Organization: USGS

BOEM Contact: Catherine Coon

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:

1. Deploy radio-tag instruments on a sufficient sample of walruses.
2. Use GIS and spatial analysis methods to define important habitats, identify migration pathways, walrus foraging behaviors and activity budgets.
3. 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.
4. 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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 the Marine Mammal Protection Act, the bowhead whale is given added protection as an endangered species under the ESA, and bowhead whales and belugas are granted additional management consideration as the targets of subsistence hunts by Alaska Natives. Under the NEPA and the 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 required to understand the effects of oil and gas exploration. 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 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: 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.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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-16-01a; AK-16-01b)

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 Cost: **$**4,437,309 plus Joint Funding (~$220,000)

Period of Performance: FY 2016-2017

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 US and form an important part of the diet and cultural base for most people in villages along the Chukchi coast. Having a good understanding of the seasonal distribution, relative abundance, and habitat use of marine mammals in the Chukchi Sea 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 in the Chukchi Sea. 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.

Since 1979, aerial surveying of the fall migration of the bowheads has been conducted, initially by the Bureau of Land Management and subsequently by MMS, now BOEM. This is one of the longest-maintained monitoring 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 Interagency Agreement between NMFS and BOEM will fly 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 shall follow protocols used by the BOEM in the past surveys of the bowhead fall migration. The scientists will be responsible for the management of this project, all necessary training of support personnel, providing all needed field equipment, conducting all logistical tasks, acquiring all necessary permits, and insuring the safety of all people involved.

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: **$**150,000
plus Joint Funding (~$1,000,000)

Period of Performance: FY 2016-2019

Conducting Organization: USFWS

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Social Indicators in Coastal Alaska: Arctic Communities (AK-11-09)

BOEM Information Need(s) to be Addressed: This study will update key socio-cultural and economic baseline data for analysis of potential local and regional impacts from OCS exploration and development activities that may occur in Federal waters off the North Slope of Alaska. Information from this study will support Outer Continental Shelf Lands Act (OCSLA) and National Environmental Policy Act (NEPA) analyses, for documentation, and may serve as the basis for long-term monitoring for oil and gas exploration and development in the Chukchi and Beaufort Seas.

Total Cost: $669,659 **Period of Performance:** FY 2011-2017

Conducting Organization: Stephen R. Braund and Associates

BOEM Contact: Chris Campbell

Description:
Background: The goal of this study is to update baseline data measuring the pace, direction, and magnitude of regional socio-economic changes, as well as the sense of well-being as expressed by residents in select Arctic coastal communities. These data will assist in NEPA evaluation of the effects of exploration and possible development of OCS energy resources in the Chukchi and Beaufort Seas on local populations through the formulation of social indicators nested within sets of key social domains. This study will facilitate evaluation of current conditions and trends in: economic prosperity; the status of health and safety; cultural continuity and well-being; changes in the status of indigenous rights and local control; quality of the physical environment; and education. Likely communities for sampling will include: Pt. Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik.

Objectives:

- Formulate a set of key social indicators nested within domains that will facilitate the monitoring of changes in human well-being in coastal communities of the U.S. Arctic most proximate to proposed oil and gas exploration and development.
- Obtain an OMB control number for a longitudinal survey instrument that can be repeated to identify long term trends, periodic changes, and fluctuations in the rate of change throughout coastal Alaska.
- Provide useful information on regional socioeconomic conditions and regional aspirations from which government officials and stakeholders can monitor and

evaluate potential changes in well-being resulting from offshore oil and gas exploration and development.

Methods: Establish formal contact with potential host communities and develop a written protocol to facilitate community participation and meaningful collaboration in the performance of this research. Conduct a literature search on previous northern social indicator studies. Utilize existing identified arctic social indicators or develop alternative relevant social indicators in conjunction with BOEM. Prepare a strategic survey instrument, pre-test it, and obtain the necessary approvals for use from relevant BOEM review offices and the Office of Management and Budget, and administer it. Organize data into a workable database and analyze with appropriate multivariate statistical techniques. Conduct a comprehensive analysis of the results of all prior tasks and prepare a draft report of the study findings. Circulate the draft report to the BOEM and host community leaders to facilitate parallel reviews by peer scientists and interested stakeholders; respond to review comments and prepare a final report, incorporating reviewer edits and comments where appropriate; report the study results to participating communities through public meetings or workshops.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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

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

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 climate change affecting 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. Now the program has come to a programmatic crossroads and requires new funding support. BOEM intends to collaborate on this established observation network and 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 Cost: $400,000 plus Joint Funding ($75,560) **Period of Performance:** FY 2016-2020

Conducting Organization: Alaska Native Tribal Health Consortium

BOEM Contact: Chris Campbell

Description:

Background: LEO is the acronym for the Local Environmental Observer Network, 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. Updates on new LEO posts are communicated through social media and a weekly e-news that is distributed to network members as well as a list-serve of over 1500 subscribers nationally and around the circumpolar north. 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, which serves as the hub, 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.

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Northern Alaska Sea Ice Project Jukebox (AK-13-03-16)

BOEM Information Need(s) to be Addressed: This project will provide a better understanding of how both natural climate change and the effects of human impacts are affecting the ecosystem by documenting observations of the changing sea ice conditions by sea ice scientists and local residents of Barrow and Kotzebue, Alaska. The inclusion of Kotzebue will serve as a baseline of observations in that community. Documenting changes in sea ice on the outer continental shelf will allow for better anticipation of subsistence hunter impacts and adaptations. Information from this study will support Outer Continental Shelf Lands Act (OCSLA) and National Environmental Policy Act (NEPA) analyses and documentation for future lease sales, EPs, and DPPs, and may serve as the basis for long term monitoring for oil and gas exploration and development in the Chukchi and Beaufort Seas.

Total Cost: $60,663
plus Joint Funding ($60,633)

Period of Performance: FY 2016-2018

Conducting Organization: CMI, UAF

BOEM Contact: Chris Campbell

Description:
Background: Sea ice is a key feature of the Arctic ecosystem and has been essential to life in coastal arctic Alaska for thousands of years. Shorefast ice provides habitat for marine mammals, influences productivity of food supplies for fish, seabirds and marine mammals, and offers access to subsistence foods for northern hunters. Given this important role in the coastal ecosystem, it is no surprise that shorefast ice also is a key feature of the icescape for humans. As an extension of the land, shorefast ice is used as a hunting and traveling platform by Arctic coastal communities and for the construction of ice roads and runways.

The *Northern Alaska Sea Ice Project Jukebox* is a longitudinal qualitative project where observations of changing sea ice. It was created by UAF in 2013, with a two-year grant from the North Pacific Research Board (NPRB), and currently spans the time period from 1978 to 2013 in the Barrow area. A project website provides access to historical and current observational recordings about sea ice in the Barrow region, creating a retrospective database of traditional knowledge and human adaptation to climate change. The Jukebox promotes using local and traditional knowledge to help understand the nearshore ice environment, and salvages archive materials through digital preservation it and website accessibility.

This study will create ten new audio/visual recordings with sea ice scientists and local residents of Barrow and Kotzebue, Alaska about their observations of changing sea ice conditions. The recordings will be added to the *Northern Alaska Sea Ice Project Jukebox*. Additionally, the study will add a photo gallery where photographs of various ice conditions and features can be viewed by users.

Objectives: The objective of this study is to document personal observations and traditional knowledge about ice in the nearshore environments near Barrow and Kotzebue to discover what has changed, how the Iñupiat are adapting to these changes, and how this knowledge can be useful in natural resource management and development decision making.

Methods: This project will expand the *Northern Alaska Sea Ice Project Jukebox* website by recording at least five local participants each from Barrow and Kotzebue, Alaska discussing their personal observations of sea and traditional knowledge of sea ice in the region. Recordings will cover topics such as knowledge about nearshore and shorefast ice conditions, ice travel, changing sea ice conditions from year to year, coastal processes, and human adaptation to the changing environment. The recordings will also incorporate western scientific knowledge. The *Northern Alaska Sea Ice Project Jukebox* website will be updated to expand the Iñupiaq sea ice terminology resource. A gallery of photos will also be added of the various ice conditions and features that can be viewed by users. Researchers will collaborate with the North Slope Borough Iñupiat History, Language and Culture Commission and the Native Village of Kotzebue for selection of narrators, training opportunities, cultural relevancy, and translation assistance. The researchers will conduct community presentations in Barrow and Kotzebue to demonstrate the up-dated Jukebox to the residents and local educators. The Jukebox will be linked with other relevant national databases, such as the Exchange for Local Observations and Knowledge of the Arctic (ELOKA). All recordings will be accessioned into the Oral History Collection at the Alaska and Polar Regions Collections and Archives at UAF's Elmer E. Rasmuson Library.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 2013-2018

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $100,000
plus Joint Funding (~$750,000)

Period of Performance: FY 2015-2019

Conducting Organization: North Pacific Research Board; Alaska SeaLife Center

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 1,000 people attended the most recent Symposium, 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 2016, there were separate workshops on a BOEM funded study, Arctic Ecosystem Integrated Survey, updates on the studies funded jointly through the Coastal Marine Institute at the University of Alaska, Fairbanks,

discussions on Walrus 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: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: $501,500
plus Joint Funding ($497,424)

Period of Performance: FY 2013-2018

Conducting Organization: CMI, UAF

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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: The BOEM *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program 2012-2017* includes a lease sale in the Cook Inlet Planning Area in 2017. 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 Cost: $450,000
plus Joint Funding (~$200,000)

Period of Performance: FY 2015-2018

Conducting Organization: Moran Environmental Recovery LCC

BOEM Contact: Catherine Coon

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.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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

Conducting Organization: NPRB

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: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Community Web Access to WRF Atmospheric Model Results and Meteorological Station Data, 1979-2009 (AK-16-03)

BOEM Information Need(s) to be Addressed: This project will assist BOEM in meeting new "Open Data policy" requirements so that significant data products produced from BOEM-funded efforts are made available for further use by broader scientific research communities and the general public.

Total Cost: $74,277 **Period of Performance:** FY 2016

Conducting Organization: Alaska Ocean Observing System (AOOS)

BOEM Contact: Warren Horowitz

Description:
Background: BOEM recently completed a study called *Beaufort and Chukchi Seas Mesoscale Meteorology Modeling* (OCS Study BOEM 2012-0119). The major study product was the Chukchi–Beaufort High-Resolution Atmospheric Reanalysis (CBHAR) using the Weather Research and Forecasting (WRF) model. The CBHAR produced near surface, high resolution (10 Km) atmospheric model output for the Beaufort and Chukchi seas Outer Continental Shelf (OCS), including the offshore and onshore areas of Russia, Alaska, and Canada. The CBHAR spanned the years between 1979-2009. Another study product was a complimentary set of observational data comprised of over 260 meteorological stations, covering the CBHAR spatial and temporal model domain. The large volume of data is currently inaccessible to the broader scientific community because of processing costs. Funds are needed to archive, display, and serve the model output and observational data as an accessible data product. The Alaska Ocean Observing System (AOOS) data management team will load the CBHAR and corresponding observational archive into the AOOS data system for long term storage and for serving out to the broader user base. Both the model and observational data will be made available for visualization, analysis and access through several existing tools already available at AOOS.

Objectives: The objective of this project is to make the CBHAR (1979-2009), the associated meteorological observational data for the same period, and the Weather Research and Forecasting (WRF) model from the BOEM Air Quality study (2009-2013) available for open use by scientific research communities and the general public.

Methods: The data team will review the model data to document the climate and forecast (CF) metadata conventions. The data will be processed, uploaded to the AOOS online data portal and linked to available visualization and analysis tools. The

meteorological observational archive will be migrated from existing formats to CF compliant NetCDF (network Common Data Form) files for posting on the AOOS data portal. Query tools will provide the user with the capability to extract subsets of the model and observational data for external use.

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): All Planning Areas

Administered By: National Program

Title: Enhancement of the Environmental Studies Program Information System and the Multipurpose Marine Cadastre to Provide Environmental Studies Program Data (NT-12-01)

BOEM Information Need(s) to be Addressed: The OCS energy extraction process requires physical, biological, oceanographic and social science information at all stages from leasing through exploration and production, to decommissioning. Regulatory agencies and prospective lease holders rely on scientific studies and other data mining exercises to build their knowledge base from past and ongoing work conducted in the Alaska OCS Region. A web-based visual display of completed and ongoing study efforts will assist BOEM in (1) planning new research, (2) promoting collaboration with other agencies on similar projects, (3) evaluating exploration and development plans, and (4) improving BOEM decision-making to safeguard activities on the OCS.

Total Cost: $1,700,000 **Period of Performance:** FY 2012-2016

Conducting Organization: NOAA-Coastal Services Center

BOEM Contact: Rick Raymond

Description:

Background: BOEM places digital copies of final study reports online. However, it remains challenging to process some report information efficiently, such as study boundaries, data collection efforts, or conclusions from multiple study efforts. It is also a challenge for internal BOEM staff to remain current with all research due to the volume of activities conducted within the OCS planning areas. BOEM as well as other agencies and academia have identified a statewide need for a centralized database of past, present and future projects with associated observations.

