Studies Development Plan 2021–2022

Environmental research proposed to begin in FY2021 to FY2022 for information needed to assess and manage impacts of offshore energy and marine mineral development on the human, marine, and coastal environments.

BOEM
Bureau of Ocean Energy Management

Table of Contents

List of Figures

List of Tables

List of Acronyms

AERMOD	American Meteorological Society/EPA Regulatory Model
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CMI	Coastal Marine Institute
COP	Construction and Operations Plan
CZMA	Coastal Zone Management Act
DOI	Department of the Interior
DPP	Development & Production Plan
EEZ	Exclusive Economic Zone
EIS	environmental impact statement
EMF	electromagnetic field
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
ESP-PAT	Environmental Studies Program Performance Assessment Tool
FWS	Fish and Wildlife Service
FY	fiscal year
G&G	geological and geophysical
GCCESU	Gulf Coast Cooperative Ecosystem Studies Unit
GOM	Gulf of Mexico
GOMR	Gulf of Mexico Region
LiDAR	light detection and ranging
LME	large marine ecosystem
LSU	Louisiana State University
MBTA	Migratory Bird Treaty Act
MMP	Marine Minerals Program
MMPA	Marine Mammal Protection Act
MSFCMA	Magnuson-Stevens Fishery Conservation & Management Act
MRDF	Mississippi River Delta Front
NASA	National Aeronautics and Space Administration
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NOSB	National Ocean Sciences Bowl
NRHP	National Register of Historic Places
NSL	National Studies List
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act

OEP	Office of Environmental Programs
OREP	Office of Renewable Energy Programs
OSRA	oil spill risk analysis
PAM	passive acoustic monitoring
PICOC	Problem, Intervention, Comparison, Outcome, and Context
RODEO	Real-time Opportunity for Development Environmental Observations
SDP	Studies Development Plan
SME	subject matter expert
SSQ	Strategic Science Question
STRETCH	Strategy for Emerging Technology
USCRP	U.S. Coastal Research Program
USGS	U.S. Geological Survey

1 Overview

1.1 Introduction

1.1.1 Bureau of Ocean Energy Management Mission

The Department of the Interior's (DOI's) Bureau of Ocean Energy Management (BOEM) is responsible for managing the development of the Nation's offshore energy and mineral resources in an environmentally and economically responsible way. These resources include oil and gas; wind, wave, and current energy; and sand, gravel, and other marine minerals.

1.1.2 Environmental Studies Program Vision & Background

Environmental stewardship is at the core of BOEM's mission. Diverse Federal laws task BOEM with protecting the marine, coastal, and human environments. BOEM utilizes the best available science to support sound policy decisions and manage Outer Continental Shelf (OCS) resources. Since 1973, Congress has funded an Environmental Studies Program (ESP) to produce research needed for decision support. The ESP has provided over $1 billion for research to this end since its inception in 1973. BOEM facilitates top-quality research by talented scientists from a range of disciplines, which is targeted to support policy needs and priorities.

★ ★ ★ ★ ★

BOEM's long-term vision is for the ESP to be the "first in class"—the best research program there is in the context of BOEM's mission and constraints.

★ ★ ★ ★ ★

BOEM's ESP was mandated after 1978 by Section 20 of the OCS Lands Act (OCSLA) to conduct studies that will provide the information needed to assess and manage impacts on the human, marine, and coastal environments from offshore energy and marine mineral development. Section 20 specifically calls for studies addressing impacts on marine biota that may result from chronic, low-level pollution or from large spills associated with OCS production, including onshore facilities. Section 20 also calls for studies to monitor human, marine, and coastal environments. These studies provide time series and data trend information for identifying significant changes in the quality and productivity of those environments and analyzing the causes of these changes.

BOEM's research mandate under OCSLA is, fundamentally, to assess and understand how the Bureau's decision-making impacts the environment, including the human environment, and how those impacts can be avoided or minimized. BOEM accomplishes this by recognizing that its decisions and policies contribute to the regional socio-ecological systems[1] that it stewards. The ESP, together with environmental assessment and regulation, constitute BOEM's

[1] Socio-ecological systems include the physical environment.

environmental program and ensure that environmental protection is a foremost concern and an indispensable requirement in BOEM's decision-making.

The ESP manages applied science research with direct relevance to the Bureau's environmental assessment needs. BOEM's OEP conducts environmental reviews, including NEPA analyses, and produces compliance documents supporting decisions on the national OCS oil and gas leasing program, renewable energy development, and marine mineral exploration and leasing activities.

Section 20 of OCSLA authorizes the ESP and establishes three general goals for the ESP:

- **Baseline Studies**: Provide information needed for the assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS and potentially affected coastal areas
- **Impact Studies**: Predict impacts on marine biota that may result from OCS activities
- **Monitoring Studies**: Monitor human, marine, and coastal environments to provide time series and data trend information for identifying significant changes in the quality and productivity of these environments, and for designing studies to identify the causes of these changes

1.1.3 Funding

Since its inception, the ESP has provided over $1 billion for research on environmental impacts and monitoring associated with energy and mineral development. Average annual planned funding for the ESP is currently $30 million, although the expenditure level has varied over the years. The ESP funds are currently dispersed for defined projects through three vehicles: interagency agreements with Federal agencies; cooperative agreements with state, local, and nonprofit institutions, including Native American Organizations; and competitive contracts. Irrespective of funding vehicles and recipients, BOEM aims to use funds in a way that will deliver the most needed and highest quality research at the best value to the government.

Between 2016 and 2020 (**Figure 1**), funding for ESP studies went to the following types of organizations:

- 42% to Federal agencies
- 30% to private organizations
- 22% to academic institutions
- 2% to state government agencies
- 2% to non-profit organizations
- 2% to other researchers

The subject matter allocation of funds over fiscal years (FYs) 2016–2020 (**Figure 1**) were the following:

- 37% to habitat and ecology
- 27% to marine mammals and other protected species

- 17% to fate and effects
- 6% to physical oceanography
- 7% to information management
- 4% to social science and economics
- 2% to air quality

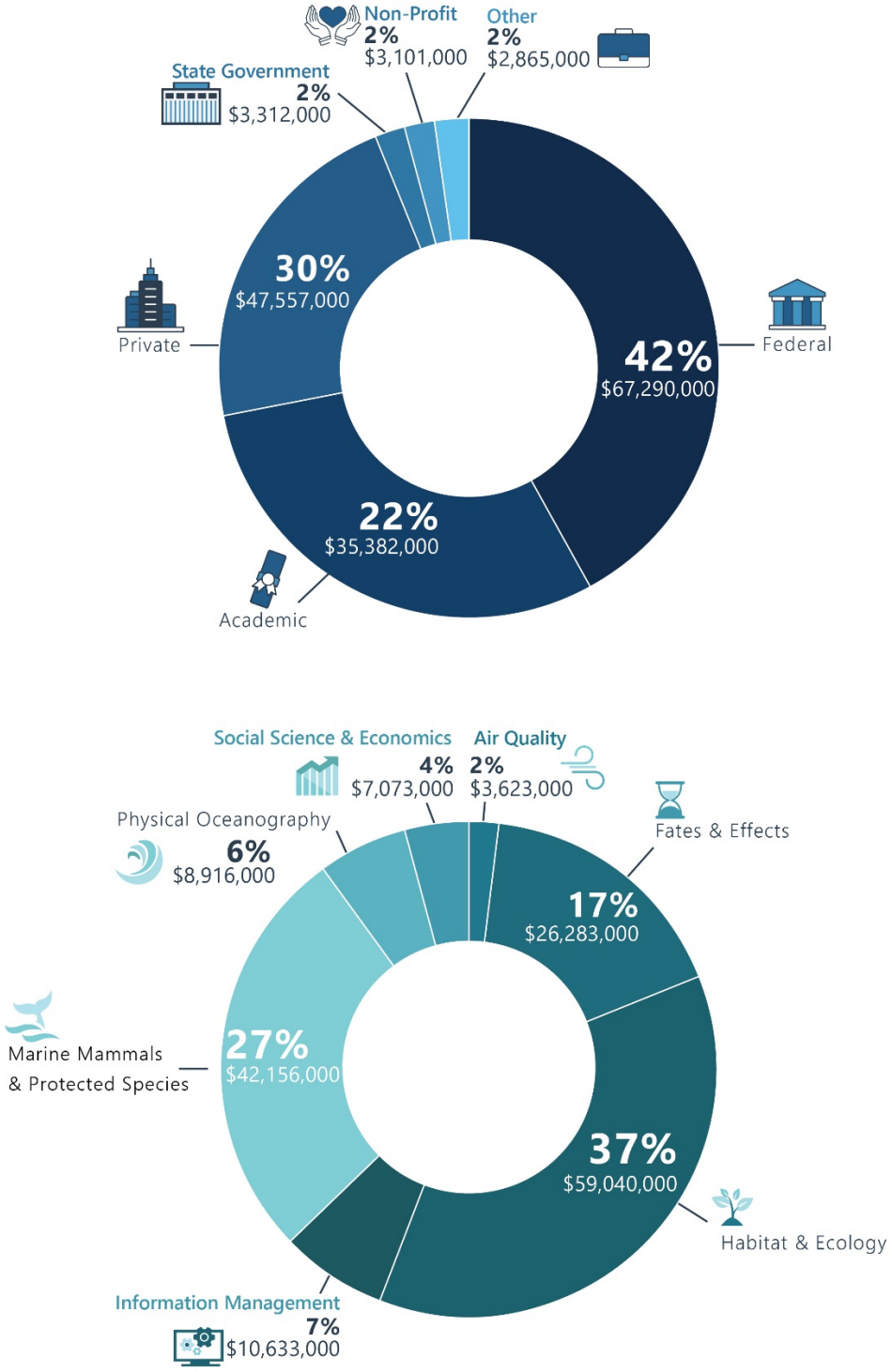


Figure 1. Cumulative ESP expenditures for FY 2016–2020 by vendor type (top) and discipline (bottom). Dollar amounts rounded to the nearest thousand dollars.

1.2 About the Studies Development Plan (SDP)

1.2.1 SDP Overview

BOEM's SDP is a strategic planning document released annually by the ESP. The SDP is used internally to outline the program's scientific direction, identify information needs, and prioritize research for the upcoming two FYs. All regional offices provide substantial input and critical review of the document. The information in the SDP is used to formulate the annual National Studies List (NSL) that describe ESP projects eligible for funding in each FY. Proposed studies within the SDP are peer reviewed by selected BOEM subject matter experts (SMEs).

All studies proposed in this SDP are subject to the availability of funds. Study needs may be adjusted after the release of this document to respond to shifting priorities, emerging information needs, and the ESP budget. This document is also a critical communication tool for the scientific community and other external stakeholders and partners.

An overview of BOEM's proposed national and regional research is provided in **Sections 2–6**. **Appendix A** includes tables summarizing new studies that are projected to begin in FY 2021 and FY 2022, and **Appendix B** provides the study profiles for each region.

1.2.2 What BOEM Needs to Know

1. **Effects of Impacting Activities:** Information on environmental impacts from activities authorized by BOEM, how to prevent or lessen adverse impacts, and how to provide information needed for legal compliance

    - Oil and other chemical releases into the sea or onshore, including both large and low-level, chronic discharges
    - Air pollutant emissions
    - Greenhouse gas emissions
    - Sound in the sea
    - Obstructions to migration or movement of biota
    - Seabed disturbance
    - Coastal lands disturbance
    - Socioeconomic impacts of exploration and development and their interactions

2. **Affected Resources:** Information on the status, trends, and resilience of potentially impacted socio-ecological system's elements

    - Distribution and abundance of species, particularly those that are highly regulated or particularly vulnerable to adverse change in status; important for subsistence, commercial, or recreational use; or invasive
    - Biogeographic areas of ecological, cultural, or commercial importance or sensitivity
    - Marine environmental quality and productivity
    - Air quality
    - Diversity and productivity of platform biota
    - Presence and nature of shipwrecks and submerged cultural landscapes

- Obstruction of access to marine sediments and the associated impact on coastal restoration projects
- Subsistence use and resources relied on by native people for food and culture
- Quality of life indicators for coastal native and other people

3. **Monitoring:** Information from monitoring on the environmental impacts of BOEM's authorizations over the entire time during which those impacts will occur, including potential future decisions

4. **Cumulative Impacts:** Information to address the requirements of the National Environmental Policy Act (NEPA), OCSLA, and other statutes on the cumulative environmental impacts of BOEM's authorizations

5. **Compliance:** Information required to demonstrate that BOEM's decisions comply with all applicable environmental laws

1.2.3 Criteria for Study Development and Approval

The following seven criteria (Criteria) are used in evaluating the priority of study topics during development and for determining whether profiles for the topics should be included in the ESP SDP or NSL.

1. **Need for Information in BOEM Decision-Making:** All studies must contribute to BOEM's need to know as described above. This requirement is not meant to favor studies addressing specific impacts (e.g., the impact of seismic airguns on commercial and recreational fish stocks) as opposed to broader studies whose insights are indirect but important to understanding the impacts of BOEM's activities (e.g., population distribution and abundance, ecosystem dynamics). As noted above, ESP studies include both expenditures to address specific research questions and expenditures for "infrastructure," such as maintenance of museum collections and ocean observing systems, which support an array of research projects addressing BOEM information needs. All study profiles must articulate the study's relevance and importance to BOEM decision-making, as well as the level of need that must be considered in setting priority. This criterion accounts for the urgency of information and is intended to provide for a reasonable level of support in each region and across BOEM's three programs: oil and gas, renewable energy, and marine minerals.

2. **Contribution to Existing Knowledge:** Studies must be designed to contribute substantially to existing knowledge, and profiles should describe how the proposed work address information needs or will improve, confirm, or challenge current understanding.

3. **Research Concept, Design, and Methodology:** All study profiles must provide a sound research concept (including questions asked), design, and methodology. This does not require a high level of detail such as would be provided in specific proposals to carry out the work, but the basic proposal concept, design, and methodology must be sound. The quality of the research design and methodological innovation are important

considerations evaluated in this criterion. The archiving of data and the curation of collected specimens are also considered core components of this criterion.

4. **Cost-Effectiveness:** Studies must be cost-effective, and the expense of a study is relevant in comparing its value with other study opportunities. This does not mean that costly studies are disfavored if the expense is necessary for important knowledge or leveraged with other funders.

5. **Leveraging Funds:** Study proposals should explore opportunities for shared funding. These may involve the transfer of funds from or to BOEM, contributions to a shared account, or coordination of separately funded work toward common objectives.

6. **Partnerships:** Study proposals should support collaboration with native people whenever appropriate and feasible and should explore any opportunities for public outreach and engagement, such as "citizen science" or involvement of aquariums or other non-profits. Partnering is encouraged with other Federal agencies, academic organizations, other non-profits, or commercial enterprises to achieve shared mission needs.

7. **Multi-Regional and Strategic Utility:** Studies may gain priority if they support multi-regional or strategic needs. Purely local studies will still be considered, but if everything else is equal, a study serving broader values is of higher priority for funding than one that does not. Collaboration is encouraged for identifying such needs.

1.2.4 Strategic Science Questions

In response to internal and external reviews of the ESP, BOEM developed a series of Strategic Science Questions (SSQs) to be addressed at the programmatic level. These questions are meant to provide consistency and guidance to the ESP research portfolio across regions as we move toward a more comprehensive understanding of those topics over the coming decade. These research questions need to be addressed at a national level and have implications across all BOEM regions and programs.

At the highest level, BOEM's ESP should strive to provide information needed to understand the uncertainty and risk of the socio-ecological systems under consideration and communicate those risks and uncertainties to decision-makers and the public.

More specifically, BOEM's ESP needs to continue to develop science that addresses the following *key questions*:

1. How can BOEM best assess **cumulative effects** within the framework of environmental assessments?

2. What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?

3. What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?

4. What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?

5. What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?

6. How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?

7. How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?

8. How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?

9. What are the best resources, measures, and systems for **long-term monitoring**?

These SSQs are also linked to the development of BOEM Centers of Expertise. By the end of FY 2021, BOEM plans to implement three centers focused on modeling and environmental risk assessment related to acoustics, air quality, and oil spills. These three key topics are directly related to BOEM's SSQs. Along with advanced modeling, these centers will drive the full range of tools BOEM uses to assess and manage risk, including scientific research, policy development, and methods for effectively communicating risk to decision-makers and stakeholders.

1.2.5 SDP Development Process

ESP projects are developed by BOEM through internal and, in certain cases, external review. Overall direction and coordination are provided by the Headquarters Office's Division of Environmental Sciences within the Office of Environmental Programs (OEP). Research projects are built by addressing BOEM's SSQs with input from BOEM's regional offices and stakeholders (BOEM 2020). Project managers identify information needs and develop specific research questions in order to provide BOEM with robust scientific information for its decision-making process on offshore energy and marine mineral planning.

The ESP introduced an updated study profile format in 2018 to further improve a profile's scientific rigor and to enhance any potential statement of work. Under this format, authors frame their proposed studies by defining the following elements: Problem, Intervention, Comparison, Outcome, and Context (PICOC). Study profiles ultimately identify a set of specific research questions that link back to the SSQs to guide ESP's broader research portfolio over the next five to ten years.

1.2.6 Conventional Energy

OCSLA (43 U.S.C. §1344) requires DOI to prepare a national OCS oil and gas leasing program consisting of a proposed lease sale schedule on the size, timing, and location of areas for Federal OCS oil and natural gas leasing. DOI has the role of ensuring that the U.S. Government

receives fair market value for acreage made available for leasing and that any oil and gas activities conserve resources, operate safely, and take maximum steps to protect the environment. The current 2017–2022 national OCS oil and gas leasing program (BOEM 2016a) addresses OCS oil and gas exploration, development, and production in the Gulf of Mexico (GOM), Pacific, and Alaska Regions (BOEM 2016a). In 2017, the Secretary directed BOEM to immediately initiate development of the next national OCS oil and gas leasing program, with full consideration given to leasing the OCS offshore Alaska, Mid-Atlantic, South Atlantic, and the GOM.

1.2.7 Renewable Energy

The Energy Policy Act of 2005 (EPAct; P.L. 109-58) amended OCSLA to add renewable energy to DOI's (and BOEM's) development and environmental protection responsibilities. There is abundant potential for renewable energy from wind, wave, and ocean currents offshore along the Atlantic and Pacific Coasts. A feasibility study for renewable energy is also currently underway in the GOM. Though these technologies are not producing energy on the U.S. OCS yet, five turbines are now producing electricity in state waters off Rhode Island. Efforts to support current and future renewable energy activities are underway, including 16 active leases along the Atlantic Coast from Massachusetts to North Carolina. Seven Construction and Operations Plans (COPs) are under review, and five more are expected within the next year.

1.2.8 Marine Minerals

OCSLA assigns DOI (delegated to BOEM) responsibility for authorizing exploration and development of non-energy minerals on the OCS, preventing the waste of natural resources, and ensuring related environmental protection. Section 8(k) of OCSLA sets forth specific requirements for the non-competitive use of sand, gravel, and other sediment and establishes the leasing framework for the competitive sale of any marine mineral. Since 1995, BOEM has executed 58 negotiated agreements and conveyed rights to approximately 164 million cubic yards of sand and sediment for coastal restoration projects along the coastline of eight different Atlantic and GOM states (statistics updated through March 2020). These projects have protected billions of dollars of infrastructure, as well as important ecological habitats, along almost 360 miles of the Nation's coastline. The Marine Minerals Program (MMP) has authorized geological and geophysical (G&G) exploration activities for a wide range of marine minerals, including sand, heavy minerals, phosphorites, gold, and other deepwater minerals of interest. The MMP is responsible for executing competitive lease agreements for other non-energy minerals, such as strategic mineral resources like copper, lead, zinc, and gold, as well as critical minerals (83 Federal Register 23295) such as cobalt, manganese, platinum, and rare earth minerals. Developers have periodically expressed interest in obtaining leases to develop these resources; however, there have been no leases issued for these resources. There are no pending lease requests for critical minerals at this time. Executive Order (EO) 13817 (*A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*) has spurred renewed interest in marine minerals, such as rare earth elements, and provided an impetus to identify domestic sources of these minerals that include potential offshore sources.

1.2.9 Geographic Focus: OCS Leasing Within the U.S. Exclusive Economic Zone (EEZ)

The OCS is defined by the Outer Continental Shelf Lands Act (43 U.S.C. § 1331) and consists of all submerged lands, subsoil, and seabed lying between the seaward extent of the states' jurisdiction and the seaward extent of Federal jurisdiction. For most coastal states, the seaward extent of their jurisdiction is 3 nautical miles (nm) from the coastline (notable exceptions include Texas and the Gulf Coast of Florida, where state jurisdiction extends 9 nautical miles from shore). The 1983 Reagan Proclamation established U.S. jurisdiction out to the limit of the EEZ. However, this 200-nautical mile limit does not define the outer limit of the OCS. In terms of BOEM's leasing authority, the EEZ boundary can be understood as a jurisdictional minimum, except where constrained by the conflicting jurisdiction of other countries.

As of May 2020, approximately 13.8 million OCS acres are actively leased by BOEM for conventional energy development, and, in 2019, OCS conventional energy development provided for almost 4% of the Nation's natural gas production and about 16% of domestic oil production.

1.3 ESP Principles

The ESP is guided by four main principles:

1. Studies conducted by BOEM must be use-inspired so that determined results may be applied toward management decisions.
2. Research supported by the Bureau must be held to the utmost scientific integrity and credibility.
3. Partnerships should be sought, whenever possible, to leverage funds with other interested Federal, state, and private stakeholders to maximize the utility of results and extend limited budgets.
4. The Bureau will engage regularly with stakeholders and pursue public education and outreach to promote quality assurance, peer review planning, and data dissemination.

1.3.1 Use-Inspired Science

BOEM embraces the concept of "use-inspired" science in developing ESP studies. "Use-inspired" means an approach that integrates the quest for fundamental understanding with the objective to inform decisions on practical problems. Scientific research that is use-inspired is designed with a view to advance broader fundamental knowledge of phenomena being examined together with providing answers to specific questions needed for management decisions.

1.3.2 Scientific Integrity and Credibility

The DOI's Scientific Integrity Policy calls for the use of science and scholarship to inform management and public policy decisions and establishes scientific and scholarly ethical standards. In addition, the policy includes codes of conduct, a process for assessing alleged

violations, and clear guidance of how employees can participate as officers or members on the boards of directors of non-Federal organizations and professional societies. This policy applies to all Department employees, including political appointees, when they engage in, supervise, manage, or influence scientific and scholarly activities; communicate information about the Department's scientific and scholarly activities; or utilize scientific and scholarly information in making agency policy, management, or regulatory decisions. Further, it applies to all contractors, cooperators, partners, permittees, and volunteers who assist with developing or applying the results of scientific and scholarly activities.[2]

To ensure consistency and transparency, the ESP follows a robust set of procedures that include multiple levels of review and approval. Research projects are identified and selected on an annual basis with an emphasis on mission relevance and scientific merit.

National attention has been directed toward the ESP's performance measures and accountability. The ESP Performance Assessment Tool (ESP-PAT) ensures the ESP fulfills its mission of providing the best possible scientific information for making decisions concerning our offshore resources. The ESP-PAT is an internal, online system used to monitor the effectiveness of ESP products in fulfilling the Bureau's information needs. This tool also tracks the program's efficiency in delivering products on time.

1.3.3 Peer Review

Section V of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (EOP 2004) requires that agencies have "a systematic process of peer review planning" and publish a "web-accessible listing of forthcoming influential scientific disseminations (i.e., an agenda) that is regularly updated by the agency." Numerous mechanisms within the ESP identify and fulfill the OMB requirement for scientific peer review. These existing mechanisms include:

- Internal review of study profiles by BOEM scientists
- External review of study profiles by other Federal and non-governmental scientists
- Review and critical input by scientific review boards or modeling review boards
- Scientific peer review of final reports
- Publication in peer-reviewed technical and/or scientific journals

Each project is evaluated for the appropriate level of peer review required for the particular effort. These measures begin early in the development stages and continue during projects. These components taken together ensure that the science co-produced by the ESP is of the highest quality and, thus, creates a sound basis for decision-making.

1.3.4 Partnering and Leveraging

The ESP regularly encourages inter- and intra-agency study collaborations with BOEM's Federal partners, and many of BOEM's important and award-winning research efforts were completed through the cooperation with agencies such as the National Aeronautics and Space

[2] https://www.doi.gov/scientificintegrity

Administration (NASA), U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and U.S. Navy's Office of Naval Research. BOEM has established partnerships with the States of Louisiana and Alaska through their respective Coastal Marine Institutes (CMIs), and the Bureau is also a member of several Coastal Ecosystem Studies Unit networks, which enable it to efficiently establish cooperative agreements with state-owned institutions.

BOEM coordinates its efforts with ocean research programs, such as the National Oceanographic Partnership Program (NOPP) and the U.S. Coastal Research Program (USCRP). NOPP is a collaboration of Federal agencies that provides leadership and coordination of national oceanographic research and education initiatives. NOPP adds significant integrative value to the individual oceanographic, ocean science, resource management, and ocean education missions of the Federal agencies and their partners, in common pursuit of the wise use of the oceans and the maintenance of their health. As a charter member of NOPP, BOEM continues to explore options to increase its participation, and its investments have grown dramatically in recent years. The ESP has funded, through NOPP, research focused on chemosynthetic communities, biological habitats supported by shipwrecks, high-frequency radar mapping of surface circulation in Alaska, improving cetacean electronic data loggers, and a variety of renewable energy projects. Several studies have received the NOPP Excellence in Partnering Award and DOI's Partners in Conservation Award. A collaboration of Federal agencies, academics, and stakeholders, USCRP aims to identify coastal research needs, foster research opportunities, enhance funding for academic programs, and promote science translation.

1.3.5 Information Management and Dissemination

Rapid information dissemination is a key ESP management activity. The ESP strives to disseminate the information it collects in a usable form and in a timely manner to relevant parties and users of the information.

Access to completed ESP studies is available through the ESP Information System (ESPIS).[3] This search tool, launched in 2015, allows text and map-based queries to find relevant study information. Study information includes downloadable electronic documents of study profiles, technical summaries and final reports, and links to associated publications and digital data. ESPIS facilitates information sharing for NEPA assessments, oil and gas and alternative energy leasing, and informing Ocean Planning initiatives. The ESPIS search tool is hosted on a shared platform with MarineCadastre.gov, which is developed in partnership with the NOAA Office for Coastal Management.[4]

BOEM presents the results of the ESP-funded research both domestically and internationally to a variety of audiences, including professional and academic societies, industry forums, and governmental workshops. These events spread scientific information to wide audiences, and

[3] http://www.boem.gov/espis/
[4] https://marinecadastre.gov/

many projects have opportunities for educational components. BOEM also publishes its own magazine *Ocean Science*[5] and quarterly *Science Notes* newsletters.[6]

Information concerning ongoing research supported through the ESP is available on the BOEM website.[7] The ongoing research is arranged by BOEM OCS Region and discipline. Information provided for each study includes a complete description, status report, cost, and expected date of its final report. Where applicable, BOEM also provides affiliated websites, presentation abstracts, and papers.

1.3.6 Outreach and Education

BOEM, like many other Federal agencies, must be able to attract well-qualified marine scientists and engineers to meet expanding and changing workforce needs. The ESP undertakes several activities to encourage students in their academic training and provide young professionals with opportunities to succeed in their careers. These activities are in support of the ESP's education goals of (1) an ocean-literate public, (2) a pipeline of marine scientists to meet ESP needs either through employment at BOEM or at universities, and (3) a science-literate marine workforce. Through cooperative agreements with universities, BOEM often supports undergraduate and graduate research. Research teams on ESP-funded projects using undergraduate and graduate students contribute to the training and career development of the next generation of marine scientists.

To encourage high school students interested in the marine sciences, the ESP provides financial support to the National Ocean Sciences Bowl (NOSB), which is a high school competition. The NOSB provides BOEM with the opportunity to develop links to the pre-college community and allow students to be aware of career opportunities in the marine sciences and in the Federal government. BOEM is profiled in the NOSB career booklet, "An Ocean of Possibilities! Careers Related to the Ocean and Aquatic Sciences." The NOSB reaches out to students and communities to increase participation by minorities, women, and disadvantaged students, which supports BOEM's goal of a diverse workforce.

[5] https://www.boem.gov/Ocean-Science/
[6] https://www.boem.gov/Science-Notes/
[7] https://www.boem.gov/environment/environmental-studies/ongoing-environmental-studies-region

2 Headquarters Studies

2.1 Introduction

BOEM's Headquarters Office provides national context for the ESP and supports linkages among the Bureau's programs and regional offices. While most of BOEM's regional offices focus on research and information needs for their respective geographic areas, studies initiated by OEP at the Headquarters Office are predominantly national in scope, have program-wide applications, or utilize emerging or new technology. Any Headquarters-led regional studies are typically focused in the Atlantic. Headquarters may also develop studies with Federal agencies, universities, or external partners in order to leverage resources and foster collaborative relationships. Efforts are made to incorporate and build upon the findings of previous studies.

To meet national assessment needs, OEP considered the areas of information that BOEM needs to know as posed in the ESP Strategic Framework (BOEM 2020). Comparison of these areas with the historical knowledge of national scientific needs identified through the development of the Programmatic Environmental Impact Statement (EIS) for the 2017–2022 national OCS oil and gas leasing program (BOEM 2016b), the Programmatic EIS currently under development,[8] other NEPA analyses, and associated consultations led to the development of this year's 14 study profiles. Further, OEP considered study needs associated with the forthcoming BOEM Centers of Expertise, which will focus on complex science and policy issues that require development of specialized expertise, models, and risk assessment frameworks, such as marine sound, air emissions, and oil spill risk and environmental effects. Lastly, OEP recently launched an initiative to promote the use of emerging technology in ESP-funded studies. This new Strategy for Emerging Technology (STRETCH) aims to establish BOEM as a leader among resource management agencies in adopting and using new and emerging technologies to answer key science questions concerning OCS energy and mineral resource development activities.

Appendix A includes the tables of proposed studies for FYs 2021 and 2022. **Appendix B** provides the profiles for the proposed studies.

2.2 Alignment with SSQs

At the national level, BOEM's ESP has focused on a few of the SSQs that support BOEM and ESP operations over the past few years. These areas of focus are how to best assess cumulative effects, the use of existing or emerging technology to achieve more effective or efficient scientific results, the acute and chronic effects of sound from BOEM-regulated activities on marine species and their environment, and the understanding the air emissions impacts of BOEM-regulated activities to the human, coastal, and marine environment.

In recent years, BOEM has funded several studies that look to utilize or optimize new technologies, such as utilizing satellite and high-resolution aerial imagery to identify and count marine and avian species; incorporating environmental deoxyribonucleic acid (eDNA) analyses

[8] https://www.boem.gov/National-Program-Learn/#peis

for species monitoring; using existing satellite resources to better detect and track large marine organisms; and an OCS genomic sampling strategy for marine invertebrates.

Current needs at the national level include learning more about socioeconomic impacts from OCS oil and gas projects, better understanding OCS oil spill occurrence rates, and validating offshore satellite data for offshore air quality management. BOEM continues to be committed to the continuous improvement of oil spill risk analysis (OSRA) estimations. As offshore activity expands into deeper waters and new geographic areas, BOEM oil spill modeling will be applied to pertinent risk assessments and validated with environmental observations. BOEM has also worked to update regional air quality models and their inputs to better understand the potential impacts of OCS energy development on the human and marine environment and is now looking to design standard operating procedures to use satellite data for offshore air quality management. Similarly, at a national level, BOEM's ESP has worked to proactively develop and fund updates to key economic analyses that support the national OCS oil and gas leasing program.

Table 1 provides more details about the studies proposed by Headquarters and their alignment with the SSQs. Study profiles can be viewed by clicking on the study title.

Table 1. Alignment of proposed FY 2021 Headquarters studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Facilitating Strategic Partnerships in Support of the Presidential Memo on Ocean Mapping, Exploration, and Characterization	✓	✓	✓	✓	-	✓	✓	-	✓	-	✓	✓
2	Socioeconomic Impacts Likely to Result from Initial Oil and Gas Projects in Frontier Areas	✓	-	-	-	-	-	-	-	-	✓	-	-
3	Imagery Acquisition to Support and Enhance BOEM's Deep Learning Projects	-	✓	-	-	-	-	-	-	-	-	✓	✓
4	National Outer Continental Shelf (OCS) Oil Spill Occurrence Rates	✓	-	-	✓	-	✓	✓	✓	-	✓	✓	
5	Validation of Offshore Satellite Data for Offshore Air Quality Management	✓	-	-	✓	-	-	-	✓	-	-	✓	✓
6	Spatial and Acoustic Ecology of Understudied ESA Listed Marine Mammals	✓	✓	-	✓	✓	-	✓	-	✓	-	✓	✓
7	Modeling Support for the Center for Marine Acoustics	✓	✓	✓	✓	✓	-	-	-	✓	-	✓	-
8	Mortality Risk for Whale and Basking Sharks During Mineral Operations	✓	✓	-	✓	✓	-	-	-	-	-	✓	✓
9	Environmental and Human Exposure to Technologically Enhanced Naturally Occurring Radioactive Materials (TENORMs) Associated with Oil and Gas (O&G) Activities in the Outer Continental Shelf (OCS)	✓	-	-	✓	-	✓	✓	-	-	✓	✓	✓

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
10	Comprehensive Guide to Deepwater Sensitive Habitats and Associated Fauna	✓	✓	✓	-	-	✓	✓	-	✓	-	✓	✓
11	Workshop on Emerging Technologies for Monitoring Marine Species and Quieting Noise Sources	✓	✓	-	-	✓	-	-	-	-	-	✓	-
12	Integrating Low Cost Emerging Technology Into Ocean Environmental Monitoring	✓	-	✓	✓	-	-	✓	-	-	-	✓	✓
13	Developing the Next Generation of Animal Tags Workshop	✓	✓	✓	-	-	-	-	-	-	-	✓	✓
14	Marine Mammal Bioenergetics Workshop	✓	✓	-	✓	✓	-	-	-	✓	-	-	-

ESP STRATEGIC SCIENCE QUESTIONS

SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?

SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?

SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?

SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?

SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?

SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?

SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?

SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?

SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

2.3 Decision Context

Within the next five to ten years, Headquarters will need to address potential impacts from decisions with program-level relevance, such as supporting the development of an upcoming national OCS oil and gas leasing program or related G&G permitting decisions, or internal policy that is Bureau-wide, including issues such as potential acoustic effects. As mentioned above, also of interest for Headquarters' near-term decisions are studies that span multiple BOEM programs or regions (for example, a study focusing on species found in multiple regions or issues that transcend a specific region or program); are demonstrative in nature (for example, to determine whether new or improved technology may be acceptable for geophysical survey to identify resources); and/or fulfill a national stakeholder outreach or education need.

2.3.1 Upcoming Decisions

- Programmatic Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) consultations and streamlining initiatives, such as for decisions related to G&G permitting and pile driving
- National OCS oil and gas leasing program, including identification of potential areas for activity exclusions or programmatic mitigation

2.3.2 Current/Relevant Issues

BOEM continues to address needs to support the development of future national OCS oil and gas leasing programs, which could potentially include the Atlantic and Pacific Oceans, GOM, and offshore Alaska. With the potential for expansion of leased areas, studies will be needed to develop new information (baseline) for future lease sales, especially if they occur in areas that have not been leased in many years. Additionally, there may be a need to expand knowledge regarding noise impacts from regulated activities on marine species and their environment. Lacking information on hearing abilities in some species, BOEM uses surrogate species as stand-ins in our environmental analyses, but it is unclear whether these are reasonable approximations. Directly measuring the hearing sensitivity and impacts of noise on certain species, such as sea turtles, will allow BOEM to better estimate acoustic impacts resulting from authorized activities nationwide.

In addition to the need for a better understanding of noise on targeted species, there is a lack of information regarding diving behavior and the spatial and acoustic ecology for marine life, such as the critically endangered North Atlantic right whale and other protected species, which creates a high degree of variability in their detection probabilities. These knowledge gaps affect the quality and utility of information gleaned from passive acoustic monitoring (PAM), which is one of BOEM's primary mitigation and monitoring tools. To address these knowledge gaps, BOEM is supporting the compilation of a fish vocalization database to make better use of existing and future PAM data used to monitor species presence. Additionally, BOEM is supporting the development of a standardized framework to integrate marine mammal genomic and visual data across currently siloed data sets for more efficient population monitoring and modeling. The Bureau also needs to both continue and initiate new long-term monitoring programs across its existing and future planning areas to determine cumulative

effects from its permitted activities on marine ecosystems and submerged archaeological resources.

BOEM is updating its Air Quality Rule, which will require more detailed air data, including emissions inventories (activity and emissions factors data), meteorological data, and photochemical and dispersion modeling. Another critical need for air quality is to replace the outdated Offshore & Coastal Dispersion modeling with U.S. Environmental Protection Agency's (EPA's) American Meteorological Society/EPA Regulatory Model (AERMOD), which will require installing platform downwash and coastal fumigation algorithms. BOEM is also considering further working with NASA to assess satellite data for offshore air quality management.

The Bureau needs to gather further information on the location and extent of critical minerals on the OCS and assess the potential impacts of their extraction on the environment. This information will build upon previous studies that analyzed the ecological structure and sensitivity of distinct deepwater habitats.

In November 2019, President Trump issued a *Memorandum on Ocean Mapping of the United States EEZ and the Shoreline and Nearshore of Alaska*.[9] Noting that the oceans contribute more than $300 billion per year of economic activity, the memorandum states that it is the policy of the United States to act boldly to safeguard the Nation's future prosperity, health, and national security through ocean mapping, exploration, and characterization. Specifically, the memorandum tasks Federal agencies with developing a national strategy for mapping, exploring, and characterizing the U.S. EEZ; a strategy for mapping the Arctic and Sub-Arctic shoreline and nearshore of Alaska; and increasing the efficiency of permitting for ocean mapping, exploration, and characterization activities.

Of particular relevance to the ESP is the national strategy for mapping, exploring, and characterizing the Nation's EEZ. This strategy is currently being finalized by the Ocean Science and Technology Subcommittee of the Ocean Policy Committee and the White House Office of Science and Technology Policy. The strategy requires Federal agencies to prioritize and coordinate with each other and with non-governmental entities, where practical, to enhance collaboration toward the collective goals. These activities include mapping U.S. EEZ waters deeper than 40 meters by 2030 (and remaining nearshore waters by 2040); identifying priority areas to further explore and characterize them; deploying new and emerging science and technologies at scale, and leveraging the expertise and resources of multi-sector partnerships—including private industry, academia, and non-governmental organizations—to conduct the mapping, exploration, and characterization as efficiently and effectively as possible. BOEM played a major role in initiating and shaping this strategy and will continue as a key player in its implementation. The ESP will evaluate and—where consistent with BOEM's mission—support research opportunities that align with this larger national effort to map, explore, and characterize the U.S. EEZ.

[9] https://www.whitehouse.gov/presidential-actions/memorandum-ocean-mapping-united-states-exclusive-economic-zone-shoreline-nearshore-alaska/

2.3.3 NEPA/Consultation Information Needs

BOEM Headquarters requires robust, current data to fully analyze and disclose the potential for impacts to biological, physical, chemical, and cultural resources from OCS activities at the programmatic and site-specific level. This analysis includes impacts from offshore oil and gas, as well as G&G activities. NEPA analyses for renewable energy and marine minerals activities are led by their respective programs. Often, the acquisition of these data is in support of known information needs or to continue monitoring of previous impacts. Assessing potential impacts, through the review of additive concerns from other anthropogenic impacts or the continuation of monitoring studies, helps the Bureau to analyze potential cumulative impacts from offshore activities. In addition, Headquarters' information needs include examining the effectiveness of current and proposed mitigation and minimization measures to lessen or eliminate impacts from oil and gas or G&G activities. Additional studies addressing these NEPA/Consultation needs will enable BOEM Headquarters to have a more robust analysis of potential impacts from OCS activities and to propose more successful mitigation and minimization measures. For the FY 2021–2022 SDP, BOEM Headquarters NEPA and consultation needs focus on the acoustic environment, air quality, ecological concerns for marine mammals and large-bodied fishes, socioeconomics, as well as an inclusive review and synthesis of the current scientific understanding regarding the physical and chemical behavior of oil in the marine environment. This information will enable BOEM to conduct more comprehensive NEPA analyses and associated consultation.

3 Alaska Studies

3.1 Introduction

The Alaska OCS encompasses 15 planning areas in the Arctic, Bering Sea, and Gulf of Alaska sub-regions (**Figure 2**). The BOEM Alaska OCS Regional Office oversees more than one billion acres on the OCS and more than 6,000 miles of coastline, which is more coastline than in the rest of the United States combined. The vastness of the Alaska OCS presents many challenges for working in the region: large and remote planning areas; diverse and extreme environmental conditions; still-evolving hydrocarbon extraction technology; and potential environmental hazards associated with offshore activities, such as seasonal sea ice coverage.

Figure 2. Alaska OCS Region planning areas

Since the ESP began almost 50 years ago, BOEM has funded nearly $500 million in environmental studies in Alaska, producing more than 1,000 technical reports and peer-

reviewed publications. Completed study reports are posted on ESPIS.[10] An alternate location for browsing Alaska Region study reports by year is the Alaska OCS Regional Office's website.[11]

The University of Alaska CMI, a cooperative arrangement created in 1993, allows the ESP in Alaska to tap the scientific expertise of regional and local experts to collect and disseminate environmental information about coastal topics associated with the development of energy resources in the Alaska OCS. In its first 25 years, the Alaska CMI has funded approximately 110 studies and leveraged over $20 million of Bureau funds into $40 million of relevant marine-based research, with non-Federal matching funds from more than 50 different organizations.

Environmental change is more evident in the Arctic than in other areas, with summer sea ice extent decreasing to record historical lows. The loss of ice cover is causing changes to the ocean currents, water chemistry, and ecosystem productivity, and has serious implications for marine mammals; birds and fish that live on, below, or near the ice; and the communities that rely on these animals for food security. Although much relevant information exists for certain Alaska OCS planning areas and trophic levels, data are patchy at a large marine ecosystem (LME) scale, and environmental conditions and other anthropogenic stressors keep changing over time. Environmental change also entrains many socioeconomic issues. Some immediate concerns include: increased shoreline erosion and permafrost melt that threatens Arctic communities and infrastructure; changes in distribution and availability of harvested subsistence species; and potential changes in commercial and subsistence fisheries as commercial species such as walleye pollock, Pacific cod, and salmon move north. In consideration of such transition, scientists are challenged to project how the changing environment will interact with OCS activities in the Arctic over the next 25–50 years.

The 2017–2022 national OCS oil and gas leasing program (BOEM 2016a), published in November 2016, includes one lease sale in the Cook Inlet planning area in 2021. No other lease sales are currently planned for the Alaska OCS Region. Currently, the Alaska OCS Region has 33 active leases from previous lease sales; there are 14 in the Cook Inlet Planning Area and 19 in the Beaufort Sea Planning Area.

In late summer 2020, Hilcorp Alaska LLC plans to conduct a geohazards survey over the 14 leases in Cook Inlet and the surrounding area. The geohazard site clearance survey is required by BOEM to identify seafloor obstructions, shallow drilling hazards, and archaeological resources prior to consideration of any further exploration activities.

On April 13, 2018, BOEM approved a revision to the Exploration Plan submitted by Eni US Operating Company, Inc. to conduct drilling into leased OCS areas in the Beaufort Sea from their Spy Island drill site, an existing gravel island located in state waters. The Bureau of Safety and Environmental Enforcement (BSEE) has approved Eni's request for a Suspension of Operations effective 4/3/2020–4/3/2022.

[10] http://www.boem.gov/espis/
[11] http://www.boem.gov/AKpubs

On October 24, 2018, BOEM issued conditional approval for the Liberty Development & Production Plan (DPP) submitted by Hilcorp Alaska LLC. The plan proposes construction of a gravel island and production facility for the Liberty Unit, which is estimated to contain up to 150 million barrels of recoverable crude oil. The Liberty Unit is located in the central Beaufort Sea about 5.5 miles offshore in Federal waters and six miles east of the existing Endicott Satellite Drilling Island. The Liberty Drilling and Production Island will be built 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. Liberty oil will be transported to shore in a single-phase subsea pipe-in-pipe pipeline, which will tie into the existing Badami pipeline for delivery of oil to the Trans-Alaska Pipeline System. Hilcorp is continuing environmental monitoring efforts prior to initiation of construction activities.

Northstar is a joint Federal/State of Alaska production unit located in the Beaufort Sea about 12 miles northwest of Prudhoe Bay. The Northstar Unit includes three OCS leases, which account for nearly 18% of total Northstar production, while the remaining 82% is allocated to state leases. Total production of crude oil from Northstar through January 2020 is approximately 176 million barrels, with the Federal portion comprising almost 30.8 million barrels.

Appendix A includes the tables of proposed studies for FYs 2021 and 2022. **Appendix B** provides the profiles for the proposed studies.

3.2 SSQs Unique to the Alaska Region

In addition to the programmatic SSQs identified in **Section 1.2.4**, the Alaska Region must consider issues related to sea ice, including the following questions:

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

3.3 Alignment with SSQs

In recent years, BOEM has placed primary emphasis on studying the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas; conducting interim baseline research; and monitoring for trends in diverse fields of interest.

Most of the projects exhibit complex, multilateral collaborations, with explicit interdisciplinary linkages between the physical and biological sciences. Many of them also provide a role for active participation by Alaska Native residents and input from sources of traditional knowledge.

BOEM needs updated information about the physical and biological environment in Cook Inlet and Shelikof Strait in anticipation of a planned lease sale in 2021 and potential exploration

activities on existing leases within Cook Inlet. There is an ongoing need for a better understanding of the causes and potential long-term effects of recent seabird die-offs and changes in forage fish populations in Cook Inlet and the Gulf of Alaska, thought to be associated with a recent period of high sea surface temperatures in the North Pacific, to support NEPA analyses, especially for evaluation of cumulative effects. Other particular interests for information include, but are not limited to an improved understanding of distribution, density, and habitat use by biological resources that could be impacted by potential oil spills, especially the Cook Inlet beluga whale; obtaining further baseline information about potential impacts from oil- and gas-related activities to the economy and subsistence use of lower Cook Inlet; assessing background contaminant levels in the water and sediment, as well as potential air quality impacts in the Cook Inlet area; and monitoring for introductions of marine non-native species.

Information about variability and long-term trends in oceanographic conditions and biological communities is also needed in the Arctic. Contemporary oceanographic measurements are needed to help diagnose recently observed changes in utilization of the Beaufort Shelf by bowhead whales and the bowhead whale migration path, and how these changes relate to evolving environmental conditions. Additional information is also needed about habitat use of marine birds, as well as effects on their productivity from environmental changes. Furthermore, improved methods are needed for detecting ringed seal lairs underneath snow to facilitate abundance and density estimates for this species protected under the ESA, as well as to mitigate potential impacts from ice roads and other oil- and gas-related activities.

The Alaska Region has considered the SSQs identified above together with these specific information needs to develop our list of studies proposed for FY 2021. The studies proposed for the Alaska Region inform a broad repertoire of knowledge and address each of the SSQs to varying extents. **Tables 2 and 3** contain a matrix indicating the strongest intersections between each study and the strategic questions.

3.4 Decision Context

3.4.1 Current/Relevant Issues

Many current issues faced by the Alaska OCS Region are tied to the effects of observed environmental changes. These issues include the recent multi-year period of drastically increased sea surface temperatures in the northern Pacific Ocean; changes in biological community composition associated with range expansions for many species and introductions of non-native species; and large reductions in sea ice, as well as changes in the timing of freeze-up and ice melt.

Changes in sea ice, particularly altered stability of landfast ice, may have important implications for activities associated with the Liberty DPP, including island construction and ice road maintenance. The upcoming 2021 Cook Inlet lease sale and potential future exploration and development activities on existing leases in Cook Inlet and the Beaufort Sea also may lead to increased levels of oil and gas activities and further expand BOEM's need for information in these areas.

In implementing EO 13795 and EO 13817, as well as the *Presidential Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska*, BOEM is evaluating expansion of its program in Alaska to include renewable energy and critical minerals. Relevant issues include renewable energy potential for the OCS off Alaska, the distribution of marine mineral deposits in the Region (including deepwater areas), and environmental considerations associated with the development of these new and technology-dependent programs.

Table 2. Alignment of proposed FY 2021 Alaska studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									ALASKA REGION QUESTIONS		
Priority Rank	Study Title	Conven-tional Energy	Renew-able Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**	AK 1: **Ocean Currents and Sea Ice**	AK 2: **Reduced Sea Ice**	AK 3: **Sea Ice and Spilled Oil**
1	Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas	✓	-	-	✓	-	-	✓	-	-	✓	✓	-	-	✓	-
2	Synthesis of Contaminants Data for Cook Inlet: Evaluation of Existing Data as "Baseline Conditions" and Recommendations for Further Monitoring	✓	-	-	✓	-	✓	-	-	-	-	✓	✓	-	-	-
3	GPS Tagging of Seabirds to Obtain Areas of Foraging Aggregations and Forage Fish Schools in Lower Cook Inlet	✓	-	-	✓	-	-	-	-	-	✓	✓	✓	-	-	-
4	Resource Areas to Support Oil Spill Risk Analysis (OSRA) and National Environmental Policy Act (NEPA) Needs in the Cook Inlet Region	✓	-	-	✓	-	-	-	-	-	-	✓	✓	-	-	-
5	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
6	Kenai Peninsula Borough Economy, 2008 to 2020	✓	-	-	✓	-	-	-	-	-	✓	-	-	-	-	-
7	Bowhead Whale Migration Patterns along the Alaskan Beaufort Shelf During a Period of Rapid Environmental Change	✓	-	-	✓	-	-	-	-	✓	-	-	✓	-	✓	-
8	Cook Inlet Synthetic Source Air Quality Model Data	✓	-	-	✓	-	-	-	✓	-	-	-	-	-	-	-

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									ALASKA REGION QUESTIONS		
		Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**	AK 1: **Ocean Currents and Sea Ice**	AK 2: **Reduced Sea Ice**	AK 3: **Sea Ice and Spilled Oil**
9	Early Detection Plan for Marine Non-native Species in Cook Inlet, Alaska	✓	-	-	✓	-	-	-	-	-	✓	-	✓	-	-	-
10	Determining Important Nearshore and Marine Sites for Shorebirds in the Beaufort Sea	✓	-	-	✓	-	-	✓	-	✓	-	✓	-	-	✓	-
11	Coastal and Submerged Historic Properties and Precontact Sites on the Alaska Outer Continental Shelf	✓	-	-	-	-	-	✓	-	-	✓	✓	-	-	-	-
12	Offshore Renewable Energy Potential on Alaska's Outer Continental Shelf (OCS)	-	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-

ESP STRATEGIC SCIENCE QUESTIONS

SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?

SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?

SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?

SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?

SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?

SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?

SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?

SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?

SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

ALASKA REGION QUESTIONS

AK 1: What role will **ocean currents and sea ice** play in distribution of anthropogenic pollutants near exploration and development prospects?

AK 2: How are ocean currents and biota, including species distributions, affected by **reduced sea ice** conditions?

AK 3: How do cold temperatures and presence of **sea ice alter the fate of spilled oil**?

Table 3. Alignment of proposed FY 2022 Alaska studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									ALASKA REGION QUESTIONS		
Priority Rank	Study Title	Conven-tional Energy	Renew-able Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**	AK 1: **Ocean Currents and Sea Ice**	AK 2: **Reduced Sea Ice**	AK 3: **Sea Ice and Spilled Oil**
1	Collaboration with the Gulf Watch Alaska Monitoring Program in Cook Inlet	✓	-	-	✓	-	✓	-	-	✓	-	-	✓	-	-	-
2	Arctic Marine Assessment Program for Protected Species (ArMAPPS)	✓	-	-	✓	✓	-	-	-	-	-	✓	✓	-	✓	-
3	Measuring and Modeling Oil Impacts on Early Life Stages of Arctic Cod	✓	-	-	-	-	✓	-	-	-	-	✓	-	-	-	-

ESP STRATEGIC SCIENCE QUESTIONS

SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?

SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?

SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?

SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?

SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?

SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?

SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?

SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?

SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

ALASKA REGION QUESTIONS

AK 1: What role will **ocean currents and sea ice** play in distribution of anthropogenic pollutants near exploration and development prospects?

AK 2: How are ocean currents and biota, including species distributions, affected by **reduced sea ice** conditions?

AK 3: How do cold temperatures and presence of **sea ice alter the fate of spilled oil**?

This page intentionally left blank to facilitate duplex printing.

3.4.2 NEPA/Consultation Information Needs

Alaska has some unique issues that influence BOEM mission and decision-making needs. These issues must be considered within the context of varying industry interest in OCS exploration and development and production, as well as potential trends in a changing environment. Specific information needs for NEPA and required consultations include direct, indirect, and cumulative effects on important species from various factors, such as loss of habitat and potential impacts due to increases in vessel traffic and other human activities, and associated increases in ambient sound levels. The potential for impacts from oil- and gas-related activities to species protected under the ESA, MMPA, and the Migratory Bird Treaty Act (MBTA) is of concern. In addition, a good understanding of the seasonal distribution, abundance, and habitat use of forage fish and species used for subsistence purposes, including key spawning areas and migration events, is fundamentally important to monitoring the potential environmental impacts associated with OCS development. How, and to what degree, subsistence activities have been affected by industry infrastructure and activity, or may be in the future, is also of ongoing information interest.

4 Gulf of Mexico Studies

4.1 Introduction

Ongoing activities in the Gulf of Mexico Region (GOMR)—managed by the New Orleans Office—consist of conventional oil and gas development and non-energy marine mineral leasing of sediment resources to support coastal restoration projects. Although there is no current development of OCS renewable energy resources in the GOMR, future interest in wind energy and possibly other offshore technologies may be on the horizon.

The environmental studies in the GOMR address issues from pre-lease through post-lease operations for conventional energy as well as marine minerals extraction from the OCS. In 1992, BOEM's predecessor agency entered into a partnership with Louisiana State University (LSU) to establish the first CMI. This partnership was developed as part of an initiative to cultivate new Federal-state cooperative agreements on environmental and socioeconomic issues of mutual concern. These projects are designed to help answer questions regarding the potential impacts from oil and gas and marine minerals activities.

A unique partnership initiated in 1996 between BOEM's predecessor agency and the USGS provided new opportunities for partnership in biological research. The USGS, through their Ecosystems Mission Area, has procured and conducted several studies for the GOMR in the past. Studies recently funded by USGS for the GOMR through this partnership included assessments of deepwater corals and land loss in relation to Louisiana's coastal habitat loss.

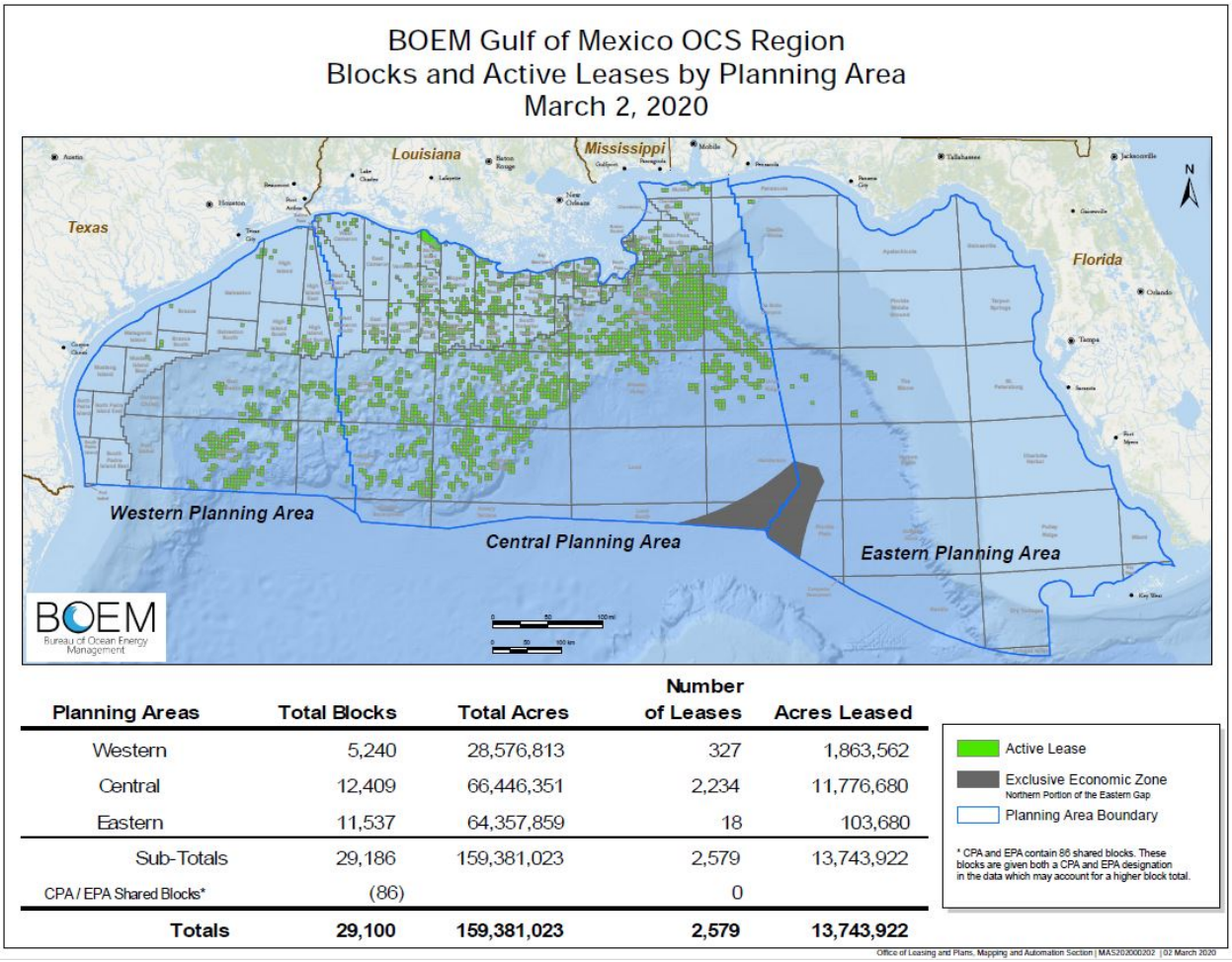
In 2010, BOEM joined the Gulf Coast Cooperative Ecosystem Studies Unit (GCCESU) as a Federal partner. Membership in the GCCESU creates additional opportunities for interdisciplinary and multi-agency research, technical assistance, and education through collaborations within a network of member Federal and state agencies, universities, and research and environmental groups.

Appendix A includes the tables of proposed studies for FYs 2021 and 2022. **Appendix B** provides the profiles for the proposed studies.

4.1.1 Conventional Energy

As of March 2, 2020, there are more than 2,500 active oil and gas leases on the GOM Federal OCS (**Figure 3**). Within active leases, there are nearly 2,000 platforms making substantial contributions to the Nation's energy supply. The GOMR currently provides approximately 25% of U.S. domestic oil production and 11% of U.S. domestic gas production. Energy exploration and production activities include leasing, exploration, development, removal of platforms, and installation of pipelines. Two lease sales were proposed for 2020 in the 2017–2022 national OCS oil and gas leasing program (BOEM 2016a); the first lease sale was held in March, and the second lease sale is anticipated to be held in the summer. For more information on the GOMR, please visit the region's website.[12]

[12] http://www.boem.gov/Gulf-of-Mexico-Region/



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	327	1,863,562
Central	12,409	66,446,351	2,234	11,776,680
Eastern	11,537	64,357,859	18	103,680
Sub-Totals	29,186	159,381,023	2,579	13,743,922
CPA / EPA Shared Blocks*	(86)		0	
Totals	**29,100**	**159,381,023**	**2,579**	**13,743,922**

Office of Leasing and Plans, Mapping and Automation Section | MAS20200202 | 02 March 2020

Figure 3. GOM OCS planning areas and active oil and gas leases (March 2, 2020)

4.1.2 Marine Mineral Activities

The MMP is actively leasing OCS sediment in the GOM for large-scale restoration projects in Mississippi, Louisiana, and Texas to repair natural resources facing chronic erosion or damage during the *Deepwater Horizon* oil spill or storm-related events. OCS sand is also occasionally leased for beach nourishment projects along the south-central and western coasts of Florida. These projects are part of the overall Federal effort to work with Gulf Coast communities to help rebuild coastal marshes and barrier islands, restore damaged beaches, protect critical infrastructure, conserve sensitive areas for wildlife, and enhance the natural protection that these landforms provide from storms. The GOM represents a unique environment of complex, competing-use challenges resulting from significant sediment resource areas, such as the Ship Shoal Area, that may also be optimum sites for oil and gas platforms and associated pipelines (**Figure 4**). These challenges are becoming more complex and deserving of rigorous and integrated environmental study, monitoring, and management.

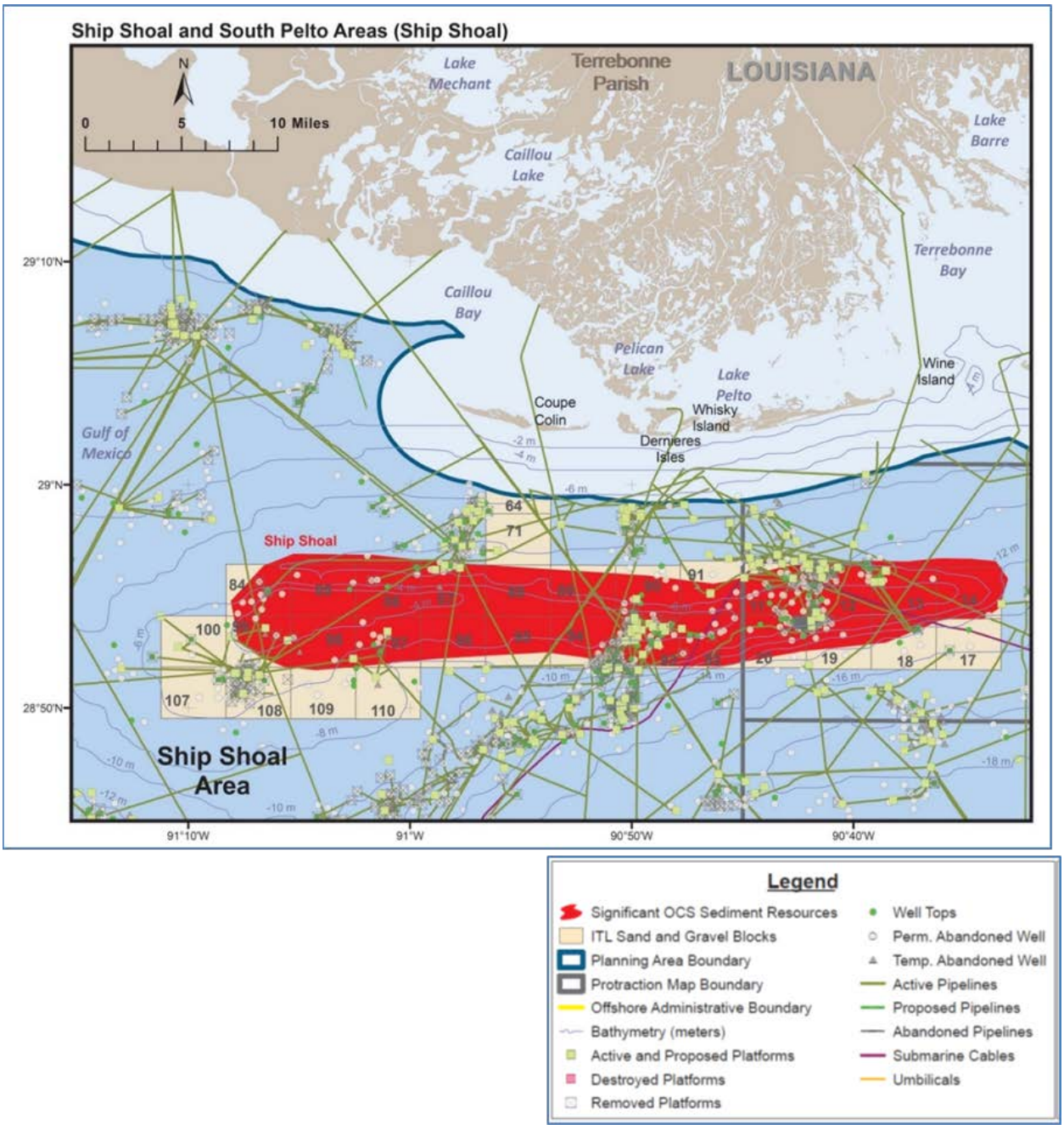


Figure 4. Complex, competing-use challenges in the GOM

Sediment resources needed to repair the damaged coastlines and barrier islands in Florida, Alabama, Mississippi, Louisiana, and Texas are estimated to be from 250 to more than 300 million cubic yards. In 2019, the Texas General Land Office finalized the Texas Coastal Resiliency Master Plan, recommending over 120 priority projects to mitigate coastal hazards, such as restoration projects along Bolivar Peninsula, Follets Island, Galveston Island, and Padre Island. Preliminary estimates indicate that over 200 million cubic yards of OCS sediment may be needed to construct beaches, dunes, and other storm risk management measures; much of which has not been identified.

4.2 Alignment with SSQs

With a robust conventional energy program spanning several decades, the New Orleans Office continues to identify information needs related to actual and potential impacts from conventional energy-related activities. The information gathered will inform cumulative impacts and other NEPA analyses, environmental consultations, mitigations, and oil spill modeling. Collection of baseline data will inform future decision-making and lay the foundation for long-term monitoring. Existing and new monitoring programs often rely on partnerships and will continue to provide valuable environmental information. In addition, studies related to marine minerals extraction will continue to provide important information for BOEM decision-making. Understanding the ecosystems in which dredging occurs, both with and without construction activity, improves BOEM's analyses of impacts and management of the resource for long-term use.

4.2.1 Conventional Energy

The New Orleans Office is proposing 13 study profiles for the FY 2021 NSL. All the profiles address at least one national SSQ, while several of the profiles address two or more questions (**Table 4**). All profiles will inform the conventional energy program; several profiles will additionally inform the Marine Minerals Program and/or Renewable Energy Program.

Several profiles propose to assess anthropogenic and other impacts on sensitive resources, ecosystems, and air and water quality; better understand physical processes and their impacts in a dynamic environment; collect baseline information; and address socioeconomic topics, such as OCS-related transportation and developing plans for collecting baseline data after catastrophic events. Other profiles focus on inventorying cultural resources and assessing their National Register of Historic Places (NRHP) eligibility or obtaining a better understanding of biological communities on shipwrecks. Finally, other profiles address the effectiveness of current mitigations developed for resource protection and the use of eDNA to compare biological community structure on artificial and natural reefs. Study results would inform future site-specific environmental reviews and environmental analyses, such as cumulative impacts.

Table 4. Alignment of proposed FY 2021 GOM studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
TBD	A Demographic Analyses Update to "Air Quality Modeling in the Gulf of Mexico Region"	✓	-	-	-	-	-	-	✓	-	✓	-	-
TBD	A Programmatic Study of Chemical Products Use in Gulf of Mexico (GOM) Oil and Gas Operations: Inventory, Disposal, Spill Risks, and Potential Environmental Impacts	✓	-	-	✓	-	✓	-	-	-	-	-	✓
TBD	Analysis of Onshore Intermodal Transportation that Supports OCS-Related Industries and Infrastructure in the Gulf of Mexico Region	✓	-	-	-	-	-	-	-	-	✓	-	-
TBD	Baseline Monitoring of Avian Activity and Offshore Structure Interactions	✓	-	-	✓	-	-	✓	-	-	-	-	-
TBD	Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico	✓	-	-	✓	-	✓	-	✓	✓	-	-	✓
TBD	Impacts of Drilling on Biological and Archaeological Resources: Revisiting Resource Avoidance Guidance for Wellsite Surface Locations	✓	-	-	✓	-	✓	✓	-	✓	-	✓	✓
TBD	Impacts of Nonstationary Source Air Emissions on Stationary Source Air Emissions	✓	-	-	✓	-	-	-	✓	-	-	-	-
TBD	Meeting the Challenge: Developing Socioeconomic Baseline Data Collection and Rapid Response Research Plans	✓	-	-	✓	-	-	-	-	-	✓	-	✓
TBD	Of National Significance: The Gulf's Nineteenth-Century Shipwrecks	✓	-	-	-	-	-	-	-	-	✓	-	-

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
TBD	Offshore Analysis of Seafloor Instability and Sediments (OASIS Partnership) with Applications to Offshore Safety and Marine Archaeology	✓	✓	✓	✓	-	-	✓	-	✓	-	✓	✓

ESP STRATEGIC SCIENCE QUESTIONS								
SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?	SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?	SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?	SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?	SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?	SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?	SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?	SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?	SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

4.2.2 Marine Minerals Activities

MMP has one new study profile proposed in the GOM for FY 2021. That proposal focuses on improving our understanding of the long-term (decadal to centennial scale) morphologic behavior of barrier island systems via the application of a morphological model that would quantify OCS sediment resources needed to restore and maintain these complex systems. In addition, this study proposes to assess the long-term resilience and cost effectiveness of using OCS sediments for restoration compared to using the nearshore sediment supply in the context of systems experiencing rapid sea level rise, coastal subsidence, and habitat transformation. The long-term, cumulative implications on system resilience by increasing sediment supply (SSQ #1) and the basin-scale effects of coastal restoration and habitat change (SSQ #4) remain important scientific questions. This study is a potential candidate for cooperative study with the LSU CMI.[13]

4.3 Decision Context

4.3.1 Current/Relevant Issues

BOEM continues to need baseline information on poorly understood resources, ecosystem dynamics, and physical processes that may impact existing infrastructure and resources. In addition, BOEM needs to obtain a better understanding of impacts from conventional energy development and related infrastructure to address various topics of interest. One information need is to inventory resources that are or may be located within BOEM's jurisdiction and could be affected by BOEM decision-making. These inventories include potential cultural resources, such as sunken historic aircraft, that have not been included in previous inventory efforts. Under BOEM's National Historic Preservation Act (NHPA) responsibilities, assessment of cultural resource eligibility for listing on the NRHP is an important component. The ultimate outcome of the NHPA's Section 106 process and BOEM's responsibility under Section 110 is to nominate eligible historic properties to the NRHP. One new study proposes to assess the National Register eligibility of several previously investigated 19th-century shipwrecks in the GOM for potential NRHP listing. BOEM also needs to better understand the biological communities inhabiting different types of sites, whether natural or artificial.

4.3.2 NEPA/Consultation Information Needs

BOEM needs new data to better understand and disclose the potential for impacts to biological and cultural resources, sensitive ecosystems, and air and water quality from sources such as drilling-related activities, oil and gas well abandonment, nonstationary source air emissions, and basin-scale restoration. Other studies will collect baseline information on avian interactions with offshore oil and gas structures; compare biological communities on artificial vs. natural reefs using eDNA; examine the chemical products used in conventional energy development; and collect information on the use of roads, railroads, and waterways connected to ports and terminals for offshore oil- and gas-related activities. These studies will provide BOEM with the information needed to better understand the effects of BOEM's programs on the human,

[13] https://www.lsu.edu/cmi/

coastal, and marine environments per OCSLA, as well as other laws including NEPA and the Coastal Zone Management Act (CZMA). Other needs include the development of best practices and protocols for collecting socioeconomic data after catastrophic events and assessment of whether oil and gas development impacts Environmental Justice communities by examining existing air quality data collected by a previous BOEM study ("Air Quality Modeling in the Gulf of Mexico Region"). Information provided by these studies will enable BOEM to conduct more comprehensive and informed environmental impact assessments and associated NEPA analyses.

Additionally, BOEM needs a better scientific understanding of the physical processes occurring in the highly dynamic Mississippi River Delta Front (MRDF) and their impacts, including events such as submarine mudslides. This information will be used to assess environmental impacts to natural and cultural resources within this area, as well as inform risk management decision-making for current and potential future oil and gas infrastructure within the MRDF. Prognostic modeling of barrier island behavior in light of different sediment supply scenarios and forcing conditions will inform ecosystem-scale strategy about how to best use limited sand resources while promoting environmental stewardship in locations where extraction is proposed.

5 Pacific Studies

5.1 Introduction

BOEM's Pacific Region includes the OCS areas offshore California, Oregon, Washington, and Hawaii (**Figure 5**). The Region's current responsibilities encompass three BOEM programs: ongoing conventional energy operations, renewable energy development, and potential leasing of marine mineral resources. The ESP started in the Pacific Region in 1973. Over its 47-year history, the program has evolved in response to (1) change in the geographic areas of activity and study; (2) change in the emphasis of disciplines highlighted for research; (3) change in the status of the Southern California Planning Area from a frontier to a mature oil and gas producing area (and a corresponding shift from pre-lease to post-lease information needs); (4) change to include frontier areas for renewable energy development offshore California, Oregon, and Hawaii; and (5) recent interest in marine mineral resources offshore California.

For this FY 2021–2022 SDP, the Pacific Region participated in outreach to many stakeholders for input, including public and private academic institutions, Federal and state agencies, the general public, private consultants, and tribal governments. The Pacific Region received and considered 15 study ideas from stakeholders, including Federal and state agencies, tribal organizations, universities, a private company, and a nonprofit organization. Additionally, eight Pacific Region staff proposed 12 study ideas. Regional managers and staff considered all relevant and mission-oriented study ideas; those found to be directly relevance and timely were prioritized by regional managers and staff and are proposed in this SDP.

Appendix A includes the tables of proposed studies for FYs 2021. **Appendix B** provides the profiles for the proposed studies.

5.1.1 Conventional Energy Activities

The current 2017–2022 national OCS oil and gas leasing program (BOEM 2016a) does not include new oil and gas lease sales for the Pacific Region. Currently, there are 34 active oil and gas leases in the Region, all of which are in the Southern California Planning Area (**Figure 6**). Oil and gas were first produced from Pacific OCS leases in 1968; annual production peaked in the mid-late 1990s and has been steadily declining. As of December 31, 2019, cumulative production was 1.4 billion barrels of oil and 1.9 trillion cubic feet of gas; annual production was 4.4 million barrels of oil and 2.9 billion cubic feet of gas (C. Baver, personal communication). The substantial decline in production since 2015 is due to a number of factors, including (1) the shut-in of six platforms (including Hidalgo, Harvest, and Hermosa, west of Point Conception) following the May 2015 break of an onshore pipeline that transported oil from the platforms, (2) the 2018 bankruptcy of the operator of Platforms Gail and Grace (in the eastern Santa Barbara Channel) and the shut-in of those platforms, (3) the temporary shut-in of Platform Irene (west of Point Arguello) in early 2019, and (4) the shut-in of Platforms Hogan and Houchin (in the eastern Santa Barbara Channel) in October 2019.

The expectation of future decommissioning of platforms in Federal waters has been discussed for years. Planning for the decommissioning of Platforms Gail and Grace, as well as Hidalgo,

Harvest, and Hermosa, is now underway. BOEM will maintain close coordination with BSEE and other Federal, state, and local permitting agencies throughout the decommissioning process.

Ongoing studies support the conventional energy program by providing important information for NEPA reviews, consultations, conditions of approval, development of notices to lessees and operators, assessment of lease stipulation and mitigation measure effectiveness, interagency working groups, and stakeholder outreach activities.

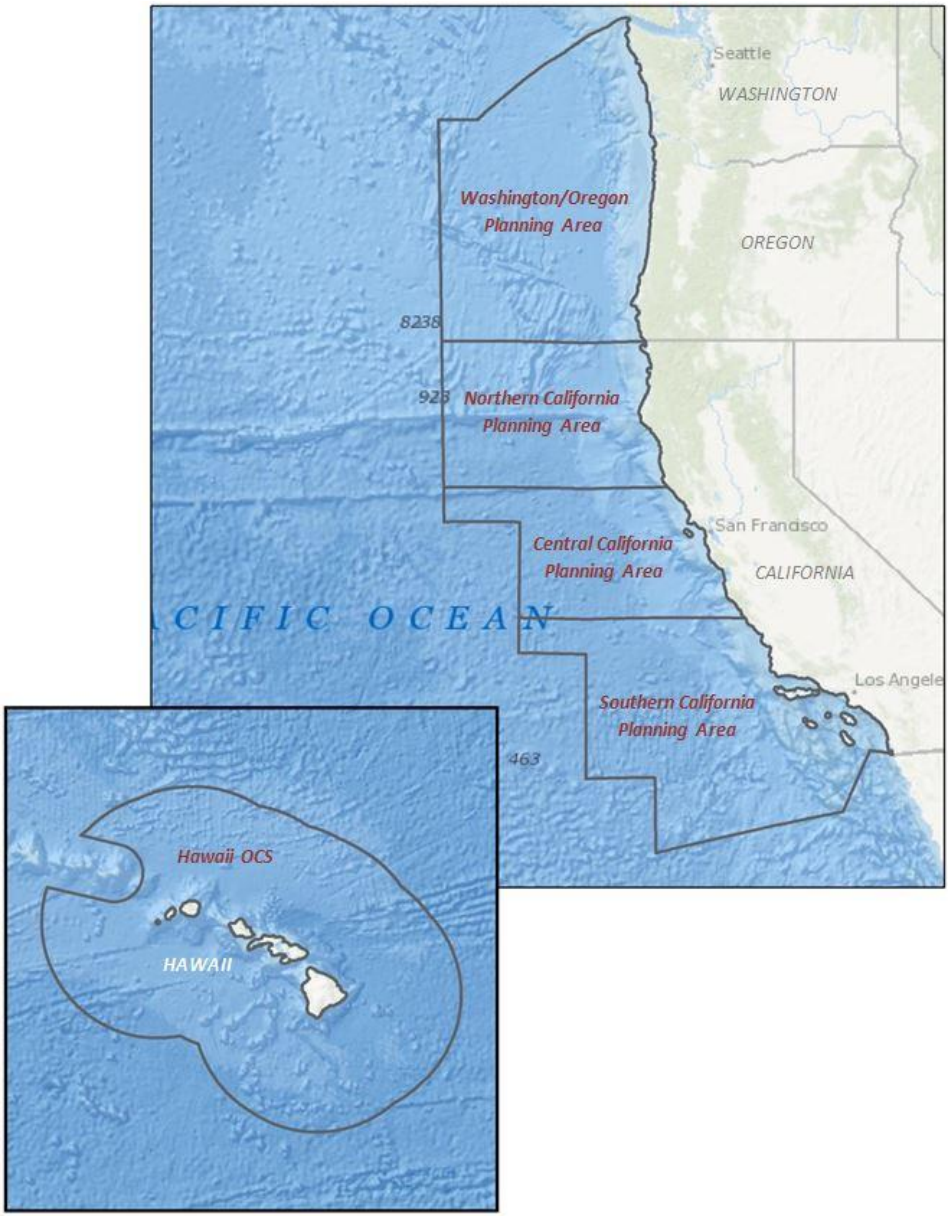


Figure 5. Pacific Region OCS planning areas

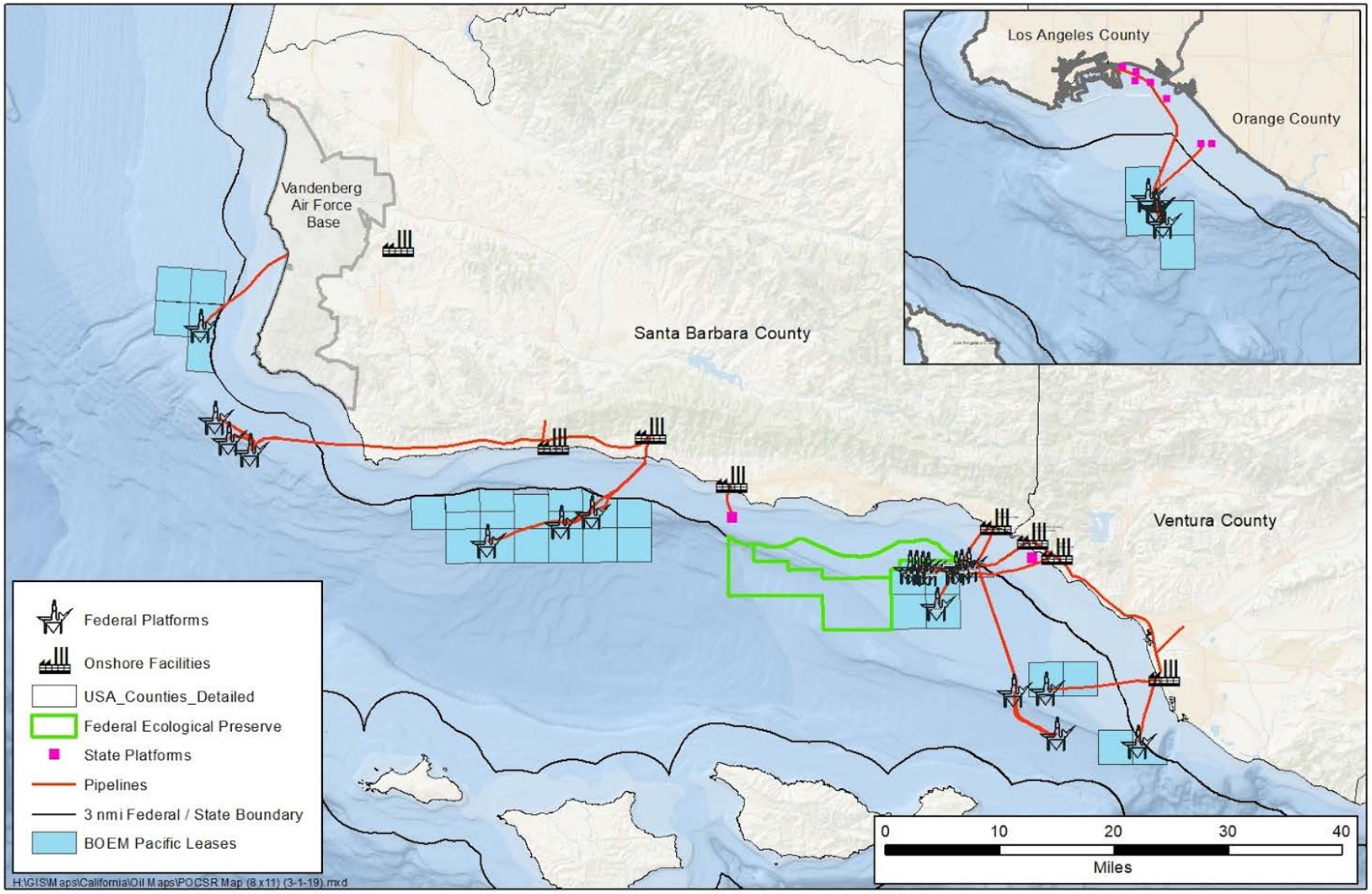


Figure 6. Oil and gas leases and facilities in the Pacific Region

5.1.2 Renewable Energy Activities

Substantial wind and wave potential along the U.S. West Coast and offshore Hawaii (**Figures 7 and 8**) has stimulated interest from renewable energy developers. Currently, developers have proposed deepwater floating wind projects offshore California and Hawaii and a wave energy project offshore Oregon. The initial stage of the commercial leasing process, in which BOEM invites (calls for) and considers information and nominations for potential wind energy leasing, is currently underway offshore California (three Call Areas) and previously took place offshore Hawaii (two Call Areas) (**Figure 9**).

Ongoing and proposed studies will provide important information for offshore planning efforts, NEPA reviews of COPs, consultations, conditions of approval, development of notices to lessees and operators, assessment of lease stipulation and mitigation measure effectiveness, renewable energy task forces, and stakeholder outreach activities.

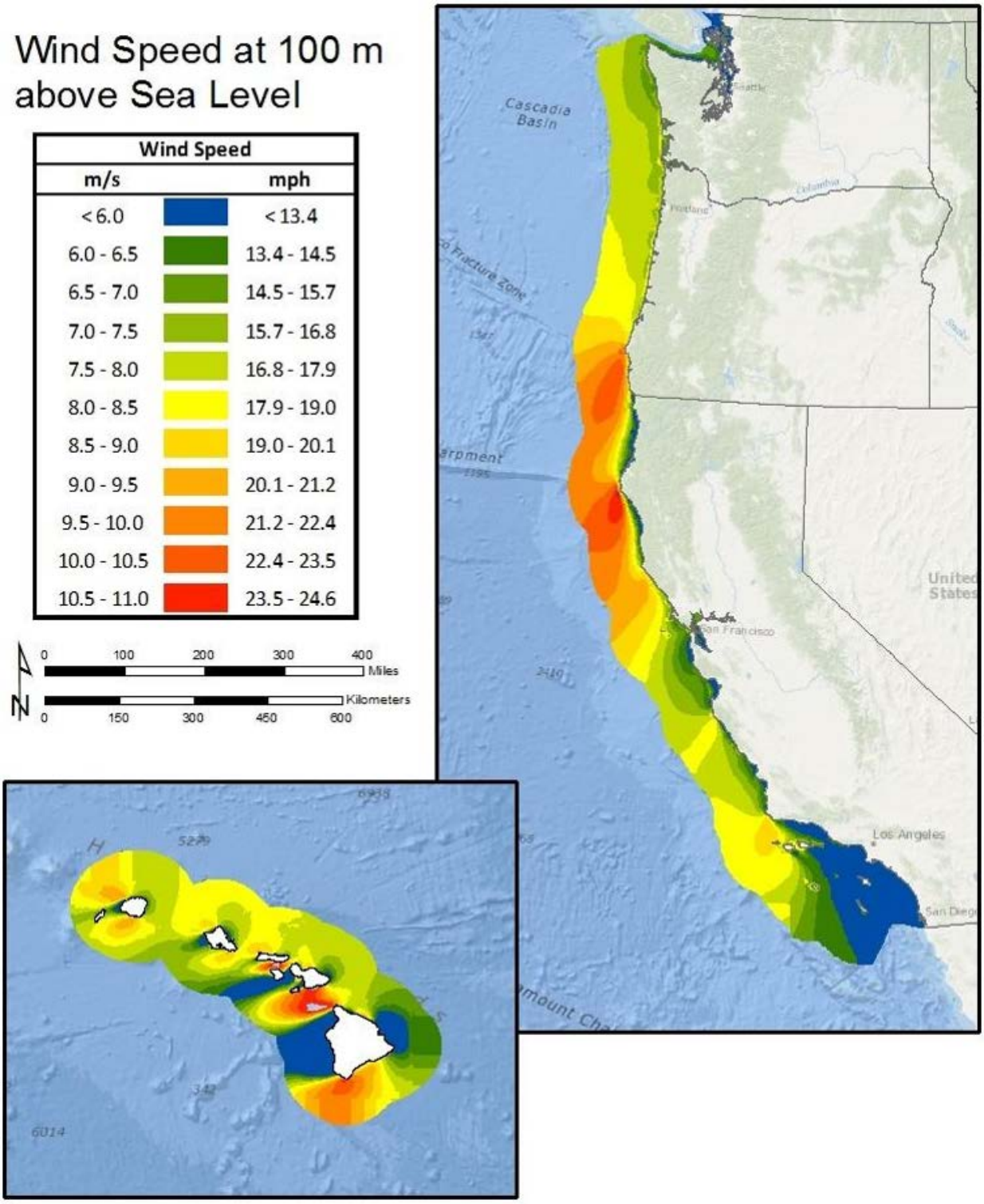


Figure 7. Annual average wind speed offshore the U.S. West Coast and Hawaii

Maps based on offshore time series wind resource data developed by the National Renewable Energy Laboratory. Data available at https://maps.nrel.gov/wind-prospector.

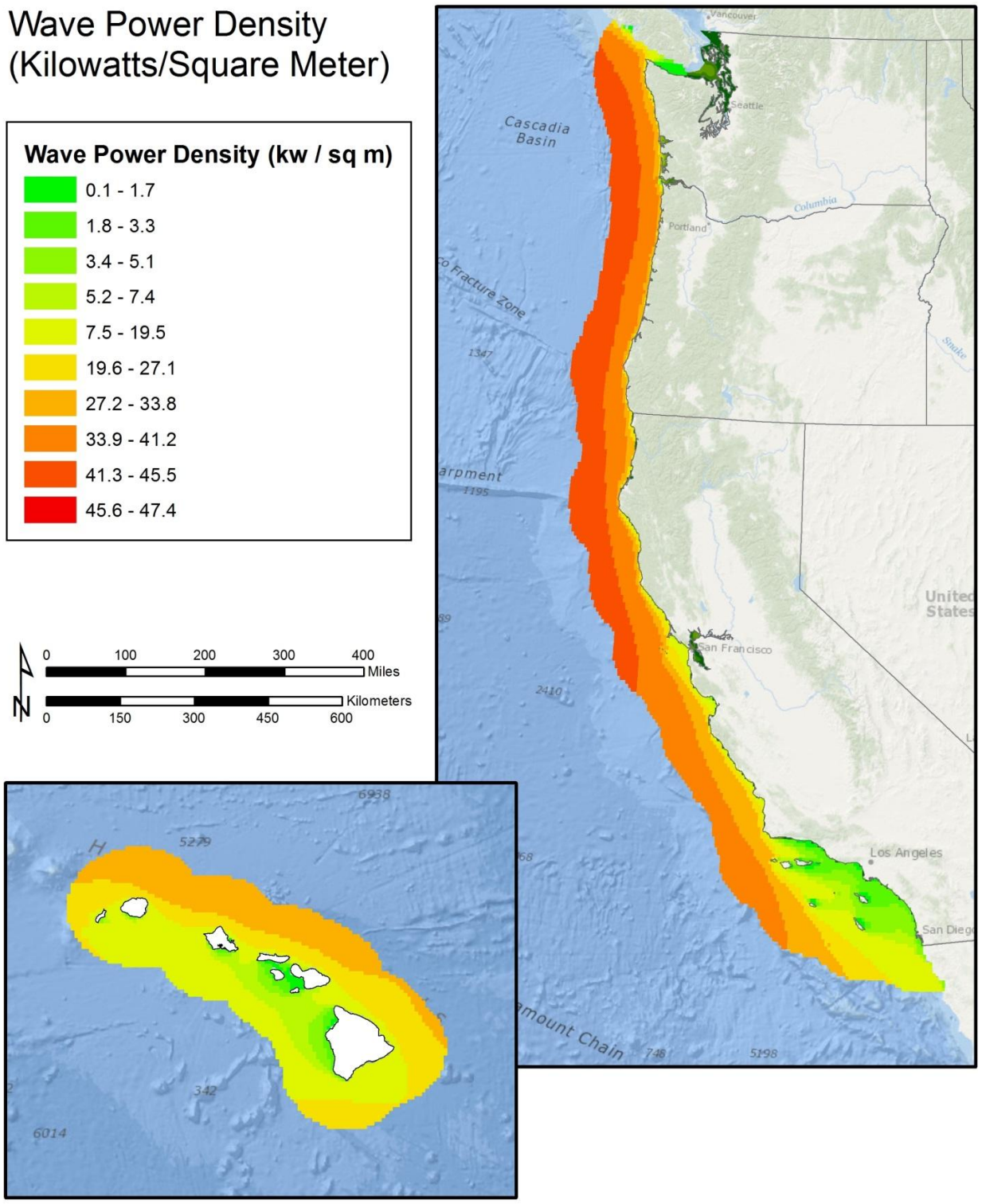


Figure 8. Annual average wave power density offshore the U.S. West Coast and Hawaii

Maps based on Electric Power Research Institute's assessment of ocean wave energy resources (EPRI 2011). Data available at https://maps.nrel.gov/mhk-atlas.