This study will design, develop, document, and implement a BOEM Internet Geospatial Web Portal utilizing the online Environmental Studies Program Information System (ESPIS) database Browser and the Marine Cadastre spatial data tool for BOEM completed and ongoing environmental studies that can be queried and displayed by internal BOEM staff and other agencies. The project is national in scope and will include a subcontract dedicated to service information needs for the Alaska OCS Region.

Objectives:

- Develop a BOEM Environmental Studies project database that can be fully utilized to query, graphically display, and extract project specific information.

- Develop programming tools that would allow BOEM staff and others to query, display, and extract available spatial data sets collected from each study.
- Automate the updating of new studies project information through development of programming tools that can seamlessly import BOEM Environmental Studies project information from newly completed or existing studies into ESPIS and the Marine Cadastre.
- Develop programming tools that can automatically search, retrieve, upload and merge project specific information and data from other State and Federal agencies, and industry, into the BOEM project database and data directories.
- Develop a BOEM Geospatial Website User Interface and Graphical Display whereby users can query, display, and extract project specific information, and display and extract BOEM Environmental Studies data sets covering the Alaska OCS.
- Provide complete documentation on the database and user interface application.
- Provide a user manual and train internal staff on the use of the BOEM Geospatial Web Portal.
- Provide online documentation for external users.

Methods: Under this study, NOAA-Coastal Services Center and BOEM internal staff will gather environmental studies project information and available data in a concerted effort to make information readily available to BOEM staff and other agencies. This effort will centralize functions to collect, catalogue, and distribute BOEM Environmental Studies project information and associated project studies data gathered since 2000. A BOEM web link will interface with ESPIS and the Marine Cadastre displaying maps of project boundaries, link to project specific information, data, metadata, and reports.

Revised Date: July 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): All Planning Areas

Administered By: National Program

Title: Developing BOEM's Access to Protected Species Occurrence Data for Impact Analyses and Rule-making (NT-14-02)

BOEM Information Need(s) to be Addressed: The Bureau of Ocean Energy Management needs ready access to information on marine protected species distribution for marine spatial planning, environmental impact assessments, rulemaking, adaptive management decisions, and day-to-day oversight of OCS operations to avoid or mitigate adverse impacts to protected species and other marine animals. A registry of protected species datasets is needed to provide BOEM analysts and decision-makers with basic support in the discovery and use of information resources.

Total Cost: $201,096 **Period of Performance:** FY 2014-2018

Conducting Organization: USGS, OBIS-USA

BOEM Contact: Jonathan N. Blythe

Description:
Background: Observations of protected species come from many and various monitoring programs and scientific research projects. Biogeographic databases are integrative tools for combining the scientific knowledge on species distribution. These databases focus on common elements of species observational effort, such as the record of a species occurrence. These data have many applications beyond the initial program or project, and in many cases, there are many routine aspects of these observational efforts that could be automated for more timely delivery of the information.

Typically, processing of observations into an archival format depends on program or project-level timelines for delivering the observation data, which may cause months or longer delays between collection of such observations and availability of information to the public. By the time data are made available using this method of data development, interest in the data or applicability to topical resource management issues, such as the navigation or siting of a drilling operation, can be greatly reduced. Federal agencies in collaboration under the Subcommittee on Ocean Science and Technology have been building an architecture to capture, store, make available and archive marine biological data. This data system provides the basic infrastructure for synthesizing disparate data from multiple research projects using many different methods of observations and platforms from which to make the observations.

The Ocean Biogeographic Information System of the United States of America (OBIS-USA) is the U. S. Federal node for the international OBIS system, and it resides within the U.S. Geological Survey. OBIS-USA is evolving to fulfill the data needs of partnering

organizations, and has served BOEM's needs by developing an archive for protected species observations. OBIS is a distributed data system that has been pivotal in performing this service for Federal biogeographic data needs. OBIS-USA plays an important coordination role, interfacing with other Federal entities, such as the U. S. Integrated Ocean Observing System (IOOS) and the National Oceanic Atmospheric Administration's National Oceanographic Data Center (NODC), and international entities such as the International OBIS and the Global Biodiversity Information Facility (GBIF). Of particular relevance, OBIS-USA leverages its relationship with OBIS-SEAMAP to provide for Federal needs for protected species data. Ongoing efforts include CetMap/ NOAA marine mammal modeling project, development of passive acoustic monitoring data and an online portal for Navy data and models, and the near-real-time delivery of sea turtle tracks.

Objectives:

- Improve timeliness and quality of data availability to BOEM personnel
- Use existing Federal resources for data management, including NODC and IOOS
- Engage in data sharing arrangements with interagency partners such as NOAA and the US Navy while maintaining a secure venue to conduct operations
- Implement automation of routine tasks such as enrollment, dissemination, modeling, and mapping for recently collected protected species data

Methods: This study will be conducted by the OBIS-USA/OBIS-SEAMAP partnership, which is uniquely qualified to produce the desired products. OBIS will evaluate experimental tools from the biogeographic community, such as the GBIF Integrated Publishing Toolkit, to develop techniques to better interface with data producers. Additionally, OBIS will evaluate the benefits and dangers of early data sharing, and trade-offs that this may present in terms data quality and publication. Subjects of interest are 1) methods to develop the adequate context to understand recent marine mammal location observations for siting decisions, 2) modeling to detect patterns and trends in marine mammal distribution, 3) tools to identify outlier observations to target adaptive sampling capabilities, and 4) visualizations of protected species data that help identify information needs for future BOEM funding.

Revised Date: August 2016

2.2 Profiles of Studies Planned for FY 2017

Table 1. BOEM Alaska OCS Region Studies Planned for FY 2017

Page Number	Discipline	Study Title
163	FE	Oil-Spill Occurrence Estimators for the Alaska Outer Continental Shelf
165	HE	Arctic Integrated Ecosystem Survey, Phase II
167	MM	Aerial Surveys of Arctic Marine Mammals (ASAMM) – Personnel and Aircraft Needs
169	PO	Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea
171	RE	Wave Energy Converter Impact Assessment
173	HE	Marine Bird Distribution and Abundance in Offshore Waters

Discipline Codes	
AQ = Air Quality & Meteorology	FE = Fates & Effects
HE = Habitat & Ecology	IM = Information Management
MM = Marine Mammals & Protected Species	PO = Physical Oceanography
RE = Renewable Energy	SE = Social & Economic Sciences

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Oil-Spill Occurrence Estimators for the Alaska Outer Continental Shelf (AK-16-04)

BOEM Information Need(s) to be Addressed: The Oil-Spill-Risk Analysis (OSRA) is a cornerstone to regional EISs, 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 in the 2017-2022 time period, concurrent with the next BOEM Five-Year Program. The project will incorporate fault-tree spill occurrence estimators into NEPA analyses for activities in the Arctic.

Total Cost: TBD **Period of Performance:** FY 2017-2022

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.

- Obtain updated 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 during the 2017-2022 Five-Year Program.

Methods: 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) 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; 3) provide updated fault tree analyses 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; 4) provide additional 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; 5) provide a formal report documenting each analytical or fault-tree update, and 6) 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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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 Cost: TBD **Period of Performance:** FY 2017-2021

Description:

Background: Arctic fishes such as Arctic cod, capelin and saffron cod are key components of the Arctic food web and contribute to supporting large numbers of seabirds and marine mammals who migrate to the Arctic to take advantage of high seasonal production. There have been a variety of surveys with different gear types, primarily a small-mesh beam trawl sampling benthic fish resources. The first comprehensive bottom trawl surveys sampling larger fishes were conducted in the western Beaufort Sea in 2008 and in the Chukchi Sea in 2012. The first comprehensive surface and mid-water trawl/acoustic survey in the Chukchi Sea was conducted in 2012/2013. This survey documented for the first time large abundances of young-of-the-year Arctic cod in the northern Chukchi Sea. Their origin (spawning areas) and fate (nursery areas) are unknown at present.

A similar survey has not been conducted in the western Beaufort Sea, and the connectivity of fish populations between the Chukchi Sea and the Beaufort Sea has not been fully assessed. The proposed survey would repeat the 2012 Chukchi Sea survey in summer 2016 to allow direct comparisons of distribution and abundance of fishes and extend the survey around Barrow into the Beaufort Sea. It will provide the first synoptic assessment of fishes in the surface waters and in mid-water throughout the Beaufort Sea. To the extent possible, the spatial resolution of the survey and survey methods will be consistent with established survey designs that are routinely conducted by the National Marine Fisheries Survey in the Bering Sea to allow for geographical comparisons. The most recent targeted fisheries work in the offshore Beaufort Sea includes: the *Beaufort Sea Marine Fish Monitoring 2008: Pilot Survey and Test of Hypotheses* (OCS Study BOEMRE 2010-048); the *Beaufort Sea Marine Fish Monitoring Survey in the Central Beaufort Sea* (AK-10-06); and the *U.S.-Canada Transboundary Fish and Lower Trophic Communities* (AK-12-04). This project is a

second phase of the study *Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area* (AK-11-08a; AK-11-08b), also known as the *Arctic Ecosystem Integrated Survey* or Arctic EIS.

Objectives:

- Quantify the distribution, abundance, and condition of demersal fishes throughout the U.S. shelf waters of the Chukchi Sea and 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 Beaufort Sea.
- Establish whether juvenile salmon utilize the coastal waters of the Beaufort Sea during late summer and determine their likely origin.
- 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.

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, in a manner similar to surveys conducted in the Canadian Beaufort Sea.

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 to an Integrated Ecosystem Assessment.

Revised Date: August 2016

nvironmental Studies Program: Alaska Annual Studies Plan FY 2017

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-16-01c; AK-16-01d)

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, MMPA documentation, and decision-making in the Beaufort and Chukchi Seas.

Total Cost: TBD **Period of Performance:** FY 2017-2019

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 US and form an important part of the diet and cultural base for most people in villages along the Chukchi coast. Having a good understanding of the seasonal distribution, relative abundance, and habitat use of marine mammals in the Chukchi Sea 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 in the Chukchi Sea. 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.

Since 1979, aerial surveying of the fall migration of the bowheads has been conducted, initially by the Bureau of Land Management and subsequently by MMS, now BOEM. This is one of the longest-maintained monitoring 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 Interagency Agreement between NMFS and BOEM will fly 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 shall follow protocols used by the BOEM in the past surveys of the bowhead fall migration. The scientists will be responsible for the management of this project, all necessary training of support personnel, providing all needed field equipment, conducting all logistical tasks, acquiring all necessary permits, and insuring the safety of all people involved.

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Wave and Hydrodynamic Modeling in the Nearshore Beaufort Sea

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 on 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 Cost: TBD **Period of Performance:** FY 2017-2021

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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): All Alaska Planning Areas

Administered By: Alaska OCS Region

Title: Wave Energy Converter Impact Assessment

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 economic 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 Cost: TBD **Period of Performance:** FY 2017-2019

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 economic 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 economic 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 offshore project area 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 economic viability of wave energy projects in Yakutat and other areas of coastal Alaska.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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

Administered By: Alaska OCS Region

Title: Marine Bird Distribution and Abundance in Offshore Waters

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 Cost: TBD **Period of Performance:** FY 2017-2021

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 2016

2.3 Profiles of Studies to be Considered for FY 2018

Table 2. BOEM Alaska OCS Region Studies to be Considered for FY 2018

Page Number	Discipline	Study Title
177	HE	Identifying Sea Otter Abundance, Distribution, and Foraging Patterns in Cook Inlet Alaska, using Unmanned Aircraft
179	HE	Updating Status and Trends of Seabirds and Forage Fish in Lower Cook Inlet
181	HE	Arctic Slope Winter Fish, Invertebrates, and Arctic Cod Spawning Survey
183	MM	The View from Above: Continued Life-History Analyses of Bowhead Whales via Aerial Photo-Identification
185	HE	Extension of the Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring
187	PO	Enhanced Verification and Interpretation of Freeze-up Conditions for the Northeast Chukchi Shelf and Beaufort Sea OCS
191	PO	Assessment of Multiple Ocean Circulation Models to Support Ensemble OSRA Experiments
193	SE	Impact Assessment of Kaktovik Whaling Activities
195	MM	Year-Round Marine Mammal Distribution in the Lower Cook Inlet Region
197	MM	Ice Seal Movements and Foraging: Village-based Satellite Tracking of Ringed and Bearded Seals (Extension)
199	SE	Polycentric Governance in Barrow, Nuiqsut, and Wainwright

Discipline Codes	
AQ = Air Quality & Meteorology	FE = Fates & Effects
HE = Habitat & Ecology	IM = Information Management
MM = Marine Mammals & Protected Species	PO = Physical Oceanography
RE = Renewable Energy	SE = Social & Economic Sciences

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Identifying Sea Otter Abundance, Distribution, and Foraging Patterns in Cook Inlet Alaska, using Unmanned Aircraft Systems (UAS) and Manned Aircraft

BOEM Information Need(s) to be Addressed: This study will provide valuable data on sea otter distribution, abundance as well as information about feeding areas utilized by sea otters, and the overlap between important sea otter feeding habitats and oil and gas lease areas essential for pre-lease and post-lease assessments. This research will form baselines for monitoring oil and gas related developments that are undertaken in Cook Inlet. Results from this study will support NEPA analysis and documentation for future lease sales in Cook Inlet under the 2017-2022 Proposed Program, as well as NEPA analysis related to EPs and DPPs.