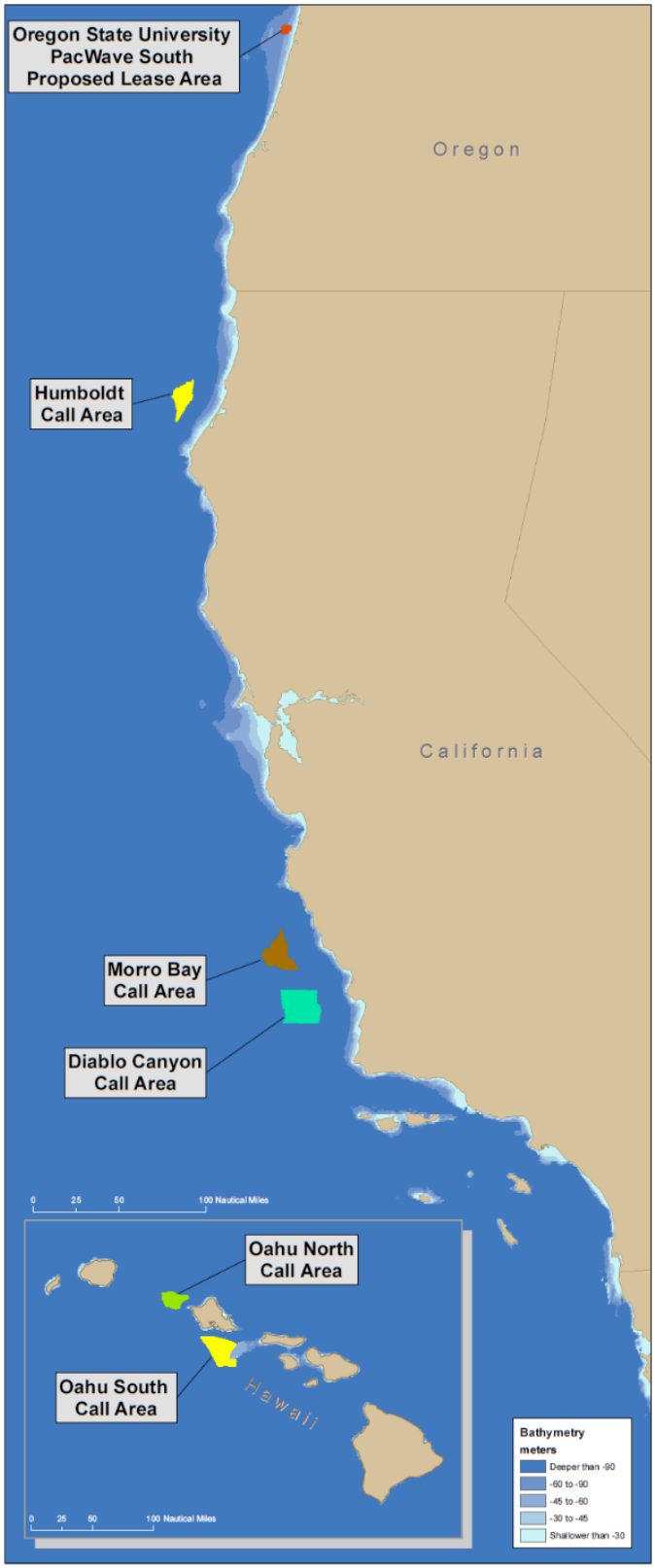


Figure 9. Areas of interest and proposed leasing for renewable energy in the California, Oregon, and Hawaii OCS

5.1.3 Marine Minerals Activities

Despite a 50-year history of exploration in marine minerals, there have been no Federal leases issued in the Pacific Region for marine minerals (i.e., sand and gravel, critical marine minerals). Although there are no pending lease requests, the State of California has expressed interest in offshore sand resources for nourishment of severely eroded coastal beaches. BOEM is considering environmental studies and resource evaluation efforts to inform potential future industry interest in critical marine minerals.

5.2 Alignment with SSQs

Current and forecasted activities in the Pacific Region (see **Section 5.1**), and BOEM's decision-making related to those activities, are the basis for BOEM's information needs and science strategies. Among the portfolio of Pacific Region studies proposed for FY 2021, the proposed studies inform conventional energy (one), renewable energy (six), and marine minerals (one). Of the six proposed studies in the portfolio, two have potential applicability to more than one program (**Table 5**).

As shown in **Table 5**, each proposed study addresses more than one of BOEM's SSQs (themes), including the following areas:

- Assessing cumulative effects (4 studies)
- Determining effects of sound (1 study)
- Determining effects of habitat or landscape alteration (5 studies)
- Determining how future ocean conditions and dynamics may mask effects of OCS activities (3 studies)
- Using social science research in impact assessment (3 studies)
- Using existing or emerging technology to improve research results (2 studies)
- Determining which resources, measures, and systems are best used for long-term monitoring (5 studies)

Table 5. Alignment of proposed FY 2021 Pacific studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Tribal Cultural Landscapes of the California Coast	-	✓	-	✓	-	-	✓	-	-	✓	-	✓
2	Using Marine Protected Area Restrictions to Predict Potential Socioeconomic Impacts of Offshore Energy Development to Commercial Fisheries	✓	✓	-	✓	-	-	-	-	-	✓	-	✓
3	Partners in Offshore Wind Environmental Research – California (POWER–California)	-	✓	-	-	✓	-	✓	-	-	-	✓	✓
4	Scaling the Possible Adverse Effects of Offshore Renewable Energy Projects on Marine Mammals of the Pacific OCS: Developing and Applying a Vulnerability Index (SPERMM)	-	✓	-	-	-	-	✓	-	✓	-	-	-
5	Detecting Wave and Current Effects from Wave Energy Converter (WEC) Devices	-	✓	-	✓	-	-	✓	-	✓	-	-	✓
6	Maritime Heritage of the U.S. Pacific Islands	-	✓	✓	✓	-	-	✓	-	✓	✓	✓	✓

ESP STRATEGIC SCIENCE QUESTIONS								
SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?	SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?	SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?	SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?	SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?	SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?	SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?	SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?	SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

This page intentionally left blank to facilitate duplex printing.

5.3 Decision Context

5.3.1 Conventional Energy Science Strategy and Decision Context

For ongoing studies, the strategy to support the Pacific Region's conventional energy program is centered on (1) continued monitoring of marine and coastal environments adjacent to oil and gas activities in the Southern California Bight to ascertain the cumulative effects of the activities, and (2) collecting environmental information to prepare for decommissioning of oil and gas facilities. As such, studies informing conventional energy address these key information needs and applied uses for informed decision-making by BOEM:

- *Information needs*:
  - Status and trends of environmental conditions and human uses within the Southern California Planning Area related to understanding cumulative impacts to affected resources and assessing effectiveness of lease stipulations and mitigation measures
  - Environmental and socioeconomic impacts of ongoing and potential oil and gas activities
  - Potential environmental and socioeconomic impacts of decommissioning of oil and gas infrastructure

- *Applied uses for informed decision-making:*
  - Environmental review and analysis of ongoing and potential oil and gas activities, as required under NEPA
  - Compliance with other environmental statutes, regulations, and EOs (e.g., ESA, MMPA, Magnuson-Stevens Fishery Conservation & Management Act [MSFCMA], MBTA, NHPA, and Environmental Justice)
  - Planning for decommissioning (e.g., acquiring information needed to evaluate foreseeable industry applications, including decommissioning, Rigs-to-Reefs, and alternate-use proposals; providing information to the Interagency Decommissioning Working Group and to other affected stakeholder groups)
  - Compliance with DOI-level strategic plan regarding mitigation policies and practices and assessment of the effectiveness of past lease stipulations, mitigation measures, and permit requirements to inform other energy programs

5.3.2 Renewable Energy Science Strategy & Decision Context

For new studies proposed for FY 2021, the strategy to support the Pacific Region's renewable energy program is centered on (1) refining information about environmental conditions and biological communities in areas of potential renewable energy development offshore California and (2) obtaining baseline information about cultural resources and human uses adjacent to areas of potential wind energy development offshore California. As such, proposed studies informing renewable energy address these key information needs and applied uses for informed decision-making by BOEM:

- *Information needs:*
  - Baseline environmental conditions, cultural resources, and human uses offshore California
  - Potential environmental and socioeconomic impacts of wind energy development offshore California and wave energy development offshore Oregon

- *Applied uses for informed decision-making:*
  - Decisions and actions related to issuance of research and commercial leases for renewable energy offshore California and Oregon (e.g., offshore planning, providing information to renewable energy task forces and to other affected stakeholder groups)
  - Environmental review and analysis of renewable energy development activities, as required under NEPA
  - Compliance with other environmental statutes, regulations, and EOs (e.g., ESA, MMPA, MSFCMA, MBTA, NHPA, and Environmental Justice)
  - Compliance with DOI-level strategic plan regarding mitigation policies and practices

6 Atlantic Studies

6.1 Introduction

The Atlantic OCS extends from Maine to Florida and is divided into four planning areas (**Figure 10**). The OCS planning areas extend from the Federal and state boundary at 3 nautical miles out to the outer boundary of the EEZ at approximately 200 nautical miles. Although not by design, these planning areas roughly coincide with the LMEs along the Atlantic as defined by NOAA.[14] On the Atlantic OCS, the renewable energy program and MMP are actively managing leases. No oil and gas exploratory drilling or development activities are currently taking place as part of the conventional energy program.

Appendix A includes the tables of proposed studies for FYs 2021 and 2022. **Appendix B** provides the profiles for the proposed studies.

6.1.1 Conventional Energy Program

BOEM anticipates new information needs in the Atlantic OCS Region that will support and inform a possible conventional energy program.

In keeping with the long-term view and mission of the ESP, BOEM will continue to strategically pursue specific studies that provide baseline information to inform decision-making across program areas and for future national OCS oil and gas leasing programs. Environmental research and knowledge related to OCS activities can take years to develop and is a necessary component of mapping new habitats and understanding the relative sensitivity of ecosystems to potential anthropogenic and natural stressors.

[14] https://www.st.nmfs.noaa.gov/ecosystems/lme/

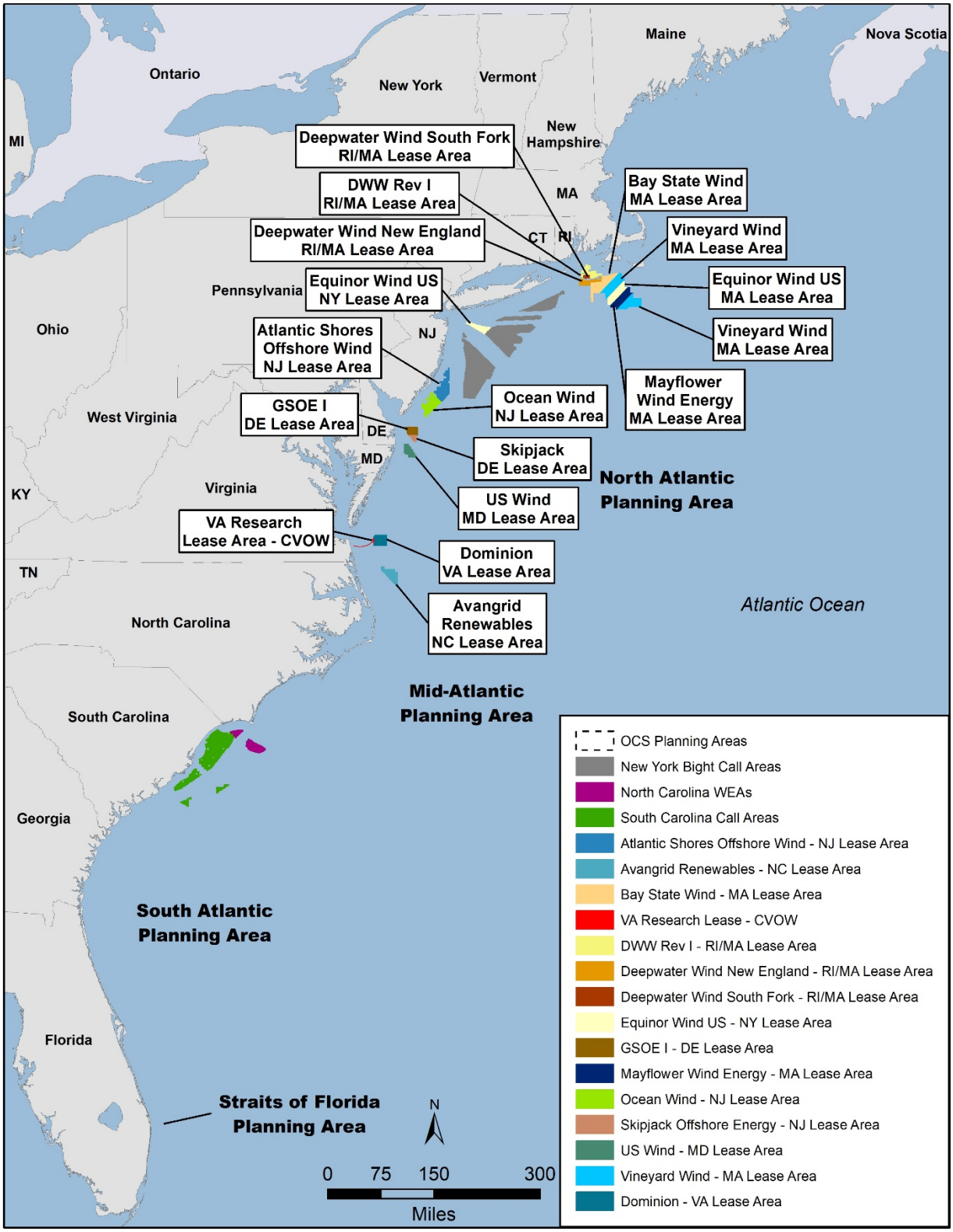


Figure 10. Atlantic Region OCS Planning Areas for renewable energy and Renewable Energy Areas

6.1.2 Renewable Energy Program

BOEM's Office of Renewable Energy Programs (OREP) is responsible for implementing and managing the Atlantic's offshore renewable energy development, including leasing, leading intergovernmental task forces, state consultations, and post-lease plan approval in Federal waters off the East Coast (**Figure 10**). The focus of the program is currently for wind projects.

OREP now has 16 active leases along the Atlantic Coast extending from Massachusetts to North Carolina. Site assessments conducted by developers are underway in many of the areas that include geophysical and biological surveys and wind resource measurements using LiDAR (light detection and ranging) buoys. The next phase of development is the submittal of COPs by industry for these lease areas. BOEM is reviewing seven COPs and anticipates up to five more during 2020. The areas for development include Massachusetts, Rhode Island, New Jersey, New York, Delaware, Maryland, and Virginia. The first two turbines on the OCS were installed off Virginia in May 2020. These are located on a research lease owned by the Commonwealth of Virginia. BOEM is actively engaged in research at this location, which included the collection of acoustic data during the installation. BOEM held the first regional task force meeting for the Gulf of Maine to initiate the process of leasing. With leasing several years out, now is the time to initiate baseline studies, such as for wildlife surveys and for tourism and recreation, areas where baseline data are often lacking. The detailed development plans will undergo environmental review, which may include identification of mitigation measures and post-construction monitoring requirements.

6.1.3 Marine Minerals Activities

The MMP continues to authorize G&G exploration offshore North Carolina and Florida and lease OCS sand for use in beach nourishment and coastal restoration New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Florida. OCS sand has been used to protect valuable Federal and state assets and infrastructure, such as National Park Service national seashores along Assateague Island (MD) and the Outer Banks (NC), and NASA's Wallops Island Flight Facility along Virginia's Eastern Shore (**Figure 11**). BOEM's resource evaluation research is focused in resource-constrained areas offshore south and mid-Atlantic states, where demand is the greatest. Some project proponents are evaluating the potential to use OCS sand offshore Long Island, New York, and New England states in the next decade. There is also growing interest in critical minerals in the Atlantic OCS, such as heavy minerals found in inner shelf sand shoals and sheets, or manganese nodules in deepwater environments such as the Blake Plateau.

Figure 11. NASA's Wallops Island Flight Facility before and after restoration

6.2 Alignment with SSQs

6.2.1 Conventional Energy Program

Table 6 shows how a proposed Atlantic OCS Region study focusing on conventional energy addresses the SSQs. This new study proposes to compile a georeferenced database of deepwater coral presence and absence in the Mid- and North Atlantic Planning Areas. The study will utilize spatial predictive modeling in order to predict and map where these corals are likely to be found. Study results will inform descriptions of the Affected Environment for NEPA analyses related to potential oil and gas activities offshore.

6.2.2 Renewable Energy Program

Tables 7 and 8 show how the Atlantic OCS Region studies focused on renewable energy address the SSQs. As offshore wind development in the Atlantic OCS Region moves from the leasing phase to the development of plans for construction, the information needs of the renewable energy program are also evolving. Early years focused on the collection of baseline information and addressing concerns raised by the public. Through the *Real-time Opportunity for Development Environmental Observations* (RODEO) study, researchers made observations during the construction and early operation of the first offshore wind development in U.S. waters near Block Island, Rhode Island. Now, the focus is on specific locations with 12 projects in the pipeline ranging from two turbines for research purposes to over 100 for commercial production. The scientific concerns that are at the forefront for FY 2021 are focused on research topics of interest to the fishing community and improving predictions of the impacts from offshore wind on that community.

Avian Species

The potential effects of offshore wind development on avian species and the overall negative impacts on avian populations have been a concern since the first proposal to build an offshore wind facility. Although an individual project may trigger many environmental concerns, effects related to avian resources tend to extend beyond the relatively small footprint of an individual project. For this reason, BOEM's avian research efforts for the Atlantic OCS are focused on identifying areas where Atlantic offshore wind energy development is least likely to negatively

impact avian populations at the regional scale. BOEM has already invested significantly in studies that address the distribution and abundance of birds and their interaction with wind development.[15] BOEM, in partnership with the Fish and Wildlife Service (FWS) and NOAA, has created a database of observations that are used to generate maps of relative abundance. The aggregation of all existing survey data into a single database allows for analysis of changes over the past few decades to inform future predicted shifts in species distribution.

Marine Fish & Fisheries

The effects of renewable energy development on fish and shellfish range from physical modification of the seafloor habitat to physical and behavior modification due to noise. These impacts also extend to the fisheries that depend on those resources. Fundamental to protecting fish species is an understanding of the physical habitat and how the fish use these habitats for important life-history events. It is important to understand this information not only at the project level but also at the regional level. BOEM has invested resources in understanding high priority fish or fisheries (Atlantic sturgeon, lobster, black sea bass), locations (leased areas), and impact-producing factors (seafloor disturbance, sound, electromagnetic field [EMF]). These priorities are informed through intergovernmental task forces, public meetings, formal information solicitations, and recommendations made in BOEM-funded studies. The New England[16] and Mid-Atlantic Fishery[17] Management Councils have also identified their information needs that cross-cut offshore wind energy. These fisheries management agencies have identified the following priorities: monkfish distribution, habitat characterization, future state habitat models, offshore wind effects on scallop production, noise effects to fish, fishing displacement due to offshore wind, effects on fisheries independent surveys, how offshore wind impacts specific fishery management measures, and differential impact to commercial and recreational fisheries.

In the Atlantic renewable energy program, BOEM has placed endangered and threatened fish species and commercially important fish species as a high priority. Within that group, BOEM then evaluates the vulnerability of the species to BOEM-permitted activities. These species have included Atlantic sturgeon (occurrence and habitat use in offshore overwintering areas), American lobster in southern New England (abundance and EMF impacts), Jonah crab (abundance), and skates (EMF impacts). Current projects include acoustic impacts to commercially important longfin squid and black sea bass, hydrodynamic modeling of scallop and other fish larvae through wind facilities, and regional habitat and fish characterization. High priority areas for study often are driven by the leasing and development timeframe and by studies that are providing baseline data on lease areas to determine if there are any habitats that may be sensitive to potential development impacts. For FY 2021, the focus is on strategic science partnerships through the Responsible Offshore Science Alliance, Responsible Offshore Development Alliance, and the Regional Wildlife Science Entity for Offshore Wind. Partnering

[15] See §*Birds and Bats* at https://www.boem.gov/Renewable-Energy-Completed-Studies/
[16] https://www.nefmc.org/
[17] https://www.mafmc.org/

with these organizations could strengthen public support for BOEM science and allow leveraging of funds to expand the capabilities of BOEM research.

Protected Species

Marine mammals on the Atlantic seaboard generally are highly migratory and use a wide area of the OCS. As a result, they may be impacted by all three of BOEM's leasing programs. Although the primary focus for protected species are whales and sea turtles, there is also a need for information about seals in the northeast region. BOEM has funded research using tags through the Atlantic Marine Assessment Program for Protected Species, but there is an overarching need to understand the distribution and habitat utilization by pinipeds in the area.

6.2.3 Marine Minerals Program

Table 9 shows MMP studies proposed for this SDP, four of which focus on the Atlantic OCS Region. Three of these studies tackle improvements in remote sensing methods, efficacy of mitigation, or understanding of impacts during the exploration of or use of OCS sand in coastal restoration projects; whereas the other focuses on the condition of benthic habitat and communities more than 50 years after test mining extracted manganese nodules from 800-meters deep on the Blake Plateau. This suite of studies addresses common strategic scientific objectives, including improving the evaluation of cumulative effects (SSQ #1), advancing our state of knowledge concerning the impacts of seafloor disturbance given different dredging or extraction methods (SSQ #4), applying new remote sensing and computer learning technologies in novel ways (SSQ #8), and testing new monitoring or geophysical surveying approaches (SSQ #9).

Novel experimental design and innovation are at the heart of all four studies. Use of new technology include the following examples:

- Use of acoustic cameras and drone technology to improve our understanding of sea turtle behavior and validate the risks and efficacy of the mitigative practice of relocation trawling
- Use of autonomous underwater vehicles to collect very high-resolution geophysical data to simultaneously identify minerals resources, map sensitive shallow-water habitats, and document the persistence of mining impacts in a complex, potentially vulnerable mesopelagic ecosystem previously disturbed

The potential gains in scientific understanding and practice are significant across this suite of studies; for example, the long-term ecological impact that potentially results from physical disturbance of the Blake Plateau is unexplored, as is the time or biophysical processes required for that habitat to equilibrate post-disturbance. Successful pursuit of the proposed studies depends on significant partnership and co-investment. We anticipate that the study results will be broadly applicable across MMP activities in different geographic regions.

6.3 Decision Context

6.3.1 Current/Relevant Issues

In the Atlantic OCS, conventional energy-related issues focus on mapping and predicting deepwater coral habitats in the Mid and North Atlantic. With the potential for future conventional energy exploration and development within the Atlantic OCS, baseline information, as well as predictive modeling and georeferenced mapping, is needed. For renewable energy, the primary focus areas include concerns raised from the fishing community, effects on the highly endangered North Atlantic right whale, and identification of post-construction information needs.

For marine minerals, the primary focus is expanding strategic efforts to identify, lease, and manage Atlantic OCS sand resources in the National Offshore Sand Inventory. The number, size, and maintenance frequency of beach nourishment and coastal restoration projects continues to increase, as does the geographic range and potential for diverse environmental impacts. The same initiative also supports the Presidential Memorandum on Ocean Mapping of the United States Exclusive Economic Zone. With President Trump's EO 13817, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, there is increased attention on the economic potential of heavy minerals in shallow-water sand ridges and sheets, as well as the potential for economically recoverable deepwater marine minerals, such as manganese nodules or crust deposits found in unique deepwater ecosystems that are comparatively understudied.

6.3.2 NEPA/Consultation Information Needs

BOEM is proposing a georeferenced mapping effort for deepwater coral communities to inform descriptions of the Affected Environment for NEPA analyses and other environmental considerations. In order to map and predict the occurrences of coral communities, BOEM also proposed to conduct predictive modeling effort and spatial analysis of these data.

For renewable energy, BOEM continues to consider the potential impacts as we move from leasing to construction. Each construction and operations plan will go through a full environmental review and associated consultations. Information BOEM's environmental studies will aid in addressing the concerns raised by the public.

For marine minerals, several proposed studies will help improve our understanding of the persistence of benthic impacts and the practical implications of long-practiced mitigation.

Appendix A includes the tables of proposed studies for FYs 2021 and 2022. **Appendix B** provides the profiles for the proposed studies.

Table 6. Alignment of Proposed FY 2021 Atlantic conventional energy studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
TBD	Data Synthesis and Advanced Predictive Modeling of Deep Coral and Hardbottom Habitats in the Mid and North Atlantic: Guiding Efficient Discovery and Protection of Sensitive Benthic Areas	✓	-	-	✓	-	-	✓	-	✓	-	-	✓

ESP STRATEGIC SCIENCE QUESTIONS								
SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?	SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?	SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?	SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?	SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?	SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?	SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?	SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?	SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

Table 7. Alignment of Proposed FY 2021 OREP studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Bioenergetic Model for North Atlantic Right Whales	✓	✓	✓	✓	✓	-	✓	-	-	-	-	✓
2	Using High-Resolution Imagery to Describe Fishing Vessel Activity on the Atlantic OCS	-	✓	✓	✓	-	-	-	-	-	✓	✓	✓
3	Protected Species Application and Information Management	✓	✓	✓	-	✓	-	✓	-	-	-	✓	✓
4	Pilot Renewable Energy Strategic Partnership Funding – Responsible Offshore Science Alliance	-	✓	-	✓	-	-	✓	-	-	✓	-	✓
5	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic	-	✓	✓	✓	-	-	✓	-	-	-	-	✓
6	Linking Multiple Data Sources to Better Describe Fishing Vessel Activity on the Atlantic OCS	-	✓	✓	✓	-	-	-	-	-	✓	-	-
7	Comparative Study of Aerial Survey Techniques	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓

ESP STRATEGIC SCIENCE QUESTIONS								
SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?	SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?	SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?	SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?	SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?	SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?	SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?	SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?	SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

Table 8. Alignment of Proposed FY 2022 OREP studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Management Strategy Evaluation for NEFSC Surveys Impacted by Offshore Wind Development	-	✓	-	✓	-	-	✓	-	-	✓	-	-
2	Ecological Baseline Study of the U.S. Outer Continental Shelf off Maine	-	✓	✓	✓	-	-	✓	-	-	-	-	✓
3	Baseline Tourism and Recreation along the Gulf of Maine	-	✓	✓	✓	-	-	-	-	-	✓	-	✓
4	Renewable Energy Strategic Partnership Funding	-	✓	-	✓	-	-	✓	-	-	✓	-	✓
5	Characterizing Habitat Utilization by Marine Mammals during Construction of Offshore Wind Farms	-	✓	-	✓	-	-	✓	-	-	-	-	-

ESP STRATEGIC SCIENCE QUESTIONS								
SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?	SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?	SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?	SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?	SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?	SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?	SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?	SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?	SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

Table 9. Alignment of Proposed FY 2021 MMP studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Shallow-water Geophysical Mapping by Autonomous Underwater Vehicle(s): Feasibility Assessment, Field Testing, and Best Practice	-	✓	✓	-	✓	-	-	-	-	-	✓	✓
2	Turtle Avoidance Technology Solutions (TATS)	-	-	✓	-	-	-	✓	-	-	-	✓	✓
3	Investigation of an Historic Seabed Mining Site on the Blake Plateau	-	-	✓	✓	-	-	✓	-	-	-	✓	-
4	Seamount Benthic Mapping and Characterization for Deep-Sea Corals, Benthic Ecosystems, and Critical Minerals of the Aleutian Islands	-	-	✓	-	-	-	✓	-	-	-	✓	-
5	Application of a Morphodynamic Model to Assist in Planning the Long-term Restoration and Maintenance of the Louisiana Barrier Island System	-	-	✓	✓	-	-	✓	-	-	-	✓	✓
6	Modeling Benthic Recovery with Variable Dredge Conditions	-	-	✓	✓	-	-	✓	-	-	-	✓	-

ESP STRATEGIC SCIENCE QUESTIONS

SSQ 1: How can BOEM best assess **cumulative effects** within the framework of environmental assessments?

SSQ 2: What are the acute and chronic effects of **sound** from BOEM-regulated activities on marine species and their environment?

SSQ 3: What are the acute and chronic effects of **exposure to hydrocarbons or other chemicals** on coastal and marine species and ecosystems?

SSQ 4: What is the effect of **habitat or landscape alteration** from BOEM-regulated activities on ecological and cultural resources?

SSQ 5: What are the **air emissions** impacts of BOEM-regulated activities to the human, coastal, and marine environment and compliance with the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments?

SSQ 6: How will **future ocean conditions and dynamics** amplify or mask effects of BOEM-regulated OCS activities?

SSQ 7: How does BOEM ensure the adequate study and integrated use of **social sciences** in assessing the impacts of OCS activities on the human environment?

SSQ 8: How can BOEM better use **existing or emerging technology** to achieve more effective or efficient scientific results?

SSQ 9: What are the best resources, measures, and systems for **long-term monitoring**?

7 References

[BOEM] Bureau of Ocean Energy Management. 2016a. 2017–2022 Outer continental shelf oil and gas leasing proposed final program. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. [accessed 2020 May 28]. https://www.boem.gov/2017-2022-OCS-Oil-and-Gas-Leasing-PFP/. 269 p.

BOEM. 2016b. Outer continental shelf oil and gas leasing program 2017–2022: final programmatic environmental impact statement. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. Available at https://www.boem.gov/oil-gas-energy/leasing/2017-2022-ocs-oil-and-gas-leasing-program. 938 p.

BOEM. 2020. Strategic framework. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. [accessed 2020 May 28]. https://www.boem.gov/sites/default/files/documents/about-boem/ESP-Strategic-Framework-Final-FY20.pdf. 12 p.

[EOP] Executive Office of the President. 2004. Final Information Quality Bulletin for Peer Review. Washington (DC): Executive Office of the President, Office of Management and Budget. [accessed 2020 May 28]. https://obamawhitehouse.archives.gov/sites/default/files/omb/assets/omb/memoranda/fy2005/m05-03.pdf. 45 p.

[EPRI] Electric Power Research Institute. 2011. Mapping and assessment of the United States ocean wave energy resource: 2011 technical report. Palo Alto (CA): Electric Power Research Institute. Report no. 1024637. [accessed 2020 May 28]. https://www.energy.gov/sites/prod/files/2013/12/f5/mappingandassessment.pdf. 176 p.

APPENDIX A: Tables of Proposed Studies for FYs 2021 and 2022

Table A-1. Headquarters studies proposed for FY 2021, alphabetized by title

Profile Page #	Discipline	Study Title
70	HE	Comprehensive Guide to Deepwater Sensitive Habitats and Associated Fauna
74	MM	Developing the Next Generation of Animal Tags Workshop
77	FE	Environmental and Human Exposure to Technologically Enhanced Naturally Occurring Radioactive Materials (TENORMs) Associated with Oil and Gas (O&G) Activities in the Outer Continental Shelf (OCS)
81	PO	Facilitating Strategic Partnerships in Support of the Presidential Memo on Ocean Mapping, Exploration, and Characterization
85	MM	Imagery Acquisition to Support and Enhance BOEM's Deep Learning Projects
87	PO	Integrating Low Cost Emerging Technology into Ocean Environmental Monitoring
90	MM	Marine Mammal Bioenergetics Workshop
95	IM	Modeling Support for the Center for Marine Acoustics
98	HE	Mortality Risk for Whale and Basking Sharks During Energy Operations
102	FE	National Outer Continental Shelf (OCS) Oil Spill Occurrence Rates
105	SE	Socioeconomic Impacts Likely to Result from Initial Oil and Gas Projects in Frontier Areas
109	MM	Spatial and Acoustic Ecology of Understudied ESA Listed Marine Mammals
113	FE	Validation of Offshore Satellite Data for Offshore Air Quality Management
116	MM	Workshop on Emerging Technologies for Monitoring Marine Species and Quieting Noise Sources

Discipline Codes

AQ = Air Quality
FE = Fates & Effects
HE = Habitat & Ecology
IM = Information Management
MM = Marine Mammals & Protected Species
PO = Physical Oceanography
SE = Socioeconomics

Table A-2. Alaska studies proposed for FY 2021, alphabetized by title

Profile Page #	Discipline	Study Title
119	MM	Bowhead Whale Migration Patterns along the Alaskan Beaufort Shelf During a Period of Rapid Environmental Change
122	SE	Coastal and Submerged Historic Properties and Precontact Sites on the Alaska Outer Continental Shelf
125	AQ	Cook Inlet Synthetic Source Air Quality Model Data
127	HE	Determining Important Nearshore and Marine Sites for Shorebirds in the Beaufort Sea
130	HE	Early Detection Plan for Marine Non-native Species in Cook Inlet, Alaska
133	HE	GPS Tagging of Seabirds to Obtain Areas of Foraging Aggregations and Forage Fish Schools in Lower Cook Inlet
136	SE	Kenai Peninsula Borough Economy, 2008 to 2020
139	IM	Offshore Renewable Energy Potential on Alaska's Outer Continental Shelf (OCS)
142	MM	Resource Areas to Support Oil Spill Risk Analysis (OSRA) and National Environmental Policy Act (NEPA) Needs in the Cook Inlet Region
145	IM	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities
147	FE	Synthesis of Contaminants Data for Cook Inlet: Evaluation of Existing Data as "Baseline Conditions" and Recommendations for Further Monitoring
150	MM	Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas

Discipline Codes

AQ = Air Quality
FE = Fates & Effects
HE = Habitat & Ecology
IM = Information Management
MM = Marine Mammals & Protected Species
PO = Physical Oceanography
SE = Socioeconomics

Table A-3. Alaska studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
152	MM	Arctic Marine Assessment Program for Protected Species (ArMAPPS)
154	IM	Collaboration with the Gulf Watch Alaska Monitoring Program in Cook Inlet
156	HE	Measuring and Modeling Oil Impacts on Early Life Stages of Arctic Cod

Discipline Codes

AQ = Air Quality
FE = Fates & Effects
HE = Habitat & Ecology
IM = Information Management
MM = Marine Mammals & Protected Species
PO = Physical Oceanography
SE = Socioeconomics

Table A-4. GOM studies proposed for FY 2021, alphabetized by title

Profile Page #	Discipline	Study Title
159	SE	A Demographic Analyses Update to "Air Quality Modeling in the Gulf of Mexico Region"
162	FE	A Programmatic Study of Chemical Products Use in Gulf of Mexico (GOM) Oil and Gas Operations: Inventory, Disposal, Spill Risks, and Potential Environmental Impacts
165	SE	Analysis of Onshore Intermodal Transportation that Supports OCS-Related Industries and Infrastructure in the Gulf of Mexico Region
168	HE	Baseline Monitoring of Avian Activity and Offshore Structure Interactions
172	AQ	Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico
175	HE	Impacts of Drilling on Biological and Archaeological Resources: Revisiting Resource Avoidance Guidance for Wellsite Surface Locations
179	AQ	Impacts of Nonstationary Source Air Emissions on Stationary Source Air Emissions
181	SE	Meeting the Challenge: Developing Socioeconomic Baseline Data Collection and Rapid Response Research Plans
184	SE	Of National Significance: The Gulf's Nineteenth-Century Shipwrecks
188	SE	Offshore Analysis of Seafloor Instability and Sediments (OASIS Partnership) with Applications to Offshore Safety and Marine Archaeology

Discipline Codes

AQ = Air Quality
FE = Fates & Effects
HE = Habitat & Ecology
IM = Information Management
MM = Marine Mammals & Protected Species
PO = Physical Oceanography
SE = Socioeconomics

Table A-5. Pacific studies proposed for FY 2021, alphabetized by title

Profile Page #	Discipline	Study Title
192	PO	Detecting Wave and Current Effects from Wave Energy Converter (WEC) Devices
194	SE	Maritime Heritage of the U.S. Pacific Islands
197	HE	Partners in Offshore Wind Environmental Research – California (POWER–California)
199	MM	Scaling the Possible Adverse Effects of Offshore Renewable Energy Projects on Marine Mammals of the Pacific OCS: Developing and Applying a Vulnerability Index (SPERMM)
203	SE	Tribal Cultural Landscapes of the California Coast
206	SE	Using Marine Protected Area Restrictions to Predict Potential Socioeconomic Impacts of Offshore Energy Development to Commercial Fisheries

Discipline Codes

AQ = Air Quality
FE = Fates & Effects
HE = Habitat & Ecology
IM = Information Management
MM = Marine Mammals & Protected Species
PO = Physical Oceanography
SE = Socioeconomics

Table A-6. Atlantic conventional energy studies proposed for FY 2021, alphabetized by title

Profile Page #	Discipline	Study Title
209	HE	Data Synthesis and Advanced Predictive Modeling of Deep Coral and Hardbottom Habitats in the Mid and North Atlantic: Guiding Efficient Discovery and Protection of Sensitive Benthic Areas

Discipline Codes

AQ = Air Quality
FE = Fates & Effects
HE = Habitat & Ecology
IM = Information Management
MM = Marine Mammals & Protected Species
PO = Physical Oceanography
SE = Socioeconomics

Table A-7. OREP studies proposed for FY 2021, alphabetized by title

Profile Page #	Discipline	Study Title
213	MM	Bioenergetic Model for North Atlantic Right Whales
216	MM	Comparative Study of Aerial Survey Techniques
218	SE	Linking Multiple Data Sources to Better Describe Fishing Vessel Activity on the Atlantic OCS
221	MM	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic
224	FE	Pilot Renewable Energy Strategic Partnership Funding – Responsible Offshore Science Alliance
226	MM	Protected Species Application and Information Management
228	SE	Using High-Resolution Imagery to Describe Fishing Vessel Activity on the Atlantic OCS
Discipline Codes		
AQ = Air Quality FE = Fates & Effects HE = Habitat & Ecology IM = Information Management		MM = Marine Mammals & Protected Species PO = Physical Oceanography SE = Socioeconomics

Table A-8. OREP studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
230	SE	Baseline Tourism and Recreation along the Gulf of Maine
233	MM	Characterizing Habitat Utilization by Marine Mammals during Construction of Offshore Wind Farms
236	MM	Ecological Baseline Study of the U.S. Outer Continental Shelf off Maine
238	HE	Management Strategy Evaluation for NEFSC Surveys Impacted by Offshore Wind Development
240	FE	Renewable Energy Strategic Partnership Funding
Discipline Codes		
AQ = Air Quality FE = Fates & Effects HE = Habitat & Ecology IM = Information Management		MM = Marine Mammals & Protected Species PO = Physical Oceanography SE = Socioeconomics

Table A-9. MMP studies proposed for FY 2021, alphabetized by title

Profile Page #	Discipline	Study Title
242	PO	Application of a Morphodynamic Model to Assist in Planning the Long-term Restoration and Maintenance of the Louisiana Barrier Island System.
245	HE	Investigation of an Historic Seabed Mining Site on the Blake Plateau
249	FE	Modeling Benthic Recovery with Variable Dredge Conditions
252	HE	Seamount Benthic Mapping and Characterization for Deep-Sea Corals, Benthic Ecosystems, and Critical Minerals of the Aleutian Islands
255	HE	Shallow-water Geophysical Mapping by Autonomous Underwater Vehicle(s): Feasibility Assessment, Field Testing, and Best Practice
258	MM	Turtle Avoidance Technology Solutions (TATS)

Discipline Codes	
AQ = Air Quality	MM = Marine Mammals & Protected Species
FE = Fates & Effects	PO = Physical Oceanography
HE = Habitat & Ecology	SE = Socioeconomics
IM = Information Management	

APPENDIX B: FY 2021–2022 Study Profiles Organized by Region

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Comprehensive Guide to Deepwater Sensitive Habitats and Associated Fauna
Administered by	Headquarters
BOEM Contact(s)	Stephanie Sharuga (stephanie.sharuga@boem.gov) Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2022
Date Revised	April 10, 2020
PICOC Summary	
Problem	The information necessary for BOEM SMEs to accurately identify and evaluate the sensitivity of important benthic habitats and fauna potentially impacted by OCS activities is lacking and/or not easily accessible. Further, BOEM's reviewers currently do not have a resource tailored for their NEPA-related needs, yet still must make judgments about site-specific mitigations or conditions of approval.
Intervention	This study will create a comprehensive guide of important sensitive deepwater benthic organisms and habitats. Information will be compiled from a variety of existing sources on deep sea corals, chemosynthetic communities, and sponges to improve identification and evaluations of sensitivity to potential impacts from OCS activities.
Comparison	N/A. Information for this study is being compiled from existing sources.
Outcome	This guide will provide relevant information needed for effective environmental assessments, mitigations, and consultations. It can be used to better inform and streamline relevant BOEM processes, including site-specific benthic impact reviews.
Context	All sensitive benthic habitats and associated fauna from each region where BOEM-regulated activities occur will be considered. The regions with the highest known or anticipated levels of activity (and potential impacts) will be given priority.

BOEM Information Need(s): There is a national need to more effectively evaluate potentially at-risk sensitive deepwater benthic habitats and associated fauna. This comprehensive guide will span BOEM's regions and can be used to inform and streamline a variety of relevant BOEM processes. It will lead to more effective assessments and consultations by providing detailed information and needed training material. The guide will be particularly useful for SMEs performing site-specific benthic reviews and applying mitigations/conditions of approval, especially when reviewing submersible imagery. The guide's information can also be used in developing the National Program. This includes National Environmental Policy Act-required documents, and especially the Affected Environment and Routine and Accidental Impacts

sections. The information will be particularly useful for informing impact analysis assumptions made about distancing mitigations. Further, the guide will inform and complement the national scale "State of the Continental Shelf" document that is currently being developed. The compiled knowledge will also inform other ongoing and future federal deepwater studies and partnerships. This guide will contain information that crosses programmatic boundaries and can be used by a wide variety of external stakeholders as well. Overall, it facilitates the agency better achieving its national monitoring, assessment, compliance, and consultation roles.

Background: The ability to make appropriate environmental protection and mitigation decisions in relation to OCS activities is directly linked to accurately identifying potentially affected habitats and their associated fauna. Considerable information about sensitive habitats and fauna already exists; however, it is currently located across disparate and incomplete sources and is not customized to fit BOEM's needs. No known guides currently exist that include multiple sensitive habitat types and associated fauna across multiple regions, or which include an evaluation of sensitivity and potential types of impact from activities in the OCS. This often makes it difficult and time-consuming to obtain the necessary information to make the most accurate and effective decisions related to these habitats and fauna.

A guide that facilitates easier identification and evaluation of sensitive habitats and fauna, and also increases understanding of their potential sensitivity to OCS activity impacts (from all programs) will enhance assessments and consultations both at the regional and national levels. It also directly ties in with current and future BOEM-funded studies and will use those previous studies to inform content of the guide. Improved information leads to more accurate identifications of deep sea coral, chemosynthetic, and sponge community presence and absence, which strengthens models (see, for example, https://marinecadastre.gov/espis/#/search/study/100144). It also can benefit partners like the Smithsonian (see https://marinecadastre.gov/espis/#/search/study/100073) by providing photos, descriptions, and DNA barcode information that can be used for a variety of purposes including updating their public-facing database.

Objectives: The overall purpose of this study is the following:

1. Compile known information and data about sensitive deepwater benthic habitats and associated fauna in the U.S. OCS in a single, visually appealing, accessible comprehensive guide and associated informational database that can be utilized by BOEM SMEs and stakeholders.
2. Significantly improve the ability of BOEM benthic reviewers to make accurate species and habitat type identifications.
3. Develop a map of known habitat sites and areas with high likelihood of having these habitats.
4. Evaluate sensitivity to potential impacts caused by OCS activities to deepwater habitats and associated fauna.
5. Improve the accuracy and efficiency of environmental assessment and consultation processes associated with regulation of OCS activities.

Methods: A comprehensive guide to sensitive deepwater benthic habitats and their associated fauna will be created using existing data and information from a wide range of sources. Sources will include literature and other less comprehensive guides and databases, some of which NOAA Office of Exploration and Research, National Centers for Coastal Ocean Science, and Deep Sea Coral Research and Technology Program have already been working on for their own mission-driven purposes. BOEM subject matter experts will also be consulted throughout development of the guide to provide expertise and BOEM-specific needs and recommendations. In order of relative BOEM mission priority, the sensitive habitats and fauna that will be the focus of the guide are: 1) deep-sea corals, 2) chemosynthetic communities, and 3) sponges, all of which provide valuable habitat both on micro and macro scales. The guide will include information available for the relevant habitats and fauna in water depths of approximately 200 m and deeper, wherever BOEM has jurisdiction.

The following will be included for each species, depending on availability of information:

- Pictures (i.e., photos and/or diagrams and including links to specimen collections, as available), including a wide variety of in situ images collected by submersibles and/or other cameras.
- Physical description, in enough detail to identify a specimen from imagery (e.g., approximate sizes, color, shape, and/or other distinguishing characteristics). DNA barcode (where available).
- Typical habitat description and geographic distribution.
- Analysis of the sensitivity of the species and/or habitats to likely OCS activities. Types of activities that might cause impacts will also be included.

In addition to species-specific information, general habitat characterizations will be provided for each habitat type and will be consistent with the Coastal and Marine Ecological Classification Standard (CMECS) where possible. These will include descriptions of typical geological and geophysical characteristics and community structures. Non-proprietary imagery, including from remote sensing, will also be included where available to provide an overall descriptive characteristic signature for each habitat type. A simple GIS application or digital map will also be created to help visualize species and habitat distributions. Additionally, there will be a section that will address data gaps and assess future needs. This section will be created in close coordination with BOEM's regional SMEs, and potentially with external stakeholder input where appropriate.

The guide will be designed as a "living document" that can be easily updated as new needs are identified or new information becomes available. It may be expanded in the future to include other benthic fauna in areas affected by OCS activities as the need for this information arises. Information in the guide can be used to evaluate variability in communities within and between regions, assess species vulnerability, evaluate potential connectivity and recruitment, and better identify keystone species. The guide will help users delineate important geographic areas. Further, it will help provide baseline environmental information and inform spatio-temporal assessments of habitat types and fauna.

Specific Research Question(s):

1. What/where are the various sources of existing information on sensitive deepwater benthic habitats, such as deep-sea coral, chemosynthetic, and sponge, in the OCS?
2. What are the characteristics that define "sensitive" fauna and benthic habitats in the OCS?
3. What are the relevant characteristics of fauna associated with sensitive benthic habitats that could be potentially impacted by OCS activities?
4. What is the relative level of sensitivity of the different deepwater benthic habitats and associated fauna?

References:

BOEM Study 2015-2020. "Data Synthesis And Advanced Predictive Modeling Of Deep Coral And Hardbottom Habitats In The Southeast Atlantic: Guiding Efficient Discovery And Protection Of Sensitive Benthic Areas", < https://marinecadastre.gov/espis/#/search/study/100144 >. Accessed March 5, 2020.