Total Cost: TBD **Period of Performance:** FY 2018-2021

Description:

Background: Following historical near-extirpation, a remnant sea otter population persisted on the west side of lower Cook Inlet, with nearly 7,000 inhabiting the Kamishak Bay area in 2002. However, sea otters did not reoccupy the east side of the Inlet until the 1960s. By 2002, the year of the last full survey, nearly 1,000 sea otters inhabited Kachemak Bay and by 2012 numbers were estimated to have reached 6,000. Currently, sea otters are thought to be expanding their range north along both sides of Cook Inlet. Seismic survey work in support of potential future oil and gas exploration activity began in 2014 along the east side of lower Cook Inlet moving northward from Anchor Point. However, effects of seismic activities and future oil and gas infrastructure on sea otter behavior and habitat use are not well documented. Decision-makers are keenly interested in understanding potential effects of seismic exploration and oil and gas development activities on sea otters. This study plans to quantify abundance, distribution, and habitat use of sea otters in Cook Inlet, and advance the technological tools needed to efficiently conduct this work. UAS-based surveys have the potential to be cheaper to operate, eliminate human risk inherent in low-level survey flights and may cause less disturbance to sea otters and other marine birds and mammals during operations. In addition, the post-processing nature of UAS-based survey analyses provides the opportunity to quantify other wildlife species encountered during surveys.

A better understanding of the use of lower Cook Inlet by sensitive species including cetaceans, sea otters, pinnipeds, and seabirds is needed to evaluate the potential effects of oil and gas exploration, development, and production in the area. Sea otters are protected under both the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA), and are an important component of nearshore marine communities. Assessment of current sea otter status and quantification of effects of

development activities on sea otter behavior and habitat use are needed to evaluate potential consequences of offshore seismic and drilling activities in the Cook Inlet.

Objectives:

- Document sea otter abundance, distribution, habitat use, and foraging ecology in Cook Inlet in relation to oil and gas development activities using UAS and manned aircraft.
- Identify sea otter habitats within Cook Inlet that are of specific importance for foraging, resting, and pup rearing.

Methods: Traditional methods to gather sea otter abundance and forage data rely on manned aerial observations and shore-based observations, respectively. This study will use these traditional aerial survey methods while also developing and applying methods using UAS technology, which holds great potential for efficient, safe, and un-biased collection of survey and foraging data. This will allow for a robust estimation of otter abundance using a proven census technique (manned aerial surveys) and allow a validation of a new method (UAS). This study will use traditional manned aerial surveys and forage observation methods to document the current status of sea otters in Cook Inlet that will serve as a baseline for future comparisons of similar UAS-derived data. Preliminary UAS work conducted in spring 2015 in cooperation with the Alaska Center for Unmanned Aircraft Systems Integration (ACUSI) demonstrated that sea otters were relatively tolerant of small rotary-wing unmanned aircraft vehicles (UAVs) hovering overhead, indicating that collection of offshore sea otter forage data from a UAV carrying a high resolution camera in the OCS is feasible.

Research goals include choosing optimal sensors that can capture high-definition observational data and fine-tuning UAV-based data acquisition methods. UAV-based forage observation methods will eliminate the nearshore bias of land-based foraging observation methods, and will allow identification of important offshore foraging habitat in Cook Inlet. Survey development will include choice of sensor(s), flight pattern optimization, and development of statistical procedures to account for diving sea otters unavailable during single overpasses. UAS-based surveys will allow cost-effective sea otter surveys at the temporal and spatial scales (e.g., daily at 100 km^2) necessary to document sea otter distribution and use patterns (e.g., "hot-spots" of persistent use) before, during and after seismic surveys and oil and gas exploration activities. In addition, the lower cost of UAS surveys will allow multi-replicate, seasonal abundance surveys in lower Cook Inlet that will document changes in sea otter distribution and hot-spot patterns in the presence of drilling platform infrastructure. Importantly, UAS-based surveys will provide economical collection of distribution information on sea otters and other marine species even before statistical methods for abundance estimates are finalized. The combination of survey and forage data will allow assessment of the effects of oil and gas activities on sea otters and potentially other marine mammal and bird species. Ultimately, we anticipate that UASs will be used exclusively for collecting these data in the future.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Updating Status and Trends of Seabirds and Forage Fish in Lower Cook Inlet

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 Cost: TBD **Period of Performance:** FY 2018-2022

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:

- 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 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Arctic Slope Winter Fish, Invertebrates, and Arctic Cod Spawning Survey

BOEM Information Need(s) to be Addressed: BOEM requires spatial and seasonal information about fish in the Chukchi and Beaufort Seas to provide complete and accurate Arctic Essential Fish Habitat and NEPA analyses. A greater understanding of Arctic cod's ecological role as both the most abundant predator and most abundant prey is needed to support analysis of the potential effects of oil and gas exploration, development, and production in the Beaufort Sea ecosystem. The under-studied winter season and the location of suspected Arctic cod spawning habitat is of increasing public concern and this information is especially important for EFH and NEPA analyses, including the potential effects of oil trapped under ice.

Total Cost: TBD **Period of Performance:** FY 2018-2022

Description:

Background: Arctic fish fill an essential Arctic ecosystem role by consuming small prey and in turn providing a food resource for larger fishes, birds, marine mammals, and people. Isolation of fish from scientific study by thick ice cover during three-fourths of the year and the majority of their lives limits our understanding of Arctic fish ecology.

By virtue of Arctic cod's dominance and ubiquity across the OCS and throughout the water column, it would be difficult to overstate its importance as the primary conduit through which an estimated 93% of lower trophic production funnels to the surface where many higher trophic predators live. To assess direct and cascading effects from potential oil and gas development on Arctic cod, and cumulative effects from climate change, it is important to understand whether this ecologically dominant and critical species is ice-obligate in one or more of its life stages and therefore at risk of extirpation in U.S. waters as the ice recedes. This study will also provide information about the interdependent roles of epibenthic invertebrate prey and the secondarily dominant snailfish, eelpouts, and sculpins, which are even less understood than Arctic cod.

The body of recent research on Arctic cod will inform this project. For example, BOEM-funded genetic studies are elucidating possible on-shore and off-shore genetic stock differentiation for Arctic cod, while open-water surveys underscore the importance of continental slope areas with recent Canadian Beaufort research suggesting Arctic cod spawn on the continental slope. In addition, the large influence of the continental slope biota and oceanography on the continental shelf ecosystem was highlighted by recent BOEM oceanography, fish, and invertebrate surveys that documented increased diversity, abundance and larger sizes along the slope. Alaskan scientists have also implemented an individual-based model that uses oceanographic currents to identify locations of larval Arctic cod caught in BOEM surveys with their likely spawning

grounds. Furthermore, scientists at the Alfred-Wegener Institute recently published on the successful adaptation of nets that can fish directly under the ice, simplifying the logistical challenges of capturing fish in their winter habitats. This recent understanding combined with new research methods have dramatically improved our capabilities, making it more feasible to study fish under winter ice and to search for critical Arctic cod spawning habitat.

This study will improve our understanding of under-ice fish ecology, the fundamental energy transfer role fish play in Arctic food web dynamics to upper trophic predators and how the ecological relationships may be influenced by climate change. Understanding this ice-covered world is of increasing importance as rapid loss of multi-year pack ice is radically altering distributions of marine mammals in the Arctic OCS as they are forced to adapt to climate-related changes in access to prey.

Objectives:

- Establish a winter fish and invertebrate monitoring baseline under the ice along the continental slope in the U.S. Beaufort Sea.
- Increase understanding for relationships among winter fish ecology, trophic interactions, and oceanographic conditions in the U.S. Arctic.
- Identify spawning times and locations of Arctic cod along the Beaufort continental slope and coast.

Methods: This study will conduct under-ice field surveys along the continental slope in the Beaufort Sea to elucidate the seasonal fish distribution and abundance, targeting Arctic cod spawning times and locations in particular. Sampling will also include crab and lower trophic organisms, genetics, energetics, and stable isotopes where possible. The project will engage local coastal residents to participate in the research and provide local and traditional knowledge about winter fish ecology. An Arctic cod spawning workshop including international Arctic cod experts, planned for January 2017, may provide information for refining planned methodologies, as well as opportunities for international collaboration.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: The View from Above: Continued Life-History Analyses of Bowhead Whales via Aerial Photo-Identification

BOEM Information Need(s) to be Addressed: BOEM needs information regarding important life history parameters of bowhead whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort Seas (BCBS) stock. Results from this study will support evaluations of the potential effects of oil and gas exploration, development and production activities on marine mammals as required under NEPA, the Endangered Species Act (ESA), and the Marine Mammal Protection Act (MMPA). Data from this project will inform NEPA assessments for lease sales, EPs, and DPPs in the Chukchi and Beaufort Seas.

Total Cost: TBD **Period of Performance:** FY 2018-2020

Description:

Background: The bowhead BCBS population is one of the most important subsistence animals for many Native communities in northern and western Alaska. The harvest is managed by the International Whaling Commission (IWC) and basic biological data are essential for setting safe harvest levels. After being severely depleted by commercial whaling in the 1800s, research indicates that this population is recovering well; however, that cumulative effects of arctic shipping, commercial fishing, climate change, and oil and gas exploration could slow population recovery. Since the mid-1970s, monitoring of the BCBS population has been primarily through ice-based surveys conducted near Barrow, Alaska. A future on-ice census may be attempted, but due to deteriorating ice conditions (related to climate warming and sea ice loss), it may be necessary to transition to aerial surveys and photo-identification mark-recapture studies for monitoring the BCBS stock. The proposed project offers a unique opportunity to match more than 30 years of aerial photos in the master catalog. This information will be valuable for (a) estimating population size and trends via capture-recapture modeling, (b) estimating survival rates far more accurately and precisely; (c) determining calving intervals; (d) evaluating changes in fishing-gear entanglements and ship strikes.

The bowhead photo-id program, which is currently managed by NOAA's Marine Mammal Laboratory (NOAA-MML), the North Slope Borough (NSB), and LGL Canada, was started by NOAA-MML, Cascadia, and LGL in the early 1980s to begin addressing questions about bowhead life history, of which very little was known. The urgency was in part from the IWC moratorium on the subsistence hunt of bowhead whales by Alaska Natives. The program grew in sophistication and was conducted intensively through the 1980s and early 1990s to investigate important life history questions, in particular calf production rates, as well as questions regarding the effects of oil and gas activities on bowhead whales. While few surveys were done from 1992 to 2002, two remarkably

successful aerial photogrammetric surveys were conducted in 2003 and 2004, funded by NSB with logistical support by LGL. In 2011, aerial photographic surveys for bowhead whales were conducted near Point Barrow, and a mark-recapture analysis is underway using the 2011 data. Further, photographs are still being collected during NMFS aerial surveys so the database spans from 1982-2015.

The collection includes at least 21,000 images of more than 13,000 individuals. However, the photo matching effort is sporadic and incomplete, although each additional inter-year re-identification provides essential information for the basic biology, conservation, and management of bowhead whales. Between the collections maintained at NOAA-MML in Seattle, WA and at LGL in King City, Ontario, there are about 5500 (naturally) marked bowhead whales in the photographically captured population (1985 -2011), representing roughly 30% of the individuals in this stock.

Objectives: The goal of this study is to assist with continuation of the NSB/NOAA-MML/LGL bowhead whale photo-identification program to:

- Evaluate the population size and trend of the BCBS bowhead whale stock.
- Refine existing estimates of individual growth rates, survival rates, calving intervals, scar accumulation, and estimated ages.
- Analyze anthropogenic injuries to bowhead whales from fisheries gear entanglement and killer whale (scarring) injuries
- Test working hypotheses about bowhead life history parameters using photo-id, including: high individual survival rates, extremely high longevity, delayed age at maturity (ca 25 years), and 3-4 year calving intervals.

Methods: Standard protocols established by NOAA-MML will be used to complete inter-year matching of aerial photographs of bowhead whales primarily taken during their spring migration past Point Barrow for the years 1985 to 2011. These aerial photographs will be used to identify individual whales. Proven scientific methods will be used for analyses such as mark-recapture abundance estimation, estimation of survival rates, calving intervals, and measurement of individual growth rates.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Extension of the Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring

BOEM Information Need(s) to be Addressed: BOEM needs a 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. Developing a biodiversity observing network can fulfill these objectives and serve as a prototype for other regions. The initial phase of AMBON was funded through the National Oceanographic Partnership Program (NOPP). Continuation of the program is necessary to accomplish the goals of sustained biodiversity observations to inform assessments of OCS energy development, management and decision-making related to oil and gas lease sales and potential future exploration, development and production, as well as monitoring of resources for invasive species and climate-induced changes that affect ecosystem functioning.

Total Cost: TBD **Period of Performance:** FY 2018-2021

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. This study 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.

While the knowledge of marine biodiversity has greatly increased over the last decade, we are lacking systematic and sustainable approaches to observing and monitoring biodiversity across different levels and at a national scale. In 2014, a Marine Biodiversity Observing Network (BON) was established for the Chukchi Sea through the National Oceanographic Partnership Program (NOPP), with partnerships from BOEM, NOAA, and Shell Industry. The Arctic Marine Biodiversity Observing Network (AMBON) project, led by the University of Alaska Fairbanks, is an end-to-end marine BON. "End-to-end" refers to integration of observations and historical data across multiple scales of diversity (genetic to ecosystem, microbes to whales), time (instants to centuries), and space (in situ to satellite remote sensing). The initial phase of the

AMBON project is working to establish the metrics to be measured, define temporal and spatial scales of measurements, initiate an Arctic network through data sharing, and contribute to a national effort to create a national BON prototype.

To be a useful tool in managing marine resources, mitigate human-induced or climate-related impacts, and provide sound basis for risk assessment, continuous data are necessary through a sustained monitoring network. The assessment of possible adverse impacts 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 especially making the observations continually over multiple years and even decades to acquire reasonable statistical confidence.

Objectives: The objective of this study is to build on emerging Distributed Biological Observatories (DBOs) and the initial phase of the AMBON project by developing a prototype ecosystem-based marine biodiversity network over the Chukchi Sea Planning Area, monitoring multiple trophic levels and species. Informed by historical data, past modeling efforts, and the initial field work of the AMBON project, the network will: expand upon planned and recently-launched observing sites, systems, and programs; employ innovative techniques for data discovery and methods that dynamically interrelate data sets to add value to existing monitoring data; and collaborate with the U. S. Integrated Ocean Observing System (IOOS) participants and funding agencies to optimize data management and modeling capabilities.

Methods: AMBON employs an end-to-end approach, studying biodiversity from microbes to whales. The approach is through field work of sampling all biodiversity components along a fixed station grid (see www.ambon-us.org). Current funding supports field work in 2015 (completed) and 2017. Additional funds will be used to continue field observations along this sampling grid in 2018 and 2019 to continue time series.

Specific ecosystem components that will be sampled include: hydrographic conditions, water column chlorophyll and phytoplankton, zooplankton, water column and sediment microbes, sediment macro-infauna, benthic epifauna, pelagic and demersal fishes, seabird, and marine mammals. Samples will be collected with traditional CTD, nets, grabs, and through observations. Biological samples will be processed to the highest taxonomic resolution possible. Biological data will be linked to environmental data collected concurrently, and also to mooring data in the sampling region. Data will be analyzed for each biological component, but also in an ecosystem approach (Do all components show similar trends? What are the temporal and spatial scales of variability?, etc). In addition, AMBON-produced data will be linked to existing data streams from past and other ongoing research efforts through the AOOS database network to assess the full suite of biodiversity in the system and to elucidate longer-term trends, where possible. Information on AMBON and its results will be presented through scientific conferences, peer-reviewed publications, and also public lectures and other outreach venues to a wide variety of stakeholders.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Enhanced Verification and Interpretation of Freeze-up Conditions for the Northeast Chukchi Shelf and Beaufort Sea OCS

BOEM Information Need(s) to be Addressed: BOEM needs to develop new data analysis methods to improve sea ice forecasting capabilities and to document a "trigger date range" for determining the end of the drilling season in response to submitted exploration plans for the OCS in the Chukchi or Beaufort Seas. BOEM analysts and managers seek more detailed spatio-temporal atmospheric, oceanographic, and sea ice data pertaining to seasonal freeze-up conditions in the vicinity of specific planned drilling locations on the Alaska OCS. More reliable and extensive information is particularly needed during the late open-water season and during the seasonal freeze-up period when frazil ice formation can create environmental concerns regarding response to spilled oil. Additional information pertinent to understanding the physical processes associated with freeze-up and associated forces that greatly impact Arctic OCS operations is also needed. Study products will support NEPA analyses for EPs and DPPs, and other BOEM decision-making needs.

Total Cost: TBD **Period of Performance:** FY 2018-2022

Description:

Background: Real-time information on ice, ocean and weather conditions, along with improved ice forecasts for the Beaufort and Chukchi Seas, are important considerations for maritime traffic and vessel safety, as well as for evaluating potential storm impacts on the coast. In addition, accurate forecasts of freeze-up conditions are especially valuable for the remote coastal communities in northern Alaska where fuel, durable goods and food are primarily resupplied by barge, and decisions are required 10-12 days in advance for delivery from west coast ports.

BOEM developed a restriction on certain late season drilling operations within the Chukchi Sea to allow a greater opportunity for oil-spill cleanup and response time in ice-free conditions. This mitigation measure, implemented with respect to a Chukchi Sea exploration plan, was established "in consideration of the distance to limited support infrastructure on the Chukchi coast, as well as limited drilling experience in the Chukchi Sea, and in keeping with the Secretary of Interior's desire to proceed cautiously with oil and gas development in the Chukchi Sea." The mitigation measure states that no exploratory drilling will be allowed below the last casing point set prior to penetrating a zone capable of flowing liquid hydrocarbons in measurable quantities into the well within 38 days of a 'trigger date' established each year by BOEM, based upon the estimated date of first ice encroachment over the drill site derived from historical data. In December 2014, BOEM analyzed 10 years (2005-2014) of National Ice Center interpreted sea ice data to calculate a range of dates that ice would first encroach within

30 Km of the proposed Burger drilling location planned for the 2015 open water drilling season in the northeast Chukchi Sea. The ice encroachment date for all years, ranged between October 24th and November 13th. From those dates, BOEM calculated a median date of first ice encroachment and called it the "trigger date". The trigger date was November 2nd for the proposed Burger drilling location. In 2015, at the end of the drilling season, BOEM calculated a final ice encroachment date of November 13th. Therefore, the first encroachment of sea ice in 2015 was eleven days later than the "trigger date", but fell within the maximum range of ice encroachment dates, based upon our analysis of ten years of sea ice data. Therefore, BOEM needs to improve its data analysis and methodology to more accurately produce a "trigger date" or "trigger date range" to account for the variability in sea ice conditions that can occur in a given drilling season. This "trigger date range" could be adjusted during the drilling season based upon an up to date forecast of sea ice conditions for the area.

Objectives:

- Document the atmospheric and oceanographic conditions that initiated freeze-up conditions on the northeast Chukchi shelf between 2006 and 2015.
- Provide atmospheric, oceanographic, and sea ice data to the BOEM Sea Ice Database at the required scales that will produce more accurate assessments of freeze-up conditions between 2007 and 2016 and beyond.
- Obtain a comprehensive understanding of the processes and feedback mechanisms that drive the ice-ocean-wave-atmosphere system by documenting the physical ice, ocean, and atmospheric processes controlling freeze-up within active lease areas.
- Provide real-time ice, ocean, and atmospheric data from this study to BOEM for incorporation into the BOEM Sea Ice Database for the purpose of improving BOEM's internal forecasting capability.
- Provide standardized real-time data to the National Weather Service (NWS) Forecasters, National Ice Center (NIC) Ice Analysts, and to NOAA modelers to improve late season modeled forecasts of freeze-up conditions.
- Develop improved "weather scale" forecasts of freeze-up conditions for the OCS in the Beaufort and Chukchi Seas in coordination with BOEM, BSEE, the National Weather Service forecasters, National Ice Center ice analysts and NOAA modelers.

Methods: Researchers will collect and analyze historical ocean, ice, wave and atmospheric field data (2007-2016) that best explains the dynamic environment processes that govern the seasonal freeze-up of sea ice. They will design and implement a comprehensive field program that will provide real-time data to forecast the timing of new ice formation during the fall freeze-up period. Instrumentation may include: High frequency Radars, drifters, gliders (AUVs) and the design and development of new sensors. Real-time data will be provided to NOAA for use by modelers, ice analysts and National Weather Service forecasters. Researchers will develop a project web portal which can provide near-real-time information on the ocean, atmosphere, and sea ice

conditions and display graphical hindcasts and forecasts of freeze-up conditions. BOEM will collaborate with the State of Alaska (University of Alaska Fairbanks and other State entities) in assessing ice conditions during the freeze-up period.

Revised Date: August 2016

This page left blank intentionally.

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

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

Administered By: Alaska OCS Region

Title: Assessment of Multiple Ocean Circulation Models to Support Ensemble OSRA Experiments

BOEM Information Need(s) to be Addressed: Oil-Spill-Risk Analysis (OSRA) is a cornerstone foundation for evaluating alternatives in OCS oil and gas leasing NEPA analyses and oil spill response plans. This study would support continuing improvement of the BOEM oil-spill trajectory model and its application in the Arctic and provide additional baseline information for NEPA analyses. Oil-spill issues constitute a significant portion of public comments submitted on NEPA documents related to proposed lease sales, EPs, and DPPs in the Alaska OCS Region.

Total Cost: TBD **Period of Performance:** FY 2018-2020

Description:

Background: To assess potential changes in the marine and coastal environment associated with offshore oil and gas development activity, it is important to understand how key environmental variables (e.g., surface winds, oceanography, and sea ice) fluctuated in the past and are predicted to act in the future in association with climate variations. To maintain its state-of-the-art in oil-spill-trajectory analysis, BOEM seeks to take advantage through time of the increasing skill of circulation models supported by more and better data. Over the past decades, BOEM and other Federal and State agencies have invested a significant amount of resources to measure and model the circulation and variability in the Alaska coastal waters. It has been an ongoing challenge to converge on a well-validated and finer-scale ocean circulation model. Modeling the coastal circulation around Alaska is particularly challenging given its complex coastline, rapidly changing weather conditions and the relative large freshwater input from river discharge and melting ice. As a result, any single model hindcast likely has large uncertainties, and a systematic effort is required to validate these hindcast model simulations against available measurements. A multi-model ensemble is the ultimate approach to providing retrospective analyses and estimating model uncertainties for surface wind, ocean currents and waves, and sea ice in Alaska coastal waters.

Objectives:

- Assess the performance and estimate the uncertainty of simulations of ocean currents and sea ice in Alaska coastal waters from multiple ocean circulation models.
- Apply short-term surface fields from multiple ocean circulation models for the Arctic to identify the physical processes most important to oil-spill trajectory analysis and evaluate sensitivities of the various models to relevant parameters.

Methods: This study will assemble model simulations for ocean currents and sea ice from multiple ocean circulation models to support ensemble and intercomparison OSRA experiments. Observational data sets will be assembled and aggregated from a variety of sources to facilitate data-model comparisons. Sensitivity analyses may be conducted to evaluate various parameterizations relevant to OSRA within the individual models. Local observations include flow measurements from acoustic Doppler current profilers and drifters and water mass data from conductivity-temperature-depth (CTD) profilers. Deliverables would include a report outlining the strengths and weaknesses of each model in relation to processes relevant to oil-spill trajectory analysis, as well as short-term (five years) surface circulation fields from the suite of models.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Impact Assessment of Kaktovik Whaling Activities

BOEM Information Need(s) to be Addressed: BOEM needs information about the fall Kaktovik subsistence whaling effort to provide a basis for evaluation of potential effects from offshore oil and gas activities in the Beaufort Sea. Using the Cross Island whaling mitigation and monitoring as a model, this study will involve long-term monitoring engaging the participation of Kaktovik whalers to document potential effects of oil and gas exploration and development activities on Kaktovik offshore subsistence hunting. The information from this study will support NEPA analysis and documentation for lease sales, EPs, and DPPs in the Beaufort Sea.

Total Cost: TBD **Period of Performance:** FY 2018-2022

Description:

Background: The Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA), which began in 1999, and its continuation (cANIMIDA) provided baseline data and monitoring results for Cross Island subsistence whaling in the vicinity of oil industry development in the Beaufort Sea OCS. The Northstar and Liberty prospects were monitored prior to development, and Northstar was monitored through construction and into production. Currently, BOEM is preparing an EIS evaluating a development plan for the Liberty prospect that would construct an island in Foggy Bay and pipe oil to shore to connect with the Badami Pipeline.

This study will monitor subsistence whaling activities occurring from Kaktovik. It should be noted that unlike the Nuiqsut fall whaling camp at Cross Island, whaling occurs directly from the community of Kaktovik. Global positioning units to map subsistence tracks in the marine environment have never been deployed in Kaktovik, and would be used to identify boat tracks, whale sightings, and takes. Efforts will also be made to capture offshore hunting tracks for animals other than bowhead whales, to the extent practicable.

Objectives:

- Assess the variability in Kaktovik subsistence whaling over time to evaluate the degree to which local conditions (e.g., ice, weather) result in variability in spatial extent, duration of the season, and success.
- Evaluate potential effects of oil and gas exploration and development activities in the Beaufort Sea on Kaktovik whaling and other offshore subsistence activities.

Methods: This study will conduct systematic observational and interview data collection from local informants including:

1. number of whales taken;
2. GPS location of whale tracks, sightings, and strikes, with direction and distance from Kaktovik;
3. number and composition of crews;
4. periodic “census” of whaling participants from Kaktovik;
5. duration of whaling season by active days;
6. number of days that weather or sea states confined crews to shore;
7. timing of whaling;
8. length of trips and area searched while whaling;
9. records of catch per unit effort; and
10. observations of whaling participants.

The study will also record information about non-whaling subsistence activities in and near Kaktovik and observations of local subsistence users. Hard copy maps should be appended as necessary for clarification of location information. Study products will include annual reports of information on harvest levels and locations of subsistence resources taken on or near Camden Bay in both tabular and geospatial formats.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Year-Round Marine Mammal Distribution in the Lower Cook Inlet Region

BOEM Information Need(s) to be Addressed: BOEM needs updated information to establish occurrence and distribution of several species of marine mammals, including multiple endangered species. This study will provide data to support evaluations of the potential effects of oil and gas exploration, development and production activities on marine mammals as required under NEPA, the Endangered Species Act (ESA), and the Marine Mammal Protection Act (MMPA). Increased understanding of the seasonal distribution of the relevant species will assist BOEM in NEPA assessments for lease sales, EPs, and DPPs, design of temporal and spatial mitigation, and monitoring of effects of oil and gas activities. It will also assist with long-term efforts to apply the best available science to adaptively manage and minimize potential effects of oil and gas activity on cetaceans. Results will also support future ESA Section 7 consultations and recovery actions, and help promote recovery of endangered Cook Inlet beluga whales.