BOEM Study 2014-2019. "Continued Archiving Of Outer Continental Shelf Invertebrates By The Smithsonian Institution National Museum Of Natural History", <https://marinecadastre.gov/espis/#/search/study/100073 >. Accessed March 5, 2020.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Developing the Next Generation of Animal Tags Workshop
Administered by	Headquarters
BOEM Contact(s)	James Price (james.price@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 13, 2020
PICOC Summary	
Problem	Recent technological developments in sensors to measure animal physiology, environmental conditions, and to increase the data throughput from animal tags to data centers present the possibility to improve tags for greater learning. Also, outstanding issues remain concerning adverse effects to the tagged animals from the tags themselves, which improved tags may mitigate or eliminate.
Intervention	This study will conduct a workshop of scientists and tag manufacturers concerned with telemetry in marine mammals, fish, and sea turtles for the purpose of advancing the capabilities of tags with reduced cost and adverse impacts to the tagged animals. Minimizing adverse effects to the tagged animals makes studying threatened or endangered species less risky. The study will also provide some seed money to interested manufacturers willing to produce testable prototypes of improved tags.
Comparison	Much has been learned from animal tags about migratory ranges and habitat utilization and behavioral response to stressors. Much more can be learned with expanded use of tags with enhanced sensor capabilities.
Outcome	A workshop will be conducted to consider user needs for expanded tag capabilities and to assess the feasibilities and possible economies in building tags with the capabilities. Some level of incentive funding for tag manufacturers will be awarded to get testable prototypes.
Context	The domain of interest is everywhere in the world's oceans (inclusive of BOEM's areas of responsibility) environmental questions remain where animal tags could facilitate the answers.

BOEM Information Need(s): To make credible assessments of possible adverse effects on marine animals from offshore energy development, BOEM needs to learn as much as possible about where the animals are, when they are there, and what they are doing when they get there. That information combined with knowledge of how offshore activities could adversely impact marine animals affords effective impact analyses and plausible mitigation measures that could be implemented. Animal tags together with other observational techniques provide the needed information about habitat use, migration patterns, and behavioral response.

Improvements in the sensory capabilities of tags, reduced adverse effects from the tags themselves, and lowering of manufacturing costs will enhance BOEM's ability to obtain the requisite environmental information.

Background: Many environmental studies funded or co-funded by BOEM have made use of animal tags along with other observational methods to acquire essential information about the migratory behavior, habitat utilization, and/or behavioral response to stressors of affected marine animals. One prominent example is the tagging of bowhead whales in the Beaufort Sea. For decades, BOEM conducted aerial surveys to observe the fall out-migration of the bowheads but had little observational information about where the bowheads traveled during the rest of their seasonal migration. Using long-lived tags, we were able to delineate their migratory route during the winter, spring, and summer and relate that to their habitat use and breeding. The ongoing Atlantic Marine Assessment Program for Protected Species (AMAPPS) and the GoMMAPPS in the Gulf of Mexico have made use of animal tags on sea turtles with comparable enhanced knowledge about their lifestyles and cycles. Other BOEM studies have tagged fish with much useful information returned.

The use of animal tags in the marine environment has only expanded among marine scientists and natural resource managers, and five years ago, under the auspices of the Marine Mammals Program at the Office of Naval Research, an organization of tag users was born, the Animal Telemetry Network (ATN). The ATN facilitates cooperative research and data sharing. It established the Data Assembly Center for archiving and sharing of tag data, and has formed partnerships with the various U. S. IOOS regions and the Canadian Ocean Tracking Network. Recently, the ATN together with the Marine Biodiversity Observation Network established the West Coast Biological Observations Coordination Network for pulling resources and coordinating observational programs for more cost-effective research with better data preservation and data sharing. The ATN is negotiating with the National Centers for Environmental Information for the permanent archiving of tag data and is negotiating with Service ARGOS for bulk-purchasing of satellite tracking service at a reduced cost.

The ATN has been accepted as a focal point among scientists using animal tags and used that position to conduct a modest workshop in 2017 among some scientists studying marine mammals and a couple of manufacturers of animal tags to explore the possible enhancement of the capabilities of the tags as per needs and wants of the user community. Key recommendations from this 2017 meeting include development of a prioritized list of enhancements the scientists want and need, to assess the technological and financial practicability of making tags that could perform in that way, and to get firm commitments from the manufacturers of tags to actually design and build one or more prototype enhanced tag for field testing.

Objectives: (1) This study will examine the kinds of information that is not currently achievable using existing technology and determine the technical feasibility of building practical tags to provide it. (2) It will also examine how tags and the methods of attaching them can be made to minimize short- and long-term injury to the tagged animals. (3) It will then provide incentive

funding on a competitive basis to commercial tag builders and/or university groups to build and test prototypes of a few different kinds of next-generation tags.

Methods: (1) The study will conduct a workshop for interested persons invited from the many participants formerly or informally in the ATN and cooperating institutions, any other scientists working with animal tags, and known manufacturers of animal tags. (2) It will then provide incentive funding on a competitive basis to commercial tag builders and/or university groups to build and test prototypes of a few different kinds of next-generation tags. (3) A post-workshop report will be produced summarizing the proceedings of the workshop, and the final report of the study will incorporate this and describe the prototype(s) developed by participating manufacturers.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Environmental and Human Exposure to Technologically Enhanced Naturally Occurring Radioactive Materials (TENORMs) Associated with Oil and Gas (O&G) Activities in the Outer Continental Shelf (OCS)
Administered by	Headquarters
BOEM Contact(s)	Stephanie Sharuga (stephanie.sharuga@boem.gov), Drew Remsen (andrew.remsen@boem.gov), Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 13, 2020
PICOC Summary	
Problem	Radiation is a concern because it potentially affects the health and safety of the environment, its resources, and humans. There is a clear need for more information and data on TENORMs, particularly those associated with O&G activities and especially in the marine environment.
Intervention	This study will compile and evaluate information on TENORMs (with an emphasis on marine environments), including background radiation levels, potential pathways of exposure, and potential effects of exposure. It will create a base of knowledge for developing models and doing evaluations of potential impacts of TENORMs on the environment and humans.
Comparison	Without this study, there will be a continued lack of knowledge on TENORMs and inability to evaluate their effects and potential impacts in the future.
Outcome	This study will expand knowledge and fill in information and data gaps related to TENORMs, especially in the marine environment. It will allow BOEM to better understand the extent and pathways of TENORMs in the OCS and evaluate related potential impacts of OCS activities on humans and the natural environment.
Context	The scope and results of this study span all BOEM regions.

BOEM Information Need(s): TENORMs are associated with many resource extraction activities; and are an area of growing concern in relation to O&G activities in particular. Despite this, there has been relatively little research into characterizing TENORMs and developing approaches to evaluate exposure risk and effects of TENORMs on the environment and humans. This study would be cutting-edge in that it focuses on the OCS and will directly address areas and resources of concern for BOEM. It will contribute to more effective assessments and consultations, as well as providing information to fill current information and data gaps. The information obtained will be relevant to informing the National OCS O&G Leasing Program, as well as a variety of National Environmental Policy Act-required documents (including Affected Environment and Routine and Accidental Impacts sections). Information from this study will be

used to better assess, monitor, and inform compliance with regulations regarding TENORM pollution related to O&G activities. It may also identify areas where additional policy development could be beneficial in order to protect humans and the environment. Further, it will contribute to addressing growing public concern over radiation in the environment.

Background: Naturally occurring radioactive materials (NORMs) are "materials which may contain any of the primordial radionuclides or radioactive elements as they occur in nature, such as radium, uranium, thorium, potassium, and their radioactive decay products, such as radium and radon, that are undisturbed as a result of human ctivities."[1] TENORMs are NORMs "that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing" (EPA, 2020a). TENORMs are commonly associated with O&G activities both on land and in marine environments. NORMs naturally occur in O&G reservoirs. During O&G extraction processes, these NORMs become concentrated – becoming TENORMs. The resulting TENORMs can be found in produced waters, sludges and sediments, mineral scales inside pipes, and contaminated equipment or components (EPA, 2020b). Once exposed during production and decommissioning activities, these TENORMs have the potential to impact the health of humans and the environment.

TENORMs have been a known issue for several decades, yet there is an ongoing, recognized gap in knowledge, especially in marine environments and the OCS. Further, over the past decade there has been growing public concern about "radiation" in the environment that makes TENORMs a timely issue to address. It has been recognized as a topic of concern and efforts are being made to decrease the knowledge gap, particularly in relation to O&G activities; however, these efforts have largely been international and, especially within the U.S., have focused more on land-based activities. This study will create a more complete picture of what the potential exposures and effects are of TENORMs on the natural environment and its resources. It will also consider multiple aspects of the human environment and social sciences such as direct human exposure and subsistence and recreational uses. The information and data produced from this study are relevant across all regions and can be updated as necessary to ensure this remains the case as new information becomes available.

Objectives: The objectives of this study are the following:

- Fill in information and data gaps on NORMs/TENORMs in the marine environment and OCS.
- Provide resources that facilitate better evaluation of exposure risk and potential effects of TENORMs occurring from O&G activities in the marine environment.

Methods: The study will enable a better understanding of what data and information are available on NORMs/TENORMs, what current concentrations are in the marine environment, and what the potential impacts are to both ecosystems and humans. This study will:

- Compile a comprehensive data and literature database and report on NORMs with an emphasis on O&G TENORMs, where available. Examples of information include: toxicity of radioactive materials and effects of exposure for humans and fauna potentially

exposed to typical TENORMs associated with O&G; information on the engineering and construction of the rigs and pipelines that serve as potential exposure sources; pathways of exposure (e.g., produced waters, scales, sediments); resources of concern potentially being exposed; toxicity of applicable radioactive materials; etc. The scope of what will be included will be heavily informed by the knowledge of BOEM subject matter experts and other experts.

- Characterize background levels in sediments, water, fauna, and equipment (if logistically feasible) in areas of the OCS open to O&G activities, discriminating between different types of ionizing radiation (e.g., beta vs. alpha particles) since the degree of hazard each presents differs. This will occur in two phases:
  - Phase 1: Compile data that already exists (e.g., discharge monitoring and toxicity test results associated with permits).
  - Phase 2: Under the assumption that too little information and data already exist, a pilot study will be conducted to collect and analyze additional samples. This will include existing samples that can be analyzed for TENORMs (if feasible), as well as collection of new samples. These samples will be taken from across a variety of geological formations in areas where O&G activities are occurring, as well as some additional comparison reference samples from areas where no activity has occurred. The sampling in the pilot study will be done in the Gulf of Mexico region due to the region's scope of O&G production. Any needed additional new sampling will be done in coordination with ongoing research cruises or other collaborative opportunities within BOEM and/or with others. For example, several potential BOEM studies have already been identified for collaboration to minimize costs and efforts with sample collection.
- Develop conceptual models characterizing the pathways, endpoints, and potential effects for TENORMs associated with O&G activities, including from the resource extraction to decommissioning stages. The focus will be on both environmental and human exposure and effects, including from direct exposure to TENORMs and exposure through the food chain. These conceptual models will enable more effective evaluations and predictions across temporal and spatial boundaries. The models will be developed in a way that is adaptable and can be used to extrapolate information relevant to all regions. This study could later be expanded out to include more specific data from additional regions, which can be used to further refine the models and allow for more region-specific adjustments to improve prediction accuracy.

Depending on the results of this study, a future study can be done that would expand sampling efforts and develop a more detailed, quantitative predictive model or set of models that can be used to further improve ability to evaluate and predict both environmental and human exposure and effects.

Specific Research Question(s):

1. What information and data are currently available on NORMs and TENORMs in the marine environment and especially for the OCS where O&G activities are occurring?

2. What are past and/or current levels of TENORMs in water, sediments, and fauna in areas where O&G activities are and are not present?
3. What are the potentially affected resources of concern?
4. What are the pathways of exposure and elevated concentrations of TENORMs associated with O&G activities?
5. What levels of TENORMs are expected to potentially cause impacts to humans and ecosystems?
6. What are the potential effects of TENORMs on the natural environment and humans?

References:

EPA. (2020a). *Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM)*. <https://www.epa.gov/radiation/technologically-enhanced-naturally-occurring-radioactive-materials-tenorm>. Accessed March 5, 2020.

EPA. (2020b). *TENORM: O&G Production Wastes*. <https://www.epa.gov/radiation/tenorm-oil-and-gas-production-wastes>. Accessed March 5, 2020.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Facilitating Strategic Partnerships in Support of the Presidential Memo on Ocean Mapping, Exploration, and Characterization
Administered by	Headquarters
BOEM Contact(s)	Mark Mueller (mark.mueller@boem.gov), Jeremy Potter (jeremy.potter@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2021–2024
Date Revised	March 6, 2020
PICOC Summary	
Problem	BOEM has contributed substantially to developing the 2019 Presidential Memorandum's (PM) Section 2 National Strategy on Ocean Mapping, Exploring and Characterizing the U.S. Exclusive Economic Zone (NOMEC). The PM calls on agencies to "act boldly" to implement its ambitious goals. BOEM's Environmental Studies Program (ESP) has trailblazed with several successful, mission-driven partnerships focused on mapping, exploring and characterizing deepwater benthic environments. To maintain its first-in-class status, the ESP must continue leading and innovating in this domain.
Intervention	This funding vehicle will support the PM's broad goals and several specific NOMEC objectives in a cost-effective and timely way that addresses BOEM mission needs. Collaboratively developed, objective criteria will help ensure a fair and transparent submission/evaluation process that can be employed year-round to strategically support emerging opportunities and partnerships.
Comparison	The current Studies Development Plan process works well for most types of studies but has limitations, particularly in responsiveness to near-term partnership funding. For example, it cannot capitalize on short-notice opportunities such as unanticipated ship time availability. This vehicle provides a nimbler way for BOEM to capitalize on availability of partner funding for low-cost/high-value partnerships, and also achieve cost savings by linking previously disconnected ESP studies with overlapping support needs.
Outcome	A standing, adaptable funding mechanism that can help (along with existing and new partners) fund necessary research involving vessels, submersibles, sensors, and scientific staff in more cost-effective ways. This will help improve resource evaluations and impact assessments through greater scientific understanding of deepwater environments, improve mitigation methods and better inform programmatic decision-making.
Context	Primarily deepwater benthic habitats and connections. Spatial domain includes all OCS planning areas under BOEM jurisdiction. May expand to Territories should BOEM/OCSLA jurisdiction be expanded.

BOEM Information Need(s): BOEM requires authoritative baseline information about deepwater habitats and resources to inform NEPA assessments (Affected Environment and potential impacts), permitting/mitigation, resource evaluation and programmatic decision-making across Regions and program areas (conventional energy, renewable energy, and marine minerals). Such information can be collected via collaborative offshore Mapping, Exploring, and Characterizing (MEC) efforts, per the recent Presidential Memorandum and its Section 2 National Strategy. BOEM's Environmental Studies Program (ESP) requires a new, more adaptable mechanism to support MEC decision-making based on subject matter expertise.

Background: Section 2 of the 2019 Presidential Memorandum (PM) on Ocean Mapping mandates a National strategy to map the ocean throughout the U.S. EEZ, identify priority areas, and explore and characterize these priority areas. The PM calls on federal agencies to "act boldly" to implement its ambitious goals. To help achieve those goals, the strategy calls for developing new ways to better leverage the expertise and resources of multi-sector partnerships and collaboration across federal agencies and non-U.S. Government entities. BOEM has contributed substantially to developing this strategy, and now must shift to implementing it.

The ESP has previously led the way in MEC through mission-driven, NOPP-sponsored partnerships with NOAA and USGS including Atlantic Canyons, Deep SEARCH, and EXPRESS—all cited as exemplary by the NOMEC Task Force. These major efforts have significantly advanced the state of science and furthered appropriate management by increasing knowledge of continental margin geology, the types of seafloor communities, and connectivity with mid-water organisms. However, there is still incomplete information available about the distribution, composition, and sensitivity of deepwater seafloor habitats (i.e., hard bottoms, cold seeps, hydrothermal vents) and their associated benthic communities. For example, through its mapping and exploration activities, Deep SEARCH yielded the first known observation of a tubeworm in the Southeast Atlantic, and discovered a complex, 85 linear mile *Lophelia pertusa* reef system in an unexpected area. Because such deepwater habitats and fauna can potentially be negatively impacted by unmitigated OCS activities, BOEM must continue to better understand these ecosystems and their sensitivity to various impact producing factors. Though BOEM first initiated deepwater study efforts due to conventional energy activities, growing interest in critical marine minerals and the potential for offshore floating wind energy production have expanded these information needs.

Therefore, the mapping, exploration and characterization supported through this funding will focus primarily (but not exclusively) on these deepwater habitats in prioritized geographic areas throughout all OCS Regions. Due to the prohibitively high costs of deepwater fieldwork, BOEM must continue to collaborate with partners on research that cost-effectively addresses common information needs. Though quite successful, the historical BOEM template for deepwater research—single area, high dollar multi-year contractor/agency partnerships—does have inherent limitations. Lessons learned suggest a more responsive, adaptive funding process guided by strategically defined criteria could more effectively advance overlapping agency objectives and achieve the broader USG goals outlined in the PM. By evolving the model, BOEM's ESP can expand the range of potential partners, better respond to short-notice

opportunities, adapt to evolving mission priorities, and maximize return on investment of federal funds.

Objectives: The ESP must demonstrate continued leadership and innovation by expanding its ability to obtain high-value deepwater information through mapping, exploration, and characterization efforts that address ongoing and emerging management needs and do so in a cost-effective manner. The envisioned funding processes and results are expected to support the following objectives:

- Provide a reliable source of ESP funding that can be that can be accessed and directed year-round to take advantage of short-notice opportunities and respond to emerging priorities;
- Reduce costs and maximize overall return on federal investments by more effectively and strategically leveraging partnerships, with preference given to projects that offer cost sharing and overlapping or complementary science/mission objectives;
- Rely on collaboratively developed, objective criteria to guide project selection. One anticipated source for these criteria will be a new, regularly updated BOEM National Deepwater Mapping, Exploration, and Characterization Strategy that will help identify and prioritize BOEM's current geographic and topical needs;
- Employ a fair and transparent "internal proposal" submission and evaluation process;
- Continue advancing mapping, exploration and characterization of sensitive seafloor habitats and fauna to help clarify the type and degree of potential impacts from conventional energy, renewable energy, and marine minerals activities for environmental assessments and programmatic decision-making;
- Provide BOEM and USGS subject matter experts more consistent access to ship time improving their ability to design and execute studies and deliver critical information;
- Encourage use of emerging technologies including remote sensing tools to more efficiently survey the seafloor and water column, in line with NOMEC Strategy Objective 4;
- Identify and map major geologic seafloor features relevant to understanding potential hazards (such as submarine landslides) and associated risks to energy infrastructure, benthic and cultural resources, and coastal tsunami risk;
- Yield information about water and seabed geochemistry (e.g., ocean acidification, methane system) to help better quantify potential baseline shifts;
- Assess relative sensitivity to impacts by comparing food-web ecology, population structure, and genetic diversity across depths and other environmental covariates;
- Provide MEC data that can also be used to inform BOEM resource evaluations; and
- Complement and build on relevant Administration directives, principally the PM Section 2 NOMEC Strategy, and maintain close ties to the associated implementation body.

Methods: A combination of two different funding mechanisms is anticipated to help fulfill the above BOEM objectives and those of the broader NOMEC Strategy. First, new inter-agency agreements (IAA) with NOAA and USGS (and/or possibly National Science Foundation) to acquire vessel/submersible/ sensor and targeted scientific staff support. NOPP involvement or sponsorship will be pursued where appropriate. These IAAs would build on the existing PC-20-03 "Fostering a Cohesive Interagency Offshore Mapping and Hard Bottom Habitat Characterization Program" project, which is limited to the Pacific. Second, a subset of available

ESP funds will be reserved or "set aside" every year to be allocated over time to low-cost/high-value interagency opportunities.

A fair and transparent internal proposal submission and evaluation process will rely on collaboratively developed, objective criteria to help identify and prioritize eligible projects according to BOEM's current geographic and topical needs. One anticipated source for these criteria will be a new, regularly updated BOEM Deepwater Mapping, Exploration, and Characterization (DMEC) Strategy that will be developed by a newly established team of the same name, composed of SMEs from every Region and relevant Programs. The team will receive and evaluate proposed project ideas/requests (a template will be provided) involving known and emerging fieldwork opportunities (such as available ship time). Preference will be given to highly leveraged projects that cost-effectively meet near to mid-term programmatic and science needs. Identifying needs and opportunities will also involve regular discussion with key federal partners that share science and mission objectives (primarily NOAA and USGS), and with non-USG entities where appropriate. Guided by the defined strategic/mission priorities and their situational awareness of regional/programmatic activities, the DMEC team will provide their input to the ESP Chiefs who will make specific funding recommendations to the DES Chief.

Discrete projects can include a broad range of interdisciplinary methods that advance mapping, sampling, and characterization of deepwater habitats. Some examples:

- Ship-based acoustic mapping can be used to measure bathymetry and delineate substrate types and the distribution of important hard bottom areas;
- Unmanned submersibles can provide seafloor imagery and enable collection of chemical, biological and geological samples;
- Trained scientific staff using laboratory materials/protocols (such as traditional taxonomic and genetic techniques) can analyze community composition and impact sensitivity;
- eDNA sampling and referencing can shed new light on biodiversity and species distribution;
- Data management best practices (such as submitting coral and sponge locations in a format consistent with the NOAA Deep Sea Coral Research and Technology Program national geodatabase) can promote data access and usability.

Results will be made available in ESPIS via final reports, peer-reviewed literature, etc. Select data can be archived through the NOAA National Centers for Environmental Information.

Specific Research Question(s):

1. Where are the sensitive hardbottom benthic habitats in deepwater areas of the OCS that could be leased for conventional energy, renewable energy, or marine minerals?
2. What are the current and projected environmental conditions and biological composition of these habitats? How are species ecologically and genetically connected?
3. How can BOEM and federal partners best collaborate to achieve agency mission objectives and further the goals of the Section 2 NOMEC Strategy?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Imagery Acquisition to Support and Enhance BOEM's Deep Learning Projects
Administered by	Headquarters
BOEM Contact(s)	Timothy White (timothy.white@boem.gov), Michael Rasser (michael.rasser@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2022
Date Revised	April 10, 2020
PICOC Summary	
Problem	Acquiring annotated digital aerial imagery remains the primary technical barricade for BOEM study Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery (NT-19-04). Key imagery datasets (e.g., NYSERDA's offshore digital aerial surveys) stay unavailable to the public and Federal agencies and require post-processing for re-use by advanced deep learning modeling. This project will acquire "private" annotated digital imagery datasets to support BOEM's digital imagery program.
Intervention	1) This study will obtain imagery and associated annotated datasets developed by The New York State Energy Research and Development Authority (NYSERDA) containing thousands of manually processed images collected over multiple years. NYSERDA Digital Aerial Surveys page Portal to NYSERDA data 2) This effort may also identify and acquire datasets in various regions across the nation.
Comparison	Train, improve, and expand existing deep learning algorithms to classify and detect objects in digital aerial imagery. Create new species-specific deep learning detectors based on newly acquired imagery.
Outcome	Updated taxa specific (seabirds, marine mammals, turtles) deep learning algorithms (each with associated error) for automating digital aerial survey operations.
Context	National

BOEM Information Need(s): BOEM's digital imagery library for deep learning modeling (c.f. BOEM study NT-19-04) is insufficient, containing a limited number of species photographed in a small geographic area. BOEM can augment this library by acquiring annotated digital imagery collected by studies conducted outside of BOEM. For example, NYSERDA conducted multi-year digital aerial surveys in the New York Bight and manually processed each image with species-specific annotation. These NYSERDA datasets contain imagery and associated annotation of seabirds, marine mammals, sea turtles, fish shoals, boat traffic, and various additional objects

of interest to BOEM. Acquiring this critical dataset and potentially others across the nation to develop and train deep learning algorithms (NT-19-04) will advance BOEM's digital aerial survey program designed to improve accuracy in detecting and classifying objects in imagery collected by aircraft surveys.

Background: A recent partnership developed between BOEM, USGS, UC Berkeley formed around building species-specific deep learning algorithms to automate detection and classification of objects in imagery collected on digital aerial surveys. To date, the collaboration designed and created neural network seabird detectors, which are deep learning programs designed detect seabirds in imagery (Ke et al., 2020, in prep), and a new high-resolution camera system to collect targeted imagery. Expanded algorithm development requires large volumes of imagery for training. BOEM's library contains a limited species profile from Cape Cod, Massachusetts and the south-Atlantic Bight.

Convolutional neural networks (CNN) revolutionized object detection in digital imagery by providing systematic and quantitative means to measure and improve accuracy in detecting and classifying objects while reducing or eliminating tedious and time-consuming manual processing steps. CNNs are the successor of multilayer perceptrons a form of computer vision that nests within the domains of artificial intelligence and deep learning.

This project proposes to dovetail with three existing BOEM studies that are collecting and processing imagery: 1) Atlantic Marine Assessment Program for Protected Species digital aerial surveys (AMAPPS III B and C). This U.S. Fish and Wildlife Service component of AMAPPS aerial surveys will target species-specific and community hotspots identified by aerial and ship-based observations; 2) PC-17-01 Seabird and Marine Mammal Surveys Near Potential Renewable Energy Sites Offshore Central and Southern California; and 3) All of these newly acquired collections will train CNNs in development by BOEM study NT-19-04 - Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery.

Objectives: Our primary goals are to: 1) acquire manually processed and annotated imagery collected on marine wildlife surveys to expand and train deep learning algorithms in development by study NT-19-04; and 2) address objectives A-E set forth in the Executive Order on Maintaining American Leadership in Artificial Intelligence (Executive Order 13859; 2019-02-11).

Methods: The acquired imagery and associated annotated datasets will support development of CNNs to detect and classify seabird, cetaceans and sea turtles in development by ongoing BOEM study NT-19-04 - Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery (Ke et al., 2020, in prep). Please refer to methods in NT-19-04.

Specific Research Question(s): Please refer to research questions in study NT-19-04.

References:

Ke T-W, Yu SX, Koneff MD, Fronczak DL, Fara LJ, Harrison TJ, Landolt KL, Lubinski BR, White TP, Yates SF, et al. In prep. A deep-learning approach to detection of marine birds from digital aerial imagery. PLOS One.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Integrating Low Cost Emerging Technology Into Ocean Environmental Monitoring
Administered by	Headquarters
BOEM Contact(s)	Michael Rasser (michael.rasser@boem.gov), Jacob Levenson (jacob.levenson@boem.gov), Stephanie Sharuga (stephanie.sharuga@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2024
Date Revised	March 9, 2020
PICOC Summary	
Problem	There is a lack of information on the distribution, abundance and ecology of deep-water species, communities and habitats – in part due to the limited availability of technology and costly nature of conducting ocean research.
Intervention	BOEM needs to evaluate how it can better integrate cost-effective, available emerging technologies into its studies. This study proposes to evaluate new and emerging technologies such as autonomous probes, baited remote underwater video (BRUV), and remotely released sensors for ocean environmental monitoring.
Comparison	The information collected during this study will be compared to traditional methods for collecting the same information that have been used by completed BOEM studies, with an emphasis on comparing costs, accuracy, and precision.
Outcome	Emerging, lower-cost technologies will be evaluated on their ability to collect data on fauna and habitats that is comparable to traditional technologies. Standard operating procedure and instructions for incorporating these technologies will be developed to guide future use.
Context	The conclusions and procedures developed in this study will be applicable to studies in all regions.

BOEM Information Need(s): BOEM needs to better understand the potential environmental impacts from resource extraction activities (e.g., oil and gas, mineral mining) on the OCS. Technologies capable of conducting effective research in the open ocean, especially the deep sea, are often not easily available and can be cost prohibitive. This makes it challenging to collect data in adequate amounts and/or in a timely manner, especially for studies that are spatially or temporally broad in scope. Data collected in this study will allow BOEM to evaluate the utility of non-traditional technologies that may be more effective at not only obtaining high-quality data but also at lower costs. This will contribute to a better understanding of sensitivity of marine habitats and fauna, which will support environmental monitoring and assessments

that are part of BOEM's national OCS oil and gas leasing program and Marine Minerals Program.

Background: BOEM is working to use new technology to create scientific value for BOEM. This study aims to advance and integrate cost-effective, emerging technologies as a standard approach for conducting ocean environmental monitoring. This includes measurements on the physical characteristics of benthic and pelagic deep sea environments, as well as the distribution and abundances of species and sensitive habitats. There are a number of promising emerging technology that have the potential to improve the ability for BOEM to collect needed information. Some examples of these include:

- Autonomous underwater probes and gliders – Typically BOEM's deep-sea research program has relied on tethered remotely operated vehicles (ROVs) or even manned underwater vehicles to collect samples and observational data from the sea floor. There are a number of less costly, although perhaps more limited in ability, options. One example is the Sea Rocket (https://hawxopenocean.com/sea-rocket/).
- Baited Remote Underwater Video (BRUV) – BOEM's research on pelagic and benthic fish species has largely been accomplished through standard trawl surveys. BRUV sampling has been limited to deployment on large and expensive benthic landers. However, recent technological advancement allows for the deployment of both pelagic and benthic remote underwater video that can be deployed, even in the deep sea, at a much lower cost.
- Deploying animal tags as sensors – Tags deployed on animals have advanced significantly in recent years to the point were they not only track the locations of animals, but measure a significant amount of environmental variables. These sensors have developed to the point where they can be deployed to measure important environmental variables, even if they are not attached to animals.
- CTD – Hardware and software that measure and record oceanographic measures for conductivity, temperature and depth (CTD) are collected across many of BOEM's studies. The current hardware and software use for these measurements are costly. However, there are emerging open source solutions to collect this data that offer the opportunity for lower-cost data collection. One example of this implementation is the "OPEN CTD Project" (https://github.com/OceanographyforEveryone/OpenCTD).

In this study BOEM scientists will collaborate to look across all ongoing and planned studies and identify new and emerging technologies that can be used to improve the cost effectiveness, quality, consistency and spatial resolution of data collected. With the assistance of a single contract vehicle, solutions will be developed that will allow for economies of scale and integration of similar types of measurements across BOEM's environmental studies. An indefinite delivery/indefinite quantity type contract will allow the flexibility to adapt workflow for new technological advances and evolving information needs. This will allow standard methods to be developed that are consistent and repeatable. It will also help create a culture of experimenting with new and innovative methods in BOEM.

Objectives: The objectives of this study are to develop a new process for integrating new and emerging technologies into BOEM studies by:

- Identifying cost-effective, emerging technologies for conducting ocean environmental monitoring, and compare to traditional methods of data collection.
- Developing standard operating procedures and making recommendations for integrating these technologies into BOEM studies.

Methods: This study will establish a new strategy for incorporating emerging technologies into BOEM studies. It will include the following stages:

1. Develop a team of BOEM scientists to look across BOEM's planned and ongoing studies and identify opportunities for integrating emerging technology. Use a flexible IDIQ contract vehicle to conduct pilot studies using identified emerging technologies through individual task orders to implement these opportunities.
2. Complete 3-4 pilot studies designed to be integrated in and complement planned studies. The initial idea is for these pilot studies to implement the technology addressed above in coordination with the other planned studies. Several planned studies proposed this year that would benefit from these technologies include "Investigation of an Historic Seabed Mining Site on the Blake Plateau" and "Turtle Avoidance Technology Solutions." The identified technologies will be used to collect data related to distribution, abundance and ecology of deep-water species, communities and habitats, which will then be evaluated and compared to data collected via more traditional approaches to determine utility and effectiveness.
3. Develop standard operating procedures and recommendations for integrating emerging technologies into BOEM studies.

Specific Research Question(s): This study is intended to address both strategy (procurement and study management process), as well as scientific questions (addressed through pilot studies), including:

- Can cost-effective, emerging technologies obtain data of the same (or better) quality as traditional methods that can be used to address BOEM needs?
- Can emerging technologies be better integrated into future BOEM studies through development of standard operating procedures and formal recommendations?
- Example research questions that could be addressed include:
    - What are the environmental conditions of sea floor open water in deep-water areas? What is the range of environmental variables such as temperature, currents and total alkalinity?
    - What is the distribution of organisms and communities of organisms in the deep sea? Is this distribution correlated with certain habitat types or environmental variables? What are the connections between the seafloor and pelagic environments?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Marine Mammal Bioenergetics Workshop
Administered by	Headquarters
BOEM Contact(s)	James Price (james.price@boem.gov), Kyle Baker (Kyle.Baker@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2022
Date Revised	April 13, 2020
PICOC Summary	
Problem	Acoustical Disturbance Impact models, typically built on the PCAD (Population Consequence of Acoustical Disturbances) framework, show a wide range of consequences (including death of the affected animals), because there are large uncertainties in the input parameters of the models. Parameterizing the bioenergetics correctly in the models and addressing feeding disturbances is of particular concern.
Intervention	This study will conduct a second workshop of experts in bioenergetics to succinctly identify ways in which bioenergetic parameterization could be improved and form partnerships to conduct the necessary research.
Comparison	Thirty-four years ago, the first bioenergetics workshop of experts was convened and significant progress was made. Many new things have been learned since then; a second workshop drawing on much newer information and understanding learned since then would be equally valuable and make comparable progress.
Outcome	More precise parameterization of bioenergetics will be realized and, in turn, the uncertainty in the impact models using them will be reduced. We should be better able to differentiate between fatal and non-fatal impacts due to acoustical disturbance.
Context	The domain of interest is wherever noise-making activities occur in the ocean proximate to marine mammals engaging in feeding, migrating, and cow-calf associations.

BOEM Information Needs: BOEM analysts can make very plausible conclusions about the short-term effects on marine mammals from anthropogenic stressors associated with offshore energy development. However, the longer-term, cumulative effects are more difficult to determine, but are equally important for the preservation of marine mammals and developing rules for offshore operations and mitigation strategies to achieve that end. Since it is difficult to practically impossible in many circumstances to directly observe cumulative effects, analysts rely on modelling to make their impact assessments. Commonly, the models pertaining to acoustical disturbances are built upon the PCAD/PCoD (population consequences of acoustical disturbances / population consequences of disturbances) framework and depend upon the

parameterization of animal physiology such as bioenergetics as inputs into the models. Uncertainties in the input parameters can result in large variation in the results of the models. It is critically important to improve our knowledge of the input parameters in order to obtain realistic-enough model results for sensible, useful impact assessments.

This study addresses BOEM's strategic framework criteria (1) Effects of Impacting Activities; (2) Affected Resources; and (4.) Cumulative Impacts.

Background: The development of the PCAD/PCoD (population consequences of acoustical disturbances / population consequences of disturbances) framework to assess the possible impacts of anthropogenic disturbance on marine mammals has primarily relied on the use of bioenergetic models to estimate the impacts of lost foraging opportunities or the additional energy costs associated with avoidance (Christiansen et al. 2013, New et al. 2013a, New et al. 2013b, Christiansen et al. 2014a, Christiansen et al. 2014b, New et al. 2014, Christiansen and Lusseau 2015, King et al. 2015, Costa et al. 2016a, Costa et al. 2016b, Schwarz et al. 2016, McHuron et al. 2017, Villegas-Amtmann et al. 2017, Farmer et al. 2018). The conceptual framework for a bioenergetics model is based on the concept that a disturbance reduces prey energy intake by a reduction in the time spent foraging, or by increasing the costs associated with foraging or some other activity such as migration, or by an increase in the allostatic load (McEwen and Wingfield 2010). Regardless of how the energy budget is modified, either via a reduction in energy intake or by increased expenditure, the end result is a reduction in energy available for reproduction and/or, in the worst case, survival of the adult (Costa 2012, Costa and Maresh 2017). While the conceptual linkages are well understood, the quality of the data for the various components and/or parameters that go into developing bioenergetics models vary greatly across marine mammals. Not surprisingly, the best data are available from research on pinnipeds with direct measurements made of the cost of reproduction, assimilation efficiency, basal metabolism, thermoregulatory costs and free ranging metabolic rates (Costa and Maresh 2017). However, there are only a few direct measurements of the metabolic components that are required to build a bioenergetics model for small cetaceans, and, for most large cetaceans, the only direct measurements are associated with measurements of body composition of harvested whales (Lockyer 2007). For gray and minke whales, however, metabolic rates were extrapolated from measurements of lung mechanics (Folkow and Blix 1992, Sumich 1994, Sumich and May 2009).

Given the limited availability of direct measurements of the many parameters needed to develop a bioenergetics model, some parameters are estimated from the few data that are available or derived from expert elicitation (King et al. 2015). Furthermore, the experience and background of individuals who are developing bioenergetics models varies considerably, with some individuals having a deep background in metabolic physiology (Costa et al. 2016c, Bejarano et al. 2017, Costa and Maresh 2017), while others are relatively new to the field (New et al. 2013b, Farmer et al. 2018). This results in an uneven implementation of the parameters necessary to populate a bioenergetics model developed on the PCoD framework, which can result in models of quite different quality and predictive capability (Braithwaite et al. 2015, Villegas-Amtmann et al. 2017). Further, there are many assumptions and parameters that go

into developing a bioenergetics model. However, not everyone uses the same approaches and, in many cases, are making their best educated guesses based on the available information.

One example of great relevance to BOEM, is the Farmer et al. (2018) study, which developed a stage-specific bioenergetic model for the Gulf of Mexico sperm whales exposed to seismic surveying sound. Their approach, while similar to models developed by others, uses a fundamentally different set of assumptions and approaches. For example, while Villegas et al (2015, 2017) and Pirotta et al. (2018) attempted to estimate field metabolic rates using observations of ventilation rates, the Farmer et al (2018) study used a value of 5 times the rate predicted for terrestrial mammals of equal size as defined by Kleiber (1975). This value was taken from Lockyer (1981), but that was just a guess. Some support for this number could have been derived from Bejarano et al (2017) who compared 3 bioenergetic models of prey intake for bottlenose dolphins using three different methods of inferring field metabolic rates. While the Farmer et al. (2018) study developed a model that implemented a much more robust partitioning of the bioenergetic components into fat, carbohydrate, and protein, the other bioenergetic models did not partition. This is exemplary of the current wide range of modelling strategies and model inputs directed at studying the same phenomena.

Trying to tame the situation, a highly successful workshop on bioenergetics modelling was held in 1985 at the sixth biennial conference of the Society for Marine Mammalogy in Vancouver, British Columbia, Canada. The workshop produced a detailed synthesis of the state of the art of marine mammal energetics modelling and the many problems (and successes) therein (Huntley et al. 1987). Much has been learned and accomplished since 1985. However, it is time now to revisit this topic, particularly since there is increased interest in the theory and practical applications of marine mammal bioenergetics and the development of bioenergetics models.

Objectives: The objectives of this study are: (1.) to comprehensively assess the deficiencies in modelling the bioenergetics of marine mammals; (2.) to develop best practices guidelines for improving the models; (3.) to identify the deficiencies in existing observations needed as model inputs and suggest observational studies, including with captive research animals, to overcome the deficiencies; and (4.) form partnerships to conduct the necessary research.

Methods: This study will conduct a bioenergetics workshop in FY 2021 to: review the state of information on marine mammal bioenergetics; identify the data gaps and approaches that can be used to fill them; and recommend ways to develop more robust bioenergetic models. The workshop will comprise individuals who are well grounded in marine mammal metabolic physiology along with individuals who have developed, or are developing, bioenergetic models based upon the PCoD framework. A comprehensive review or synthesis article for publication in a peer-reviewed journal and, possibly, a dedicated volume on marine mammal energetics will be produced.

Specific Research Question(s): (1) What are the deficiencies in the current modelling approaches of marine mammal energetics? (2) How can they be overcome to produce better models? (3.) What are the deficiencies in the data available to drive the models? (4.) What observational studies are needed to remedy the deficiencies?

References:

Bejarano, A. C., R. S. Wells, and D. P. Costa. 2017. Development of a bioenergetic model for estimating energy requirements and prey biomass consumption of the bottlenose dolphin Tursiops truncatus. Ecological Modelling 356:162-172.

Braithwaite, J. E., J. J. Meeuwig, and M. R. Hipsey. 2015. Optimal migration energetics of humpback whales and the implications of disturbance. Conservation Physiology 3.

Christiansen, F., and D. Lusseau. 2015. Linking Behavior to Vital Rates to Measure the Effects of Non-Lethal Disturbance on Wildlife. Conservation Letters 8:424-431.

Christiansen, F., M. Rasmussen, and D. Lusseau. 2013. Whale watching disrupts feeding activities of minke whales on a feeding ground. Marine Ecology Progress Series 478:239-251.

Christiansen, F., M. H. Rasmussen, and D. Lusseau. 2014a. Inferring energy expenditure from respiration rates in minke whales to measure the effects of whale watching boat interactions. Journal of Experimental Marine Biology and Ecology 459:96-104.

Christiansen, F., G. A. Víkingsson, M. H. Rasmussen, D. Lusseau, and D. Costa. 2014b. Female body condition affects foetal growth in a capital breeding mysticete. Functional Ecology 28:579-588.

Costa, D. P. 2012. A Bioenergetics Approach to Developing the PCAD Model. Pages 423-426 in A. N. Popper and A. Hawkins, editors. The Effects of Noise on Aquatic Life. Advances in Experimental Medicine and Biology Springer Science+Business Media.

Costa, D. P., L. A. Hückstädt, L. K. Schwarz, A. S. Friedlaender, B. R. Mate, A. N. Zerbini, A. Kennedy, and N. J. Gales. 2016a. Assessing the exposure of animals to acoustic disturbance: Towards an understanding of the population consequences of disturbance. Proceedings of Meetings on Acoustics 27:010027.

Costa, D. P., and J. L. Maresh. 2017. Energetics. Pages 329-335 in B. Würsig, J. G. M. Thewissen, and K. Kovacs, editors. Encyclopedia of Marine Mammals. Academic Press.

Costa, D. P., L. Schwarz, P. Robinson, R. S. Schick, P. A. Morris, R. Condit, D. E. Crocker, and A. M. Kilpatrick. 2016c. A Bioenergetics Approach to Understanding the Population Consequences of Disturbance: Elephant Seals as a Model System. Adv Exp Med Biol 875:161-169.

Farmer, N. A., D. P. Noren, E. M. Fougères, A. Machernis, and K. Baker. 2018. Resilience of the endangered sperm whale Physeter macrocephalus to foraging disturbance in the Gulf of Mexico, USA: a bioenergetic approach. Marine Ecology Progress Series 589:241-261.

Folkow, L. P., and A. S. Blix. 1992. Metabolic rates of minke whales (Balaenoptera acutorostrata) in cold water. Acta Physiol Scand 146:141-150.

Huntley, A. C., D. P. Costa, G. A. J. Worthy, and M. A. Castellini, editors. 1987. Approaches to Marine Mammal Energetics. Allen Press, Lawrence, KS.

King, S. L., R. S. Schick, C. Donovan, C. G. Booth, M. Burgman, L. Thomas, J. Harwood, and C. Kurle. 2015. An interim framework for assessing the population consequences of disturbance. Methods in Ecology and Evolution:n/a-n/a.

Lockyer, C. 2007. All creatures great and smaller: a study in cetacean life history energetics. Journal of the Marine Biological Association of the United Kingdom 87:1035-1045.

McEwen, B. S., and J. C. Wingfield. 2010. What is in a name? Integrating homeostasis, allostasis and stress. Hormones and Behavior 57:105-111.

McHuron, E. A., D. P. Costa, L. Schwarz, and M. Mangel. 2017. State-dependent behavioural theory for assessing the fitness consequences of anthropogenic disturbance on capital and income breeders. Methods in Ecology and Evolution 8:552-560.

New, L. F., J. S. Clark, D. P. Costa, E. Fleishman, M. A. Hindell, T. Klanjšček, D. Lusseau, S. Kraus, C. R. McMahon, P. W. Robinson, R. S. Schick, L. K. Schwarz, S. E. Simmons, L. Thomas, P. Tyack, and J. Harwood. 2014. Using short-term measures of behaviour to estimate long-term fitness of southern elephant seals. Marine Ecology Progress Series 496:99-108.

New, L. F., J. Harwood, L. Thomas, C. Donovan, J. S. Clark, G. Hastie, P. M. Thompson, B. Cheney, L. Scott-Hayward, and D. Lusseau. 2013a. Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. Functional Ecology 27:314-322.

New, L. F., D. J. Moretti, S. K. Hooker, D. P. Costa, and S. E. Simmons. 2013b. Using energetic models to investigate the survival and reproduction of beaked whales (family Ziphiidae). PLoS ONE 8:e68725.

Schwarz, L. K., E. McHuron, M. Mangel, R. S. Wells, and D. P. Costa. 2016. Stochastic dynamic programming: An approach for modelling the population consequences of disturbance due to lost foraging opportunities. Proceedings of Meetings on Acoustics 27:040004.

Sumich, J. L. 1994. Oxygen Extraction in Free-Swimming Gray Whale Calves. Marine Mammal Science 10:226-230.

Sumich, J. L., and M. A. May. 2009. Scaling and remote monitoring of tidal lung volumes of young gray whales, Eschrichtius robustus. Marine Mammal Science 25:221-228.

Villegas-Amtmann, S., L. K. Schwarz, G. Gailey, O. Sychenko, and D. P. Costa. 2017. East or west: the energetic cost of being a gray whale and the consequence of losing energy to disturbance. Endangered Species Research 34:167-183.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Modeling Support for the Center for Marine Acoustics
Administered by	Headquarters
BOEM Contact(s)	Stanley Labak (Stanley.labak@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	March 6, 2020
PICOC Summary	
Problem	The Center for Marine Acoustics (CMA), a BOEM Centers of Excellence (COEs) "First in Class" requires external assistance in establishing this capability. Multiple specific and highly specialized models, databases and algorithms need to be acquired and, in some cases, reported on in order to create this capability.
Intervention	To identify and acquire these needed components and knowledge. The ultimate metric is self-defined in the goal of establishing a peer-reviewed and certified, state-of-the-art, acoustic impact modelling capability at BOEM within three years.
Comparison	This effort is not a standard ESP study. It is the essential acquisition of components and knowledge necessary to establish this acoustic modelling capability. Without these essentials, the modelling capability would be second rate, at best. They are essential.
Outcome	The modelling capability described above, within three years.
Context	This is a capability that would predominantly reside in the BOEM Sterling office, but some components and personnel might also be in multiple BOEM regional offices. The analyses and modelling capability, when completed, could and will be applied to all BOEM Programs and the entire outer continental shelf.