Total Cost: TBD **Period of Performance:** FY 2018-2021

Description:

Background: There are at least a dozen species of marine mammals that occur within lower Cook Inlet, which is the area of principal interest for OCS oil and gas exploration and developement. This area overlaps with Cook Inlet beluga critical habitat, and what little is known of this species' winter distribution from scarce sightings and passive acoustic data indicates they are present within the area. Several proposed recovery tasks will benefit from an improved understanding of Cook Inlet beluga winter habitat use. Endangered fin and humpback whales are known to be present and to feed in this and adjacent areas in significant numbers year-round, and feed intensively within and downstream of this area seasonally. Detection of the critically endangered North Pacific right whale in the bays of eastern Kodiak Island, and historical data showing catches along the southern entrance to Shelikof Strait and near the Barren Islands, demonstrate the potential presence of this ESA listed species. However, recent studies were inadequate to establish if North Pacific right whales occur in or near lower Cook Inlet. Blue whales are resident in the deeper waters of the Gulf of Alaska and may occasionally pass through the deeper portions of lower Cook Inlet and Shelikof Strait. This study will add to our collective knowledge of year-round distribution of sei, gray, killer, and minke whales, and harbor and Dall's porpoise.

Some species of cetaceans may be adversely affected by routine operations associated with OCS oil and gas exploration and development, including seismic surveys, drilling, production and shipping. Data indicate that underwater noise associated with high-energy seismic exploration may cause some cetaceans to avoid areas where seismic

exploration is occurring. Other types of activity associated with oil and gas development may disturb and modify the behavior of cetaceans, hamper their ability to communicate, navigate, forage, or avoid predators, or put them at risk from ship strike.

Objectives:

- Document the year-round spatial and temporal distribution and relative abundance of cetacean populations within the lease area, from Kalgin Island in lower Cook Inlet to the northern portion of Shelikof Strait.
- Document cetacean migratory paths and access routes to the area of principal interest in lower Cook Inlet through year-round monitoring off the Barren Islands and southwest entrance of Shelikof Strait.
- Document spatial and temporal use of the area by endangered Cook Inlet beluga whales.

Methods: This study will provide documentation on the temporal and spatial distribution of cetaceans in lower Cook Inlet and access areas through continuous year-round passive acoustic monitoring. Two types of long-term acoustic moorings will be used: deep, broad-band, linear moorings for detection of all marine mammal species and shallow, low-profile, narrow-band moorings for detection of beluga echolocation. A total of 7-9 moorings will be deployed both within the lower Cook Inlet area of interest (objective 1) and outside of this area (objectives 2 and 3). Moorings will be deployed in year 1 and turned around every six months to reduce potential mooring loss and to allow continuous year-round monitoring at maximum sampling rate, until they are retrieved in year 3. Recordings will be analyzed to assess the interannual variability in the spatio-temporal distribution of all calling and echolocating marine mammals, vessel and airgun signals, and ambient noise. Habitat and seasonal importance will be defined based on the duration of acoustic encounters for each species. Furthermore, collocation of moorings with biophysical instrumentation to evaluate how oceanographic parameters and prey availability affect distribution and habitat use of the above species may be considered if available funding is sufficient.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Bering Sea, Chukchi Sea, Beaufort Sea

Administered By: Alaska OCS Region

Title: Ice Seal Movements and Foraging: Village-based Satellite Tracking of Ringed and Bearded Seals (Extension)

BOEM Information Need(s) to be Addressed: This study is an extension of a currently funded telemetry project regarding ringed and bearded seal movements and feeding areas in the Beaufort, Chukchi and Bering Seas. More information is needed on seal movements and feeding areas relative to areas of interest for oil and gas leasing, exploration and development. Specific information needs include seasonal movements; fidelity to summer, winter, and breeding areas; location of important feeding habitats; and the degree to which seals are pelagic in summer. In preparation for winter and for the spring pupping and breeding season, seals gain weight in late summer through fall and winter, therefore knowing movements and habitat use during this time period is especially important. Study results may be used to design monitoring and mitigation measures and will support NEPA analyses for lease sales, EPs, DPPs. Since ice seals have been petitioned for listing under the ESA, information from this study also may prove especially useful for future ESA Section 7 consultations.

Total Cost: TBD **Period of Performance:** FY 2018-2021

Description:

Background: A previous satellite telemetry study of seals tagged in Kotzebue Sound showed large scale movements of both species and all age classes. During the current BOEM study local seal hunters from Bering and Chukchi Sea communities were trained to capture and tag seals with satellite transmitters. This allowed for distribution of tagging locations throughout the species' range to provide a broader understanding of seal movements than information gained from tagging in one location only. As of 16 November 2015, tracking of 6 ringed seals has covered an average of 297 (range 83–511) days and tracking of 12 bearded seals has covered an average of 139 (range 11–414) days. These tagged seals regularly travel long distances that have included the Bering, Beaufort, and Chukchi Seas and they have been tracked from Alaska to Russia and Canada. A total of 7 seal hunters from 6 villages have now been trained and supplied with capture equipment and tags so that the capacity for seal tagging has recently been greatly expanded. By early 2017, another 3 hunters will be trained in an additional 3 villages creating a well-trained, effective and motivated team prepared to tag approximately 20–30 seals per year during 2017–2020. By extending this project we can take advantage of the most widely distributed and experienced seal tagging team available to date and collect the data needed for a general understanding of the movements and habitat use of two ice seal species (ringed and bearded seals) with important habitats in the Bering, Chukchi, and Beaufort Seas off Alaska and beyond. By continuing to work with the hunters and their communities we can also add to the documentation of traditional and local knowledge (TK) during a time of great change in the marine environment. Collections of TK to date have provided information valuable

to oceanography (changes in currents), meteorology (more wind, bigger storms), climatology (fewer pressure ridges in winter ice), biology (more seals hauled out on land), and sociology (hunters need to be ready because the seal hunting season is shorter now).

With additional satellite telemetry data we can analyze these extensive movements using oceanographic models. Long distance movements made by seals might be influenced by the velocity and direction of currents. Furthermore, if fish are more likely to be found along fronts and stratified layers, such oceanographic features may also attract seals. If such relationships exist we will quickly gain a greater understanding of seal movements with possible predictive capabilities.

Objectives:

- Work with 10 previously trained seal hunters to capture and tag up to 15 ringed and 15 bearded seals per year at multiple locations in the Bering and Chukchi Seas.
- Using satellite telemetry with CTD tags, document the movements, diving behavior, and habitat use of ringed and bearded seals, including use of lease sale areas, patterns and timing of movement through Bering Strait, fidelity to winter and summer areas, use of sea ice, and identification of feeding areas.
- Collect additional local and traditional knowledge to better understand seal movements and habitat use relating to climate change from a local perspective.
- Analyze seal movements using oceanographic models to explain seal movements throughout their range.

Methods: During the current BOEM funded project, a total of 7 seal hunters have been trained to capture and tag ringed and bearded seals near their communities. These hunter-taggers are now experienced and effective at deploying satellite transmitters. They use their own boats and experience and know where and when to find seals. They can evaluate the local weather and ice conditions and take advantage of conditions immediately and more efficiently than non-local biologists can, making the study extremely efficient and cost effective. Oceanographic models, include information on current velocity, current direction, and the location of salinity and temperature fronts, are available. Seal movements can be analyzed relative to these oceanographic variables to evaluate any potential relationships.

Revised Date: August 2016

Environmental Studies Program: Alaska Annual Studies Plan FY 2017

Study Area(s): Beaufort Sea, Chukchi Sea

Administered By: Alaska OCS Region

Title: Polycentric Governance in Barrow, Nuiqsut, and Wainwright

BOEM Information Need(s) to be Addressed: The Alaska OCS Region needs a finer grained understanding of the complex institutional arrangements that arise in Arctic coastal communities to assess how local governance institutions might be unexpectedly affected by oil and gas exploration, development, and production. A retrospective analysis of recent Shell Offshore exploration activities may offer an opportunity for insights into this type of social process. The information will support NEPA analysis and documentation for Beaufort Sea lease sales and DPPs, as well as the 2017-2022 Five Year Program. It can also be used more broadly in other endeavors, for example, to inform BOEM of community/tribal/North Slope Borough dynamics, which could enable a better understanding of multifaceted governance and promote better working relationships at local and regional scales.

Total Cost: TBD **Period of Performance:** FY 2018-2021

Description:

Background: On the North Slope of Alaska, multiple institutions of governance exist at different scales. Local authorities with overlapping jurisdictions minimally include (1) the local office of the Alaska Native Claims Act (ANCSA) regional corporation; (2) the ANCSA village corporation office; (3) the borough offices (equivalent to the county seat in other parts of the U.S.); (4) the city government, (5) the community tribal organization office; (6) the regional tribal organization; (7) the Alaska Eskimo Whaling Commission office (AEWC); and (8) the school district.

This study is intended to clarify the relationships of decentralized, but often shared, governance structures in Alaskan coastal communities. The study will investigate the extent to which complementary multiple authorities exist at scalar levels of governance to offset limitations, and will produce a unique analysis of how situated actors at different levels of governance opportunistically interact and influence each other's decision-making (Anderson and Ostrom, 2007).

The purpose of the study is also to (1) delineate and assess the structural and functional facets of these institutional arrangements; (2) assess the resiliency and vulnerability of polycentric arrangements; (3) assess the prevalence of polycentrism in mixed cash-subsistence economies; (4) identify functional linkages between polycentric arrangements with subsistence harvest. A better grasp of the multiple authorities and linkages between formal and informal arrangements can provide an over-arching insight into the resiliency on a multi-scalar level.

Objectives:

- Improve the capacity of BOEM analysts to forecast a broader range of socio-economic impacts of offshore energy exploration activities on coastal community institutions and residents.
- Retroactively identify direct and indirect effects of Shell Offshore exploration activities on formal governance institutions and Alaska Native residents in select communities.

Methods: This study will involve establishing a systematic inventory of institutional entities in Barrow, Nuiqsut, and Wainwright that operate at multiple scales. It will use established ethnographic methodologies to (1) Coordinate with the NSB and study communities to obtain concurrence and support; (2) Conduct a literature search of polycentric systems and the applicability for assessing Beaufort Sea communities; (3) Conduct ethnographic research; (4) Develop a rigorous analytic method to evaluate the functionality of the institutional arrangements, especially in a mixed cash-subsistence economy, such as the "Institutional Analysis and Development" framework (Ostrom, 2010); (5) Explain any documented changes by reference to fieldwork and published literature; (6) Explain the differences and similarities of the institutional arrangements in the three study communities and if they are interdependent or independent; (7) Assess how effectively these institutional arrangements contribute to resilience or vulnerability of a study community; (8) Describe the effects of Shell's interaction with multiple authorities on a multi-scalar level to obtain a finer grained baseline that would describe possible outcomes in future NEPA analyses; (9) Assess how the arrangements adapt to changing circumstances; and (10) document findings in a comprehensive report.

References:

Anderson, K. and E. Ostrom. 2007. An Analytical Agenda for the Study of Decentralized Resource Regimes. Prepared by Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program, Office of International Research, Education, and Development, Virginia Tech.

Ostrom, E. 2010. Beyond Markets and States: Polycentric Governance of Complex Economic Systems. American Economic Review 100 (June 2010): 1-33.

Revised Date: August 2016

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 2019 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 waxing and waning industry interest in OCS exploration, development and production, as well as potential trends in a changing climate.

The *2017-2022 Outer Continental Shelf Oil and Gas Leasing Proposed Program* (USDOI, BOEM, 2016) points to the ongoing need for development of scientific information in the pre-lease sale process. This *Proposed Program* identifies one potential lease sale each in the Beaufort Sea (2020), Cook Inlet (2021), and Chukchi Sea (2022) Planning Areas. Again, these potential sales are scheduled late in the five-year period to provide additional opportunity to evaluate and obtain information regarding environmental issues, subsistence use needs, infrastructure capabilities, and results from any exploration activity associated with existing leases.

Many of the studies proposed for FY 2017 and FY 2018 address the topical areas described below. These will be re-assessed as part of the FY 2018 planning process.

3.1 Climate 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 in the case of ice leads, as evidenced by recent improvements in satellite oceanography.

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 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 COMIDA-CAB and the “Hanna Shoal Ecosystem Study.” 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 in the Beaufort and Chukchi Seas is quite limited. 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. In addition, advancement of UAS technologies will lead to expanded research opportunities for bowhead whales. BOEM anticipates pursuit of new opportunities to obtain and update information on bowhead behavior in response to industrial noise through the use of appropriate research partnerships.

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 in each of the last seven years, except for 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 potentially exposed to short-term or cumulative impact factors for which behavioral or monitoring studies may be needed include polar bears, beluga whales, ringed seals, ribbon seals and bearded seals.