BOEM Information Need(s): BOEM is currently in the process of establishing several Centers of Excellence (COEs)/" First in Class," including the Center for Marine Acoustics (CMA). As the name implies, the CMA will focus on the acoustic-focused aspects of the technical and environmental issues pertinent to BOEM and its three program areas (O&G, Minerals and Renewables). The purpose behind this effort is to establish, internal to BOEM, a capability to address four of the Strategic Science Questions, numbers 1, 2, 8 and 9 for underwater acoustic issues (e.g., 1. Cumulative effect for environmental assessments, 2 acute and chronic effects, 8 better using emerging technologies to achieve scientific results, and 9 best affected resources , measurements and systems for long-term monitoring). Additionally, the CMA will ultimately be tasked to produce the technical/numeric acoustic modelling and risk assessment results that will be included in all BOEM environmental compliance documents, specifically all NEPA, MMPA

and ESA documents, petitions or authorization requests, as well as the supporting technical documents for various consultations. Also, the CMA will provide the technical background and support necessary for BOEM to proactively engage NOAA/NMFS, FWS and the Army Corp of Engineers, and others in future discussions concerning acoustic thresholds guidance, and the development of regulatory approaches and policy.

Background: This project is not a standard or typical ESP study. It is designed to support the creation of an acoustic modelling capability at BOEM. The CMA is envisioned as serving as the centralized BOEM asset that is capable of addressing all acoustic technical analyses and acoustic impact modelling requirements necessary to support the three BOEM programmatic areas. Essentially, the CMA will serve as the BOEM subject matter expert (SME) for acoustics, an SME which is capable of producing definitive analytical and modelling results of sufficient quality, as recognized external to BOEM, that they can be readily used by BOEM during interactions with all external entities and organizations. In order to develop this capability, the CMA will need to build a capability in all areas of acoustic impact modelling and the numerous modelling sub-specialties including, but not limited to, acoustic sources, propagation, animal movement and risk assessment modelling. BOEM will need to acquire a suite of state-of-the-art models and databases in each of these modelling sub-specialties, as well as the knowledge/experience to properly use them.

Objectives: The ultimate object of this study is the development of a complete and certified acoustic and risk assessment modelling capability at BOEM. The details of exactly which models, databases and briefing is not completely known at this time but will be determined and specified during the next few months (e.g., March – September 2020), as the personnel acquisitions for the CMA and the operational plan is developed. Specific sub-objectives and the pathways to accomplishing them will be identified during FY 20, and refined during the two years of this study, as needed.

Methods: The development of BOEM's acoustic modelling capability is envisioned as a three-year process. In the first year, a basic acoustic modelling capability will be established, and the details of a technical specification plan will be generated. During the second year the acquisition of models/databases, personnel and technical knowledge as specified in the specification plan will be enacted. It should be noted that there will be a continued need to reassess and refine the needs and required actions as personnel are hired, trained and problems are encountered with integrating the modelling capability. The third year will include the refining of the individual sub-models, their integration via developed code into a coherent and streamlined whole, and the preparations for completing the certification process. Historically, many of these components change and improve frequently (i.e., better databases and analytical techniques are discovered, policy and acoustic threshold guidance changes, etc.) and this requires a continuous refinement of the goals and modelling processes.

Specific Research Question(s): Although the development of this modelling capability at BOEM is a practical application and answers to numerous scientific questions in itself, the utility of developing this capability beyond the practical application to completing required environmental documents, will be the ability to anticipate and actually proactively drive the

direction of research and policy for future acoustic impacts associated with BOEM-related Outer Continental Shelf (OCS) activities.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Mortality Risk for Whale and Basking Sharks During Energy Operations
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Courtney Elliton (courtney.elliton@boem.gov), Ross Del Rio (ross.delrio@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement, Internal Study
Performance Period	FY 2021–2023
Date Revised	March 4, 2020
PICOC Summary	
Problem	BOEM-authorized projects have been shown to cause mortality to large-bodied elasmobranchs that feed at a low trophic level. While much work has been accomplished on commercially valuable species habitat use and relationship to oil and gas infrastructure, specific data gaps remain as to the relationship between non-commercially harvested species whose populations continue to decline. Information on the behavioral ecology of these world's largest fishes can inform an understanding as to continued risk posed.
Intervention	Gathering behavioral information on habitat use as well as synthesizing existing telemetry would inform assessment of risk associated BOEM actions.
Comparison	Direct observations of mortality to these species have occurred with energy operations both in the US and internationally. Not pursuing this study will likely lead to continued mortality, which is not accounted for in national and regional impact analysis due to inadequate documentation of these events.
Outcome	The outcome of this study would describe the behavioral ecology of select large pelagic species of fishes, both basking sharks and whale sharks, impacted by geophysical activity and ship-strikes during exploration and construction phases of energy development.
Context	National need (transects program areas and regions).

BOEM Information Need(s): Populations of whale and basking sharks have been in dramatic decline. Documenting mortality events of these two species is difficult as, unlike whale carcasses that float at the surface for an extended time period, shark carcasses sink to the bottom of the ocean allowing for only a brief time period to observe the event. As a result of this combined with their epipelagic nature, there is considerable risk that BOEM activities may contribute to whale and basking shark mortality, further adding to their population decline due to a lack of mandated reporting and observation challenges. Despite this, direct observations of mortality to these species has occurred with energy operations both in the US and internationally. These species move across regional program area boundaries as well as across BOEM program areas and may face significant cumulative impacts as a result. Not pursuing this

study will likely lead to continued mortality, which is currently not factored into national and regional impact analysis due to inadequate documentation of these events.

Background: Similar to marine mammals, lower-trophic-level-feeding, large-bodied sharks spend a significant amount of time at, or just below, the ocean's surface. This behavior could lead to a higher risk of mortality due to spatial and temporal overlap with energy industry operations (i.e., geophysical surveys), increased vessel traffic, and/or increased noise exposure levels. The risk of ship strikes or entanglement in geophysical gear may be considerable in waters where Bureau of Ocean Energy Management (BOEM) permitted activities occur. Unlike large whales, which float post-mortem, large sharks such as whale sharks (*Rhincodon typus*) and basking sharks (*Cetorhinus maximus*) are negatively buoyant and sink; this likely leads to under-reporting of mortalities from vessel interactions. These species are of concern internationally and are protected by international treaties of which the U.S. is a signatory to the Convention on Migratory Species (CMS) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). Multiple geophysical surveys, offshore energy construction, and associated vessel traffic intersect with known aggregations of these species. Information from this study, focused on whale and basking sharks, will better quantify the risk of entanglement and ship strikes associated with energy development. Further, results from this study could be applied to other lower-trophic-level-feeding, large-bodied fishes and be used in preparation of BOEM environmental impact analyses.

Lower-trophic-level-feeding, large-bodied sharks are found globally. Whale sharks typically aggregate at the surface in large numbers in the Atlantic, Pacific, and northern Gulf of Mexico. Additionally, basking sharks are found throughout the U.S. Atlantic and Pacific waters. This surface aggregating behavioral trait exposes both species to energy operations in multiple countries during their respective migrations. The fourth International Whale Shark Conference in 2016 brought together whale shark experts from around the world to discuss research, conservation, behavior, and population status of the world's largest fish. A common theme emerged that activities associated with oil and gas development likely impact this species globally. At least one confirmed mortality due to entanglement in geophysical survey gear associated with oil and gas development was reported to the Bureau of Safety and Environmental Enforcement (BSEE) in November of 2014. However, with the exception of nodal surveys, reporting whale shark mortalities has not been required by BSEE. Anecdotal reports of mortalities of whale sharks associated with geophysical operations and vessel traffic associated with oil and gas development have occurred in Mozambique, Mexico, and Belize. Scarification studies demonstrate susceptibility to small vessel strikes (Ramirez-Macias *et al.* 2012), however risk to large vessel collisions and streamer entanglement risk has not been quantified. Seasonal aggregation sites in the northern and southern Gulf of Mexico represent two of the largest whale shark feeding aggregations known worldwide (de la Parra-Venegas *et al.* 2013, Hoffmayer *et al.* 2013; McKinney *et al.* 2017), suggesting that whale sharks may be more susceptible to ship strikes in this region. Additionally, during the *Deepwater Horizon* explosion, oil spill, and response, whale sharks were documented by National Oceanic & Atmospheric Administration (NOAA) airborne surveys swimming in the surface oil slick.

A 2016 update by the International Union for the Conservation of Nature (IUCN) Shark Specialist Group listed the population status of the whale shark as endangered globally (Pierce and Norman 2016). Recent data from mark-recapture and telemetry studies indicate that the Atlantic population has declined about 30% and the Pacific population declined approximately 50% since the last assessment conducted in 2010. Whale sharks support a multi-million dollar tourism industry upon which coastal communities depend. This tourism industry includes SCUBA diving and whale shark watching excursions and extends from the southern U.S. coastal states throughout Central America. (Rooker *et al.,* 2019)

The nation of Qatar limits geophysical survey activity and ship speed in the Al-Shaheen oil fields during seasonal aggregations of whale sharks due to their affinity to oil platforms. U.S. Federal Regulations specify that geophysical operations must not "Cause harm or damage to life (including fish and other aquatic life), property, or to the marine, coastal, or human environment" as a result of geophysical surveys (30 CFR §551.6 (a)(2)). However, BOEM currently does not employ mitigation measures to protect fishes. Information from this study will be used to understand the risk of mortality in relation to energy operations, and potentially aid in the development of mitigation measures to protect these species.

Objectives: The purpose of this study is to understand how ecological and behavioral drivers impact risk of mortality to whale and basking sharks; an ongoing and active issue in the offshore energy industry.

Methods: The study will collect new, and synthesize existing, data on spatial and behavioral ecology of these species in the vicinity of both renewable and non-renewable energy operations to determine risk in relation to habitat use. It will leverage existing data sets collected by government, academia and NGO studies. Additional telemetry data will improve fine-scale behavior and interaction risk. Animal-borne sensors which sample at rapid intervals, typically sub-second, collect information on pitch, roll, heading and depth as well as other oceanographic variables can be utilized to visualize an animal's behavior. These methods are widely recognized for understanding behavioral ecology and have been used to understand vessel strike risk on similar species, such as large whales. Methods are additionally employed at several BOEM studies investigating fine-scale habitat use. (For example, Fine-scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico, pg 160)

- Use of data logging inertial measurement tags to describe the fine-scale behavior of whale sharks;
- Gathering spatial information on movement in relation to energy operations using satellite linked telemetry;
- Use of available land and satellite based automatic identification system (AIS) receivers to characterize vessel traffic, specifically energy operations and support vessels, in the vicinity of whale shark aggregation areas to assess spatial and temporal overlap;
- Combining the information gathered in the above methods to produce a risk assessment model that can be extrapolated to other lower-trophic-level-feeding, large-bodied sharks which exhibit similar behavior; (see Vanderlaan, 2007)

- An education component, in partnership with the Association of Zoos and Aquariums, including video content distributed to NOAA's Ocean Today Kiosk Network and telemetry shared via Science on a Sphere to deliver educational content to an estimated 60 million visitors to partner institutions globally.

Specific Research Question(s): How does site fidelity and surface feeding behavior impact risk of mortality to large-bodied/low-trophic feeding elasmobranchs? Risk will be assessed by quantifying the amount of time these large-bodied/low-trophic elasmobranchs spend within core BOEM activity areas.

References:

de la Parra Venegas R., Hueter R., González Cano J., Tyminski J., Gregorio Remolina J., Maslanka M, Ormos A., Weigt L., and Carlson B., Dove A., 2011. *An unprecedented aggregation of whale sharks, (Rhincodon typus), in Mexican coastal waters of the Caribbean Sea*. PLoS ONE 6:e18994.

Hoffmayer E., McKinney J. A., Franks J. S., Hendon J., and Driggers III W. B., 2013. *Whale Shark Aggregations in the Northern Gulf of Mexico*. PeerJ PrePrints 1:e85v1 https://doi.org/10.7287/peerj.preprints.85v1

McKinney, J.A., Hoffmayer, E. R., Holmberg, J., Graham, R. T, Driggers III, W.B., de la Parra-Venegas, R., Galvan-Pastoriza, B. G., Fox, S., Pierce, S., and Dove, A. D., 2017. *Long-term assessment of whale shark population demography and connectivity using photo-identification in the Western Atlantic Ocean*. PLOSone.

Rooker, J.R., Dance, M.A., Wells, R.J.D., Ajemian, M.J., Block, B.A., Castleton, M.R., Drymon, J.M., Falterman, B.J., Franks, J.S., Hammerschlag, N., Hendon, J.M., Hoffmayer, E.R., Kraus, R.T., McKinney, J.A., Secor, D.H., Stunz, G.W., and Walter, J.W., 2019. *Population connectivity of pelagic megafauna in the Cuba-Mexico-United States triangle.* Scientific reports 9.1: 1663.

Pierce, S. J. and Norman, B., 2016. *Rhincodon typus*. The IUCN Red List of Threatened Species 2016: e.T19488A2365291. Downloaded on 06 July 2016.

Ramírez-Macías, D., Meekan, M., La Parra-Venegas, D., Remolina-Suárez, F., Trigo-Mendoza, M., and Vázquez-Juárez, R., 2012. *Patterns in composition, abundance and scarring of whale sharks Rhincodon typus near Holbox Island, Mexico*. Journal of fish biology, 80(5), 1401-1416.

Vanderlaan, A. S. M., and Taggart, C. T., 2007. *Vessel collisions with whales: the probability of lethal injury based on vessel speed*. Marine Mammal Science 23 (1), 145–156.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	National Outer Continental Shelf (OCS) Oil Spill Occurrence Rates
Administered by	Headquarters
BOEM Contact(s)	TBD
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	February 6, 2020
PICOC Summary	
Problem	OCS petroleum hydrocarbon spill data for analyses—including the number, volume, and rate of such petroleum hydrocarbon spills—is needed to support the assessment of potential impacts under the National Environmental Policy Act (NEPA).
Intervention	Updated OCS petroleum hydrocarbon spill data will be collected into a systematic collation of data for mathematical analyses.
Comparison	A suite of objective statistical methodologies will provide estimates of petroleum hydrocarbon spill rates to use in oil spill risk analysis (OSRA) and NEPA analyses.
Outcome	This study will deliver National estimates of the occurrence of OCS oil spills for a range of spill volume size classes.
Context	All OCS planning areas.

BOEM Information Need(s): OCS oil spill occurrence rates and their confidence intervals as well as spill volumes are used for analyzing potential oil spills and their impacts in NEPA documents and oil spill response plans. With the implementation of the Oil Pollution Act of 1990 (U.S. Public Law 101-380, August 18, 1990), estimates of oil spill occurrence became even more important to natural resource trustees and to responsible parties involved in oil and gas activities. The Bureau of Ocean Energy Management (BOEM) needs up-to-date quantifications of spill occurrence for the OCS to perform OSRA (https://www.boem.gov/environment/environmental-assessment/oil spill-occurrence-rate-oil spill-risk-analysis-osra).

Background: The OSRA model, developed in 1975 by the Department of the Interior (DOI), is a tool that evaluates large offshore oil spill risks. This model is used to develop probabilistic estimates of oil spill occurrence and contact. A realistic, objective methodology for estimating oil spill occurrence rates is required for the model's application. This study will provide rates that can be applied or adjusted for each OCS region. OSRA results are used in preparation of NEPA documents such as Environmental Impact Statements (EISs) and Environmental Assessments (EAs) that inform the leasing process and subsequent environmental oversight. Spill rates and median spill volumes are also used in NEPA oil spill scenarios, including cumulative scenarios.

Currently, the Bureau of Safety & Environmental Enforcement (BSEE) maintains OCS spill data related to oil and gas activities on the OCS. BSEE receives these data from operators, who are required to submit offshore incident reports to the agency for various safety and environmental events, including spills of chemicals or crude oil (30 Code of Federal Regulations [CFR] 250.187, 30 CFR 254.46, and BSEE Notice to Lessees [NTL] 2019-N05). Spills may include crude or refined petroleum, drilling fluids, other chemicals, or mixtures thereof. BOEM uses these spill data and derived spill rates to assess and disclose oil spill risks to help inform leasing and plan decisions[18]. The BSEE spill data and BOEM analyses have also been used to support BSEE responsibilities, principally oil spill response planning, drilling permitting, and rulemaking. Both bureaus have an interest in ensuring oil spill data and spill rate analyses are updated regularly. Since 1975, a series of spill rate analyses have been conducted by BOEM or its predecessors (e.g., Anderson *et al.*, 2012), where spill rates were determined in terms of the volume of oil produced or handled. The most recent by ABS Consulting, Inc. (2016) collated data through as late as 2015. Ongoing studies will collate data through as late as 2021 but are not designed to analyze National OCS spill rates (ABS Consulting, 2018; https://marinecadastre.gov/espis/#/search/study/100250). This study proposes to Nationally update OCS spill data and spill rate analyses through calendar year 2022 (1964–2022).

Objectives: The overarching goal of this study is to update oil spill rate data for OCS platforms and pipelines, as well as spill rates from 1) U.S. and worldwide tankers and 2) U.S. barges. Having updated oil spill and oil spill occurrence rate data and their uncertainty is critically important to analyze the potential risk and consequence of OCS oil spills, investigate causal factors contributing to the occurrence, size, or frequency of oil spills, enhance oil spill response planning, and target future regulatory reform to better manage risk.

Specific objectives are:

- Examination of historical spill occurrences and of volume of oil handled
- Analysis of other potential exposure variables and casual factors
- Estimate spill occurrence rates and normalize these rates 1) based on number of spills per volume handled and 2) other relevant exposure variables
- Complete OCS spill rate trend analyses
- Estimate median and mean spill volumes for a range of spill size classes
- Estimate uncertainty metrics such as confidence intervals
- Prepare reports that presents the data and methods used, data analyses, and significance of findings

Methods: The investigators will update National OCS oil spill occurrence estimates previously calculated for OCS (ABS Consulting Inc., 2016). They will collect, examine, and reconcile crude and refined oil spill records and cleanup reports for the OCS for spills ≥ 1 barrel from industry, U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), U.S. Department of the Interior (DOI), BOEM, BSEE, U.S. Department of Transportation, Pipeline and Hazardous

[18] https://www.boem.gov/environment/environmental-assessment/oil spill-modeling-program-additional-references

Materials Safety Administration (USDOT, PHMSA), state (e.g., Alaska Department of Environmental Conservation [ADEC]), and other datasets through 2022. The investigators will also calculate accident frequencies for small spills and perform appropriate statistical analyses, including trend analysis. Results will be collated into an electronic database in a standard format.

Specific Research Question(s): What are the OCS spill rates, median volumes, and mean volumes for small and large spills and their uncertainty?

References:

Anderson, C.M. Mayes, M., and LaBelle, R.P. 2012. Update of Occurrence Rates for Offshore Oil Spills. Bureau of Ocean Energy Management OCS Report 2012-069. Bureau of Ocean Energy Management, Herndon, VA (https://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Assessment/Oil_Spill_Modeling/AndersonMayesLabelle2012.pdf)

ABS Consulting, Inc. 2016. 2016 Update of Occurrence Rates for Offshore Oil Spills. Prepared by ABS Consulting Inc. for USDOI, BOEM/BSEE. Sterling, VA: USDOI, BOEM/BSEE. 95 pp. https://www.bsee.gov/sites/bsee.gov/files/osrr-oil spill-response-research/1086aa.pdf.

ABS Consulting, Inc. 2018. US Outer Continental Shelf Oil Spill Statistics OCS Study BOEM 2018-006. Anchorage, AK: USDOI, BOEM, Alaska OCS Region. 44 pp. https://marinecadastre.gov/espis/#/search/study/100225.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Socioeconomic Impacts Likely to Result from Initial Oil and Gas Projects in Frontier Areas
Administered by	Headquarters
BOEM Contact(s)	Kristen Strellec (Kristen.strellec@boem.gov), Laura Mansfield (Laura.Mansfield@boem.gov), and Kim Marshall Mclean (kimberly.marshallmclean@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 10, 2020
PICOC Summary	
Problem	BOEM has a variety of socioeconomic information but does not have a set of comprehensive narratives describing in a consistent manner the widely varying geographic and temporal distribution of socioeconomic impacts likely to result from oil and gas activities in and near each of the diverse frontier planning areas (those other than the Central and Western GOM and S. California) BOEM is responsible for managing.
Intervention	The study will describe the area-specific patterns of socioeconomic impacts likely to occur as an initial new representative project in each frontier area progresses through each project development phase from exploration through decommissioning.
Comparison	The narrative descriptions and select quantitative data will reflect the variation in nature, level, and geographic and temporal distribution of impacts caused by area-to-area differences in geology and technological requirements, the demography of nearby areas, the existing state of industrial development and proximity to infrastructure and support, and other factors.
Outcome	The study will produce a comprehensive set of narratives with supporting data that describe representative, area-specific projects and the pattern of socioeconomic impacts likely to occur as a result of the baseline characteristics (e.g., resources and operating conditions, along with demography and economic development of nearby communities) of each area. These narratives would support NEPA analyses, program decision documents, and responses to inquiries from stakeholders and public officials.
Context	OCS oil and gas projects have the same development stages (exploration, development, production, and decommissioning), but their length, the required spending levels, and patterns of resulting socioeconomic impacts could vary considerably in their geographical and temporal distribution, especially with the wide range of circumstances OCS lessees could face in the various frontier areas.

BOEM Information Need(s): Of the 26 OCS planning areas, three—the Western and Central Gulf of Mexico (GOM) and Southern California—have a long history of oil and gas development activities. For all three, OCS-related activities were an extension of activities on shore and in state waters—they could rely on extensive networks of supporting infrastructure, local oil and gas companies and suppliers, experienced workers, etc. For these areas, especially the Central and Western GOM, additional projects reinforce the status quo and are unlikely to produce noticeable new socioeconomic impacts, they alone certainly would not change existing patterns of socioeconomic impacts. In contrast, for the other 23 "frontier" planning areas, any new projects would be the initial projects in the area and would result in new (and often noticeable) socioeconomic impacts. (The Beaufort Sea production from a project in state waters; the activities related to the small, isolated portion of the deep-water Eastern GOM available for leasing; and history of exploratory drilling in other areas are substantively unimportant in this regard and are ignored here for simplicity.) To varying degrees, even a single project could have noticeable impacts on some nearby communities. And, for most of the frontier areas, the geographical and temporal distributions of associated activities and resulting impacts would differ considerably from those seen in and near the three mature areas and certainly would vary across the OCS. A few of the frontier areas share some characteristics of the mature areas when oil and gas projects there first moved beyond state waters. Some have no oil and gas activities nearby but are near major, industrialized population centers and extensive infrastructure such as transportation centers (including ports) and networks. Others are far from any major population centers and infrastructure. The resource potential and feasible patterns of resource development also vary considerably.

BOEM has a considerable base of socioeconomic information on coastal communities but would benefit from a single set of consistently developed descriptions of the potential socioeconomic impacts from a representative initial project in each frontier planning area (or group of planning areas with similar impact patterns), effectively illustrating distinctions and identifying different geographical and temporal distributions of impacts that result from the huge differences in circumstances that exist for these planning areas. Such an approach would improve the quality and consistency of the bureau's socioeconomic analyses at all levels, reduce the amount of staff time spent on these analyses, improve socioeconomic analysis in analytical documents, make it easier for decision-makers and readers to determine major takeaways, and enhance BOEM's ability to respond to public inquiries in a variety of circumstances.

Narratives describing oil and gas development patterns and potential socioeconomic impacts can be incorporated into programmatic and lease sale NEPA assessments and the Section 18 Equitable Sharing analysis in the national OCS oil and gas leasing program decision documents to enhance the reader's understanding of a representative project lifecycle and likely associated impacts. These narratives and supporting data would complement and tier off of previous BOEM studies and information produced from the Environmental Studies Program.

Background: Assessment of potential socioeconomic effects is an important part of the information BOEM must provide to support decisions at the programmatic, sale, and lease-plan approval stages. Those potential effects also are very important to residents of affected

communities and the officials who represent them. An improved understanding of the ranges in spatial (local, regional, national) and temporal distributions of socioeconomic impacts associated with new oil and gas projects would be useful as BOEM aims to better discern impact variations among planning areas. For example, while additional new projects in the Gulf of Mexico tend to sustain (rather than change) employment levels and related socioeconomic conditions for communities along and near the Gulf Coast, the effects of new development in some frontier areas on nearby communities could vary considerably, and many might experience both a lower percentage of the benefits of employment and significant changes in land use due to construction or expansion of infrastructure. Consistent narrative descriptions across planning areas on these types of socioeconomic dynamics will complement BOEM's existing suite of information and better enable document authors to write more succinctly and highlight important considerations.

Objectives: For each frontier planning area (or group of areas with similar characteristics), obtain a consistent, well-supported, comprehensive narrative description of the following:

- Characteristics of the offshore area and relevant onshore areas that tend to cause the magnitude or the spatial and/or temporal distributions of the impacts to vary from area to area
- Primary and support activities likely to occur as a generic project suited for the relevant conditions passes through each phase of OCS development,
- General nature and magnitude of the effects of these activities, including employment, labor income, and other socioeconomic and fiscal impacts, and
- Extent to which activities and impacts could be expected to occur locally or elsewhere, and the extent to which this geographic distribution is likely to change over time and why (e.g., long-term production or action on additional leases justifies relocation of certain kinds of support facilities and/or creates opportunities for certain kinds of support services).

Methods: This study will have two phases: Phase 1 will provide high-level narratives describing the distinct pattern of socioeconomic impacts likely to emerge in each frontier planning area if oil and gas development occurs; Phase 2 will supplement the initial narratives for the Alaska planning areas with more in-depth analysis and (broad-range) estimates of likely employment and similar measures.

In Phase 1, working with BOEM's Resource Evaluation offices, the contractor will provide a high-level description of the likely nature, magnitude, and geographic and temporal distribution of socioeconomic impacts likely to result from the development stages of an initial project in each of the 23 frontier planning areas (excluding only the Central and Western GOM and Southern California). Where appropriate, a single descriptive narrative may apply to multiple planning areas with similar patterns of impacts. Each narrative will briefly describe the relevant activities associated with a representative oil and gas project suitable for the area as the project progresses through its different stages (exploration, development, production, and decommissioning). For each stage of the project, the narrative will include information such as the extent to which the affected community is likely to experience impacts from different kinds

of activities (e.g., construction, logistical support, labor housing and support, provision of goods and services) and how long the impacts are likely be felt. At a minimum, the effective definition of "communities" would be no less specific than one or more "local" boroughs/counties, the rest of the adjacent state, and the rest of the U.S., with more specificity where appropriate.

The contractor will identify any location-specific differences in a representative project that could be expected to appreciably affect likely socioeconomic impacts and factors that could significantly alter the nature and spatial and temporal distribution of impacts from primary and supporting activities across planning areas. For example, the geographic distribution of impacts is likely to be affected by the presence or absence of nearby industrial centers and may change over the course of the project for many areas. Depending in part on the location of a frontier area, as the initial project goes into the production phase, support facilities may be constructed or expanded nearby, local businesses may supply more of the goods and services that had previously been purchased from vendors in established areas, and some workers may relocate closer to their workplaces. In addition, some areas may have resources that require—or could support—multiple projects. The activities associated with additional projects could cause greater changes in geographical distribution of impacts to occur over time. In Phase 1, the narratives will provide high-level descriptions of any such changes likely to occur over the stages of development.

By themselves, Phase 1 deliverables would be useful for Section 18 analyses, the draft Programmatic EIS, and EIS's for Alaska sales proposed for the near future (e.g., Cook Inlet under the current Program and an early Beaufort Sea sale in the Proposed Program).

In Phase 2 of the study, for the Alaska planning areas, the contractor will expand the narratives with more detailed information about the nature of the impacts in each location and will supplement them with estimates of suitable quantitative *ranges* of likely employment, income, revenues, and—possibly—other factors to help identify the *magnitude* of impacts on affected communities. The ranges will be wide/robust enough to capture the inherent uncertainties and foreseeable differences in technology and other factors. These enhancements will include estimated ranges of the likely proportion of employment and other such factors communities would experience, as well as descriptions of the nature of the jobs and/or revenues.

An optional task would apply the Phase 2 enhancements to as many as three additional narratives for frontier planning/program areas in one or more of the other OCS regions.

Specific Research Question(s):

1. What are the important differences among frontier planning areas in the nature, the level, and the temporal and geographic distribution of logistical and other support?
2. What are the types of socioeconomic impacts associated with each activity during each project stage? What are the factors that could alter the nature and spatial and temporal distributions of these stage-specific impacts?
3. What is the relative magnitude of the socioeconomic impacts over time (e.g., ranges of employment/income and local/state revenues), and how is that likely to be felt in which communities (e.g., local counties/boroughs, adjacent states)?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Spatial and Acoustic Ecology of Understudied ESA Listed Marine Mammals
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement, Internal Study, Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 23, 2020
PICOC Summary	
Problem	Information on availability bias (i.e., how often we expect to detect them) is lacking for some ESA-listed baleen whale species (e.g., sei, fin, North Atlantic right) leading to uncertainty in these species density estimations. Additionally, the lack of data on the spatial and acoustic behavioral ecology (i.e., what they are doing when they are making particular vocalizations) of these species limits our ability to comprehensively analyze Passive Acoustic Monitoring (PAM) data. The more we know about what they are doing when we hear them, and whether we can *expect* to hear them, the better we can assess potential impacts.
Intervention	Use acoustic and telemetry tags to gather information on the spatial and acoustic behavior of these targeted ESA-listed species.
Comparison	Estimate the degree of overlap and exchange between areas of offshore energy development interest and critical habitats of endangered cetacean species in US Federal waters
Outcome	The data will improve abundance estimates, increase the value of existing PAM data and inform the assessment of the effectiveness of PAM as a mitigation strategy for these understudied priority ESA-listed whale species. Additionally, short- and long-term habitat usage and movements of these species will assist in identifying potentially important biological areas for these species.
Context	Atlantic, Gulf of Mexico and Pacific (depending on species prioritization)

BOEM Information Need(s): BOEM requires robust, current data to (1) fully analyze and disclose the potential for impacts to protected species from OCS activities at the programmatic and site-specific level, (2) help ensure that a species is not jeopardized by an activity or that critical habitat is not adversely modified by that activity pursuant to the ESA, (3) minimize incidental take of marine mammals resulting from BOEM-permitted activities, thus meeting not only the small numbers and negligible impact requirement under the MMPA, but also making every effort to maintain the health and stability of marine mammal populations and their ecosystem, and (4) fulfill Federal assessment and consultation responsibilities that usually include the need for BOEM to design and implement mitigation measures to reduce or

eliminate impacts from regulated activities on protected and managed species. These mitigation measures often include the use of PAM, but we cannot know if PAM is effective unless we have basic information on how frequently they vocalize in a given area or when exhibiting a particular behavior.

Background: The lack of information about diving behavior and spatial and acoustic ecology for species like the highly endangered North Atlantic right and other protected whale species creates a high degree of variability in their detection probabilities, leading to high degrees of uncertainty in density and abundance estimates. These data needs also limit the value of data from passive acoustic monitoring (PAM), which is one of BOEM's primary mitigation and monitoring tools. BOEM relies on density and abundance data (e.g., Roberts et al., 2016) to assess the potential impacts on protected species from BOEM-permitted activities. Several ESA-listed large whale species occur throughout the OCS whose acoustic behavior, particularly cue rates, as they relate to habitat usage, is poorly understood or completely unknown. For example, North Atlantic right whales have dramatically different acoustic behavior in the Southeast versus the Northeast parts of their range. Their acoustic behavior in the Mid-Atlantic, where they occur year round, has never been studied. This adds tremendous uncertainty into the density and abundance data models because we are forced to make assumptions in the absence of an understanding of how their vocalizations tie to their behavior. For this reason, it is currently unknown whether passive acoustic monitoring will be an effective mitigation option in the Mid-Atlantic for North Atlantic right whales with no behavioral call rate information in this region – if we don't know whether they make noise while they are there, we cannot say that PAM would be effective in detecting them.

Traditional survey methods for cetaceans (whales, dolphins and porpoises) include shipboard or aerial surveys. However, these surveys provide a snapshot of cetacean occurrence in any given area and these data are spatially and temporally restricted since they can only be obtained under appropriate survey conditions (e.g., good visibility). Therefore, although aerial and broadscale vessel-based survey data provide much-needed regional data, they are of limited use to infer habitat use patterns in fine spatial and temporal scales, including local and migratory movements, preferred habitats and how animals behave underwater.

Establishing cue rates (i.e., a key for PAM analyses) for understudied ESA-listed cetaceans in diverse behavioral states and habitats also allows for PAM data collected previously through BOEM studies to be reanalyzed and be more useful in various ways, including informing and advancing density and abundance estimation using acoustic data. This information will also provide much-needed species-specific behavioral data (for example, dive durations) to feed in to population-level impact modeling analyses – an emphasized need identified by The National Academies of Sciences Committee (NASEM, 2016). The US Navy's Living Marine Resources program has recently invested in the Acoustic Cue Rate for Passive Acoustic Density Estimation project which is looking at historical PAM data to understand the current state of cue stability. As the species identified in this profile have little/no cue rate information, the data gathering in this profile would feed directly into this Navy funded project and make the collection of this data even more timely. It also enhances our acoustic science partnership with the Navy, a key goal through BOEM's Center for Marine Acoustics.

The data collected during this study will assist in improving the analytical robustness and biological meaningfulness of acoustic data collected during BOEM-funded studies (Atlantic, Pacific and Gulf of Mexico Marine Assessment Program for Protected Species (AMAPPS/PacMAPPS/GoMAPPS), as well as the credibility of impact analyses conducted by BOEM. Additionally, implementing this study would provide BOEM with a means of validating BOEM's current PAM practices for endangered species impact mitigation.

Objectives:

4. Describe acoustic and foraging ecology of understudied and/or ESA-listed whale species (for example, sei, fin, right whales) where significant data gaps in cue rates exist (e.g., species identified in the BOEM 2018 workshop report from SPAM-I);
5. Verify and/or establish cue rates combined with visual observation to inform accurate density modeling of data deficient marine mammal species applicable to multiple BOEM programs and regions for impact analysis;
6. Update uncertainty analysis for OCS to inform planning and mitigation design in all BOEM's regions;
7. Aid in validating acoustic propagation models by having multiple receiving nodes operating simultaneously;
8. Inform potential overlap of biologically important areas for these understudied ESA-listed species with BOEM's areas of interest.

Methods: This project will utilize validated and available techniques and technologies: 1) Mobile 3D passive acoustic monitoring. Vessel and AUV-based PAM will provide ground truthing and guidance for the stationary PAM; and 2) Animal tagging. Electronic tags such as satellite linked position tags and 3-D accelerometer/acoustic tags will also be used to augment remote study of targeted species to provide a better understanding of habitat use and movement in relation to acoustic behavior. These tags will be deployed from vessels.

Specific Research Question(s):

9. What are the species/regions/life stages where acoustic behavioral information is needed to support detection and mitigation?
10. Are density models improved upon by reducing availability bias?
11. What is the overlap of understudied, endangered and at-risk cetacean species with areas of interest to BOEM for offshore energy development?
12. What is the importance of these areas of overlap to endangered and at-risk cetacean species?

References:

National Academies of Sciences, Engineering, and Medicine (NASEM), 2016. *Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals*. Washington, D.C: The National Academies Press. doi: 10.1 7226/23479.

Roberts, J.J., Best, B.D., Mannocci, L., Fujioka, E., Halpin, P.N., Palka, D.L., Garrison, L.P, Mullin, K.D., Cole, T.V.N., Khan, C.B., McLellan, W.A., Pabst, D.A., and Lockhart, G.G., 2016. *Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico*. Scientific Reports. 6: 22615.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Validation of Satellite Data Use for Offshore Air Quality Management
Administered by	Headquarters
BOEM Contact(s)	Holli Wecht (Holli.Ensz@boem.gov); Angel McCoy (Angel.McCoy@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2025
Date Revised	March 5, 2020
PICOC Summary	
Problem	The Outer Continental Shelf Lands Act (OCSLA) requires BOEM to assess offshore oil and gas activities emissions such that the National Ambient Air Quality Standards (NAAQS) of any state are not significantly impacted. BOEM doesn't have monitors offshore to monitor and track air emissions to determine compliance with OCSLA. BOEM does have offshore emissions inventories and modeling studies but would like to validate these studies.
Intervention	NASA has provided BOEM a scoping study (through a past IA) that suggests existing satellites could monitor offshore total column NO_2, among other pollutants, but these satellites only pass twice a day. A new satellite (NASA TEMPO, anticipated launch mid-2022) will be able to monitor and track offshore air pollutants hourly during daylight. Plus, NASA wants to test a new instrument (CHAPS-D) on aircraft as a demonstration that this instrument concept might be helpful for tracking pollutants as well. This IA will validate the CHAPS-D instrument and TEMPO satellite data. As a follow-on to this IA BOEM would participate in training with NASA on how to analyze satellite data of air pollutants (NO_2, formaldehyde) in near real time to manage offshore air quality (in particular, specific TEMPO satellite data suggesting offshore hot spots or areas over the NAAQS, flaring events, and tracking air pollutants).
Comparison	NASA should analyze the TEMPO and CHAPS-D instrument data against measured data in the Gulf of Mexico Region. NASA should also verify BOEM's emissions and modeling data.
Outcome	Ultimate goal of this IA would be to have a well-informed validation campaign that can inform BOEM's air quality scientists on the future use of hourly/daily TEMPO satellite views to monitor and track air pollutants in near time in the GOM. Then, to expand to the Atlantic and Pacific for baseline air quality data pre-oil and gas development.
Context	GOM, Atlantic and Pacific OCS Regions

BOEM Information Need(s): BOEM is required to analyze Outer Continental Shelf (OCS) oil and gas activities air quality impacts to the states as mandated by the Outer Continental Shelf Lands Act (OCSLA) and these assessments are used by BOEM in National Environmental Protection Act

(NEPA) Environmental Assessments (EAs) and Environmental Impact Statements (EISs). Any improvements to or additions of the data for these assessments would support BOEM's air quality regulations and NEPA analyses. This interagency agreement involves working with NASA's Atmospheric Chemistry and Dynamics Laboratory at Goddard Space Flight Center to assess the probability of use of satellite data for air quality applications, specifically through the estimation and monitoring of offshore ground level concentrations of pollutants and through improvements and validations in the BOEM's existing emissions inventories and photochemical modeling so that BOEM can use near real time satellite data to track and monitor offshore pollutants.

Background: The Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (USEPA) to set the National Ambient Air Quality Standards (NAAQS) for widespread pollutants from numerous and diverse sources considered harmful to public health and the environment. The law also requires the USEPA to periodically review the standards to ensure that they provide adequate health and environmental protection, and to update those standards as necessary. The USEPA has set standards for six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter ($PM_{2.5}$ and PM_{10}), and sulfur dioxide (SO_2). Volatile organic compounds (VOCs) should also be assessed as ozone is formed through photochemical reactions involving both NO_2 and VOCs.

The OCSLA requires BOEM to ensure compliance with the NAAQS to the extent that OCS oil and gas exploration, development, and production activities significantly impact the air quality of any state. BOEM is tasked with analyzing OCS oil and gas activities' air quality impacts pre- and post-lease for NEPA documents. BOEM has oil and gas facilities in the Pacific and Gulf of Mexico (GOM) Regions; and has issued leases in the Atlantic Region for renewable development. Satellites could be an essential tool to aid BOEM in conducting these assessments.

Satellites have become increasingly capable of identifying and measuring the quantity of certain criteria NAAQS, their precursors, and assessing visibility. NASA satellite data provide information on five of the criteria pollutants (not lead). Particulate matter is inferred from aerosol optical depth data. VOCs are inferred from formaldehyde (HCHO), which is a proxy for VOC reactivity since the oxidation of VOCs usually produce HCHO. The capability that satellites have become increasingly capable of identifying and measuring the quantity of certain criteria pollutants has been identified through BOEM's ongoing inter-agency agreement which demonstrated that the Pandora instrument, which measures the NO_2 column, correlates closely with the TROPOMI satellite total column NO_2 offshore. The TEMPO instrument will provide similar satellite data, but hourly so that pollution plumes can be more positively tracked.

Objectives: The purpose of this Interagency Agreement is to continue the efforts between NASA and BOEM by:

1. Assessing the applicability of the CHAPS-D instrument and TEMPO satellite datasets to support BOEM's air quality regulations and NEPA analyses. Specifically this study would determine the feasibility of using satellite data in offshore environments in the GOM, Pacific, Atlantic and Alaska Regions for estimating and monitoring long-term trends of

the ground level concentrations of criteria NAAQS, precursors, and visibility pollutants where there are no monitors in the GOM and Pacific Regions, along with estimating and monitoring background concentration data in the Atlantic Region before oil and gas or renewables development.

2. Validating the CHAPS-D instrument and TEMPO satellite data with offshore measurements in a field campaign.

Methods: The study will entail an ongoing partnership with NASA: 1) assess the applicability of the CHAPS-D instrument and TEMPO satellite datasets to support BOEM's air quality regulations, and 2) validate the CHAPS-D instrument and TEMPO satellite data using ground-truth observations.

Validation will include ground-truth data provided by BOEM to compare to the same constituent species of O_3, CO and NO_2, and column NO_2 observed by satellite. Given the results of the 2019 study on GOM NO_2 and detailed BOEM distributions of OCS, supply ship, non-supply marine and land-side NO_2 sources, the preferred platform is a research vessel that would coordinate operations with aircraft and satellite sampling over a ~2-week period. Some level of cross-calibration would be provided by revisiting the general range of near-shore and deepwater platforms that were sampled in 2019. Power requirements to operate standard Air Quality instruments are minimal; berthing is needed for 4-6 operators.

Based on the accessibility and the validation, NASA should draft a final report that BOEM scientists could use to inform their analysis of near real time satellite data to identify hot spots (or offshore areas above the NAAQS), flaring events, and track/monitor offshore pollutants. The final report should also detail all the above objectives and conclusions.

Specific Research Question(s): Can satellite data take the place of offshore monitors for tracking and monitoring of pollutants to ensure compliance with OCSLA?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Workshop on Emerging Technologies for Monitoring Marine Species and Quieting Noise Sources
Administered by	Headquarters
BOEM Contact(s)	Erica Staaterman (erica.staaterman@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021
Date Revised	March 5, 2020
PICOC Summary	
Problem	The federal community needs to be informed of the newest tools for monitoring for marine mammals and quieting noise sources and is seeking ideas for how to test their effectiveness and incentivize their use.
Intervention	Host an event that would bring together the technology makers, operators (e.g., G&G and pile-driving industry), federal regulators, and scientists to learn about the latest technology and brainstorm methods for testing how effective they are.
Comparison	Without this information, we may be in the dark regarding new technologies that are more effective than our current ones, so we'd miss the opportunity to implement better and potentially cheaper mitigation methods.
Outcome	Improved understanding among regulatory community regarding what is currently out there and what is coming soon. Potential for offering a monetary prize to the best-developed idea for how to test efficacy of various mitigation and monitoring methods. Generate ideas for ways to incentivize use of certain technologies.
Context	National

BOEM Information Need(s):

When BOEM-authorized activities are expected to introduce sound into the marine environment, operators must estimate how many individual animals may be exposed to sound at harmful levels, i.e., how many "takes" would occur under the ESA and MMPA. In order to do this, one must understand how loud the sound source is and how it will propagate through the ocean. With pile-driving, for example, industry often proposes or federal regulators require certain noise-reduction technologies, which should decrease the size of the acoustic impact zones and reduce the number of takes. However, there are few published studies on the effectiveness of these systems, so there is a large degree of uncertainty with these reductions. Furthermore, when out on the water, operators are required to continuously monitor for the presence of marine mammals and other protected species (e.g., sea turtles) and are often required to shut down operations when they come too close, yet there are concerns about missed detections and challenges to operating in low-visibility situations.

It is important for BOEM and its federal partners (NMFS, USFWS, USGS, NSF) to fully understand the quieting technologies that are now available – how much they reduce the amount of noise introduced into the environment – and to understand how well various monitoring techniques work. We also need to be aware of emerging quieting and monitoring technologies that are coming soon and could potentially be more effective than existing techniques.

This fits into several OEP strategic goals: one of the goals of the Center for Marine Acoustics is to push ourselves and our federal partners to innovate the ways we measure noise, mitigate, and monitor potential impacts on animals. This study also encourages the use of emerging technology to ask important science and regulatory questions. It also addresses two of the OEP strategic science questions: 1) What are the acute and chronic effects of sound from BOEM-regulated activities on marine species and their environment? And 2) How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?

Background:

Seven years ago, BOEM hosted a workshop to better understand what technologies were out there (CSA 2014), but we already know that things have changed since then, with the advancement of marine vibroseis and the increased use of photography drones, for example. What is unclear is whether some of these alternative technologies are just as effective as traditional ones. Federal regulators have struggled to answer the question of "how well do these mitigation strategies work?" and "what else could do it better?" for a long time.

The SOST interagency task force for ocean noise and marine life has discussed the notion of co-funding a study to test mitigation effectiveness, but after several conversations we realized that we may first need a workshop to become better formed about existing and emerging mitigations. Furthermore, we want to ask the broader scientific community how *they* would design a study to test efficacy (one can imagine that a field study would be very expensive, so it's important to be very deliberate about this). So, the group landed on the idea of having a workshop that would be a combination of information sharing (asking the developers to showcase their technologies) and brainstorming (asking the developers, scientists, and regulators to work together to design potential experiments). We also discussed the notion of offering a prize to the best idea – to then co-fund an experiment. Finally, we want to generate ideas for how we might incentivize the use of new, quieter technologies.

The SOST is still in discussions about refining the scope of the workshop, and I have recently received input from our federal partners about their preferred agenda topics. For example, both ONR and LMR (Navy) would prefer to see more of a focus on emerging technology for monitoring (e.g., thermal cameras and nightvision); NSF shares this interest but also wants to learn about quieter technologies for imaging the subseafloor; MMC is interested in monitoring in low-visibility conditions but also wants to hear about quieting technologies for pile-driving and seismic surveys. BOEM has an interest in all of these topics. Some of our partners (Navy, NSF) may be able to contribute funds, depending on whether the agenda meets their needs.

These dialogues are ongoing and we have not narrowed in on a clear structure for the workshop, but this will continue to evolve over the coming months.

Objectives:

- To obtain a better understanding of the efficacy of existing noise abatement technologies and alternative technologies.
- To learn about emerging technologies and methods for monitoring the presence of protected species.
- To design experiments that could test the efficacy of some of these tools.

Methods: See above–this is a workshop, not a study per se. However, one thing worth mentioning is that we would want to hire a contractor to compile all of the latest information about existing quieting technologies into a pre-workshop report. Then we could make targeted invitations to focus the workshop on the tools that we want to learn more about (since it's unlikely we could invite everyone).

Specific Research Question(s):

1. How can we reduce the noise introduced into the marine environment during offshore energy development?

2. How can we be sure that we are able to detect the presence of protected species that are in the vicinity of ongoing operations?

References:

CSA Ocean Sciences, Inc. 2014. Quieting Technologies for Reducing Noise during Seismic Surveying and Pile Driving Workshop summary report. 3 p. OCS Study BOEM 2014-061. Obligation No.: M12PC00008.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Bowhead Whale Migration Patterns along the Alaskan Beaufort Shelf During a Period of Rapid Environmental Change
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Dr. Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Cooperative Agreement or Contract
Performance Period	FY 2021–2024
Date Revised	April 28, 2020
PICOC Summary	
Problem	Evolving environmental conditions on the Beaufort Shelf appear to be changing the utilization of the shelf by bowhead whales and the bowhead whale migration path may be shifting farther offshore. Very few bowheads were seen on the Beaufort Shelf during the 2019 fall migration and only one whale was landed during the 2019 fall bowhead hunt at Utqiaġvik, Alaska. However, the lack of contemporary measurements of hydrographic and whale prey conditions create challenges for diagnosing the changes near Pt. Barrow and across the Beaufort Shelf that may have influenced the bowhead whale migration.
Intervention	This study would renew and geographically expand annual hydrographic and plankton sampling conducted under the "BOWFEST" study (Shelden and Mocklin, Editors 2013).
Comparison	Collected data will be examined in the context of an 11-year (2005-2015) record of late August-early September biophysical (hydrography, currents, zooplankton) conditions in the NE Chukchi and western Beaufort seas.
Outcome	This project will provide new basic information on hydrography, circulation, and zooplankton prey fields encountered by migrating bowhead whales to improve understanding of the recent behavioral changes of the whales. Results from this effort also will provide context for assessing ongoing changes to the ecosystem and establish a baseline for the "new normal" that is currently being observed.
Context	Northeast Chukchi Sea and Beaufort Sea shelf

BOEM Information Need(s): This project will provide information on how biological and physical characteristics in the Beaufort and Chukchi seas may be transforming in response to ongoing environmental change and how they may influence bowhead whale utilization patterns, such as migration pathways and feeding locations, on the Beaufort Shelf. 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 bowhead whales.

Background: The rate of change of summer-fall conditions in the Arctic has accelerated in recent years. The fall of 2016 saw almost no upwelling winds along the Beaufort Shelf and the bowhead whale migration path lay offshore of the shelf, almost out of range of the Utqiaġvik hunters. The summer of 2019 was extremely warm along the entire Alaskan coast, with numerous die-offs of seabirds attributed to starvation because of a paucity of the large crustacean prey (copepods, krill). Fall 2019 saw the unprecedented failure of the fall bowhead hunt at Utqiaġvik, with migrating bowhead whales not being seen within the safe operating zone for the hunters. The first and only fall whale was landed 16 November. Moreover, few or no bowhead whales were observed on the western Beaufort Shelf through Oct. 30, 2019 by survey flights of the Aerial Surveys of Arctic Marine Mammals (ASAMM) program. The absence of the bowhead whales has been hypothesized to be caused by warm ocean temperatures or a lack of bowhead prey in the region that resulted in a delayed fall migration of the whales or in the whale's fall migration path lying much further offshore. In order to diagnose underlying causes contributing to recent dramatic changes in bowhead migration, contemporaneous measurements of the hydrographic and whale prey conditions are needed.

Objectives: This study will examine recent ecosystem changes in the Beaufort Sea and how they may be influencing bowhead whale migration patterns. Specific objectives include the following:

- Quantify the biological and physical environments in the western and central portions of the Beaufort shelf, including upwelling induced introduction of krill through shelf-edge depressions
- Assess the linkages between environmental conditions and physical drivers at local and regional scales
- Examine longer-term trends and evaluate whether recent conditions on the Beaufort Shelf will occur more frequently

Methods: Researchers will conduct vessel-based *in situ* sampling to monitor hydrography and zooplankton conditions in late summer along transects in Barrow Canyon, the western Beaufort shelf, and the shelf near Prudhoe. Seasonal and year-round moorings will monitor circulation and acoustic backscatter (zooplankton proxy) in Barrow Canyon and on the Beaufort shelf. Researchers will use a combination of historical data, including long-term monitoring programs, and model output to examine longer-term trends in Beaufort Shelf conditions and provide context to the mechanisms identified from the fieldwork.

Specific Research Question(s):

1. Are unusual/extreme conditions in the Chukchi and Beaufort seas becoming more common?

2. What factors contribute to interannual variability of zooplankton available to bowhead whales during their fall migration?

3. Are there environmental cues that influence timing of fall bowhead migration?

4. What is the relationship between availability of zooplankton on the Beaufort Shelf and local and regional physical forcing mechanisms?

References:

Shelden, K.E.W., and J.A. Mocklin, Editors. 2013. Bowhead Whale Feeding Ecology Study (BOWFEST) in the western Beaufort Sea. Final Report, OCS Study BOEM 2013-0114. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-6349.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Coastal and Submerged Historic Properties and Precontact Sites on the Alaska Outer Continental Shelf
Administered by	Alaska OCS Region
BOEM Contact(s)	Dr. Jeffrey Brooks (jeffrey.brooks@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 28, 2020
PICOC Summary	
Problem	Energy development activities on the sea floor and coast could affect submerged and terrestrial historic properties and precontact sites. Spatial data about these resources should be updated to ensure accurate consultations with the State Historic Preservation Office and other parties. The lack of data could delay approval of exploration and development plans.
Intervention	The study will develop information on Alaska's submerged and coastal historic properties and precontact sites, including their known, reported, or potential locations.
Comparison	BOEM will compare results with existing geo-referenced databases in the state and other regions.
Outcome	BOEM will use these data to describe the affected environment, develop alternatives to proposed actions, analyze potential effects, develop mitigation measures, and conduct consultations. The study will add the Alaska OCS to the national database.
Context	This study is relevant to all Alaska OCS planning areas.

BOEM Information Need(s): An inventory and analysis of submerged and coastal historic properties and precontact sites is needed to inform environmental impact assessments and mitigation of potential impacts to these resources. Specific mission-critical assessments, including visual impacts, affected environment, cumulative effects, and site-specific disturbances to the seafloor, are required under the National Environmental Policy Act, Section 106 of the National Historic Preservation Act, and Executive Order 11593. Results from this study would assist BOEM in meeting requirements to apply the National Register Criteria to properties that may be affected by its undertakings and consult with the Alaska State Historic Preservation Office (SHPO) and other parties. The information also would help BOEM analysts interpret and evaluate specific archaeological surveys conducted by operators to comply with Federal regulations at 30 CFR 550.194.

Background: For the Alaska OCS, BOEM has assembled a list of shipwrecks discovered prior to 2011 (www.boem.gov/Alaska-Coast-Shipwrecks). BOEM needs to update data in the current

shipwrecks list. Updates could include new shipwreck discoveries, shipwreck names, vessel types, site locations, site descriptions, and geology. Updating shipwreck information would enhance BOEM's assessments of potential effects to the resources.

The Alaska OCS holds potential for submerged and coastal precontact sites related to human migration into and settlement of the Americas. Existing information has not been adequately compiled and analyzed to thoroughly address precontact sites. This study will provide a framework to better predict locations of paleo landforms and potential precontact sites.

Project proponents and operators conduct site-specific surveys on a project-by-project basis. Information from this study will inform these site-specific surveys. BOEM has systematically collected this information for all planning areas except in Alaska. This study will add the Alaska OCS to the national database.

Objectives:

- Develop a geo-referenced inventory of known, reported, and potential historic shipwreck and aircraft wreck sites for the Alaska OCS.
- Assess potential precontact sites, developing a GIS-based model to help indicate where intact submerged paleo landforms might be expected to occur.
- Develop a geo-referenced database of coastal precontact sites that could be impacted by onshore infrastructure tied to future development in the Alaska OCS.
- Develop a geo-referenced database of coastal historic properties that could be impacted by alteration of the adjacent seascape.

Methods: This study will compile existing data from the State of Alaska, published research, and archival documents (e.g., maps, charts, ethnographies, maritime surveys). Researchers will provide a literature review and synthesis to help support required consultations with the SHPO and other consulting parties. Researchers will develop a GIS-based inventory of known, reported, and potential historic properties, precontact sites, and other cultural and historic resources important to Alaska Native tribes and corporations. The database will be compatible with ArcGIS. Researchers will discuss results in relation to current and evolving theories of precontact settlement patterns, paleo-shorelines, sea level rise, and regional geology. Researchers will include properties nominated to or eligible for listing in the National Register of Historic Places. They will provide a final report and databases similar to deliverables developed for the Pacific, Gulf of Mexico, and Atlantic OCS regions (e.g., ICF International et al., 2013; NOAA Maritime Heritage Program, 2017; Pearson et al., 2003; Van Tilburg et al., 2017; Watson et al., 2017).

Specific Research Question(s):

1. What are the types and potential locations of submerged historic properties and precontact sites in the Exclusive Economic Zone of the Alaska OCS?

2. What are the types and potential locations of terrestrial historic properties and precontact sites in Alaska's coastal areas?

3. What types of cultural and historic resources could be affected by OCS development?

References:

ICF International, Davis Geo-archaeological Research, and Southeastern Archaeological Research. 2013. Inventory and Analysis of Coastal and Submerged Archaeological Site Occurrence on the Pacific Outer Continental Shelf. OCS Study BOEM 2013-0115. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, 280 pp.

NOAA Maritime Heritage Program. 2017. The Unseen Landscape: Inventory and Assessment of Submerged Cultural Resources in Hawai`i. OCS Study BOEM 2017-021. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, 240 pp.

Pearson, C.E., S.R. James, Jr., M.C. Krivor, S.D. El Darragi, and L. Cunningham. 2003. Refining and Revising the Gulf of Mexico Outer Continental Shelf Region High-Probability Model for Historic Shipwrecks: Final report. OCS Study MMS 2003-060 Volume I: Executive Summary. New Orleans, LA: U.S. Department of the Interior, Minerals Management Service, 13 pp.

Van Tilburg H, T.K. Watson, K. Faria, K. Hoomanawanui, I. Ho-Lastiama, W. Ritte, K. Maly, M. Nahoopii, K. Horcajo, K. Kaupiko, D. Ball D. 2017. A Guidance Document for Characterizing Native Hawaiian Cultural Landscapes. OCS Study BOEM 2017-023. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, 208 pp.

Watson TK, K. Hoomanawanui, R. Thurman, B. Thao, K. Boyne. 2017. Na ‘Ikena I Kai (Seaward Viewsheds): Inventory of Terrestrial Properties for Assessment of Marine Viewsheds on the Eight Main Hawaiian Islands. OCS Study BOEM 2017-022. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, 137 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Cook Inlet Synthetic Source Air Quality Model Data
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Dr. Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2022
Date Revised	April 28, 2020
PICOC Summary	
Problem	BOEM is required under NEPA to analyze the potential impacts to air quality from the activities it authorizes. Streamlined NEPA timelines require readily available modeling assessments for air quality to facilitate a fast, comprehensive analysis of potential impacts from activities on the OCS.
Intervention	This study will model potential air quality impacts associated with hypothetical oil and gas activities on the OCS in lower Cook Inlet.
Comparison	The resulting dataset will provide readily available shoreline pollutant concentrations for hypothetical emission sources that can be compared to plans for geological and geophysical surveys and exploration and development scenarios in Cook Inlet.
Outcome	This air quality modeling dataset will provide information to estimate shoreline concentrations of oil- and gas-related air pollutants that will support impact analysis for future NEPA assessments.
Context	Lower Cook Inlet

BOEM Information Need(s): BOEM requires information to assess the cumulative air quality impact of OCS oil and gas activity in Cook Inlet. This information will support BOEM and various Federal and State agencies in assuring compliance with the Clean Air Act and environmental justice initiatives. Under the current NEPA streamlining policy, the timelines of BOEM's NEPA analyses can range from one year for an EIS to as short as a month for an EA. These short timelines make it challenging to conduct project specific dispersion modeling used in NEPA analysis.

Background: The BOEM "Arctic Air Quality Assessment Modeling" study modeled shoreline pollutant concentrations for hypothetical emission source locations distributed across the OCS in the Beaufort and Chukchi seas as a means for evaluating the existing emissions exemption threshold formulas (Do et al. 2017). These formulas are used by BOEM to identify whether a facility described in an EP or DPP is exempt from further air quality regulatory review, including facility specific modeling, because the project's potential emissions would not cause significant impacts to the air quality of any state.

Modeling hypothetical sources allowed the flexibility to pair various emission levels with various distances to shore to ensure the formula was tested with the full range of possible values. The model results also provide information for estimating the potential impacts from exploration and development activities and facilities on the OCS related to lease sales, exploration plans, or development and production plans in these areas.

Objectives: This study will develop an air quality modeling assessment dataset for lower Cook Inlet that would allow users in BOEM to select various hypothetical air emission sources and to quickly estimate the potential for onshore impacts from the selected OCS activities.

Methods: The study will use a combination of AERMOD and CALPUFF dispersion modeling to develop a tool that will provide a high-case scenario of potential air quality impacts from proposed offshore activities or facilities. The types and locations of hypothetical emission sources and the analysis protocols will be developed following the procedures outlined in Do et al. (2017).

Specific Research Question(s): What are the potential shoreline air quality impacts associated with hypothetical pollutant emission sources in lower Cook Inlet?

References:

Do, B., N. Hilliard, L. Dayton, J. Sellers, and P. Fields Simms. 2017. Arctic Air Quality Impact Assessment Modeling Study – Evaluation of the Emissions Exemption Thresholds Report. Prepared by Eastern Research Group, Incorporated for U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-040, 59 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Determining Important Nearshore and Marine Sites for Shorebirds in the Beaufort Sea
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Interagency Agreement or Cooperative Agreement
Performance Period	FY 2021–2024
Date Revised	April 28, 2020
PICOC Summary	
Problem	Shorebirds are heavily dependent on coastal and marine areas of the Beaufort Sea during the pre- and post-breeding periods to acquire the necessary fat reserves to successfully nest and for migration to nonbreeding grounds. A better understanding of the patterns of habitat use, including relative importance of the various stopover sites, is needed to assess potential effects of environmental change and industrial development.
Intervention	Shorebirds at nearshore and marine areas will be equipped with satellite tags to determine the relative timing, durations of stay, and movement patterns of birds among post-breeding staging sites.
Comparison	Data will be collected during the post-breeding period over three years to assess interannual variability and relative importance of staging and stopover habitat types and geographic locations along the Beaufort Sea coast prior to initiation of activities at the Liberty Oil and Gas Development project.
Outcome	This study will provide baseline information on shorebird population size, trends, and updated locations of staging areas and important breeding areas to inform decision-making regarding oil and gas activities.
Context	Beaufort Sea

BOEM Information Need(s): Satellite tracking information on shorebirds that are heavily using the nearshore and marine waters at differing levels is needed to inform location and mitigation planning decisions. Information on patterns of nearby habitat use before and after construction of the Liberty Oil field would help BOEM evaluate potential impacts associated with oil and gas development on nearshore areas used by shorebirds.

Background: Several North American shorebird species are declining for reasons unknown. Recent analyses indicate conditions on migratory stopovers or overwintering sites are likely driving annual survival rates (Weiser et al. 2018). Shorebirds are heavily dependent on nearshore and marine areas of the Arctic during the post-breeding “staging” period to acquire the necessary fat reserves to successfully migrate to their nonbreeding grounds (Connors et al. 1979). These areas are experiencing large-scale environmental change and increased human

activity. Changes such as receding Arctic pack ice, unprecedented storm surges, and glacial melt are altering the distribution of marine food webs (Arrigo et al. 2008) and the character and extent of coastal lagoons and river deltas (Tape et al. 2013, Churchwell 2015). These changes are likely to affect invertebrate abundance, diversity, and distribution that directly impact shorebird use of coastal areas. The reduced extent and persistence of sea ice is also leading to additional vessel traffic and recent government decisions have opened new areas to oil and gas exploration, which could affect shorebirds directly or indirectly. Information on shorebird distribution and movement in nearshore and marine areas in Arctic Alaska is limited, making it difficult to assess and mitigate potential effects of future development.

Objectives:

- Examine the post-breeding habitat use of shorebird species breeding near the planned Liberty Development site and in the Arctic National Wildlife Refuge.
- Determine migratory routes and relative use of post-breeding areas, including nearshore stopover sites and marine habitat, of several species of Beaufort Sea breeding shorebirds.
- Describe the relative importance of locations and habitat types across the Beaufort coastline and marine areas

Methods: Three yet to be determined species of nesting shorebirds will be captured in nearshore areas during June – July of 2021 to 2023. Candidate shorebird species include Dunlin, Semipalmated Sandpiper, American Golden-plover, Pectoral Sandpiper, Long-billed Dowitcher, Stilt Sandpiper, and Red Phalarope, and Red-necked Phalarope. Birds will be trapped, processed and equipped with tracking tags using established protocols from prior studies. The small tags will transmit data to satellites (e.g., Argos) and thus not require recapture of birds. It is anticipated that the type of tags used will generate >200 locations per individual bird each post-breeding season with high accuracy. GIS-based spatial analysis tools will be used to analyze locations, generate track lines, determine probabilistic migration routes, timing of movements, site use, residence time, and connectivity. These data will be further analyzed to pinpoint important post-breeding habitat sites and types, and linkages between breeding and migration sites. The relative importance of locations and habitat types across the Beaufort coastline and marine areas will be described, in part by overlapping utilization distributions for multiple individuals. This process will be repeated to identify “super-hot spots” or areas of persistence that involve multiple species. As an additional measure for population-level use of each hot spot, researchers will also calculate the proportion of total bird days spent at each hot spot for all individuals of a species. Finally, researchers will provide recommendations of key species and sites for monitoring of impacts during construction and operation of the Liberty Development and suggest additional measures to further reduce impacts to shorebirds.

Specific Research Question(s):

1. Do post-breeding shorebirds consistently use nearshore and marine sites in the Beaufort in proximity to oil, gas, and marine mineral activities?

2. Can environmental impacts be differentiated from human impacts in the understanding of the patterns of habitat use of shorebirds, including relative importance of the various stopover sites?
3. Which species and locations are the best focal points for monitoring of potential impacts from construction and operation activities at the Liberty Development?

References:

Arrigo, K.R., G. van Dijken, and S. Pabi. 2008. Impact of a shrinking Arctic ice cover on marine primary production. Geophysical Research Letters 35, L19603.

Churchwell, R.T. 2015. Stopover ecology of Semipalmated Sandpipers (*Calidris pusilla*) at coastal deltas of the Beaufort Sea, Alaska. Ph.D. Dissertation, University of Alaska, Fairbanks.

Connors, P.G., Myers, J.P., and Pitelka, F.A. 1979. Seasonal habitat use by Arctic Alaskan shorebirds. Studies in Avian Biology 2:101 – 111.

Tape, K.D., P.L Flint, B.W. Meixell, and B.V. Gaglioti. 2013. Inundation, sedimentation, and subsidence creates goose habitat along the Arctic coast of Alaska. Environmental Research Letters (online at stacks.iop.org/ERL/8/045031.

Weiser, E.L., R.B. Lanctot, S.C. Brown, H.R. Gates, R.L. Bentzen, J. Bêty, M.L. Boldenow, W.B. English, S.E. Franks, L. Koloski, E. Kwon, J.F. Lamarre, D.B. Lank, J.R. Liebezeit, L. McKinnon, E. Nol, J. Rausch, S.T. Saalfeld, N.R. Senner, D.H. Ward, P.F. Woodard, and B.K. Sandercock. 2018. Environmental and ecological conditions at Arctic breeding sites have limited effects on true survival rates of adult shorebirds. The Auk: Ornithological Advances 135:29-43.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Early Detection Plan for Marine Non-native Species in Cook Inlet, Alaska
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 28, 2020
PICOC Summary	
Problem	The potential for introductions of marine Non-Native Species (mNNS) in the Alaska region is increasing in response to a changing climate coupled with increased shipping and other human activities. There are currently no tools or protocols in place to provide guidance for the early detection, containment and/or removal of invasive species for oil and gas activities on the Alaska OCS.
Intervention	This study will create a baseline record of the current planktonic, benthic and attached organism communities to provide a benchmark comparison to detect mNNS and develop early detection monitoring and response plans for any mNNS that is deemed invasive.
Comparison	This study complements planned and ongoing efforts by multiple organizations in Alaska to establish a baseline record of plankton, attached and benthic communities, including those currently associated with existing infrastructure in state waters.
Outcome	This study will provide baseline data and a monitoring plan for the early detection of mNNS, and an associated response plan aimed at containment and eradication of detected invasive species.
Context	Cook Inlet Planning Area

BOEM Information Need(s): The National Environmental Policy Act (NEPA) requires BOEM to evaluate potential impacts that may be associated with Outer Continental Shelf (OCS) oil and gas activities. In addition, NOAA's National Marine Fisheries Service has emphasized the importance for marine non-native species (mNNS) monitoring as part of the Essential Fish Habitat (EFH) consultation process. Results from this study will inform analyses under the NEPA for future lease sales and may facilitate development of potential mitigation measures.

Background: Increased ship traffic and other activities offshore of Alaska, including new OCS infrastructure that could create new habitats for establishment of mNNS, together with ocean warming will increase the potential for the introduction of mNNS. The definition of a non-native species is any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to a particular ecosystem; whereas the definition of an invasive species is a non-native species whose introduction does or is likely to cause

economic or environmental harm or harm to human health (Executive Order 13112). The detection of mNNS is the first step towards identifying and preventing the establishment of invasive species.

Monitoring for mNNS has not been a primary focus in relation to oil and gas development in Alaska. This project will develop a standardized monitoring plan for mNNS to guide current and future development activities within the Cook Inlet Planning Area. Results from this project will complement other BOEM-supported efforts in Cook Inlet (NT-17-x10) and the Arctic (AK-15-01; AK-20-07) and help to extend the reach of PlateWatch (platewatch.nisbase.org), a citizen science network in southeast Alaska, as well as parallel efforts to monitor plankton communities by the Prince William Sound Regional Citizens' Advisory Council.

Objectives:

- Establish a baseline dataset of benthic and planktonic species associated with key habitat types in Cook Inlet to use as a comparison benchmark for future monitoring.
- Establish a monitoring plan for detection of benthic and planktonic mNNS covering key habitat types in the vicinity of current and potential future oil and gas activities in Cook Inlet.
- Record LTK for comparison and inclusion into biological assessments and incorporate citizen science in the monitoring plan, where practical.
- Provide an early detection response plan that includes evaluation and protocols for potential containment and eradication, in the event mNNS are detected and considered invasive.

Methods: Work will include the development of a current biological inventory for selected taxonomic groups of benthic and planktonic organisms associated with key substrate types (e.g., hard, soft, and artificial, among others) to contribute to the baseline dataset for comparison with future sampling efforts. Additional field sampling, including settlement devices, plankton tows, substrate scrapes, and collection of open water eDNA, may be required to achieve an adequate inventory across key substrate types. Taxonomic and genetic data will be verified by experts and compared with the compiled baseline community database to determine presence of mNNS; sequences will be accessible through GenBank. Species records will be archived, linked with results from other relevant projects, and published on the AOOS website. The status of LTK as it relates to marine invertebrates and introductions of non-native species may be captured via community and panel discussions, reporting from the LEO network, and digitization of physical records. Where practical, local citizens will be involved with the field surveys.

A monitoring plan will be developed for detecting mNNS in Cook Inlet near areas of existing State of Alaska oil and gas installations and potential future OCS activity. This monitoring plan will include a sampling design that covers the necessary temporal and spatial scales needed to identify the introduction of mNNS based on known pathways of introduction. Species distribution models will also be considered to highlight species with broad environmental tolerance that would be considered likely invaders as the climate changes. This study also will develop an early detection response plan that includes containment and eradication protocols

in the event mNNS are detected and deemed invasive. Suggested protocols for containment and/or eradication will be based on current best practices used in analogous habitats, when possible, or analogous taxonomies.

Specific Research Question(s):

1. What do marine invertebrate communities look like near areas of current and potential future oil and gas installations in Cook Inlet?
2. Are artificial substrates and habitats created from Installations facilitating the establishment of mNNS in Cook Inlet?
3. How can LTK inform mNNS monitoring and management?
4. What is an appropriate response plan for notification, containment and eradication if an invasive species is identified?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	GPS Tagging of Seabirds to Obtain Areas of Foraging Aggregations and Forage Fish Schools in Lower Cook Inlet
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 28, 2020
PICOC Summary	
Problem	Research suggests that recent seabird population declines and breeding failures in the Cook Inlet Planning Area are the result of a warming environment and changes in the marine ecosystem. Given these changing environmental conditions, a better understanding of baseline distribution and foraging habitat requirements is needed to provide environmental managers with tools to assess the potential cumulative effects of oil- and gas-related activities on seabird populations in the Cook Inlet Planning Area.
Intervention	This study will focus on capturing adult kittiwakes and murres at colonies and fitting them with GPS units to document their foraging movements in Cook Inlet.
Comparison	Results will be evaluated in the context of extensive historical data to help document changes in seabird populations and foraging areas in Cook Inlet.
Outcome	This study will link seabird foraging success to foraging locations and species of forage fish at these locations and will help identify important foraging hotspots within the Cook Inlet Planning Area.
Context	Cook Inlet Planning Area

BOEM Information Need(s): Given the population decline of seabirds in the Cook Inlet Planning Area, BOEM needs more detailed information on the temporal and spatial distribution of seabird foraging activities, forage fish aggregations and type of forage at these aggregations. This study will support BOEM NEPA analyses for potential future Cook Inlet lease sales, exploration plans and development and production plans providing information to: 1) better assess the potential cumulative impacts of oil- and gas-related activities on Cook Inlet seabirds, 2) better define sensitive resource areas for Oil Spill Risk Analyses (OSRA), and 3) help develop mitigation measures and strategies to reduce potential disturbance to seabird populations due to OCS oil- and gas-related activities.

Background: The 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 response of seabirds to

fluctuating forage fish densities around seabird colonies in lower Cook Inlet. Major ecosystem changes have occurred since those surveys were conducted, including a persistent (2014-2016) marine heat wave (MHW) in the North Pacific (aka "the Blob"), an associated murre die-off of unprecedented scale, and acute failures at murre breeding colonies (Piatt et al. 2020). The USGS OCS program supported research in 2016-2019 (AK-16-09) that repeated historical studies of 1995-2001, and a follow-on study (AK-20-10) will continue surveys to quantify the impact of the MHW on seabirds and their prey in Lower Cook Inlet (LCI), and to characterize recovery over time.

Objectives:

- Track seabird movements and diving behavior with GPS and activity loggers to identify hotspot foraging areas, and link breeding biology and body condition to foraging success and the density/quality of prey concentrations.
- Provide the location of foraging areas to help further assess the spatial distribution of forage fish aggregations and seabird foraging aggregations, in lower Cook Inlet.

Methods: This study will complement ongoing BOEM-supported efforts assessing seabird and forage fish status, trends, and ecology in LCI (AK-16-09, AK-20-10). Researchers will capture adult kittiwakes and murres at LCI colonies, fit them with GPS units to the tail feathers (kittiwakes) or lower back (murres) as described by Elliott et al. (2013, 2014), and collect blood samples. For both species, GPS points will be recorded every 1 minute while the bird is not diving. The units also will record dive duration for murres (kittiwakes do not dive). The strong relationship between dive duration and dive depth will allow researchers to infer dive depth and thereby obtain three-dimensional information on bird movement. After 5 days of data collection, capture sites will be revisited, all tagged birds recaptured, and devices redeployed on new birds, to maximize sample size. Because the units download to a base station, data will be collected even if recapture is problematic. During the recapture and tag removal, a second blood sample will be taken, and body mass will be measured to examine change in body mass and metabolites and identify successful foraging periods.

Important foraging sites will be identified based on factors such as the frequency and persistence of foraging visits to a site and whether visits to a site resulted in a successful foraging period. Foraging sites will be visited through efforts of a separate study (AK-20-10) to determine the characteristics of the forage fish aggregations (e.g., density, species, energetic value) and seabird aggregations at each site.

Specific Research Question(s):

1. Where are the most important and persistent feeding aggregation sites in lower Cook Inlet?

2. Are these foraging hotspots defined by particular prey species concentrations or other environmental characteristics?

References:

Elliott KH, Ricklefs RE, Gaston AJ, Hatch SA, Speakman JR, Davoren GK (2013) High flight costs, but low dive costs, in auks support the biomechanical hypothesis for flightlessness in penguins. Proc Natl Acad Sci 110:9380-9384

Elliott KH, Chivers LS, Bessey L, Gaston AJ, Hatch SA, Kato A, Osborne O, Ropert-Coudert Y, Speakman JR, Hare JF (2014) Windscapes shape seabird instantaneous energy costs but adult behavior buffers impact on offspring. Movement Ecol 2:17

Piatt, J.F., Parrish, J.K., Renner, H.M., Schoen, S.K., Jones, T.T., Arimitsu, M.L., Kuletz, K.J., Bodenstein, B., García-Reyes, M., Duerr, R.S. and Corcoran, R.M., 2020. Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. PloS one, 15(1), p.e0226087.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Kenai Peninsula Borough Economy, 2008 to 2020
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Dr. Jeffrey Brooks (jeffrey.brooks@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 28, 2020
PICOC Summary	
Problem	The Kenai Peninsula Borough bears most of the costs and benefits of OCS energy development in the Cook Inlet Planning Area. The communities of the area have experienced unprecedented changes in economic conditions, including an ongoing state recession.
Intervention	The study will describe changes in the structure of the principle components of the population and economy, including Native corporations, oil and gas, commercial fishing, and recreation and tourism. Researchers will make a quantitative and qualitative description of borough revenue, expenditures, and government services.
Comparison	The study will document trends over a 12-year period.
Outcome	Documentation of the changes in the economic conditions of the Kenai Peninsula Borough and its diverse communities.
Context	The Kenai Peninsula Borough adjacent to the Cook Inlet planning area

BOEM Information Need(s): BOEM needs updated baseline information on the population, economy, and institutions of the Kenai Peninsula Borough (KPB) and its diverse communities. Lease Sale 244 in 2017 leased 14 blocks in the Cook Inlet Planning Area and exploration activities are planned on those blocks. Lease Sale 258 is scheduled for 2021 under the 2017 to 2022 Five-Year Program. This study will provide information for the description of the existing environment and analysis of impacts to the economy, social systems, commercial and sport fishing, recreation, and tourism in environmental analyses for future lease sales, Exploration Plans, and Development and Production Plans.

Background: The villages within the KPB primarily have mixed subsistence-cash economies, towns have primarily commercial fishing based-economies, and cities have diverse economies predominantly in the oil and gas and government sectors. Existing information collected and reported in past studies has been aggregated at the borough-level. This study will provide a finer analysis of community-level effects. The 12-year study period will allow researchers to capture major trends and changes experienced by communities caused by growth and decline in the major sectors. A similar study of the North Slope Borough Economy was invaluable in

completing similar environmental analyses for Beaufort and Chukchi Sea OCS activities (Northern Economics 2006).

Objectives:

- Describe the structure of the KPB and constituent communities and how it has changed from 2008 to the 2020, including employment and income, in- and out-migration, demographic trends, institutional analyses of local and regional governments, non-profit and other entities, revenues, and expenditures.
- Evaluate the role of the Alaska Native Claims Settlement Act (ANCSA) regional and village corporations in the KPB as a force for economic development and delivery of public services.
- Identify how the KPB and its communities, regional and village corporations, tribes, and others used revenues from the oil and gas industry from 2008 to 2020.
- Establish a basis for assessing social and economic effects of future onshore and offshore energy development activities.

Methods: Researchers will develop a qualitative and quantitative profile of the borough and its communities for a 12-year period and provide trend data to document major changes across economic sectors, using existing information from land use and zoning plans, community development plans, and U.S. census data. Researchers also will compare borough-level trends with economic trends in the State of Alaska. The focus will be on commercial fishing, oil and gas development, recreation, and tourism. Researchers will describe trends in revenues and expenditures and the private, public, and non-profit sectors, including Alaska Native corporations, as well as trends in income, employment, out-migration, and in-migration and how these relate to other sectors, including subsistence and commercial fishing. Finally, researchers will apply a typology of village, town, and city to describe how the KPB and local governments have adapted to the decline in revenues and how individuals, households, and communities have responded to changing conditions. This typology has proven useful for distinguishing effects between communities in previous studies (e.g., USDOI, MMS 2003; USDOI, BOEM 2016).

Specific Research Question(s):

1. What is the structure of the population and economy of the KBP?
2. How has the KPB changed and adapted during the study period?
3. How have communities changed and adapted during the study period?
4. How do local and regional institutions contribute to the economy of the KPB?

References:

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

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

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

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Offshore Renewable Energy Potential on Alaska's Outer Continental Shelf (OCS)
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Dr. Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 28, 2020
PICOC Summary	
Problem	The Energy Policy Act of 2005 (EPAct) delegated regulatory authority to BOEM over renewable energy resources on the U.S. OCS, but the current program does not actively consider renewable energy in Alaska. Information about ocean energy resources on the OCS is needed to inform a decision about whether to pursue an Alaska Renewables Energy Program.
Intervention	This study will assess offshore renewable energy potential on the OCS off Alaska and consider the economic viability of recovering and transporting energy.
Comparison	OCS wind energy, ocean thermal energy, ocean wave energy, and ocean current energy will be assessed for Alaska and compared to other regions.
Outcome	This study would enable a more informed decision about whether to develop a renewables program on the Alaska OCS. Future renewable energy projects, if economically feasible, have the potential to make significant contributions to our nation's energy portfolio.
Context	All renewable energy potential for the Alaska OCS would be considered.

BOEM Information Need(s): The consideration of a renewable energy program in Alaska is needed to uphold the OCS Lands Act mandate to manage the exploration and development of the nation's offshore energy and mineral resources in an environmentally and economically responsible way. The development of a renewables program would be in line with current political priorities including Executive Order 13795 – *Implementing an America-First Offshore Energy Strategy* by advancing energy innovation, exploration, and production. BOEM's Renewable Energy Program states that "the areas appropriate for renewable energy development have likely never been studied for such development and, in some cases, there is information lacking about the physical and biological environment." It emphasizes that "the need for continuing to pursue information to ensure access to the OCS for renewable energy development is a high priority for BOEM."

Background: A 2008 BOEM study titled *Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the OCS* did not

consider resources on the Alaska OCS, but it serves as a good model for this study. The 2008 study objectives were to identify, collect, evaluate, and synthesize existing information on offshore alternative energy activities. A workshop was also held to identify alternative energy environmental information needs.

A recent report *America's Oceans: A Decadal Vision* by the National Science and Technology Council (2018) recognized that "America's coastline and extensive EEZ contains vast untapped renewable (wave, tidal, wind, thermal) and non-renewable (oil and gas) energy sources to help power the Nation. Aligning energy innovation with emerging developments in ocean science, security, and maritime technology could provide dynamic opportunities to further drive coastal economic development." Exploring potential energy sources is one of the report's identified research priorities for the next decade. This study would be the first step in achieving this goal in Alaska.

Objectives: The objective of this study is to establish an understanding of the offshore renewable energy potential on the Alaska OCS, focusing on identifying high potential areas and sources, economic feasibility, and management strategies that would be relevant for expanding BOEM's Renewable Energy Program to the Alaska OCS.

Methods: This study will conduct a literature review compiling all available information about offshore renewable energy potential on the Alaska OCS with analysis focused on identifying areas most attractive for leasing, likely near population centers or existing infrastructure. Energy potential is defined to include what is recoverable with current technologies or those that may be realistically developed in the next ten years. The analysis would include a discussion of economic feasibility, through literature investigations and interviews with technology and industry experts as well as state and local governments. Finally, the study will provide recommendations for further research to inform National Environmental Policy Act (NEPA) analysis that would be needed should a renewable energy program be implemented in Alaska. These recommendations would consider habitat and landscape alteration, cumulative effects, integration of social sciences into environmental assessments, and other issues.

Specific Research Question(s):

1. What is the overall offshore renewable energy potential on the Alaska OCS?
2. Where are the areas most attractive for leasing?
3. Is it economically feasible to recover this energy with current technologies? Economic feasibility should consider changes in energy resources throughout a year, in different climate scenarios, different levels of infrastructure, and reasonably foreseeable technological advancements in energy capture, storage, and transport.
4. How does this potential compare with offshore renewable energy potential and current activities on the Atlantic and Pacific OCS?

5. If a renewable energy program is practical at this time: What strategy should BOEM take to effectively design studies to provide baseline data needed for a leasing program?

6. If a renewable energy program is not practical at this time: Under what conditions could it be more viable, and what indicators may demonstrate a need to reconsider development of a program in the future?

References:

National Science and Technology Council, 2018. Science and Technology for America's Oceans; A Decadal Vision. Executive Office of the President of the United States. November 2018. https://www.whitehouse.gov/wp-content/uploads/2018/11/Science-and-Technology-for-Americas-Oceans-A-Decadal-Vision.pdf

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Resource Areas to Support Oil Spill Risk Analysis (OSRA) and National Environmental Policy Act (NEPA) Needs in the Cook Inlet Region
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Cooperative Agreement or Contract
Performance Period	FY 2021–2024
Date Revised	April 28, 2020
PICOC Summary	
Problem	Tools and methods are needed to identify Environmental Resource Areas (ERAs) for marine mammals, cetaceans, terrestrial mammals and other biological resources to support the assessment of potential impacts from Outer Continental Shelf (OCS) oil- and gas-related activities in Cook Inlet.
Intervention	This study will synthesize available information for biological resources to facilitate the development of methods to identify the spatial and temporal resource distributions or habitat areas of importance.
Comparison	This study will provide improved efficiency over existing approaches that are individualized for various resources in developing and refining ERAs. This approach will allow for increased continuity to update information following staff changes.
Outcome	A consistent approach that can be applied to multiple resources and planning areas to assist BOEM in defining ERAs to support OSRA and NEPA assessments. This project will complement existing BOEM efforts (e.g., study AK-18-01).
Context	Cook Inlet Planning Area and adjacent areas

BOEM Information Need(s): This study will collate and refine information on the density and spatial and temporal distribution of biological resources and associated habitat areas in the region of Cook Inlet to provide tools to model and map resource areas to help refine ERAs used in BOEM's OSRA and NEPA analyses. These products will assist with NEPA analyses for future lease sales and other OCS activities, ESA Section 7 consultations, and decision-making related to potential impacts to resources from activities in the Cook Inlet Planning Area of Alaska. The approach developed through this effort may be applied to other OCS planning areas.

Background: BOEM and others have amassed extensive datasets documenting spatial and temporal presence and other information for a wide range of species and habitats in the Cook Inlet region. The distributions of many species are temporally and spatially structured, showing seasonal or interannual changes in response to various mechanisms. These factors affect the vulnerability of a species to contact from a potential oil spill, which BOEM considers as part of

its OSRA through identification of ERAs. ERAs are areas of concern relating to social, environmental, or economic resources, including critical habitat or use areas for different species of concern. Each ERA has a spatial and temporal attribute and its vulnerability may vary according to the time of year. This study will complement the current study "Environmental Resource Areas: Developing Products to Support Oil Spill Risk Analysis (OSRA) and National Environmental Policy Act (NEPA)" (AK-18-01), which is focused on seabirds and forage fish.

Objectives: The overall goal of this study is to establish a consistent foundation for developing and refining ERAs used for OSRA. It will build on current efforts focused on seabirds and forage fish by synthesizing existing data for other biological resources and habitat areas in Alaska's Cook Inlet region. Specifically, this project will:

- Use spatial techniques to provide density information or other datasets that are appropriate for identifying ERAs for the species or populations evaluated to support OSRA in the Cook Inlet region.
- Provide a synthesis report, as a description of the biological affected environment, that can inform NEPA assessments for the Cook Inlet region.
- Assess the biological inventories and resource areas to help determine future data collection priorities to best support OSRA and NEPA.

Methods: This study will collate and refine biological inventories for Alaska's Cook Inlet region by compiling data from state, federal, private sector, and academia sources. Researchers will engage with representatives from communities in the Cook Inlet region and other entities (Cook Inlet Regional Citizens Advisory Council, NOAA, USFWS, Gulf Watch Alaska, National Park Service, etc.) who may be conducting marine biological monitoring activities. Researchers will consider various advanced modeling techniques (e.g., Quakenbush and Citta 2013, Citta et al. 2015, Roberts et al. 2016) to identify the most appropriate methods for providing BOEM with data products to evaluate the distribution, habitat use, density/abundance and temporal timing of biological resources. As appropriate, statisticians, data management specialists, oceanographers, or specialists in passive acoustics or aerial surveys will be consulted for additional input regarding advanced data analyses.

The synthesis report will describe the biological affected environment and address additional information needs, approaches for incorporating Local and Traditional Knowledge, and areas where synergy is needed to provide better information for decision-makers. Data products will include maps and data layers suitable for plotting in Geographic Information Systems (GIS) to facilitate additional analyses. BOEM analysts will coordinate with the researchers to tailor data products to best suit BOEM's needs.

Specific Research Question(s):

1. What biological inventories are available for the Cook Inlet region?
2. Are inventories available and adequate for each biological resource to define important resource areas?

3. What resources and data collection focuses should be prioritized for future studies planning?

4. What are the best approaches for cooperation and synergy to achieve future research goals in the most cost-effective and efficient manner?

References:

Citta, J. J., Quakenbush, L. T., Okkonen, S. R., Druckenmiller, M. L., Maslowski, W. Clement-Kinney, J., George, J. C., Brower, H., Small, R. J., Ashjian, C. J., Harwood, L. A., Heide-Jørgensen, M. P., 2015. Ecological characteristics of core-use areas used by Bering–Chukchi–Beaufort (BCB) bowhead whales, 2006–2012. Progress in Oceanography, 136:201-222. http://dx.doi.org/10.1016/j.pocean.2014.08.012.

Quakenbush, L.T., and Citta, J.J., 2013. Kernel densities from satellite-tracked bowhead whales, 2006-2012, for use in determining environmental resource areas for oil spill response analysis. Special Technical Report, submitted to BOEM, August 2013. 11pp + GIS shapefiles.

Roberts, J. J.; Best, B. Mannocci, D., Fujioka, L., E., E.; Halpin, P. N., Palka, D. L., Garrison, L. P., Mullin, K. D., Cole, T. V. N., Khan, C. B., McLellan, W. M., Pabst, D. A., Lockhart, G. G., 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6: 22615. doi: 10.1038/srep22615.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2024
Date Revised	April 10, 2020
PICOC Summary	
Problem	A large amount of information exists on historical Alaska Outer Continental Shelf (OCS) oil and gas exploration, development, and production activities. However, this information is dispersed throughout the body of scientific and gray literature or held by government agencies and other entities and is not readily accessible.
Intervention	This study will collate and synthesize BOEM Environmental Studies Program and operator reports and Resource Evaluation well information to develop a geodatabase and associated synthesis report that is readily accessible to BOEM staff and stakeholders.
Comparison	The synthesis will enable prompt access to information, understanding of how historical oil and gas development relates to the current activities in Alaska, as well as provide validation for exploration and development (E&D) scenario levels of activities.
Outcome	A synthesis of Federal OCS historical oil and gas activity information will improve access, supply context, and support integrated geospatial assessments of potential direct, indirect, and cumulative impacts.
Context	Beaufort Sea, Bering Sea, Chukchi Sea, Cook Inlet, Gulf of Alaska

BOEM Information Need(s): BOEM is required under the National Environmental Policy Act (NEPA) to evaluate potential impacts that may be associated with Outer Continental Shelf (OCS) oil and gas exploration, development, and production activities. Collating and synthesizing information on historical oil and gas activities on the Alaska OCS will support the validation of exploration and development scenarios for future NEPA analyses, identify levels of historical impact producing factors, and contribute to a better understanding of the spatial and temporal scope of past, present, and reasonably foreseeable activities for evaluating cumulative impacts.

Background: BOEM uses information regarding Alaska OCS oil and gas exploration, development, and production activities. Information about the number, timing, location, water depth, well cellar depth, and results of wells drilled; discharges, facility types as well as aircraft/vessels/vehicles utilized, transportation routes used, and the number and frequency of trips are correlated with impact producing factors for NEPA assessment. Much of the historical

information is contained within Environmental Studies Program reports (e.g., Kevin Waring and Associates 1985; Northern Resource Management 1980) and operator reports submitted to BOEM or its predecessors. BOEM's Alaska Resource Evaluation section has collated some information on Alaska OCS wells, however, it is difficult to find and synthesize activity information in a timely manner to answer questions related to historical OCS activities.

Objectives: This study will synthesize historical Alaska OCS well data together with exploration and development activity information to create a geodatabase and a detailed written account of oil and gas exploration, development drilling, and production activities that occurred between 1979 and 2020 on the Alaska OCS in the Beaufort Sea, Bering Sea, Chukchi Sea, Cook Inlet, and Gulf of Alaska.

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

Specific Research Question(s):

1. What are the levels of historical Federal OCS oil and gas activities and can they be used as input to or validation of E&D Scenarios used in NEPA assessments?

2. What are the levels and spatial and temporal distribution of OCS activities compared to existing leases?

References:

Kevin Waring Associates. 1985. Monitoring Oil Exploration Activities in the Lower Cook Inlet. OCS Report MMS 84-006. Anchorage, AK: Prepared for USDOI, MMS, Alaska OCS Office. 193 pp. + Appendices.