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 in the Bering, Chukchi and Beaufort Seas 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

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.

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

SECTION 4.0 LITERATURE CITED

Berchok, C. L., J. L. Crance, E. Garland, J. A. Mocklin, P. J. Stabeno, J. M. Napp, B. Rone, A. H. Spear, M. Wang, and C. W. Clark. 2015. *Chukchi Offshore Monitoring In Drilling Area (COMIDA): Factors Affecting the Distribution and Relative Abundance of Endangered Whales and Other Marine Mammals in the Chukchi Sea.* Final Report of the Chukchi Sea Acoustics, Oceanography, and Zooplankton Study. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, Seattle, Washington. OCS Study BOEM 2015-034. 362 pp.

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

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

Kasper J. and A. Mahoney. 2015. *IceTrackers 2015, Field deployment notes*; unpublished report from BOEM study: Development and Testing of a Low-Cost Satellite-Tracked Ice Drifter for Arctic Waters (AK-13-03-07). University of Alaska Coastal Marine Institute, Fairbanks, Alaska.

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

Quakenbush, L.T., R.J. Small, and J.J. Citta. 2013. *Satellite tracking of bowhead whales: movements and analysis from 2006 to 2012.* Prepared for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region, Anchorage, Alaska. OCS Study BOEM 2013-01110. 60 pp. plus appendices.

Stephen R. Braund & Associates. 2013. *Aggregate Effects of Oil Industry Operations on Iñupiaq Subsistence Activities, Nuiqsut, Alaska: A History and Analysis of Mitigation and Monitoring.* Prepared for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Anchorage, Alaska. OCS Study BOEM 2013-212. 250 pp. plus appendices.

USDOI, BOEM. 2012. *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program 2012-2017.* Herndon, Virginia.

USDOI, BOEM. 2016. *2017-2022 Outer Continental Shelf Oil and Gas Leasing Proposed Program.* Sterling, Virginia.

White House. 2013a. *Arctic Research Plan: FY 2013-2017, February 2013*. Executive Office of the President, National Science and Technology Council. Washington, D.C. 104 pp.

White House. 2013b. *National Strategy for the Arctic Region, May 2013*. Washington, D.C. 13 pp.

White House. 2014. *Implementation Plan for the National Strategy for the Arctic Region, January 2014*. Washington, D.C. 33 pp.

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

This table is organized to display recent BOEM-directed research as it supports the national *Arctic Research Plan FY 2013-2017* (White House 2013a), issued by the Executive Office of the President, National Science and Technology Council, February 2013. The *Arctic Research Plan* was produced by the Interagency Arctic Research Policy Committee (IARPC) in recognition of responsibilities described in the Arctic Research Policy Act of 1984. IARPC activities are chaired by the National Science Foundation and serve to coordinate science and technology policy across diverse Federal institutions. Chapter 3 of the *Arctic Research Plan* (ARP) discusses each numbered item identified in the table below, and can be accessed from the White House web portal. The *Arctic Research Plan* directly supports the *Implementation Plan for the National Strategy for the Arctic Region*, issued in January 2014 (White House, 2014). IARPC is currently preparing the *Arctic Research Plan: 2017-2021*, which is targeted for release in December 2016.

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
3.1	**Understand Sea-ice Processes, Ecosystem Processes, Ecosystem Services, and Climate Feedbacks In The Beaufort and Chukchi Seas And The Contiguous Arctic Ocean**				
3.1.1	**Develop a framework of observations and modeling to support forecasting of sea-ice extent on seasonal to annual scales for operational and research needs**				
	Characterization of the Circulation on the continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas	UAF	$5,056,252	2012 - 2016	high frequency radar, ocean currents, gliders, drifters, Barrow Canyon
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Satellite-Tracked Drifter Measurements in the Northeast Chukchi Sea	UAF	$459,892	2011 - 2015	ocean currents, current velocities
	Development and Testing of a Low-Cost Satellite Tracked Ice Drifter for Arctic Alaska	UAF-CMI	$433,409	2014 - 2017	ice velocities, model validation
	Development of an Accurate Model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response	UAF-CMI	$359,078	2013 - 2016	spill response, ice velocities, ice deformation, convergence zone
	Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers University	$489,735	2015 - 2017	ocean currents, ice coverage, hindcast
	Measuring Wave Forces along Alaska's Coastal Sea Ice	UAF-CMI	$311,392	2016 - 2019	landfast ice, stability, stresses, wave energy propagation, breakout events
	Community Web Access to WRF Atmospheric Model Results and Meteorological Station Data, 1979-2009	AOOS	$74,277	2016	meteorological observations
3.1.2	**Identify study sites in the Beaufort and Chukchi Seas and the contiguous Arctic Ocean where climate feedbacks are active**				
	Arctic Air Quality Impact Assessment Modeling	ERG	$1,766,025	2013 - 2018	pollutants, air quality, meteorological model
	Hanna Shoal Ecosystem Study	UT-Austin	$5,665,144	2011 - 2016	ocean currents, species distribution, food web, diversity

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas	UAF	$5,056,252	2012 - 2016	high frequency radar, ocean currents, gliders, drifters, Barrow Canyon
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts	UAF-CMI	$72,178	2014 - 2017	ocean currents, storm surges
	Development of an Accurate Model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response	UAF-CMI	$359,078	2013 - 2016	spill response, ice velocities, ice deformation, convergence zone
	Measuring Wave Forces along Alaska's Coastal Sea Ice	UAF-CMI	$311,392	2016 - 2019	landfast ice, stability, stresses, wave energy propagation, breakout events
	Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers University	$489,735	2015 - 2017	ocean currents, ice coverage, hindcast
	Changes in Beaufort-Chukchi Seas Intense Storm Activity and Impacts on Surface Climate and Ocean Properties	UAF-CMI	$25,000	2016 - 2017	climatology, storm tracks, heat budget
3.1.3	**Complete deployment of a Distributed Biological Observatory in the Arctic Ocean to create long-term data sets on biological, physical, and chemical variability, change, and ecosystem response**				
	Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring	UAF, NOAA, Shell	$1,500,000	2015 - 2020	Genetics, DBO, microbes, plankton, benthos, fish, marine mammals
	Hanna Shoal Ecosystem Study	UT-Austin	$5,665,144	2011 - 2016	food web, ocean currents, species distribution, diversity
	Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic (CHAOZ)	NOAA	$4,304,300	2010 - 2015	tracking, cetaceans, climate modeling, hydrophone array, biophysical moorings
	Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ)	NOAA	$3,933,671	2014 – 2017	passive acoustic, zooplankton detection, TAPS-6
	ANIMIDA III: Contaminants, Sources, and Bioaccumulation	Olgoonik/ Fairweather	$2,700,000	2013 - 2017	monitoring, sediment, bivalves, amphipods, hydrocarbons
	Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area (Arctic Ecosystem Integrated Survey)	UAF, NOAA	$2,695,000	2012 - 2016	ecology, demersal, pelagic, invertebrate, food-web
	Arctic Integrated Ecosystem Survey, Phase II	TBD	TBD	2017 - 2021	ecology, demersal, pelagic, invertebrate, food-web
3.1.4	**Develop integrated ecosystem research in the Beaufort and Chukchi Seas**				
	Collaboration with North Pacific Research Board "Arctic Integrated Ecosystem Research project"	NPRB, NSB	$1,000,000	2016 - 2020	oceanography, plankton, fish, seabirds, marine mammals, subsistence resources, food security
	Arctic Integrated Ecosystem Survey, Phase II	TBD	TBD	2017 - 2021	ecology, demersal, pelagic, invertebrate, food-web
	Marine Arctic Ecosystem Study (MARES)	NOPP, Stantec	$5,000,000	2014 - 2019	Mackenzie plume, water column properties, shelf/slope exchange, marine mammal tagging

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea	NOAA	$14,586,585	2011 - 2016	pinnipeds, cetaceans, migration, satellite-track, tags, aerial, abundance
	Hanna Shoal Ecosystem Study	UT-Austin	$5,665,144	2011 - 2016	food web, ocean currents, species distribution, diversity
	Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic (CHAOZ)	NOAA	$4,304,300	2010 - 2015	tracking, cetaceans, climate modeling, hydrophone array, biophysical moorings
	Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ)	NOAA	$3,933,671	2014 – 2017	passive acoustic, zooplankton detection, TAPS-6
	ANIMIDA III: Contaminants, Sources, and Bioaccumulation	Olgoonik/ Fairweather	$2,700,000	2013 - 2017	monitoring, sediment, bivalves, amphipods, hydrocarbons
	ANIMIDA III: Arctic Kelp Communities in the Beaufort Sea: Sentinels of Long-Term Change	UT-Austin	$623,661	2012 - 2017	boulder patch, Liberty Prospect, ambient light, Camden Bay
	Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area (Arctic Ecosystem Integrated Survey)	UAF, NOAA	$2,600,000	2012 - 2016	ecology, demersal, pelagic, invertebrate, food-web
	Genomics of Arctic Cod: A Sentinel Species in a Changing Environment	USGS	$300,000	2014 - 2017	genetics, genomics, transcriptomics, arctic cod, boreogadus saida
	Distribution and Habitat Use of Fish in the Nearshore Ecosystem of the Beaufort and Chukchi Sea	NOAA	$164,000	2012 - 2016	nearshore habitat diversity, diet, temperature, salinity, Peard Bay, baseline
	Alaska Monitoring and Assessment Program (AKMAP) Survey of Estuaries within the National Petroleum Reserve-Alaska	UAF-CMI	$250,594	2015-2017	Sediment chemistry, water column chemistry, benthos, epifauna, fish
3.2	**Understand Terrestrial Ice Processes, Ecosystem Processes, Ecosystem Services, And Climate Feedbacks In The Arctic**				
3.2.1	**Perform glacial-process studies targeting specific dynamic regimes**				
	Not Jurisdiction of BOEM				
3.2.2	**Coordinate and integrate terrestrial ecosystem research efforts**				
	Marine Mammal/Physical Oceanography Synthesis (SOAR - Synthesis of Arctic Research)	NOAA	$1,798,459	2011 - 2016	riverine, traditional knowledge, oceanography, marine mammals
	Demography and Behavior of Polar Bears Summering on Shore in Alaska	USGS	$1,480,767	2009 - 2014	coastline, habitat, Barter Island, Cross Island, demographic, behavior
	ShoreZone Mapping of the North Slope of Alaska	Nuka	$554,121	2011 - 2015	imagery, groundtruthing, geomorphic, nearshore habitat, mapping
	Wading Shorebirds Habitats, Food Resources, Associated Infauna, Sediment Characteristics and Bioremediation	UAF	$365,236	2011 - 2016	macrofauna assemblage, littoral zone, interstitial, invertebrates, shorebirds
	Shorebirds and Infaunal Abundance and Distribution on Delta Mudflats along the Beaufort Sea	USGS	$237,169	2011 - 2015	invertebrate, foraging, shorebirds, sediment, chemical footprint
	Biodegradation and Transport of Crude Oil in Sand and Gravel Beaches of Arctic Alaska	UAF-CMI	$56,310	2013 - 2017	viscosity, sediments, soil profile, wave action, porosity, density

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Alaska Monitoring and Assessment Program (AKMAP) Survey of Estuaries within the National Petroleum Reserve-Alaska	UAF-CMI	$250,594	2015-2017	Sediment chemistry, water column chemistry, benthos, epifauna, fish
3.2.3	**Identify and study key sites where climate feedbacks are active, including permafrost, snow, hydrates, and glaciers**				
	Not Jurisdiction of BOEM				
3.2.4	**Investigate the frequency and severity of wildland fires in the Arctic**				
	Not Jurisdiction of BOEM				
3.2.5	**Conduct socio-economic research to understand ecosystem services as increased warming changes the Arctic tundra**				
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$399,470	2016 - 2020	traditional knowledge, subsistence, Iñupiat
	COMIDA: Impact Monitoring for Offshore Subsistence Hunting	Stephen R. Braund	$999,805	2009 - 2013	marine mammal, fish, harvest, climate, sea ice
	The Study of Sharing Networks to Assess the Vulnerabilities of Local Communities to Oil and Gas Development Impacts in Arctic Alaska	UAF	$785,000	2007 - 2016	subsistence, Wainwright, Kaktovik, Venetie, Iñupiat
	Social Indicators in Coastal Alaska: Arctic Communities	Stephen R. Braund	$669,656	2011 - 2017	cultural, health, climate, subsistence
	Continuation of Impact Assessment for Cross Island Whaling Activities - Beaufort Sea	ASCR	$328,507	2008 - 2013	Iñupiat, Nuiqsut, bowhead whale, subsistence, migration, hunting
	Subsistence Use and Knowledge of Salmon in Barrow and Nuiqsut	UAF-CMI	$119,459	2009 - 2013	Inupiat, fishing, traditional knowledge
3.3	**Understand Atmospheric Surface Heat, Energy, And Mass Balances**				
3.3.1	**Improve understanding of short-lived climate forcers (SLCFs); source regions, direct and indirect effects, and net impact on Arctic warming**				
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Arctic Air Quality Impact Assessment Modeling	ERG	$1,766,025	2013 - 2018	pollutants, air quality, meteorological model
	Biogeochemical Assessment of the OCS Arctic Waters: Current Status and Vulnerability to Climate Change	UAF-CMI	$756,704	2008 - 2014	Bering Sea, hydrographic, climate, net ecosystem production
	Changes in Beaufort-Chukchi Seas Intense Storm Activity and Impacts on Surface Climate and Ocean Properties	UAF-CMI	$25,000	2016 - 2017	climatology, storm tracks, heat budget
	Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts	UAF-CMI	$72,178	2014 - 2017	ocean currents, storm surges
3.3.2	**Improve understanding of processes that control the formation, longevity, and physical properties of Arctic clouds, including the effects of—and sensitivities to—aerosols**				
	Arctic Air Quality Impact Assessment Modeling	ERG	$1,751,036	2013 - 2016	pollutants, air quality
3.3.3	**Develop an integrated understanding of Arctic atmospheric processes, their impact on the surface energy budget, and their linkages with oceanic, terrestrial, and cryospheric systems**				
	Arctic Air Quality Impact Assessment Modeling	ERG	$1,751,036	2013 - 2016	pollutants, air quality
	Changes in Beaufort-Chukchi Seas Intense Storm Activity and Impacts on Surface Climate and Ocean Properties	UAF-CMI	$25,000	2016 - 2017	climatology, storm tracks, heat budget
	Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts	UAF	$72,178	2014 - 2017	ocean currents, storm surges

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Measuring Wave Forces along Alaska's Coastal Sea Ice	UAF-CMI	$311,392	2016 - 2019	landfast ice, stability, stresses, wave energy propagation, breakout events
	Development of an autonomous Carbon Glider to Monitor sea-air CO2 fluxes in the Chukchi Sea	UAF-CMI	$125,000	2015 - 2017	Carbon dioxide cycling, ocean acidification
	Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers University	$489,735	2015 - 2017	ocean currents, ice coverage, hindcast
3.4	**Integrate And Continue To Deploy A National Arctic Observing System And Promote International Cooperation To Create A Circumpolar Arctic Observing System**				
3.4.1	**Facilitate observing-system design for the Arctic**				
	Field Evaluation of Unmanned Aircraft System for Studying Cetacean Distribution, Density, and Habitat Use in the Arctic	NOAA, ONR	$1,000,000	2015 - 2018	Drones, aerial survey, encounter rate, detection
	Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring	UAF, NOAA, Shell	$1,500,000	2015 - 2020	Genetics, DBO, microbes, plankton, benthos, fish, marine mammals
	Development of an autonomous Carbon Glider to Monitor sea-air CO2 fluxes in the Chukchi Sea	UAF-CMI	$125,000	2015 - 2017	Carbon dioxide cycling, ocean acidification
	Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea	NOAA	$14,586,585	2011 - 2016	pinnipeds, cetaceans, migration, satellite-track, tags, aerial, abundance
	Marine Arctic Ecosystem Study (MARES)	NOPP, Stantec	$5,000,000	2014 - 2019	Mackenzie plume, water column properties, shelf/slope exchange, marine mammal tagging
	U.S.-Canada Transboundary Fish and Lower Trophic Communities	UAF	$5,191,125	2012 - 2016	food web, DBO, arctic cod, Canada
	Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas	UAF	$5,056,252	2012 - 2016	high frequency radar, ocean currents, gliders, drifters, Barrow Canyon
	Arctic Whale Ecology Study: Use of the Chukchi Sea by Endangered Baleen and other Whales (ARCWEST)	NOAA	$4,502,000	2012 - 2017	Smith Bay, Barrow Canyon, distribution, habitat, Barrow Arch, nutrients
	COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic	NOAA	$4,304,300	2010 - 2015	marine mammals, zooplankton, TAPS-6
	Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ)	NOAA	$3,933,671	2014 - 2017	passive acoustic, zooplankton detection, TAPS-6
	ANIMIDA III: Contaminants, Sources, and Bioaccumulation	Olgoonik/ Fairweather	$2,700,000	2013 - 2017	monitoring, sediment, bivalves, amphipods, hydrocarbons
	Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area (Arctic Ecosystem Integrated Survey)	UAF, NOAA	$2,600,000	2012 - 2016	ecology, demersal, pelagic, invertebrate, food-web
	Arctic Integrated Ecosystem Survey, Phase II	TBD	TBD	2017 - 2021	ecology, demersal, pelagic, invertebrate, food-web
	Beaufort Sea Marine Fish Monitoring Survey in the Central Beaufort Sea	UAF	$1,764,252	2010 - 2016	food web, isotope, Barrow Canyon, arctic cod, benthic, pelagic, demersal

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Ice Seal Movements and Foraging: Village-based Satellite Tracking of Ringed and Bearded Seals	ADF&G	$1,174,994	2013 - 2017	pinnipeds, tagging, Kotzebue, habitat, ice seal committee, bathymetry, ice edge
	COMIDA: Impact Monitoring for Offshore Subsistence Hunting	Stephen R. Braund	$999,805	2009 - 2013	Iñupiat, Point Lay, Wainwright, gps, sea ice, traditional knowledge
	The Study of Sharing Networks to Assess the Vulnerabilities of Local Communities to O&G Development Impacts in Arctic Alaska	UAF	$785,000	2007 - 2016	subsistence, Wainwright, Kaktovik, Venetie, Iñupiat
3.4.2	**Assess local-resident priorities for addressing change**				
	Social Indicators in Coastal Alaska: Arctic Communities	Stephen R. Braund	$669,659	2011 - 2017	household survey, traditional knowledge, health, subsistence
	Aggregate Effects Research & Environmental Mitigation Monitoring of Oil Operations in the Vicinity of Nuiqsut	Stephen R. Braund	$373,298	2009 - 2013	Iñupiat, Nuiqsut, oil, gas, subsistence, harvest, mitigation
	Continuation of Impact Assessment for Cross Island Whaling Activities - Beaufort Sea	ASCR	$328,507	2008 - 2013	Iñupiat, Nuiqsut, bowhead, subsistence, gps, harvest, hunt
	Dispersal Patterns and Summer Ocean Distribution of Adult Dolly Varden from the Wulik River, Alaska, using Satellite Tags.	UAF-CMI	$146,510	2012 - 2013	fish, distribution, migration, subsistence,
	Subsistence Use and Knowledge of Beaufort Salmon Populations	UAF-CMI	$119,459	2009 - 2012	Iñupiat, traditional knowledge, Barrow, Nuiqsut, whitefish
3.4.3	**Combine in-situ and remotely sensed observations of sea ice with local community and traditional knowledge**				
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$399,470	2016 - 2020	traditional knowledge, subsistence, Iñupiat
	Northern Alaska Sea Ice Project Jukebox	UAF-CMI	$60,633	2016 - 2018	traditional knowledge, ice observations, Barrow, Kotzebue
	Community Based Monitoring: LEO Network	ANTHC	$400,000	2016 - 2020	community-based monitoring, observations
	Crude Oil Infiltration and Movement in First-year Sea Ice: Impacts on Ice-associated Biota and Physical Constraints	UAF-CMI	$298,214	2014 - 2017	oil spill, temperature, salinity, brine channel network, sea ice
	Distribution and Abundance of Select Trace Metals in Chukchi and Beaufort Sea Ice	UAF-CMI	$262,073	2013 - 2016	trace metals, sea ice, laboratory, seawater, Camden Bay
3.4.4	**Conduct long-term monitoring of key outlet glaciers and tidewater glaciers**				
	Not Jurisdiction of BOEM				
3.4.5	**Monitor the biological and physical state of the Arctic marine environment**				
	Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea	NOAA	$14,586,585	2011 - 2016	pinnipeds, cetaceans, migration, satellite-track, tags, aerial, abundance
	Hanna Shoal Ecosystem Study	UT-Austin	$5,665,144	2011 - 2016	oceanography, benthic biota, food web, sediment chemistry, contaminants
	Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring	UAF, NOAA, Shell	$1,500,000	2015 - 2020	Genetics, DBO, microbes, plankton, benthos, fish, marine mammals
	Marine Arctic Ecosystem Study (MARES)	Stantec NOPP	$5,000,000	2014 - 2019	Mackenzie plume, water column properties, shelf/slope exchange, marine mammal tagging

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic	NOAA	$4,304,300	2010 - 2015	marine mammals, zooplankton, biophysical conditions
	Chukchi Acoustic, Oceanography and Zooplankton Study: Hanna Shoal (Extension of CHAOZ)	NOAA	$3,933,671	2014 - 2017	passive acoustic, zooplankton detection, TAPS-6
	ANIMIDA III: Contaminants, Sources, and Bioaccumulation	Olgoonik/ Fairweather	$2,700,000	2013 - 2017	monitoring, sediment, bivalves, amphipods, hydrocarbons
	ANIMIDA III: Arctic Kelp Communities in the Beaufort Sea: Sentinels of Long-Term Change	UT-Austin	$623,661	2012 - 2017	boulder patch, Liberty Prospect, ambient light, Camden Bay
	Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring	ADF&G	$2,699,857	2012 - 2015	tagging, Saint Lawrence, Point Hope, Canada, sensors, monitoring, ambient
	Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area (Arctic Ecosystem Integrated Survey)	UAF, NOAA	$2,600,000	2012 - 2016	ecology, demersal, pelagic, invertebrate, food-web
	Arctic Integrated Ecosystem Survey, Phase II	TBD	TBD	2017 - 2021	ecology, demersal, pelagic, invertebrate, food-web
	Alaska Monitoring and Assessment Program (AKMAP) Survey of Estuaries within the National Petroleum Reserve-Alaska	UAF-CMI	$250,594	2015-2017	Sediment chemistry, water column chemistry, benthos, epifauna, fish
	Beaufort Sea Marine Fish Monitoring Survey in the Central Beaufort Sea	UAF	$1,764,252	2010 - 2016	food web, isotope, Barrow Canyon, arctic cod, benthic, pelagic, demersal
	Ice Seal Movements and Foraging: Village based Satellite Tracking and Acoustic Monitoring of Ringed, Bearded, and Spotted Seals	ADF&G	$1,174,994	2013 - 2017	satellite, telemetry, habitat, mapping
	COMIDA: Impact Monitoring for Offshore Subsistence Hunting	Stephen R. Braund	$999,805	2009 - 2017	Chukchi Sea, Iñupiat, harvest, Point Lay, Wainwright, boat tracks, traditional knowledge
	Biogeochemical Assessment of the OCS Arctic Waters: Current Status and Vulnerability to Climate Change	UAF-CMI	$756,704	2008 - 2014	Bering Sea, hydrographic, climate, net ecosystem production
	Genomics of Arctic Cod: A Sentinel Species in a Changing Environment	USGS	$300,000	2014 - 2017	genetics, genomics, transcriptomics, arctic cod, Boreogadus saida
3.4.6	**Assess the effects of clouds and atmospheric constituents on surface radiation balance**				
	Arctic Air Quality Impact Assessment Modeling	ERG	$1,766,025	2013 - 2018	pollutants, air quality, meteorological model
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Changes in Beaufort-Chukchi Seas Intense Storm Activity and Impacts on Surface Climate and Ocean Properties	UAF-CMI	$25,000	2016 - 2017	climatology, storm tracks, heat budget
3.4.7	**Assess the impact of terrestrial warming and permafrost thawing on the carbon cycle**				
	Not Jurisdiction of BOEM				
3.4.8	**Improve data access**				
	Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area (Arctic Ecosystem Integrated Survey)	UAF, NOAA	$2,600,000	2012 - 2016	ecology, demersal, pelagic, invertebrate, food-web
	Arctic Integrated Ecosystem Survey, Phase II	TBD	TBD	2017 - 2021	ecology, demersal, pelagic, invertebrate, food-web

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Marine Mammal/Physical Oceanography Synthesis (SOAR - Synthesis of Arctic Research)	NOAA	$1,798,459	2011 - 2016	traditional knowledge, oceanography, marine mammals
	Initiating an Arctic Marine Biodiversity Observing Network (AMBON) for Ecosystem Monitoring	UAF, NOAA, Shell	$1,500,000	2015 - 2020	Genetics, DBO, microbes, plankton, benthos, fish, marine mammals
	Community Web Access to WRF Atmospheric Model Results and Meteorological Station Data, 1979-2009	AOOS	$74,277	2016	meteorological observations
	Collaboration with North Pacific Research Board "Arctic Integrated Ecosystem Research project"	NPRB, NSB	$1,000,000	2016 - 2020	oceanography, plankton, fish, seabirds, marine mammals, subsistence resources, food security
	Enhancement of the Environmental Studies Program Information System and the Multipurpose Marine Cadastre to Provide Environmental Studies Program Data	NOAA	$1,700,000	2012 - 2015	geoespis, database, noaa-csc, geospatial web portal
	Developing BOEM's Access to Protected Species Occurrence Data for Impact Analysis and Rulemaking	USGS, NOAA, Duke	$180,000	2014-2016	bowhead whale, distribution, density, OBIS
	Alaska Marine Science Symposium (co-sponsor)	NPRB	$100,000	2010 - 2014	workshop, environmental studies program
3.4.9	**Engage indigenous observers and communities in monitoring environmental parameters**				
	Social Indicators in Coastal Alaska: Arctic Communities	Stephen R. Braund	$669,659	2011 - 2017	marine mammal, fish, subsistence, harvest,
	ShoreZone Mapping of the North Slope of Alaska	Nuka	$554,121	2011 - 2015	imagery, groundtruthing, geomorphic, nearshore habitat, mapping
	Subsistence Mapping of Nuiqsut, Kaktovik and Barrow : Past and Present Comparison	Stephen R. Braund	$399,994	2004 - 2007	Iñupiat, harvest, traditional knowledge
	Aggregate Effects Research & Environmental Mitigation Monitoring of Oil Operations in the Vicinity of Nuiqsut	Stephen R. Braund	$393,490	2009 - 2013	Iñupiat, oil, gas, subsistence, harvest, mitigation
	Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts	UAF-CMI	$72,178	2014 - 2017	ocean currents, storm surges
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$399,470	2016 - 2020	traditional knowledge, subsistence, Iñupiat
	Northern Alaska Sea Ice Project Jukebox	UAF-CMI	$60,633	2016 - 2018	traditional knowledge, ice observations, Barrow, Kotzebue
	Community Based Monitoring: LEO Network	ANTHC	$400,000	2016 - 2020	community-based monitoring, observations
3.5	**Integrate Arctic Regional Models**				
3.5.1	**Inventory Arctic modeling activities**				
	Development of an accurate model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response	UAF-CMI	$359,078	2013 - 2016	spill response, oil trajectories, ice velocities, ice deformation, convergence zone
	Loss of Well Control Occurrence and Size Estimators for Alaska OCS	Bercha	$298,540	2012 - 2014	risk assessment, oil spill, offshore, onshore
	Update to the Fault Tree for Oil-spill Occurrence Estimators	Bercha	$229,840	2011 - 2016	risk assessment, arctic conditions