Northern Resource Management. 1980. Monitoring Oil Exploration Activities in the Lower Cook Inlet. Anchorage, AK: Prepared for USDOI, BLM, Alaska OCS Office. 206 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Synthesis of Contaminants Data for Cook Inlet: Evaluation of Existing Data as "Baseline Conditions" and Recommendations for Further Monitoring
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2021–2023
Date Revised	April 28, 2020
PICOC Summary	
Problem	Contaminant background levels in Cook Inlet Planning Area water and sediment are necessary for supporting National Environmental Policy Act (NEPA) analyses of potential impacts from Federal outer continental shelf (OCS) oil- and gas-related activities.
Intervention	This study will compile existing information about a suite of contaminants to provide the foundation upon which to better evaluate any potential impacts to water and sediment quality from Federal OCS oil- and gas-related activities in Cook Inlet.
Comparison	This study will produce a contaminant baseline that can be compared against promulgated Federal and State water quality criteria.
Outcome	The resulting data synthesis would facilitate a thorough analysis of potential oil and gas impacts on water and sediment quality. The results of the report would identify information needs and recommend a sampling and monitoring program.
Context	Cook Inlet Planning Area

BOEM Information Need(s): Synthesized, updated, and readily accessible contaminants information would support environmental analyses for future Cook Inlet Planning Area lease sales, Exploration Plans, and Development and Production Plans. Baseline data compared against promulgated water and sediment quality criteria is necessary to assess potential impacts of future OCS activities. This information would also be used to develop a sampling and monitoring program to inform contaminant data collection for the Cook Inlet Planning Area.

Background: Since oil industry operations began in Cook Inlet in the late 1960s, there have been various contaminant assessments, usually focusing on hydrocarbons and heavy metals in the water column, sediments, or tissues of resident organisms. Most of these efforts were targeted on specific areas of the Inlet, such as produced water discharge locations, or were otherwise limited in scope. Although several projects have assessed anthropogenic contaminant sources, few were designed as monitoring programs or used a statistical approach that allows for interpretation of background levels and natural sources. The more

comprehensive studies include the Sediment Quality study in depositional areas of lower Cook Inlet and Shelikof Strait by the former Minerals Management Service (MMS) (MMS 2000-024) and the Integrated Environmental Monitoring and Assessment Program (ICIEMAP) led by the Cook Inlet Regional Citizens Advisory Council (CIRCAC).

Objectives:

- Identify and compile existing organic and inorganic contaminants data, as well as a comprehensive list of any known or potential contaminant sources for the Cook Inlet Planning Area.
- Conduct a meta-analysis of existing data sets to evaluate the comparability of prior statistical designs and analytic methods and, when combined, as representative of baseline conditions in the Cook Inlet Planning Area.
- Compare data against Federal and State regulatory threshold levels.
- Recommend a study approach that would assess baseline conditions in Cook Inlet and monitor sediment contaminants (e.g., hydrocarbons and priority metals) in areas potentially impacted by Federal OCS oil- and gas-related activities.

Methods: This study will compile existing inorganic and organic contaminants data and metadata for the water column, sediment, and benthic infaunal tissue in the Cook Inlet Planning Area. Efforts will focus on hydrocarbons, metals, technologically enhanced naturally occurring radioactive materials (TENORMs), and the Environmental Protection Agency's (EPA's) 126 priority pollutants. Researchers will collect associated data, such as total suspended sediments (TSS), salinity, total organic carbon (TOC), sediment grain size, and other concomitant data. They will assemble data into an integrated dataset and develop visualization tools to facilitate data exploration, summaries, sharing, and interactive comparisons. The researchers will conduct a meta-analysis, including comparisons against current threshold levels published by EPA, State of Alaska, and the National Oceanic & Atmospheric Administration (NOAA) (e.g., ambient water quality criteria, human health criteria, Alaska Water Quality Standards, 18 Alaska Administrative Code [AAC] 70, and NOAA sediment criteria).

A team of experts (contaminants specialists and statisticians) will evaluate the dataset for comparability of results and its "representativeness" of conditions in Cook Inlet and identify recommendations for further study.

Specific Research Question(s):

1. Does the meta-analysis provide for a contemporary comparable baseline of contaminant data in the Cook Inlet Planning Area?

2. Do background contaminant levels exceed current EPA, State of Alaska, and NOAA promulgated threshold levels?

3. What areas in the Cook Inlet Planning Area, if any, could benefit from further contaminant sampling and monitoring to fill information needs?

References:

Boehm, P.D. 2001. Sediment Quality in Depositional Areas of Shelikof Strait and Outermost Cook Inlet. OCS Study MMS 2000-024. Cambridge, MA: Prepared by Arthur D. Little, Inc. for USDOI, MMS, Alaska OCS Region. 345 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2021–2023
Date Revised	April 28, 2020
PICOC Summary	
Problem	An estimate of the number of ringed seals that occur and could be disturbed within oil and gas project areas is needed to assess potential impacts to them for Endangered Species Act (ESA) Section 7 consultations and NEPA documents. Ringed seals stay under the ice and snow in winter and are not visible for counting during ice road and island building or winter seismic and drilling operations.
Intervention	This study will enhance ring seal assessments by establishing viable ways to locate ringed seals and their under-snow structures using satellite-telemetry tags that sense and record whether a seal is inside a lair, and a sensor web to monitor under-snow structures for ringed seal activity.
Comparison	This study will consider various approaches to develop capabilities for sensing ringed seal lairs and monitor their use and provide suggested mitigation measures to reduce impacts to ringed seals.
Outcome	This study will produce new technological and logistical solutions for quantifying impacts of oil and gas activities on ringed seals and refining guidance for future permitting and mitigation decisions for BOEM. The new technology will also expand capabilities for population assessment of ringed seals, facilitate research on their habitat requirements, and improve understanding about their vulnerability in a warming Arctic.
Context	Bering, Chukchi, and Beaufort seas

BOEM Information Need(s): Ringed seals are the most numerous marine mammals present during winter in the coastal OCS of the Alaskan Arctic and they are listed as threatened under the ESA. BOEM needs better information on ringed seals that may be affected by actions that could cause disturbance or injury (known as “take” under ESA), during the winter and early spring, when their breathing holes and under-snow lairs are inconspicuous to human observers and are susceptible to ice road, gravel island, and seismic and drilling operations. This information will support ESA Section 7 consultations and NEPA analyses to inform permitting decisions related to these activities.

Background: Recent advances in technology have created the potential for key improvements in understanding ringed seal use of under-snow lairs and how sensitive that use is to various human activities. Bio-loggers have been proposed as a viable approach for integrating new sensors into tags that would indicate ringed seal presence inside lairs. These tags could be useful for studying responses of seals near oil and gas activities during infrastructure development. A redundant wireless network would autonomously indicate the presence/absence of seals in the lair structures and track structure integrity through the onset of melt and eventual collapse. Such monitoring of ringed seals' responses to human activities would support development of satellite remote sensing techniques. These new technologies would more easily and economically characterize important ringed seal breeding habitat.

Objectives: This study will enhance capacity for assessment of impacts on ringed seals by establishing a viable solution for maintaining the capability to find ringed seals and their under-snow structures and developing associated mitigation measures to reduce impacts.

Methods: Researchers will construct prototype bio-logger devices and test them in artificial snow structures. Testing will be conducted at various stages of snow transformation (full winter conditions, melt season, and collapse) over two winter seasons to evaluate performance. The final tag design will be available for the research community to deploy.

Researchers will coordinate discussions among stakeholders, including BOEM, NOAA, industry representatives, Alaska Native organizations, and university researchers, to identify requirements and design a 'sensor web' to monitor under-snow structures for ringed seal activity. The web will monitor under-snow lair use and conditions throughout the snow-covered period and relay the data autonomously to an internet node to ensure continuous availability of ringed-seal detection for mapping structures around oil and gas activities and for supporting research to improve understanding of ringed seal behavior and habitat needs. Final products will include recommendations for application of the sensor web to best mitigate potential impacts to ringed seals from oil and gas exploration, development, and production activities.

Specific Research Question(s): How can new technology expand capabilities, facilitate research on the habitat of ringed seals, and improve understanding about potential impacts from oil and gas activities?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Arctic Marine Assessment Program for Protected Species (ArMAPPS)
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2022–2026
Date Revised	April 28, 2020
PICOC Summary	
Problem	Marine ecosystems in the U.S. Arctic support a high diversity of cetacean species, several of which are listed as endangered under the Endangered Species Act (ESA). BOEM must assess potential impacts to these species from future OCS activities. However, collecting high-quality data over such large spatial scales is both logistically challenging and costly.
Intervention	In this study, BOEM will partner with NOAA, the Navy, and other entities to conduct rotational, large-scale, visual and acoustic ship-board or aerial surveys in the Bering, Chukchi, and Beaufort seas to obtain data on the presence, distribution, and abundance of cetaceans, with particular focus on subsistence-harvested species such as bowhead and beluga whales. Habitat-based density models will be developed to generate fine-scale predictions of cetacean seasonal density or occurrence.
Comparison	These surveys will provide baseline information and facilitate future comparisons to examine the potential effects of natural and anthropogenic disturbances. The resulting habitat density models will be compared to areas of potential oil and gas activity, as well as areas identified by BOEM's oil spill trajectory modeling.
Outcome	ArMAPPS will provide periodic data on the abundance and distribution of cetaceans in the Alaskan Arctic and facilitate the development of habitat-based density models to better understand how natural and anthropogenic disturbances could affect cetacean species.
Context	Bering, Chukchi, and Beaufort seas

BOEM Information Need(s): BOEM needs periodically updated information on cetacean abundance and distribution to assess overlap between species' habitat and potential oil and gas activities in the U.S. Arctic. This project will provide cetacean information required for consultations and assessments under the ESA, Marine Mammal Protection Act (MMPA), and National Environmental Policy Act (NEPA) analyses for future lease sales, Exploration Plans, and Development and Production Plans.

Background: Federal agencies are responsible for assessing populations and managing potential impacts to protected species within the waters of the U.S. Exclusive Economic Zone (EEZ). This mandate led to the development of three very successful large-scale, multi-agency, cetacean assessment programs jointly established and funded by BOEM, NOAA, and the U.S. Navy: 1) Atlantic Marine Assessment Program for Protected Species (AMAPPS), 2) Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS; https://www.boem.gov/environment/environmental-studies/gommapps), and 3) Pacific Marine Assessment Partnership for Protected Species (PacMAPPS). The ArMAPPS program would expand these efforts to the Arctic and provide opportunities for collecting high-quality data to meet the needs of several federal agencies.

Objectives:

- Use visual and acoustic survey techniques to collect abundance and distribution data for cetaceans in the Bering, Chukchi, and Beaufort seas.
- Conduct satellite telemetry studies to determine foraging behavior and seasonal movements of target cetacean species.
- Collect data on life history, residence time, and stock structure when possible.
- Develop habitat-based density models for generating fine-scale predictions of cetacean seasonal density or occurrence and for understanding how these are changing with the environment.

Methods: Visual and acoustic shipboard and aerial surveys will be conducted on a rotational basis in the Bering, Chukchi, and Beaufort seas to collect abundance and distribution data of cetaceans. A refined survey schedule will be developed collaboratively through discussion among BOEM partners including but not limited to the Navy and NOAA. Survey efforts will be designed with a 5-6-year rotation among subregions such as the Beaufort Sea, Chukchi Sea, northern Bering Sea, and southeastern Bering Sea. The survey design will consist of predetermined track lines within survey strata, defined for each geographic subregion given current information on cetacean distribution. A higher proportion of survey effort will be allocated within areas where cetacean abundance for some species is expected to be higher. Researchers will analyze acoustic and line-transect survey data independently to calculate abundance estimates for as many cetacean species as possible. Additionally, visual and acoustic detections will be combined to examine spatial variation in the probability of occurrence for cetacean species following emerging analytical techniques; while distribution data will be linked to habitat characteristics to create fine-scale spatially explicit density estimates that can be used to meet regulatory requirements of BOEM.

Specific Research Question(s): What is the abundance, seasonal distribution, and habitat use of cetaceans in the Bering, Chukchi, and Beaufort seas?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Collaboration with the Gulf Watch Alaska Monitoring Program in Cook Inlet
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Dr. Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2022–2025
Date Revised	April 28, 2020
PICOC Summary	
Problem	This study will build upon ongoing monitoring efforts to examine areas where collaborative studies can facilitate environmental monitoring efforts and inform decision-making on the sustainable use of resources in marine environment.
Intervention	BOEM will enhance existing working relationships with Gulf Watch Alaska and the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC), NOAA, AOOS, industry and others by establishing financial cooperation, data sharing agreements, and logistical support agreements.
Comparison	BOEM and Gulf Watch Alaska will partner on collaborative research, leveraging expertise across several partners in Cook Inlet.
Outcome	This project will support mutually identified information needs on the physical and biological processes in the marine environment.
Context	Cook Inlet and the northern Gulf of Alaska

BOEM Information Need(s): BOEM needs updated information regarding the physical and biological environment, including variability in oceanographic conditions and plankton communities, as well as data related to sensitive species. BOEM strives to leverage funding for updated environmental data collection as significant opportunities arise and is seeking to partner with Gulf Watch Alaska on new collaborative research in the Cook Inlet and the northern Gulf of Alaska as that program develops its next five-year plan.

Research from this collaboration will support mutually identified information needs related to environmental drivers, nearshore and pelagic ecosystems, and science synthesis. Data and results from this partnership 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.

Background: Gulf Watch Alaska (https://gulfwatchalaska.org/) is the long-term ecosystem-monitoring program of the EVOSTC for the marine ecosystem affected by the 1989 oil spill. The Trustee Council began funding the program in 2012; however, many of the studies have a much

longer time series. A plan is currently being developed for the third 5-year increment of the program, which is anticipated to span a period totaling 20-years. Gulf Watch Alaska conducts collaborative research in the Cook Inlet and the northern Gulf of Alaska, leveraging expertise across several partners, including NOAA, Alaska Ocean Observing System (AOOS), USGS, USFWS, National Park Service, Prince William Sound Science Center, University of Alaska Fairbanks and others. BOEM recently collaborated with NOAA, USFWS, and National Park Service through Gulf Watch Alaska on the project "Ecological Processes in Lower Cook Inlet and Kachemak Bay: A Partnership in Monitoring." Ongoing efforts from Gulf Watch Alaska include:

- Examining seasonal and inter-annual variability in oceanographic conditions and plankton communities and provide information to assess long-term trends.
- Enhanced monitoring of sensitive species (seabirds, sea otters) and habitats in conjunction with monitoring of environmental conditions.
- Synthesizing data both across the Gulf Watch Alaska geographic sampling region and across time to understand what is affecting differing population responses to environmental variability.

Objectives: BOEM seeks to build upon existing working relationships with EVOSTC and Gulf Watch Alaska, NOAA, USGS, AOOS, and others by collaborating with scientists conducting long-term monitoring and synthesis through the Gulf Watch Alaska program.

Methods: BOEM will collaborate with the Gulf Watch Alaska team to continue the long-term monitoring and synthesis efforts and advance collaborative studies that could help enhance informed decision-making on the sustainable use of resources.

Specific Research Question(s): What is the range of environmental effects in Cook Inlet and the northern Gulf of Alaska from environmental change occurring in the marine environment?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Measuring and Modeling Oil Impacts on Early Life Stages of Arctic Cod
Administered by	Alaska OCS Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2022–2024
Date Revised	April 28, 2020
PICOC Summary	
Problem	An oil spill in the Alaskan Arctic OCS Region could have ecosystem-wide impacts by way of injury to early life stages of Arctic cod, a keystone species. Drastic changes in the distribution and abundance of Arctic cod would lead to widespread food-web changes, particularly in ice-obligate species. Additionally, these effects may be exacerbated by thermal stress associated with atmospheric warming.
Intervention	This study will expose Arctic cod eggs and larvae to environmentally relevant concentrations of fresh and weathered oil to obtain a better understanding of the effects of low-level oil exposure on this vulnerable species.
Comparison	All experimental treatments and sampling of oil-exposed embryos will occur alongside unexposed, replicated control treatments. Data will be incorporated in Arctic cod Individual Based Models (IBMs) under varying oil spill scenarios explored by the GNOME oil spill/fate model.
Outcome	This project will 1) characterize latent effects of early life stage oil exposures on Arctic cod that impact survival, growth, and reproduction, and 2) develop a modeling framework that can incorporate oil injury to assess the impact of various oil spill scenarios on Arctic cod early life stages, under current and future climate scenarios.
Context	Beaufort and Chukchi seas

BOEM Information Need(s): BOEM needs a better understanding of the acute and latent effects of low-level exposures to fresh and weathered oil on early life stages of Arctic cod under current and future climate scenarios. This data would inform National Environmental Policy Act (NEPA) documents for OCS Leasing and Exploration Plans and lend to Oil Spill Risk Analysis (OSRA) and other assessments for oil exploration and development activities.

Background: Arctic cod (*Boreogadus saida*) is a keystone species in the Alaskan Arctic and one of few species that link the lower and higher trophic levels. Arctic cod, especially early life stages, are especially sensitive to injury from oil exposure, and the buoyancy and long development time of Arctic cod embryos makes them particularly susceptible to injury (Laurel et al. 2019). For the past four years, NOAA has been working with its counterpart in Norway,

the Institute of Marine Research (IMR), to investigate low-level toxic impacts of oil to high latitude fish species in both the North Pacific and North Atlantic, including circumpolar Arctic species. In 2017, a new oil-dosing lab was established by the Alaska Fisheries Science Center (AFSC), putting NOAA and its partners in a unique position to study the effects of oil exposure on sensitive early life stages of Arctic cod and other key species under variable climatic conditions. In 2018 and 2019, a biophysical Individual Based Model (IBM) for Arctic cod, developed under the North Pacific Research Board (NPRB) Project #1508 (Arctic Gadids in a Changing Climate), also became available to 'scale-up' oil impacts by incorporating oil injury data (e.g., growth impacts) alongside the established oil spill and fate model (GNOME, General NOAA Operational Modeling Environment). Incorporating new oil injury data into modeling frameworks that account for biophysical transport of the species (IBMs) alongside oil spill scenarios (e.g., GNOME) are about 3 years into development in the Norwegian Arctic (Barents Sea) but have yet to be developed in the Alaskan Arctic OCS Region.

Objectives: The goal of this project is to supply information needed to spatially and temporally quantify the acute and chronic effects of exposure to hydrocarbons on this key marine forage fish. Specific objectives include:

- Determine the delayed effects of low oil dose embryonic exposure on the biochemistry, physiology, growth and behavior of feeding larval/juvenile stages.
- Modeling the spatio-temporal dispersal and fate of hydrocarbons from several oil spill scenarios over the Alaskan Arctic OCS
- Integrating the oil exposure of individual embryos using IBMs to evaluate the multi-stressor effects on growth and survival in a dynamic oceanographic environment

Methods: Husbandry and larviculture are now routine procedures in the NOAA-AFSC laboratory in Newport, Oregon, following 6 years of broodstock development of Arctic cod. In this study, Arctic cod embryos will be exposed to environmentally relevant concentrations of fresh and weathered oil for short periods (~3 days) using an extremely reliable, continuously generated oil dispersion laboratory established in the Newport lab. Exposures will be fully characterized by (1) measuring PAHs in water and in embryos at key points before, during and after exposure, and (2) quantifying CYP1A mRNA expression levels as a marker of PAH exposure. In addition, endpoint measures will be applied at relevant ontogenetic stages. These include measures of growth, survival, condition (lipid), gene expression, morphometric defects, cardiac performance, respiration, and swim activity.

Results from exposed eggs and larvae will be simulated by communicating with the oil dispersal and fate model, which will enable quantification of acute or sub-lethal effects. Particles will be initiated at hypothesized spawning grounds and drift along individual drift trajectories will be determined by their time-dependent ambient currents, while simulated growth and development of each particle in the model will be based on ambient temperature. Individual exposure of eggs and larvae will be tracked by communicating with the oil dispersal and fate model, which will enable quantification of acute or sub-lethal effects. Data will be incorporated in Arctic cod Individual Based Models (IBMs) under varying oil spill scenarios explored by the GNOME oil spill/fate model.

Specific Research Question(s):

1. What are the impacts of oil exposure on the early life stages of Arctic cod?
2. How are the effects of oil exposure on the early life stages of Arctic cod predicted to vary under current and future climate change scenarios?

References:

Laurel BJ, Copeman LA, Iseri P, Spencer ML, Hutchinson G, Nordtug T, Donald CE, Meier S, Allan SE, Boyd DT, Ylitalo GM, Cameron JR, French BL, Linbo TL, Scholz NL, Incardona JP (2019). Embryonic crude oil exposure impairs growth and lipid allocation in a keystone Arctic forage fish. iScience. https://doi.org/10.1016/j.isci.2019.08.051

Environmental Studies Program: Studies Development Plan | FY 2021–2022

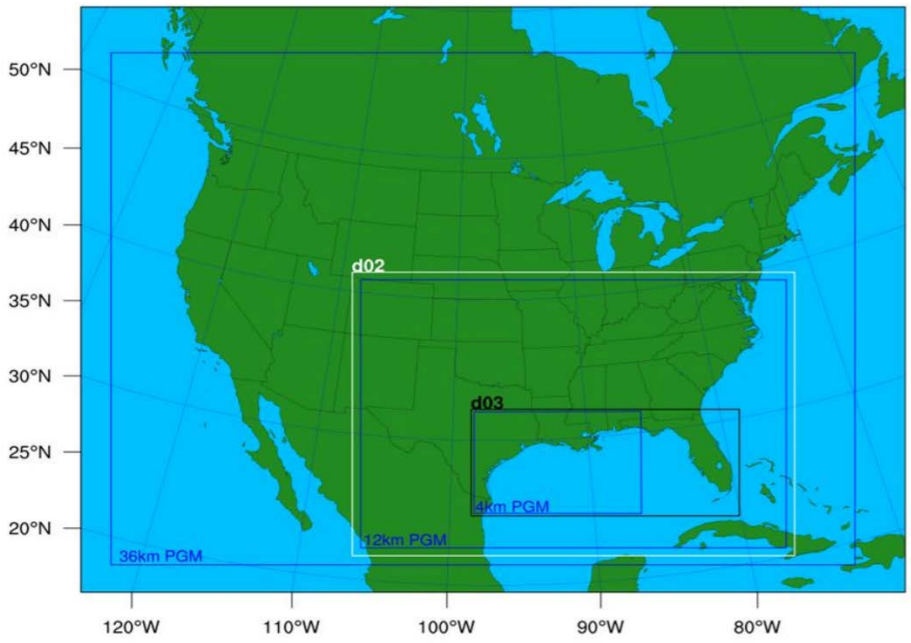
Title	A Demographic Analysis Update to "Air Quality Modeling in the Gulf of Mexico Region"
Administered by	New Orleans Office
BOEM Contact(s)	Victoria Phaneuf (victoria.phaneuf@boem.gov), Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2022
Date Revised	February 26, 2020
PICOC Summary	
Problem	BOEM has new air quality modeling data on the impacts of oil and gas OCS activities in the Gulf of Mexico Region, but the study did not specify the OCS contribution to the air quality in Environmental Justice communities.
Intervention	Use air quality modeling results from the *Air Quality Modeling in the Gulf of Mexico Region Study* to determine the air pollutant concentrations from oil and gas OCS activities to geographic areas containing Environmental Justice communities.
Comparison	The *Air Quality Modeling in the Gulf of Mexico Region Study* provided an impact analysis for air quality in the region; however, it was not targeted to Environmental Justice communities. Adding a consideration of impacts within and outside Environmental Justice communities will help define direct impacts of BOEM's activities.
Outcome	BOEM will gain understanding of the pre-lease air quality impacts of oil and gas OCS activities on Environmental Justice communities in the Gulf of Mexico Region
Context	Gulf Coast of the United States

BOEM Information Need(s): BOEM's existing data from the *Air Quality Modeling in the Gulf of Mexico Region Study* is needed to assess whether the Outer Continental Shelf (OCS) oil and gas development has impacts to Environmental Justice (EJ) communities, as required by Executive Order 12898. This information will be used by BOEM to write environmental analyses, including National Environmental Policy Act (NEPA) Environmental Impact Statements (EIS) and E.O. 12898.

Background: In the *Air Quality Modeling in the Gulf of Mexico Region Study* (Wilson et al. 2019), air quality modeling was conducted to assess the existing and future impacts (based on the 2017-2022 E&D mid-price scenario) from OCS oil and gas development to the states, as required under OCSLA section 5(a)(8), which requires compliance with the National Ambient Air Quality Standards (NAAQS) pursuant to the Clean Air Act (42 U.S.C. 7401 et. seq.). NAAQS cover

six common criteria air pollutants (carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide) that are considered harmful to the public (USEPA, 2020). The *Air Quality Modeling in the Gulf of Mexico Region Study* has been peer reviewed by the National Academy of Sciences (National Academies of Sciences, Engineering, and Medicine, 2019). Utilizing data from this existing study is valuable because the data is timely and it is a study of high public interest.

The *Air Quality Modeling in the Gulf of Mexico Region Study* found impacts in some onshore areas along the Gulf Coast of the United States but was not targeted to areas with EJ communities. The U.S. Census Bureau will release data from the 2020 decennial census beginning in spring 2021, providing updated information on the location and composition of EJ communities. Under E.O. 12898, BOEM is required to consider disproportionate human health or environmental effects of agency actions to EJ communities. Now that BOEM has new information on the spatial distribution of air quality impacts and the location and composition of EJ communities, we need to do additional analyses to understand if there are potential impacts on these communities as the first step to determining if those impacts are disproportionate. The *Air Quality Modeling in the Gulf of Mexico Region Study* modeled OCS oil and gas activities impacts at the 4 km spatial level along the Gulf Coast. The study report only detailed the area of the highest level of impact, but there are emissions impacts throughout the 4 km grid. This information can be used to focus in on areas of EJ communities.



Objectives: Identify the criteria air pollutant concentrations from OCS oil and gas activities on the air quality of EJ communities in the Gulf Coast.

Methods: Using the six demographic indicators from the Environmental Protection Agency's (EPA) EJSCREEN tool, identify census block groups containing concentrations of these populations according to principles laid out by the Council on Environmental Quality (EPA 2016,

2019). Use existing photochemical modeled data from the *Air Quality Modeling in the Gulf of Mexico Region Study* to determine the air pollutant concentrations of criteria air pollutants from new sources in single-sale and 10-sale scenarios in areas of EJ communities (Wilson et al. 2019). These sources are described in Table 4-13 in the *Air Quality Modeling in the Gulf of Mexico Region Study* (Wilson et al. 2019). The different modeled scenarios, with focus on areas of EJ communities, will be compared, as will results for EJ communities and non-EJ communities in NAAQS nonattainment areas.

Specific Research Question(s):

1. What is the air quality impacts for a no-sale scenario on areas with EJ communities?
2. What is the air quality impacts for a single-sale scenario on areas with EJ communities?
3. What is the air quality impacts for a 10-sale scenario on areas with EJ communities?
4. Do EJ communities in the Gulf Coast located in NAAQS nonattainment areas have air quality impacts from OCS activities? If so, are they disproportionate compared to impacts experienced by other communities in the NAAQS nonattainment areas?

References:

EPA. 2016. Promising Practices for EJ Methodologies in NEPA Reviews. EPA 300B16001. Washington, DC. March. Internet website: https://www.epa.gov/sites/production/files/2016-08/documents/nepa_promising_practices_document_2016.pdf. Accessed February 26, 2020.

National Academies of Sciences, Engineering, and Medicine 2019. *Review of the Bureau of Ocean Energy Management "Air Quality Modeling in the Gulf of Mexico Region" Study*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25600.

USEPA. *Criteria Air Pollutants.* Internet website: https://www.epa.gov/criteria-air-pollutants#self. Accessed February 21, 2020.

USEPA. 2019. EJSCREEN Technical Documentation. Internet website: https://www.epa.gov/sites/production/files/2017-09/documents/2017_ejscreen_technical_document.pdf. Accessed February 26, 2020.

Wilson D, Stoeckenius T, Brashers B, Do B. 2019. Air quality modeling in the Gulf of Mexico Region. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico Region. OCS Study BOEM 2019-057. Prepared by the Eastern Research Group, Inc. 655 p.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	A Programmatic Study of Chemical Products Used in Gulf of Mexico (GOM) Oil and Gas Operations: Inventory, Disposal, Spill Risks, and Potential Environmental Impacts
Administered by	New Orleans Office
BOEM Contact(s)	Ross Del Rio (ross.delrio@boem.gov), Trevis Olivier (trevis.olivier@boem.gov), Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Interagency Agreement, Contract
Performance Period	FY 2021–2024
Date Revised	April 13, 2020
PICOC Summary	
Problem	BOEM needs an up to date inventory of chemical products used by the offshore oil and gas industry. BOEM routinely receives comments and requests for this information on Lease Sale National Environmental Policy Act (NEPA) documents, often citing concerns regarding potential pollutants in produced waters.
Intervention	Literature synthesis and coordination with offshore oil and gas operators to develop an updated inventory of the chemicals used in offshore oil and gas operations and their disposal methods, as well as evaluating the risks of a spill of such chemicals.
Comparison	Comparing updated inventory data to the Boehm (2001) inventory data; including a comparison of inventory data between deep and shallow water depths and with other existing inventory data from onshore and State waters.
Outcome	This study will result in an updated chemical product inventory and understanding of the chemicals used in offshore oil and gas operations; including disposal methods, fates, and risks of a spill of such chemicals.
Context	Central GOM, Western GOM, Eastern GOM

BOEM Information Need(s): Chemical products used in the GOM remains a controversial topic to the public and of high importance to BOEM's NEPA analyses. BOEM routinely receives comments and requests for this information on Lease Sale NEPA documents from the U.S. Environmental Protection Agency, non-governmental organizations, and the general public. BOEM needs an updated, descriptive inventory of the chemicals used by the offshore oil and gas industry in the GOM. These oil and gas activities are authorized under the Outer Continental Shelf Lands Act (OCSLA). According to OCSLA (42 U.S.C. *§* 1346) BOEM must conduct assessments of environmental impacts related to oil and gas development. Furthermore, this information is needed to better evaluate the waters and sediments of the GOM, as well as the associated biota, in BOEM's leasing NEPA documents. A centralized, vetted,

and citable study such as this will aid greatly in responding to the questions and concerns that continually arise during the NEPA and consultation processes.

Background: Though Boehm et al. (2001) was originally labelled as a literature review, it had in practice a broader scope as it involved important participation from oil and gas operators, chemical suppliers, and government agencies. The study estimated chemical amounts such as sodium hydroxide, zinc bromide, surfactants, corrosion inhibitors and more. The study also developed models for offshore exploration and production operations to estimate the volume of chemical transported, stored, and expected to be used at any one time in the GOM and to assess the ecological risks of chemical spills. In addition, a study like the one proposed here was completed for chemicals associated with offshore wind power generation facilities (Bejarano et al., 2013). In this study BOEM identified volumes and types of chemicals commonly present in offshore wind turbines; modeled fate, transport, behavior, and environmental concentrations of chemicals; and an assessed the potential consequences to ecological and socioeconomic resources arising several spill scenarios.

Objective: This project would update the highly valuable Boehm (2001) report completed by BOEM (formerly Minerals Management Service). The overarching goal of this study is to develop a "cradle to grave" inventory of chemical products, compounds, and mixtures used in oil and gas exploration and production activities in the GOM that includes properties, transport, storage, usage, treatment, and disposal information while considering the risk of possible spills as well as the consequences of spills and disposal to water quality with the cumulative effects of any inputs of the same chemicals through activities other than outer continental shelf (OCS) exploration and production.

Methods: The study methods are similar to those used by Boehm et al. (2001) including participation and data collection from stakeholders, a thorough literature search, and the use of models or calculations as appropriate. For example, in the Boehm et al. (2001) study, models were used to estimate future use of chemicals, transport of chemicals, as well as the ecological risks of chemical spills (i.e., CHEMMAP). A critical component of this study will be establishing the working group.

- Formulate a strategy to establish a working group between stakeholders, and federal and state agencies;
- establish an updated baseline inventory of the chemical products, compounds, and mixtures in current use by operators in the GOM;
- estimate the amount of such chemicals expected to be used in the future in the GOM (values should be separated between shallow and deepwater depths);
- locate and collect technical information on chemical volumes in GOM operations (values should be separated between shallow and deepwater depths);
- estimate the volume of each chemical disposed of and describe the common disposal method and location;
- develop conceptual models using a range of chemical spill scenarios and predicted impacts as a result of these spills;

- develop an inventory (including Material Safety Data Sheets) of types and amounts of hazardous substances stored, handled, transferred to and from, disposed of, and used on offshore oil and gas facilities in all water depths; and
- compare volumes of chemicals released to the GOM by OCS oil and gas activities to other activities that input the same chemicals, or categories of chemicals, into the GOM directly or indirectly (e.g., runoff or river drainage).

Specific Research Question(s):

1. What chemicals are being used in all phases of offshore exploration and development in both shallow and deepwater depths?
2. What quantity of such chemicals are expected to be used in the future in the GOM?
3. What volume of each chemical (or categories of chemicals) is recycled vs disposed of, how, and where?
4. What chemical spill impacts can be reasonably expected after developing conceptual models?
5. What types and amounts of hazardous substances (defined in 40 CFR 116) are stored, handled, transferred to and from, disposed of, and used on OCS oil and gas facilities in all water depths?
6. How do volumes of chemicals released to the GOM by oil and gas activities compare to other activities that input the same chemicals, or categories of chemicals, into the GOM directly or indirectly (e.g., runoff or river drainage)?

References:

Bejarano, A.C., Michel, J., Rowe, J., Li, Z., French McCay, D., McStay, L., and Etkin, D.S., 2013. Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf. US Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-213.

Boehm, P., Turton, D., Raval, A., Caudle, D., French, D., Rabalais, N., Spies, R., and Johnson, J., 2001. Deepwater Program: Literature Review, Environmental Risks of Chemical Products Used in Gulf of Mexico Deepwater Oil and Gas Operations; Volume I: Technical Report. OCS Study MMS 2001-011. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 326 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Analysis of Onshore Intermodal Transportation that Supports OCS-Related Industries and Infrastructure in the Gulf of Mexico Region
Administered by	New Orleans Office
BOEM Contact(s)	Sindey Chaky (sindey.chaky@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	March 3, 2020
PICOC Summary	
Problem	BOEM does not have current information regarding onshore intermodal transportation that supports OCS-related industries and infrastructure, particularly roads, railroads, and waterways connected to ports and terminals.
Intervention	This study will document and analyze onshore intermodal transportation associated with OCS-related industries and infrastructure.
Comparison	This study will expand our knowledge of how onshore intermodal transportation interacts with OCS-related industries and infrastructure.
Outcome	BOEM will acquire a greater understanding of onshore intermodal transportation systems and analyses of key OCS-related onshore transportation routes, usage estimates, and geographic locations.
Context	BOEM-defined Economic Impact Areas (EIA) in the Gulf of Mexico Region.

BOEM Information Need(s): BOEM requires a better understanding of onshore transportation associated with OCS activities in order to fulfill its environmental analysis obligations under OCSLA, NEPA, and the CZMA, particularly regarding impacts to coastal communities and industries. Onshore transportation systems are critical to OCS activities, and the associated support sectors and activities are substantial inputs to the social and economic onshore consequences of the Leasing Program. Specifically, the agency needs maps and, where possible, usage estimates of major rail, road, and water transportation routes used to support OCS activities. The data will be used to support environmental analyses of infrastructure, economics, and social factors.

Background: The social and economic consequences of OCS activities occur onshore; many are associated with onshore infrastructure used to support offshore petroleum exploration, development and use. A great deal of BOEM socioeconomic research has focused on documenting and mapping the major types of OCS onshore support infrastructure, such as ports, fabrication, ship and pipe yards, heliports, and refineries; describing and documenting the industries and activities associated with these infrastructure types; and describing and documenting travel to and from offshore platforms. (Dismukes, 2010 and 2011). While BOEM's efforts include transportation systems that link the shore to the OCS, they have not

systematically addressed the onshore transportation web: the roads, railroads and waterways used in support of OCS-related activities.

The onshore intermodal transportation system supports OCS activities by allowing the movement of products among intermediate consumers (e.g., from a factory to platform fabricator) and to the final consumers. Because of the substantial demand for goods generated for OCS-related activities (e.g., pipes and umbilicals, drilling muds), inshore OCS-related transportation sectors, most notably the trucking sector, are also large. Many offshore workers commute long distances to work, which generates additional demands on transportation infrastructures. Much of this OCS-related activity is "intermodal;" equipment, materials, supplies, and people are brought to coastal areas by road, railroad, or waterway and then, are moved offshore after being transferred to a different mode of transportation at ports and heliports or transformed into vessels and platforms in fabrication and shipyards. Just as the offshore side of this system raises assessment issues, the land side does as well, due to the scale of the demand and the fact that transportation infrastructure may contribute to socioeconomic problems, some of which will likely become more pressing as deepwater developments continue to concentrate support-related activities into fewer ports.

Objectives: This study seeks to understand the effects of the onshore intermodal transportation system on industry and infrastructure by focusing on three of its commercial elements: transportation by truck, transportation by water, and transportation by rail. For each of these commercial elements, it seeks a clear picture of the system in terms of economic sectors (i.e the industries involved) and geography (i.e., flows of traffic).

Methods: This study will describe and analyze the industry sectors associated with each of the three transportation types in terms of organization, size, employment, industry trends, and their relationship to the Gulf petroleum industry and offshore oil. This study will identify and map the major onshore transportation routes used for offshore support including highways and key road connections, railroad trunk lines and key service spurs, and canals and other waterways. When appropriate, it will estimate levels of use for components of the systems. For each type of infrastructure, it will identify the various choke points (places where the transportation system is limited and/or the demands on it are high) where offshore has caused problems (e.g., LA 1). Primary and secondary information will be collected from a wide range of sources including: federal and state government databases, media and trade press publications, commercial sources, and other industry-related information such as trade association-specific publications and press announcements.

Specific Research Question(s): How does the shore-side part of the intermodal transportation system function, specifically looking at: transportation by truck, transportation by water, and transportation by rail? For each of these commercial elements what are the economic sectors and industries involved? What is their geography, and what are the flows of traffic? Where are there choke points where transportation needs are close to or exceed the infrastructure?

References:

Dismukes, D.E. 2010. Fact book: Offshore oil and gas industry support sectors. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEMRE 2010-042. 138 pp.

Dismukes, D.E. 2011. OCS-related infrastructure fact book. Volume I: Post-hurricane impact assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2011-043. 372 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Baseline Monitoring of Avian Activity and Offshore Structure Interactions
Administered by	New Orleans Office
BOEM Contact(s)	Dave Moran (dave.moran@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021-2024
Date Revised	March 2, 2020
PICOC Summary	
Problem	The negative effects of offshore structures on abundances of eastern North American nocturnally migrating bird species of conservation concern or otherwise at risk need to be determined.
Intervention	For offshore structures, technology that detects flocks of passerine birds nocturnally circling (circulating) will be used.
Comparison	Russell's (2005) study with daytime observations including any dead birds found at dawn showed variability across offshore structures in bird interactions with them. Mortality was broken down by species. Russell's (2005) mortality data (negative impacts of collisions) will be combined with this study's data: collision, starvation, and exhaustion from nocturnal circulation (negative impacts).
Outcome	The effect of birds stopping over may be somewhat negative which would not create an issue with continued use of attracting white lights to bird species of conservation concern. However, the net effect may be more serious creating a need for potential mitigation (for example, changing to green lights, downdshielding lights, or turning some lights off to stop attracting and retaining large flocks of birds flying at night).
Context	Populations of all migrating bird species that are both of conservation concern and that are trans-Gulf migrants are covered in two places: the North American breeding bird survey and the Avian Conservation Assessment Database (both of which cover all of North America). These databases could be used to identify species with unhealthy populations and this study would be directed at those species. Negative impacts of platforms would not be at the population level but could still require lighting mitigation.

BOEM Information Need(s) Results from this study will inform understanding of NEPA routine impacts (from a lease sale) and NEPA cumulative impacts (of all OCS oil and gas activities) of structure lighting and presence. Results will also indicate if there is a need to mitigate by altering the nocturnal lighting pattern on offshore structures. The level of impacts needs to be determined to apply any necessary mitigation. Russell (2005) notes that there is need for study on why certain platforms in certain areas have high mortality, what can be done about it, and

how we need a better understanding of what causes circulation events in both spring and fall. However, this study focuses on spring because then birds are encountering offshore structures after their trans-Gulf flights when their energy reserves are low. Even so, birds have migrated across the Gulf long before platforms and likely only benefit from stopping over when weather is bad (for example, storms or strong headwinds).

Background: We do not understand the effect of different colors of light on the orientation of nocturnally migrating passerine birds under different weather conditions. We also do not know the role of disorientation of such birds in their tendency to stop over and/or circle offshore structures (Evans et al., 2007; Van de Laar, 2007; Poot et al., 2008; Wiltschko et al., 2016). . Effects of light color probably affect whether or not birds are attracted to or instead fly by offshore structures (not stopping over) under various levels of visibility. This light issue is not specifically addressed in this study but if this research were to find strong negative impacts it would need to be addressed in a subsequent study. Among concepts anticipated for such a study is quantum mechanics related to the visual magnetic compass of birds (Lewis, 2018; Player and Hore, 2019). Publications are now available on this topic, but they may not be essential for designing such a study. Billions of birds migrate each year in the Americas with hundreds of millions crossing the GOM to reach their destinations. In the 1990s, MMS supported a diurnal study (Russell, 2005) that visually detected birds from certain oil/gas platforms including timing and collisions with structures. Scientists collected carcasses from the previous night to perform necropsies to detect causes of mortality. Russell (2005) identified about 200,000 bird mortalities that had occurred annually over the entire 2,400 active platforms in federal Gulf waters. From duration of circulation events and size of flocks circling, species-specific energetic models associated with circulation events might predict the incidence of exhaustion events. This study will address this as an objective.

Objectives: The study will address, for species of conservation concern or otherwise with unhealthy populations, any interactions of avian species due to collisions or exhaustion from nocturnal circulation. The first objective would be to assess whether attraction to platforms at night by white lights does no harm. The second objective is to create species-specific energetic models associated with circulation events to predict the incidence of exhaustion events due to circulation.

Methods: The Assessment Process of all the major bird initiatives (Partners in Flight landbird, waterbird, waterfowl, and shorebird initiatives) would be used to detect any unhealthy maximum global combined score for any species in this study showing negative impacts (Berlanga et al., 2010; Panjabi et al., 2012; Rosenberg et al., 2016). An unhealthy population status would also be indicated for any listed species or species of conservation concern.

Audio recorders such as the Wildlife Acoustics Song Meter SM-4 Acoustic Recorder ($849.00) with SMM_A1 ($219.00) are available. A second model audio recorder is the Nagra LB, or a custom recorder can be constructed from a Raspberry Pi Audio Card. Recently developed software for audio recorders is BirdVoxDetect (Lostanlen et al., 2019). The observers could position three audio devices on the outer edges of structures to assess exact movements and positions using triangulation. An offshore structure would first have to be assessed for ambient

noise at the potential locations of the recorders on the structures to assure that that does not interfere with recording of birds. Observers would need to be experts at bird identification. The most negative impacts of structures would probably involve large flocks of birds. Therefore, a large number (maybe 50) offshore structures would be sampled to acquire incidences of large flocks. That number would also address any issue with variability among offshore structures by using a large sample size. Compact radar could be used first to detect birds circling and then the observers could turn on audio recorders which would record to species. The observers would also periodically and briefly shine a powerful light on any circulating birds indicated on radar and use powerful binoculars to identify the bird(s) to species. Duration of circling and any observed circling bird falling into the water or leaving and continuing migration by each observed bird would be recorded. Brief exposure to bright light would minimize confounding of impacts of offshore structure lights versus impacts of the bright lights. Songbirds usually migrate at night and stop over to rest and feed during the day. That does not always happen for birds stopping over on offshore structures because birds are attracted to white lights there at night when they otherwise would be migrating. Under certain levels of visibility in the night sky, birds may show attraction to red or green lights. However, green lights usually would not attract birds so shifting from white lights to green ones would be a possible mitigation. Results of negative effects in this study could indicate the need for a follow-up study on impacts of light. Birds also sometimes migrate during the day if they do not make it all the way to a stopover site by dawn but may then stop over on offshore structures for the day. The observers could also perform necropsies to determine cause of mortality (e.g., assessing collisions, starvation, and exhaustion). Birds that starve would be found dead with no energy stores left while birds exhausted from nocturnal circulation would be birds circling and then collapsing into the water. Such birds would likely also be starved but from circling, not from trans-Gulf migration.

Species-specific models of impacts of nocturnal circulation would be developed. Data needed would be number of birds circling and duration of circling events.

Two methods suggested by Russell (2005) are not feasible. Night vision optics cannot work under cloudy skies or other types of absence of celestial light when birds would be interacting with offshore structures the most. Thermal imaging would not allow identification to species.

Specific Research Question(s): What are the levels of negative effects of OCS offshore structures on trans-Gulf migrant birds during spring migration? Will such effects be sufficiently severe such that a follow-up study on effects of light mitigation is triggered?

References:

Arnold, T.W., and R.M. Zink. 2011. Collision mortality has no discernable effect on population trends in North American birds. PloS one 6(9).

Berlanga, H., J.A. Kennedy, T.D. Rich, M.C. Arizmendi, C.J. Beardmore, P.J. Blancher, G.S. Butcher, A.R. Couturier, A.A. Dayer, D.W. Demarest, W.E. Easton, M. Gustafson, E. Inego-Elias, E.A. Krebs, A.O. Panjabi, V. Rodriguez Contreras, K.V. Rosenberg, J.M. Ruth, E. Santana Castellon, R. Ma. Vidal, and T. Will. 2010. Saving our shared birds: Partners in Flight tri-national vision for landbird conservation. Cornell Lab of Ornithology: Ithaca, NY

Evans, W.R., Y. Akasshi, N.S. Altman, and A.M. Manville. 2007. Response of night-migrating songbirds in cloud to colored and flashing light. North American Birds 60:476-488.

Lebbin, D.J., M.G. Harvey, T.C. Lenz, M.J. Andersen, and J.M. Ellis. 2007. Nocturnal migrants foraging at night by artificial light. Wilson Journal of Ornithology 119: 506-508.

Lewis, A. 2018. Spin dynamics in radical pairs. Springer.

Lostanlen, V., J. Salamon, A. Farnsworth, S. Kelling, and J. Pablo-Bello. 2019. Robust sound event detection in bioacoustics sensor networks. PLoS ONE 14(10):eo214168. https://doi.org/10.1371/journal.pone.0214168

Panjabi, A.O., W.E. Easton, P.J. Blancher, A.E. Shaw, R. Anders, C.J. Beardmore, A.F. Camfield, D.W. Demarest, R. Dettmers, R.H. Keller, K.V. Rosenberg, and T. Will. 2019. Avian Conservation Assessment Database Handbook, Version 2019. Partners in Flight Technical Series No. 8. Available from: http://pif.birdconservancy.org

Player, T.C., and P.J. Hore. 2019. Viability of superoxide-containing radical pairs as magnetoreceptors. The Journal of Chemical Physics 151:225101.