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Development of Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers	$450,000	2015 - 2017	3D coupled ice-ocean circulation, hindcast, barrier islands, eddies
	Measuring Wave Forces along Alaska's Coastal Sea Ice	UAF-CMI	$311,392	2016 - 2019	landfast ice, stability, stresses, wave energy propagation, breakout events
3.5.2	**Encourage coordinated approaches that better represent Arctic processes in Earthsystem models**				
	Development of an accurate model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response	UAF-CMI	$359,078	2013 - 2016	spill response, oil trajectories, ice velocities, ice deformation, convergence zone
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Development of Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers	$450,000	2015 - 2017	3D coupled ice-ocean circulation, hindcast, barrier islands, eddies
3.5.3	**Build Arctic and subsystem models for coupling with regional and global approaches**				
	Development of Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers	$450,000	2015 - 2017	3D coupled ice-ocean circulation, hindcast, barrier islands, eddies
	Development of an accurate model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response	UAF-CMI	$359,078	2013 -2016	spill response, oil trajectories, ice velocities, ice deformation, convergence zone
3.5.4	**Develop models of Arctic land ice mass loss, connections to ocean and atmospheric variability, and implications for sea level**				
	Not Jurisdiction of BOEM				
3.5.5	**Increase Arctic model resolution to improve prediction and inform future research and observations**				
	Development of an accurate model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing Decision Support for Spill Response	UAF-CMI	$359,078	2013 -2016	spill response, oil trajectories, ice velocities, ice deformation, convergence zone
	Development of Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers	$450,000	2015-2017	3D coupled ice-ocean circulation, hindcast, barrier islands, eddies
3.5.6	**Use insights from models to inform process research; use process research to evaluate and improve models**				
	Marine Mammal/Physical Oceanography Synthesis (SOAR - Synthesis of Arctic Research)	NOAA	$1,798,459	2011 - 2016	riverine, traditional knowledge, oceanography, marine mammals
	Measuring Wave Forces along Alaska's Coastal Sea Ice	UAF-CMI	$311,392	2016 - 2019	landfast ice, stability, stresses, wave energy propagation, breakout events
	Arctic Tracer Release Experiment: Applications for Mapping Spilled Oil in Arctic Waters	UAF	$1,249,977	2013 - 2016	dispersed dye , drifters, high frequency radar, gliders, drifters, NOAA
	Development of an accurate model of the Beaufort and Chukchi Ice Drift and Dispersion for Forecasting Spill Trajectories and Providing	UAF-CMI	$359,078	2013 -2016	spill response, oil trajectories, ice velocities, ice

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Decision Support for Spill Response				deformation, convergence zone
	Characterization of the Circulation on the continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas	UAF	$5,056,252	2012 - 2016	high frequency radar, ocean currents, gliders, drifters, Barrow Canyon
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Application of High Frequency Radar to Potential Hydrocarbon Development Areas in the Northeast Chukchi Sea	UAF	$1,056,322	2009 - 2014	surface currents, Barrow Canyon, circulation
	Satellite-Tracked Drifter Measurements in the Northeast Chukchi Sea	UAF	$459,892	2011 - 2015	ocean currents, current velocities
	Development and Testing of a Low-Cost Satellite Tracked Ice Drifter for Arctic Alaska	UAF-CMI	$433,409	2014 - 2017	ice velocities, model validation
	Development of Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers	$450,000	2015 - 2017	3D coupled ice-ocean circulation, hindcast, barrier islands, eddies
3.5.7	**Integrate Arctic climate-model results with observational validation and verification to understand the principal drivers and uncertainties of Arctic climate changes**				
	Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	NOAA	$2,068,928	2010 - 2015	ice coverage, forecast
	Satellite-Tracked Drifter Measurements in the Northeast Chukchi Sea	UAF	$459,892	2011 - 2015	ocean currents, current velocities
	ShoreZone Mapping of the North Slope of Alaska	Nuka	$554,121	2011 - 2015	imagery, groundtruthing, geomorphic, nearshore habitat, mapping
	Development and Testing of a Low-Cost Satellite Tracked Ice Drifter for Arctic Alaska	UAF-CMI	$433,409	2014 - 2017	ice velocities, model validation
	Development of Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas	Rutgers	$450,000	2015 - 2017	3D coupled ice-ocean circulation, hindcast, barrier islands, eddies
3.6	**Assess Strengths And Vulnerabilities Of Arctic Communities Facing The Impacts Of Climate Change And Assist In Developing Adaptation Strategies And Tools To Maximize Sustainability, Well-Being, And Cultural And Linguistic Heritage**				
3.6.1	**In collaboration with local communities, develop methods for assessing community sustainability and resilience and determine the efficiency of current adaptation strategies**				
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$399,470	2016 - 2020	traditional knowledge, subsistence, Iñupiat
	Community Based Monitoring: LEO Network	ANTHC	$400,000	2016 - 2020	community-based monitoring, observations
	The Study of Sharing Networks to Assess the Vulnerabilities of Local Communities to Oil and Gas Development Impacts in Arctic Alaska	UAF	$785,000	2007 - 2016	subsistence, Wainwright, Kaktovik, Venetie, Iñupiat
	Social Indicators in Coastal Alaska: Arctic Communities	Stephen R. Braund	$669,659	2011 - 2017	marine mammal, fish, subsistence, harvest
	Aggregate Effects Research & Environmental Mitigation Monitoring of Oil Operations in the Vicinity of Nuiqsut	Stephen R. Braund	$373,298	2009 - 2013	Iñupiat, oil, gas, subsistence, harvest
3.6.2	**Identify the current vulnerabilities of Arctic communities and ecosystems to climate change and explore their interactions with socio-economic and other stressors**				
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$399,470	2016 - 2020	traditional knowledge, subsistence, Iñupiat
	Northern Alaska Sea Ice Project Jukebox	UAF-CMI	$60,633	2016 - 2018	traditional knowledge, ice observations, Barrow, Kotzebue

ARP Item	Research Topic	BOEM Partner	BOEM Funding	Study Duration	Key Words
	Community Based Monitoring: LEO Network	ANTHC	$400,000	2016 - 2020	community-based monitoring, observations
	Social Indicators in Coastal Alaska: Arctic Communities	Stephen R. Braund	$669,659	2011 - 2017	traditional knowledge, climate change, subsistence, economy,
	Aggregate Effects Research & Environmental Mitigation Monitoring of Oil Operations in the Vicinity of Nuiqsut	Stephen R. Braund	$393,490	2009 - 2013	Iñupiat, Nuiqsut, oil, gas, subsistence, harvest, mitigation
3.6.3	**Develop projections of future climate scenarios and demographic conditions to forecast potential strengths and weaknesses of human and ecological systems in the Arctic**				
	Social Indicators in Coastal Alaska: Arctic Communities	Stephen R. Braund	$669,659	2011 - 2017	communities, economic, cultural, subsistence, Arctic Council
3.6.4	**Assist Arctic communities in documenting, revitalizing, and strengthening indigenous languages and cultural heritage**				
	A Year in the Life of a Bowhead Whale: An Animated Film	UAF-CMI	$87,587	2012 - 2014	Alaska Museum of the North, animated film, production, storyboarding
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$399,470	2016 - 2020	traditional knowledge, subsistence, Iñupiat
	Community Based Monitoring: LEO Network	ANTHC	$400,000	2016 - 2020	community-based monitoring, observations
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	TBD			
3.7	**Understand Factors That Impact Human Health In The Arctic, Including Infectious And Non-Communicable Diseases, Climate Change, Environmental Contamination, And Behavior And Mental-Health Disorders**				
3.7.1	**Continue to expand circumpolar surveillance and research for infectious diseases, non-communicable diseases, trauma, injury, sanitation services, and indoor air quality to help prevent morbidity and mortality**				
	Not Jurisdiction of BOEM				
3.7.2	**Continue interagency collaboration to monitor the impacts of climate change and environmental contaminants on human health and wildlife**				
	Fate and Persistence of Oil Spill Response Chemicals in Arctic Seawater	UAF-CMI	$215,000	2015 - 2018	dispersant toxicity, microbial community
	ANIMIDA III: Contaminants, Sources, and Bioaccumulation	Olgoonik/ Fairweather	$2,700,000	2013 - 2017	long term monitoring, sediment, bivalves, amphipods, hydrocarbons
	Arctic Air Quality Impact Assessment Modeling	ERG	$1,751,036	2013 - 2016	pollutants, air quality
	Sensitivity to Hydrocarbons and Baselines of Exposure in Marine Birds on the Chukchi and Beaufort Seas	UAF-CMI	$194,676	2013 - 2016	marine birds, crude oil, cytochrome p450, 7-ethoxyresorufin-*O*-deethylase
	ANIMIDA III: Arctic Kelp Communities in the Beaufort Sea: Sentinels of Long-Term Change	UT-Austin	$128,774	2014 - 2017	cANIMIDA, Camden Bay, chemical finerprint, biota, sediments
	Community Based Monitoring: LEO Network	ANTHC	$400,000	2016 - 2020	community-based monitoring, observations

3.7.3	**Continue to support investigator-initiated research in major health priority areas such as mental health including substance abuse and suicide, obesity, diabetes, and cancer**				
	Not Jurisdiction of BOEM				
3.7.4	**Continue to engage indigenous communities and tribal groups in research activities and projects in the Arctic**				
	Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts	NSB-DWM	$399,470	2016 - 2020	traditional knowledge, subsistence, Iñupiat
	Northern Alaska Sea Ice Project Jukebox	UAF-CMI	$60,633	2016 - 2018	traditional knowledge, ice observations, Barrow, Kotzebue
	Community Based Monitoring: LEO Network	ANTHC	$400,000	2016 - 2020	community-based monitoring, observations
	Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring	ADF&G	$2,699,857	2012 - 2015	tagging, Saint Lawrence, Point Hope, Canada,
	Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area (Arctic Ecosystem Integrated Survey)	UAF, NOAA	$2,600,000	2012 - 2016	ecology, demersal, pelagic, invertebrate, food-web
	Ice Seal Movements and Foraging: Village based Satellite Tracking and Acoustic Monitoring of Ringed, Bearded, and Spotted Seals With the TEK component, this should be included here	ADF&G	$1,174,994	2013 - 2017	Traditional knowledge, satellite telemetry, habitat, satellite mapping
	COMIDA: Impact Monitoring for Offshore Subsistence Hunting	Stephen R. Braund	$999,805	2009 - 2013	Iñupiat, harvest, Point Lay, Wainwright, climate, sea ice, traditional knowledge,
	The Study of Sharing Networks to Assess the Vulnerabilities of Local Communities to Oil and Gas Development Impacts in Arctic Alaska	UAF	$785,000	2007 - 2016	subsistence, Wainwright, Kaktovik, Venetie,
	Social Indicators in Coastal Alaska: Arctic Communities	Stephen R. Braund	$669,659	2011 - 2017	communities, economic, cultural, subsistence, Arctic Council
	Continuation of Impact Assessment for Cross Island Whaling Activities - Beaufort Sea	ASCR	$328,507	2008 - 2013	Nuiqsut, subsistence, Nuiqsut Whalers Association, Alaska Eskimo Whaling Commission
	Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts	UAF-CMI	$72,178	2014 - 2017	ocean currents, storm surges

CONTRIBUTING ALASKA OCS REGION STAFF

Chris Campbell, Sociocultural Specialist

Cathy Coon, Marine Biologist

Dr. Heather Crowley, Oceanographer

Carol Fairfield, Marine Ecologist

Warren Horowitz, Oceanographer

Virginia Raps, Meteorologist

Rick Raymond, Wildlife Biologist

Kate Wedemeyer, Fisheries Oceanographer

Carla Langley, GIS Specialist

Marty Byrne, GIS Specialist