Poot, H., B.J. Ens, H. de Vries, M.A. Donners, M.R. Wemand, and J.M. Marquenie. 2008. Green light for nocturnally migrating birds. Ecology and Society, 13(2).

Rosenberg, K.V., J.A. Kennedy, R. Dettmers, R.P. Ford, D. Reynolds, J.D. Alexander, C.J. Beardmore, P.J. Blancher, R.E. Bogart, G.S. Butcher, A.S. Camfield, A. Couturier, D.W. Demarest, W.E. Easton, J.J. Giocomo, R.H. Keller, A.E. Mini, A.O. Panjabi, D.N Pashley, T.D. Rich, J.M. Ruth, H. Stabins, J. Stanton, and T. Will. 2016. Partners in Flight land conservation plan: 2016 revision for Canada and the United States. Partners in Flight Science Committee.

Russell, R.W. 2005. Interactions between migrating birds and offshore oil and gas platforms in the northern Gulf of Mexico: Final Report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2005-009. 348 pp.

Van de Laar, I. N. G. F. J. T. 2007. Green light to birds. Investigation into the effect of bird-friendly lighting. Report NAM locatie L15-FSA-1. Assen, the Netherlands: Nederlandse Aardolie Maatschappij.

Wiltschko, R., M. Ahmad, D. Nießner, D. Gehring, and W. Wiltschko. 2016. Light-dependent magnetoreception in birds: the crucial step occurs in the dark. Journal of the Royal Society Interface 13(118):20152010.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico
Administered by	New Orleans Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement, Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 13, 2020
PICOC Summary	
Problem	Abandoned oil and gas wells are not typically inspected. If there are abandoned wells that leak, little is known about the environmental impact on the air and water quality.
Intervention	Identify leaks from abandoned wells and measure to determine if the leaks are significant enough to emit air pollution at the sea surface, affect water quality, or have potential to impact coastal areas.
Comparison	Comparison between the air and water quality impacts of leaking and non-leaking abandoned wells.
Outcome	Assessment of the environmental risks from abandoned oil and gas wells.
Context	Central GOM and Western GOM

BOEM Information Need(s): BOEM needs to identify if there are abandoned oil and gas wells leaking in the GOM. These activities are authorized under the Outer Continental Shelf Lands Act (OCSLA) and leakage could have long-term impacts to the human and marine environment. According to OCSLA (42 U.S.C. *§* 1346) BOEM must conduct assessments of environmental impacts related to oil and gas development. The data collected from this study would be used in environmental analyses, prepared pursuant to the National Environmental Policy Act, because potential leaks would be identified and measured to examine the environmental risks to the water and air quality. Furthermore, this information would support BOEM's emission inventories and Tribal Consultation responsibilities. Native American Tribes have voiced concerns about the potential for oil leaks from abandoned wells to contaminate coastal areas, including archaeological sites and other resources. Finally, BOEM also needs to be aware of other federal agencies initiatives such as geological sequestration activities in the GOM. Information gained from this study may help inform future offshore geological sequestration activities by understanding the vulnerability of the wells to leakage.

Background: It has been shown that leaking abandoned oil and gas wells onshore in the United States emit methane (Townsend-Small et al., 2016a). In the State of Louisiana "orphan wells" are known with some located in state waters of the GOM (DNR, 2020). Orphan wells are unrestored abandoned oil and gas wells. In the federal waters of the GOM, it is not well

understood if abandoned wells are leaking and if this could cause long-term impacts to the air and water quality. The GOM has an abundant amount of abandoned oil and gas wells with some dating back to the 1960s. Due to the large number of wells, few inspections are conducted. Evaluating the environmental risks will support BOEM's future decommissioning environmental impact statement for the GOM.

A study funded by BOEM (formerly Minerals Management Service) conducted an operational risk assessment on temporarily abandoned or shut-in wells. Their work identified possible leak paths from permanently abandoned wells. They also found wells with sour fluids—those containing significant amounts of hydrogen sulfide—have a significantly higher probability of premature component failure because of higher corrosion rates (Nichol et al., 2000). Often abandoned wells are injected with waste fluids in accordance with the National Pollutant Discharge Elimination System (NPDES) general permit (USEPA, 2017). The risks associated with downhole waste are unknown.

In the future, abandoned wells could be injected with carbon dioxide (CO_2) for permanent geologic storage. A primary concern for the security of CO_2 storage is the potential for leakage through pre-existing wellbores (Nogues et al., 2012). The Department of Energy (DOE) has been conducting research projects on assessing offshore storage potential in the GOM (DOE, 2020) and the Internal Revenue Service (IRS) recently published a news release on carbon capture credits (IRS, 2020).

Objectives:

- Identify if abandoned oil and gas wells leak.
- Measure the leak characteristics to determine if the leak is significant enough to emit air pollution at the sea surface, affect water quality within the water column or have the potential to impact coastal areas.

Methods: This project would identify leaks from 30–50 randomly selected abandoned wells by using subsurface cameras, water column measurements (temperature, dissolved oxygen, dissolved methane, etc.), and surface measurements. This would include collecting water samples from leaking and non-leaking wells to extract volatile air pollutants (methane and volatile organic compounds) using headspace extraction methods (Townsend-Small et al., 2016b). Wells selected for this study may include areas for potential CO_2 geological storage (DOE, 2020). Video footage would be collected using a remotely operated vehicle (ROV). Water samples and water column measurements would be collected using a water sampler device and Sonde, respectively. Water column profiles would be generated. Satellite data may be used to identify the extent of leaks. For oil, slicks have been observable by the synthetic aperture radar (MacDonald et al., 2015).

Specific Research Question(s):

1. Are there abandoned oil and gas wells leaking in the GOM?
2. Is there a correlation between the age of well and potential for leakage? Or other correlations?
3. Are the leaks enough to emit air pollution at the sea surface?

4. If the leaks are enough to emit air pollution at the sea surface, what are the emission rates?
5. Are the leaks enough to affect water quality in the vicinity of the well?
6. Do the leaks have the potential to reach coastal areas?

References:

DOE. *OFFSHORE PROJECTS.* Accessed April 2, 2020. Internet website: https://netl.doe.gov/coal/carbon-storage/storage-infrastructure/offshore-projects

IRS. *IRS provides answers and a safe harbor on carbon capture credits.* Accessed April 2, 2020. Internet website: https://www.irs.gov/newsroom/irs-provides-answers-and-a-safe-harbor-on-carbon-capture-credits

MacDonald I.R., Garcia-Pineda O., Beet A., Daneshgar-Asi S., Feng L., Graettinger G., French-McCay D., Holmes J., Hu C., Huffer F., Leifer I., Muller-Karger F., Solow A., Silva M., Swayze G. 2015. *Natural and unnatural oil slicks in the GOM.* Journal of Geophysical Research: Oceans, 120(12):8364–8380. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2015JC011062

Nichol J.R., Kariyawasam S.N. 2000. *Risk Assessment of Temporarily Abandoned or Shut-in Wells.* Minerals Management Service. https://www.bsee.gov/research-record/tap-329-risk-assessment-temporarily-abandoned-or-shut-wells

Nogues J.P., Court B., Dobossy M., Nordbotten J.M., Celia M.A. 2012. *A methodology to estimate maximum probable leakage along old wells in a geological sequestration operation.* International Journal of Greenhouse Gas Control. 7:39-47 https://doi.org/10.1016/j.ijggc.2011.12.003.

DNR. *Oilfield Site Restoration (OSR) Program.* Accessed April 7, 2020. Internet website: http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=155

Townsend-Small A., Ferrara T.W., Lyon D.R., Fries A.E., Lamb B.K. 2016a. *Emissions of coalbed and natural gas methane from abandoned oil and gas wells in the United States.* Geophysical Research Letters, 43: 2283-2290, https://doi.org/10.1002/2015GL067623.

Townsend-Small A, Disbennett D.A., Fernandez J.M., Ransohoff R.W., Mackay R.,Bourbonniere R. 2016b. *Quantifying emissions of methane derived from anaerobic organic matter respiration and natural gas extraction in Lake Erie.* Limnology and Oceanography, 61: S356-S366, https://doi.org/10.1002/lno.10273.

USEPA. *The NPDES General Permit for New and Existing Sources and New Dischargers in the Offshore Subcategory for the Western Portion of the Outer Continental Shelf of the Gulf of the Mexico (GMG290000).* Accessed February 13, 2020. Internet website: https://www.epa.gov/sites/production/files/2017-09/documents/2017_final_gp_for_fr_091817.pdf.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Impacts of Drilling on Biological and Archaeological Resources: Revisiting Resource Avoidance Guidance for Wellsite Surface Locations
Administered by	New Orleans Office
BOEM Contact(s)	Katherine Segarra (Katherine.Segarra@boem.gov), Scott Sorset (Scott.Sorset@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2024
Date Revised	April 2, 2020
PICOC Summary	
Problem	As the scope of exploration and development of oil and gas resources on the U.S. Outer Continental Shelf (OCS) expands, the efficacy of BOEM's current mitigations should be examined. Specifically, the impacts of drilling activities on benthic environmental and cultural resources should be better characterized to design effective mitigation measures for OCS oil and gas development.
Intervention	Current avoidance measures and other mitigation strategies will be evaluated based on the results of this study to minimize impacts from drilling activities on biological and archaeological resources
Comparison	Assess the potential impacts of drilling at depths relevant to anticipated development scenarios through pre- and post-drilling measurements and comparisons to expected results from CSA's 2006 study.
Outcome	The results of this study will determine whether current minimum separation distances between well site surface locations and potentially sensitive biological and cultural resources are sufficient and to make recommendations regarding future stipulations and post-lease mitigations. This effort aligns with BOEM's adaptive management and long-term monitoring practices.
Context	Drilling sites at depth ranges between 200 and 3000 m applicable to future forecasted Gulf of Mexico OCS Region drilling and inform impact assessments in all OCS regions .

BOEM Information Need(s): Understanding the impacts of OCS activity on benthic and cultural resources is paramount to the environmentally responsible development of oil and gas. This study will examine how seabed disturbance via drilling may affect biological resources (e.g., shallow and deepwater coral, benthic fish species, chemosynthetic communities, and other live bottom habitats), cultural resources (e.g., shipwrecks), and protected and regulated resources (e.g., Essential Fish Habitat [EFH]). BOEM's current mitigations rely on limited and dated studies (CSA 2006; NRC 1983; Neff 2005) to determine the minimum distance(s) necessary to avoid impacts to biologically sensitive areas and archaeological resources. BOEM is responsible for

documenting these routine impacts as part of its environmental compliance practices under the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), National Historic Preservation Act (NHPA), Magnuson-Stevens Act, and OCS Lands Act. The results of this study will satisfy information needs on drilling disturbance for NEPA analyses and inform an evaluation on current avoidance buffers for post-lease drilling activity.

Background: Bottom-disturbing operations, such as drilling wells and placement of infrastructure, can cause damage to any resources that reside on or near the seabed. Biological and archaeological resources are particularly sensitive to those impacts. Biologically sensitive communities may be smothered or exposed to toxins and archaeological resources may be permanently destroyed. Stipulations to avoid and protect such habitats have been made a part of appropriate OCS oil and gas leases since 1973. However, the efficacy of BOEM's mitigations regarding bottom impacts has not been rigorously evaluated or updated since a 2006 study (CSA 2006), which examined physical, chemical, and biological impacts from drilling in medium water depths.

A better appraisal of the potential benthic impacts from drilling is needed to ensure environmentally responsible development of the OCS. Thus, examining the efficacy of current mitigation measures would help the Bureau prepare and plan for expected scales of impact to ecologically sensitive benthic environments.

Objectives:
Understand the effects of accumulation of drilling muds and cuttings on the seafloor. The results would immediately inform BOEM's current avoidance mitigations and would help guide further investigations of drilling impacts.

- Assess the impact distance of drilling for benthic habitats and shipwrecks as determined by sediment/drilling mud accumulation.
- Compare the accumulation of drilling muds and cuttings at drill sites of differing water depth and other geophysical features (e.g., current regimes, sediment type). This includes a comparison of results with those from CSA (2006).
- Evaluate current mitigations against findings of drilling activity impacts and provide recommendations to management on best practices for mitigations regarding bottom-disturbing activities.

Methods: Through the drilling permit process, study sites will be identified that are targeted for imminent drilling. CSA (2006) sampled drilling sites in 1000 to 1125 m water. This study will target duplicate sites in shallow, shelf water (200 –300 m), medium depths (1000-1500 m; to compare directly with CSA) and deeper (2000–3000 m) water.

Comparison of seabed data (multibeam, sidescan sonar, sub-bottom profiler, and photomosaics) collected via Autonomous Underwater Vehicle (AUV) before and after drilling will allow BOEM to determine the vertical and horizontal extent of drill splay. Baseline data will be collected prior to drilling and the surveys will be repeated (with the same equipment on the same survey lines) within one year after drilling. If permissions are obtained, gravity cores will

also be collected within the drill splay to provide an independent assessment of vertical accumulation and to characterize the deposited muds and cuttings. Coring locations will be determined based on the results of the post-drilling survey to target the drill splay. Four cores will be collected along a single transect along the radius of the maximum drill splay starting at 1000' minimum distance from the drill site. A fifth, 'control' core will be taken outside of the splay at the edge of the survey area (~10,000 feet from drill site). Potential target analyses on the sediment cores include grain size, heavy metals, and hydrocarbon compounds.

Specific Research Questions:

1. How does the accumulation of drilling muds and cuttings vary with distance from drill site and water depth?

2. Are BOEM's current avoidance guidelines for well site surface locations sufficient to mitigate impacts to biological and archaeological resources?

References:

Austin, D., B. Carriker, T. McGuire, J. Pratt, T. Priest, and A. G. Pulsipher. 2004. History of the offshore oil and gas industry in southern Louisiana: Interim report; Volume I: Papers on the evolving offshore industry. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2004-049. 98 pp.

Continental Shelf Associates, Inc. 2006. Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico. Volume I: Executive Summary. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2006-044. 45 pp.

DeBlois, E. M., D. Paine, B. W. Kilgour, E. Tracey, R. D. Crowley, U. P. Williams, G. G. Janes. 2014. Alterations in bottom sediment physical and chemical characteristics at the Terra Nova offshore oil development over ten years of drilling on the grand banks of Newfoundland, Canada. Deep Sea Research Part II: Topical Studies in Oceanography 110: 13-25.

Henry, L-A, Harries, D, Kingston, P & Roberts, J. 2017. Historic scale and persistence of drill cuttings impacts on North Sea benthos. Marine Environmental Research. DOI: 10.1016/j.marenvres.2017.05.008.

National Research Council (NRC). 1983. Drilling Discharges in the Marine Environment. Panel on Assessment of Fates and Effects of Drilling Fluids and Cuttings in the Marine Environment, September 26, 1982. Washington, DC: National Academy Press for Marine Board, Commission on Engineering and Technical Systems, NRC, 180 pp.

Nedelec, S. L., A. N. Radford, S. D. Simpson, B. Nedelec, D. Lecchini and S. C. Mills (2014). "Anthropogenic noise playback impairs embryonic development and increases mortality in a marine invertebrate." Scientific Reports 4: 5891.

Neff, J. 2005. Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment: a synthesis and annotated bibliography. Report prepared for the Petroleum Environmental Research Forum (PERF) and American Petroleum Institute, Washington, DC.

Salerno, J., Little, B., Lee, J., Hamdan, L. J. (2018). Exposure to Crude Oil and Chemical Dispersant May Impact Marine Microbial Biofilm Composition and Steel Corrosion. Frontiers in Marine Science, 5(196), 1-14.

Solan, M., C. Hauton, J. A. Godbold, C. L. Wood, T. G. Leighton, and P. White (2016). "Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties." Scientific Reports 6: 20540.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Impacts of Nonstationary Source Air Emissions on Stationary Source Air Emissions
Administered by	New Orleans Office
BOEM Contact(s)	José L. Hernández (jose.hernandez@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2025
Date Revised	February 20, 2020
PICOC Summary	
Problem	Nonstationary source air emissions could contribute to air quality regulatory exceedances when nearby emitting stationary sources.
Intervention	Perform air dispersion modeling to determine at what distance could the nonstationary source(s) affect emissions from the nearby stationary source(s).
Comparison	Compare air quality regulatory standards, combined nonstationary sources and stationary sources modeled pollutant concentrations, and individually modeled pollutant concentrations of nonstationary sources and stationary sources.
Outcome	Provide guidance on distances at which nonstationary source(s) should be considered in a stationary source air quality analysis.
Context	Central Gulf of Mexico, Western Gulf of Mexico

BOEM Information Need(s): BOEM needs to learn how distances between nonstationary and stationary sources within a project influence dispersion modeling result. As part of plan review process, explained at 30 CFR 550 Subpart B, the oil and gas operator may need to present an air quality modeling report because projected emissions exceed the BOEM exemption levels. The modeled scenario could simply represent one stationary source of emissions or could be as complex as to include a combination of stationary and nonstationary sources within a radius of 10 or more miles. Through modeling experiments this study will explore the significance of distance, among sources and to shoreline, on predictions of the air quality impact and the results will be used to improve the plans review process.

Background: BOEM regulates emissions for projects that range from compact, occupy less than one square mile to the spider-like deep-water projects where wells may produce to a floating production host facility ten or more miles away. This wide range of project architecture results in air pollution emissions that may originate within a compact area or over a 100 square mile area.

Objectives: The objective of this study is to determine the distances between stationary and nonstationary air pollution sources within a single project or projects , hereafter called

scenario, and the distances to the shoreline at which the sources within the scenario should be evaluated as a single source or as independent pollution sources. The second objective is to present this information so it can be used as guidance to improve the plan review process.

Methods: The study has three parts, analysis of synthetic emission sources, analysis of actual emission sources and guidance development for BOEM. The first part evaluates synthetic scenarios that combine multiple emissions sources and determines their impact to shoreline. Here, a scenario is a combination of mobile and stationary sources at realistic distances from each other, based on plans reviewed by BOEM. Combination of sources should be comprehensive enough to cover simple plans (e.g., platform and few support vessels) up to complex plans (e.g., several platforms, mobile offshore drilling units (MODUs) and support vessels spread across several blocks. This part simultaneously evaluates individual sources and the scenario (all-contained) at a specific distance to shoreline, then smoothly moving away from the shoreline determines at which distance sources within a single scenario are independent based on shoreline concentrations.

Secondly, the study will evaluate several actual emission sources in the GOM to confirm the synthetic source results. The actual source cases will be based on a range of Gulf of Mexico projects, small and large, shallow water and deep water, compact or expansive, their characteristic drilling and production emissions, the distances between the sources that comprise the project and the distance from the project to shore. The results from the synthetic source modeling and the actual source modeling will be compared to ensure that the study has evaluated a wide range of emissions and source configurations.

Lastly, the effort will develop guidance to assist BOEM to determine if the proposed emissions of the project should be considered as one project or several independent sources. That determination will influence the plan review determination as to whether the proposed emissions are within the regulatory Emission Exemption Thresholds. Finally, the guidance would assist BOEM to determine when to re-assess emissions from otherwise exempt facilities, that may in combination with other facilities in the area, affect the air quality of an onshore area according to 30 CFR 550.303(j).

Specific Research Question(s): Does BOEM's existing modeling guidance for operators represent the impacts from both the stationary and non-stationary emissions sources within a project at the shoreline point of regulatory compliance? If not, how can BOEM objectively set policy so as to protect the shoreline point of regulatory compliance?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Meeting the Challenge: Developing Socioeconomic Baseline Data Collection and Rapid Response Research Plans
Administered by	New Orleans Office
BOEM Contact(s)	Victoria Phaneuf (victoria.phaneuf@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2021–2023
Date Revised	February 19, 2020
PICOC Summary	
Problem	BOEM lacks a protocol for conducting research on the socioeconomic effects of catastrophic events.
Intervention	Identify and document best practices in research on catastrophic events and monitoring to support that research.
Comparison	Identify best research practices and protocols for studying catastrophic events that respond to our mission and are informed by the best available science.
Outcome	BOEM will gain information and analysis necessary for its development of monitoring and catastrophic event research protocols.
Context	Staff are working on developing a monitoring program and a rapid response research protocol for the Gulf of Mexico Region (GOMR). This research would support that effort.

BOEM Information Need(s): BOEM's social science research program is not organized to respond quickly to catastrophic events with studies of their socioeconomic effects. Of relevance to BOEM's mission, these include hurricanes that impact the offshore oil and gas industry, such as Harvey, and significant oil spills, such as Deepwater Horizon.

As a result, despite public interest and concern, how these events affect various communities and the oil industry is poorly understood. This knowledge gap hinders BOEM's ability to analyze catastrophic spill impacts in its National Environmental Policy Act (NEPA) documentation, as recommended by the Council on Environmental Quality (2010). Long-term monitoring on the human environment is mandated in the Outer Continental Shelf Lands Act (OCSLA), would contribute to national OCS oil and gas leasing program development and NEPA analysis of the cumulative effects of OCS activity, and would provide a baseline for understanding the impacts of catastrophic events. BOEM does not have: 1) a protocol for socioeconomic research in case of a catastrophic event, or 2) a socioeconomic monitoring program. GOMR staff are working to improve BOEM's NEPA assessments and future Environmental Studies Program (ESP)-supported research on cumulative impacts and catastrophic events by developing a monitoring program and a catastrophic event research protocol. This study will support that effort.

Background: Catastrophic events, including oil spills and hurricanes, while rare, can have significant and complex socioeconomic impacts. The low rate of occurrence combined with the immediacy of their impacts mean that research efforts are difficult to plan in advance. These research efforts must rely on existing baseline data if they are to illustrate changes resulting from an event. Such research is difficult to incorporate into existing agency and university studies models that require months or years of planning and contracting before a study can begin. For these reasons, most of the existing research on catastrophic events did not incorporate baseline data or data on immediate impacts. For example, during the Deepwater Horizon spill in 2010, BOEM was the only Federal agency that responded with a study of the socioeconomic impacts as they were occurring (Austin et al., 2014). This was not planned in advance: BOEM was fortunate enough to have a seasoned team of contractors conducting fieldwork in the area and could quickly redirect the research. In the years following the spill, considerable resources were devoted to understanding the disaster's impacts (NAS 2017), but could not make up for their lack of baseline knowledge and early, sustained data collection.

Rapid-response research protocols exist (i.e., NHC 2017; NIEHS 2017). They are not suited to BOEM's needs because they cover many kinds of disasters and are therefore not sufficiently targeted. BOEM's interest is focused on catastrophic events impacting its OCS activities. The rarity of such events presents challenges to program and study development and funding not addressed by existing rapid-response protocols.

While BOEM's geographic focus presents challenges, it also offers an opportunity: socioeconomic monitoring of affected areas would provide baseline information that much rapid-response research lacks. For BOEM, systematic collection of baseline data is already desired to support a holistic understanding of the cumulative impacts of OCS activity. If carefully designed, this will also provide information necessary to studying the impacts of rare events.

Objectives: GOMR staff are working to outline a socioeconomic monitoring protocol and catastrophic event research plan. This study will provide expert and technical support by identifying best practices in rapid-response research. The objectives for this study are:

- To identify key background socioeconomic data and associated best practices for data collection needed to study catastrophic events in the GOM needed to support a long-term monitoring plan.
- To identify and assess existing protocols for socioeconomic rapid-response research and suggest adaptations to meet BOEM's needs.

Methods: This study will review and analyze existing socioeconomic rapid-response research programs, protocols, and theories to synthesize relevant research and government agency practice and identify best practices for developing a studies program designed to collect baseline information and conduct socioeconomic research on catastrophic events.

Specific Research Question(s):

1. What existing protocols and best practices suit BOEM's research needs for understanding catastrophic events?

2. What baseline data should be collected as part of a long-term monitoring plan to support this effort?

References:

Austin, D., B. Marks, K. McClain T. McGuire, B. McMahan, V. Phaneuf, P. Prakash, B. Rogers, C. Ware, and J. Whalen. 2014. Offshore Oil and the Deepwater Horizon: Social Effects on Gulf Coast Communities. BOEM 2014-617 and BOEM 2014-618. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region.

Council on Environmental Quality (CEQ). 2010. Report regarding the Minerals Management Service's National Environmental Policy Act policies, practices, and procedures as they relate to Outer Continental Shelf oil and gas exploration and development. 41 pp.

National Academy of Sciences (NAS). 2017. Gulf Research Program. Online: http://www.nationalacademies.org/gulf/about/index.html. Accessed January 18, 2017.

Natural Hazards Center (NHC) 2017. Quick Response Grant Program. Online: https://hazards.colorado.edu/research/quick-response. Accessed January 23, 2017.

National Institute of Environmental Health Sciences (NIEHS). 2017. NIH Disaster Research Response (DR2). Online: https://dr2.nlm.nih.gov/protocols. Accessed January 18, 2017.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Of National Significance: The Gulf's Nineteenth-Century Shipwrecks
Administered by	New Orleans Office
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov), Douglas Jones (douglas.Jones@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2024
Date Revised	February 14, 2020
PICOC Summary	
Problem	BOEM is responsible under Section 110 of NHPA for nominating historic properties to the NRHP. Since there is no regulatory timeline for completion, staff resources are instead dedicated to the persistent and time-sensitive demands of NEPA and operational permitting. As a result, GOMR has a backlog of NRHP eligible nineteenth-century historic properties that have been subject to archaeological analysis but have not been nominated. Additionally, compiling the information for each nomination package is time-intensive and requires an individual with experience in writing successful nominations that meet the requirements of the Keeper of the NRHP.
Intervention	Develop a detailed historic context encompassing the range of nineteenth-century shipwrecks that have been or may be discovered on the Gulf of Mexico O.C.S. Using this historic context as supporting documentation, as well as existing BOEM archaeological data, complete and submit NRHP nominations for up to 12 individual shipwreck sites.
Comparison	Requirements will be compared against the criteria for evaluation for listing in the NRHP set forth by the National Park Service.
Outcome	BOEM has numerous shipwrecks falling under the umbrella of nineteenth-century seafaring in the Gulf of Mexico that must be nominated to the NRHP, therefore this effort fulfills of BOEM's obligations under Sec. 110 of the NHPA to nominate eligible properties within its jurisdiction to the NRHP.
Context	Oceangoing vessels of the nineteenth-century Gulf of Mexico

BOEM Information Need(s): The Bureau of Ocean Energy Management (BOEM) is responsible under Section 110 of the National Historic Preservation Act (NHPA [54 U.S.C. 306102(b)(1)]) for nominating historic properties to the National Register of Historic Places (NRHP). Since there is no regulatory timeline for completion, these efforts fall by the wayside against the persistent and critical demands of the National Environmental Policy Act (NEPA) and operational permitting. Additionally, compiling the information for each nomination package is time intensive. It benefits from an individual experienced in writing successful nominations of shipwrecks that meet the requirements of the Keeper of the NRHP as well as knowledge of the

historical and maritime context of the period. Due to the Agency's typical operational priorities, BOEM staff are unable to dedicate the resources or time necessary to complete these nominations in a timely manner. These archaeological resources are regionally and nationally significant, and this effort will provide BOEM with a spotlight to the Agency's years of a concerted effort in their documentation and research.

Background: BOEM has served as the primary Federal Steward of the cultural heritage found on the Gulf of Mexico Outer Continental Shelf (O.C.S.): protecting or mitigating effects to known sites from energy development and mineral extraction through the establishment of avoidance requirements; studying important sites in conjunction with Federal, State, and Tribal partners; and nominating significant historic properties to the NRHP. Nominating sites in the deep sea (sometimes exceeding 10,000 feet) requires additional coordination best performed by specialists who have experience successfully nominating submerged properties to the NRHP, and who can advise BOEM through the development of a best practices document on finding ways to fulfill our statutory obligations.

BOEM has become internationally recognized for the vast array of nineteenth-century shipwrecks discovered during industry archaeological surveys before or during exploration of the O.C.S., and which have been further documented through BOEM-sponsored archaeological investigations and environmental studies (Atauz et al. 2006; Church and Warren 2008; Ford et al. 2008; Brooks et al. 2016). At least 12 potentially NRHP eligible nineteenth-century shipwrecks have been discovered to date. We are confident these are likely eligible for the Register and have sufficient data available for a contractor to prepare nominations. Due to the extent of maritime activity during that time period, the Gulf of Mexico is a hotspot for these historically significant cultural resources and BOEM needs to fulfill its responsibility to have these sites nominated to the NRHP in support of the Department of the Interior's mission to "conserve and manage the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people…" (N.P.S., 1997).

The protection of historical sites as significant symbols of our American heritage became a national policy through the enactment of the 1906 Antiquities Act, the 1935 Historic Sites Act, and the 1966 National Historic Preservation Act (NHPA), as amended. Congress empowered the Secretary of the Interior to manage the Nation's preservation program with the mission to recognize significant properties of archaeological and historical nature that may be in the form of districts, sites, buildings, structures, and objects significant in history or prehistory. Nominating eligible properties to the National Register is a crucial step and obligation within all Federal preservation programs (N.P.S., 1997).

Objectives:

- Develop a historic context document to support nominations, either individually or as multiple properties, of the range of eligible nineteenth-century shipwrecks in the Gulf of Mexico that have been or that may yet be discovered.
- Develop a best practices document to facilitate the efficient creation of future nomination packages by BOEM subject matter experts. Develop nomination packages

for 12 shipwrecks that are likely eligible to fulfill BOEM's requirements under Section 110 of the NHPA.

- In the spirit of sharing this heritage with the American Public, professionally produce five-minute video documentaries of each of the twelve sites using photographs, ROV footage, and interviews with scientists to be hosted on the BOEM website.

Methods: The contractor will use guidance provided in National Register Bulletins 12, 15, 16A, 16B, 20, 21, 28, and 36, combined with previous site investigation data and site reports on file with BOEM, to produce national register nominations for the below listed sites. The contractor will also produce a comprehensive historic context document for nineteenth-century shipwrecks in the Gulf of Mexico and incorporate that information into NRHP nomination forms and a multi-property listing.

The twelve sites selected as potentially eligible for nomination proposed are:

#	Site Name	Vessel ID	#	Site Name	Vessel ID
1	7,000 Foot Wreck	15373	7	Monterrey A Shipwreck	15577
2	15377 Shipwreck	15377	8	Monterrey B Shipwreck	15578
3	Ewing Bank Shipwreck	15401	9	Monterrey C Shipwreck	15583
4	Green Lantern Shipwreck	337	10	New York	344
5	Mardi Gras Shipwreck	15321	11	Viosca Knoll Shipwreck	15303
6	Mica Shipwreck	15169	12	Vernon Basin 2109 Wreck	15831

Specific Research Question(s):

1. How do these twelve shipwrecks demonstrate the critical elements for eligibility themselves and for others not yet discovered?
2. Overall how do these resources contribute to our understanding of our Nation's nineteenth-century heritage?
3. Are any of the sites not included eligible under the multiproperty listing?
4. How does each site individually meet the criterion for listing in the NRHP?

References:

Atauz, A.D., W. Bryant, T. Jones, and B. Phaneuf. 2006. Mica shipwreck project: Deepwater archaeological investigation of a 19th Century shipwreck in the Gulf of Mexico. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico O.C.S. Region, New Orleans, LA. O.C.S. Study MMS 2006-072. 116 pp.

Brooks, J.M., C. Fisher, H. Roberts, E. Cordes, I. Baums, B. Bernard, R. Church, P. Etnoyer, C. German, E. Goehring, I. McDonald, Harry Roberts, T. Shank, D. Warren, S. Welsh, G. Wolff, D. Weaver. 2015. Exploration and research of northern Gulf of Mexico deepwater natural and artificial hard-bottom habitats with emphasis on coral communities: Reefs, rigs, and wrecks—"Lophelia II" Final report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico O.C.S. Region, New Orleans, LA. O.C.S. Study BOEM 2016-021. 628 p.

Church, R.A. and D.J. Warren. 2008. Viosca Knoll Wreck: Discovery and investigation of an early nineteenth-century sailing ship in 2,000 feet of water. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico O.C.S. Region, New Orleans, LA. O.C.S. Study MMS 2008-018. 41 pp.

Ford, B., A. Borgens, W. Bryant, D. Marshall, P. Hitchcock, C. Arias, and D. Hamilton. 2008. Archaeological excavation of the Mardi Gras Shipwreck (16GM01), Gulf of Mexico continental slope. Prepared by Texas A&M University. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico O.C.S. Region, New Orleans, LA. O.C.S. Report MMS 2008-037. 313 pp.

National Parks Service, U.S. Department of Interior. Revised 1997. How to Apply the National Register Criteria for Evaluation. By P.W. Andrus, R.H. Shrimpton, B.L. Savage, S.D. Pope, A.J. Lee, T. Gossett, and K. Badamo. Washington: Government Printing Office, February 1990. (National Register Bulletin no. 15).

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Offshore Analysis of Seafloor Instability and Sediments (OASIS Partnership) with Applications to Offshore Safety and Marine Archaeology
Administered by	New Orleans Office
BOEM Contact(s)	Doug Jones (douglas.jones@boem.gov), Melanie Damour (melanie.damour@boem.gov), Guillermo Auad (Guillermo.Auad@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2021–2026
Date Revised	February 12, 2020
PICOC Summary	
Problem	Gravity flows (GF) (or currents) in the Mississippi River Delta Front (MRDF) are known to displace large volumes of sediment mixed with seawater. These high-energy events have damaged infrastructure, causing multiple oil spills including the second largest oil spill in U.S. history. GF additionally have displaced shipwrecks hundreds of meters over short time periods, potentially impacting these wrecks and further endangering nearby oil and gas infrastructure. There is currently a limited understanding of the triggering mechanisms for GF, the dynamic processes at work once they are underway, as well as their frequency, power, and scale.
Intervention	Use new and existing data sets to characterize sediments and physical oceanographic processes at selected locations in the MRDF, including known shipwreck locations; conduct baseline archaeological analysis at these sites; and test if *in situ* acoustic sensors could monitor potential future shipwreck displacement due to GF activity.
Comparison	Evaluate the spatial extent, frequency, and magnitude of previous GF events at these selected locations, relative to regional and site-specific analyses from previous studies within the MRDF.
Outcome	Identification of high, intermediate, and low-risk areas for future occurrence of GF. Identification of key locations to deploy monitoring equipment able to detect intermediate to large high-energy sediment transport events. Obtain a better understanding of environmental factors and processes that initiate these events in the MRDF and test new and/or existing technologies to detect and monitor GF events.
Context	Central GOM; MRDF offshore Louisiana

BOEM Information Need(s): This study proposes a multi-disciplinary investigation of selected known and potential shipwreck sites within the Mississippi River Delta Front (MRDF) as markers to identify previous and predict future impacts from Gravity Flows (GF; also called density flows or gravity currents), and to examine the localized environmental factors influencing the

magnitude and frequency of these events. A better understanding of GF occurrences and their impacts is needed to inform BOEM's National Historic Preservation Act (NHPA) and National Environmental Policy Act (NEPA) analyses of the affected environment and potentially significant historic properties on the OCS; to develop appropriate mitigation strategies for industry avoidance of shipwrecks and benthic habitats in the MRDF; and to inform leasing and permitting decisions regarding exploration and development activities in the MRDF. Specifically, the information needed includes: a) the type, size, distribution, and depth of sediments; b) the probability of GF event occurrence in the study area in the short-term (i.e., sub-decadal) and identification of low- to high-risk areas; c) documentation and monitoring of known shipwreck locations and conditions; d) the impacts of gravity flows on benthic communities; and e) an evaluation of the applicability of new or existing technologies to detect high-energy sediment transport events in the study areas remotely, more accurately, and in near real time.

Background: Gravity Flows are driven by gravitational forces, involve a combination of water and sediments or rocks, and require a sloping bottom to develop momentum. Scientists classify GFs into several sub-types depending on their density, among other properties, e.g., debris flows, hyperpycnal flows, grain flows, fluidal flows, and turbidity flows, among others. The OASIS study will consider any high-energy sediment transport as GFs in general.

The MRDF is a highly dynamic environment where oceanic, atmospheric, and fluvial drivers interact. These interactions include sediment deposition, seafloor instability, annual storms and hurricanes, and occasional high-energy sediment transport processes. In 2004, the Taylor Energy platform in MC20 was toppled by gravity flows a few days after the passage of Hurricane Ivan. This led to the longest and second largest oil spill in U.S. history. Annually, GFs are the cause of about 5% of all broken/damaged pipelines in the Gulf of Mexico. In addition to being actively leased for oil and gas development, the MRDF also contains dozens of known shipwrecks of potential historical significance and benthic habitats. Industry surveys and recent BOEM collaborative research yielded evidence that shipwrecks are being displaced as much as hundreds of meters by GF events of unknown frequency and scale (Chaytor et al. 2019). As part of its responsibilities under the NHPA, BOEM requires avoidance of historic shipwrecks during permitted activities; however, there is often a delay of years or decades between when industry surveys locate these sites and when permitted activities take place. During this interval, sediment transport processes have displaced shipwrecks in the MRDF beyond the boundaries of the initial avoidance requirement, placing both the archaeological sites and industry infrastructure at risk.

Since the late 1970s, BOEM and industry have sponsored numerous studies that examined sediment transport in the MRDF and identified areas of instabilities and GF activity that pose a considerable risk to oil- and gas-related infrastructure (Coleman et al. 1980, Nodine et al. 2007, Bentley et al. 2018). Using coupled ocean-wave-sediment models, Arango et al. (2016) identified a time lag of a few days between maximum atmospheric forcing and maximum offshore sediment transport, consistent with observed time lag between the passage of Hurricane Ivan in 2004 and the toppling of the Taylor Energy platform (MC20) by GFs. Many of these studies have identified impacts to oil and gas infrastructure following hurricanes or major

storm events; however, more recent studies suggest that GFs may be occurring during annual or shorter timescales (Obelcz et al. 2017, Galloway 2017).

Industry surveys of lease blocks within the MRDF to date have resulted in avoidance mitigations applied to 11 suspected shipwrecks and another 10 sonar targets indicative of potential shipwrecks. Repeat surveys have identified significant seafloor displacement of at least three of these shipwrecks, including a known World War II casualty (S.S. *Virginia*) and another suspected World War II wreck (S.S. *Rawleigh Warner*). Only *Virginia*'s current location is accurately known, and GFs have moved it more than 500 m since it was discovered in 2003, well outside of its original avoidance area. The movement of shipwrecks during GF could pose a hazard to nearby pipelines or other oil and gas infrastructure and introduce adverse impacts to the shipwrecks that invalidate previous NEPA and NHPA analyses, potentially triggering renewed agency consultations. Furthermore, because these shipwrecks provide temporally well-constrained markers of short- and long-term GF dynamics, they are invaluable seafloor features for evaluating the geologic conditions actively driving GFs.

BOEM is currently leading an interagency working group (OASIS) of Federal agencies with scientific research and/or resource management interests related to GFs in the MRDF. The OASIS group currently includes BOEM, BSEE, USGS, NOAA, Naval Research Laboratory, Naval Oceanographic Office, and National Geospatial-Intelligence Agency. BOEM anticipates that there will be multiple partnership opportunities to collaboratively achieve the objectives of this study.

Objectives: In addition to other objectives from OASIS partners, BOEM's are:

- Identify areas of past high-energy sediment transport, i.e., GFs.
- Identify areas of low to high risk for the near-future occurrence of GFs.
- Quantify the volume, frequency, energy, and speed of past events.
- Identify hazard potential/risk for shipwrecks, offshore infrastructure (including pipelines) based on their location, type, and occurrence and probability.
- Provide quantitative and qualitative characterizations of benthic communities affected by these events, e.g., before and after descriptions.
- Track the long-term movement of known shipwrecks and evaluate their physical condition while characterizing chemical and biological states over time.

Methods: Analyze existing and to-be collected observational data including a) sediment type, size, depth; b) time-series bathymetry; and c) acoustic recordings as well as modeling results aimed to enhance our understanding of triggering mechanisms and GF evolution processes. Use machine-learning tools to identify historical events and patterns among other applications. In addition, select known and potential shipwreck sites for additional investigation from current data; collect new geotechnical and geophysical data at selected study locations including sediment cores, ultra-high-resolution multibeam bathymetry (<2 m resolution), side-scan sonar, and CHIRP seismic profiles; conduct ROV investigations of confirmed wrecks and their surrounding seabed to inform archaeological analysis and seabed characterization.

Specific Research Question(s): 1) What are the site-specific geological and environmental conditions at areas on the MRDF known to have been impacted by GF? 2) What are the areas with high, moderate, and low probability of GF occurrence? 3) What is the frequency, power, location, and scale of past GF events? 4) How do GF events impact known archaeological sites, and is there a risk of associated impacts to infrastructure? 5) In what ways might archaeological sites be used to effectively track and study future GF events, and what locations should be monitored with which types of sensors? 6) How are benthic communities impacted by GF events?

References:

Arango, H.G., D.J. Robertson, C.K. Harris, J.J. Birchler, T.A. Kniskern, J.P.M. Syvitski, C.J. Jenkins, E. Hutton, E. H. Meiburg, and S. Radhakrishnan. 2016. Shelf-Slope Sediment Exchange in the Northern Gulf of Mexico: Application of Numerical Models for Extreme Events. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2016-038. 116 p.

Bentley, S.J., Xu, K., Georgiou, I., Maloney, J.M., 2018. *Mass Wasting Processes and Products of the Mississippi Delta Front: Data Synthesis and Observation*, M13AC00013 Final Report, US Dept. of Interior, Bureau of Ocean Energy Management, Gulf of Mexico Regional Office, New Orleans, Louisiana. 201 p.

Chaytor, J.D., Baldwin, W.E., Bentley, S.J., Damour, M., Jones, D., Maloney, J., Miner, M., Obelcz, J., and Xu, K. 2019. Short- and Long-Term Movement of Mudflows on the Mississippi River Delta Front and Their Known and Potential Impacts on Oil and Gas Infrastructure. Subaqueous Mass Movements and Their Consequences. Geological Society of London, Special Publications 500, Doi: 10.1144/SP500-2019-183

Coleman, J.M., Prior, D.B., and Garrison, L. 1980. *Minerals Management Service Open File Report 80-02*.

Galloway, N., Levy, T., and George, T., 2017. *Mapping Active GF Features off Southwest Pass, Louisiana, Gulf of Mexico*. U.S. Hydro 2017 Proceedings.

Nodine, M.C., Cheon, J.Y., Wright, S.G., and Gilbert, R.B., 2007. *Mudslides during Hurricane Ivan and an assessment of the potential for future mudflows in the Gulf of Mexico*: Phase II Project Report Prepared for the Minerals Management Service, MMS/OTRC Cooperative Research Agreement 1435-01-04-CA-35515, Task Order 39239, MMS TAR Project Number 552, 177 p.

Obelcz J., K. Xu, I.Y. Georgiou, J. Maloney, S.J. Bentley, and M.D. Miner, 2017. *Annual-periodicity submarine landslides on the Mississippi River Delta Front not associated with catastrophic events*, Geology, Doi: 10.1130/G38688.1

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Detecting Wave and Current Effects from Wave Energy Converter (WEC) Devices
Administered by	Pacific OCS Region
BOEM Contact(s)	Susan Zaleski (susan.zaleski@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2021–2025
Date Revised	May 8, 2020
PICOC Summary	
Problem	The Oregon coastal environment may change once WEC devices are installed in the future.
Intervention	Measure wave and current interannual variability and intertidal biological communities.
Comparison	Compare wave and current measurements at sites along the coast and to previously collected physical oceanographic measurements and biological data.
Outcome	Determine whether the change in the climate of waves and currents after WEC deployment can be measured. Determine whether a resulting change in intertidal biological communities can be detected.
Context	Oregon coastline near planned Federal WEC installation

BOEM Information Need(s): BOEM needs to understand effects from planned WEC deployments. To what extent do WEC devices dampen wave height or modify currents, which could in turn affect the abundance, distribution, and composition of nearby intertidal communities. This information will help inform prospective WEC deployments at the Oregon test facility offshore of Newport, Oregon as well as considerations for other future WEC installations. This information will be utilized in future National Environmental Policy Act (NEPA) analyses.

Background: A pilot study along the Oregon coast was conducted through the MARINe (Multi-Agency Rocky Intertidal Network) program, where researchers deployed pressure sensors at 8 rocky intertidal sites. The power analysis indicates they could detect a 10% change in wave climate in the intertidal area. If they increased the sampling period from 75 to 150 days, they would have the power to detect a 5% change (Raimondi, 2015). A separate effort by researchers at Oregon State University has been validating and improving the SWAN (Simulating WAves Nearshore) wave model off the coast of Oregon (O'Dea et al., 2018). They modeled the impact of hypothetical WEC arrays on wave energy in the surf zone where model results indicate further spaced WEC devices have less of an effect on the wave energy close to shore.

Objectives: The purpose of this study is to determine:

1. Will planned installations of WEC devices affect the wave and current climate?
2. If yes, does the change in wave and current climate affect the biological communities in the rocky intertidal?

Methods: The goals of the study would be accomplished through three main efforts:

1. Collect in situ measurements of the wave and current climate at multiple intertidal sites and nearshore locations using Acoustic Wave & Current profilers (AWACs), or similar. Use a Before-After-Control-Impact Paired (BACIP) sampling design to have the power to detect changes from natural variation.
2. Compile and compare local wind data.
3. Utilize the wind, wave, and current climate measurements to inform and continue to improve the SWAN model.
4. Collect biological data (https://marine.ucsc.edu/methods/biodiversity-methods.html) at multiple field sites to determine if there is an effect from a change in wave or current climate (this could be additional sampling that would supplement the ongoing MARINe monitoring in Oregon).

Specific Research Question(s):

1. Will planned installations of WEC devices affect the wave or current climate?
2. If yes, does the change in the wave or current climate affect the biological communities in the rocky intertidal?

References:

O'Dea, A., Haller, M., and Ozkan-Haller, H.T., 2018. The impact of wave energy converter arrays on wave-induced forcing in the surf zone. Ocean Engineering 161: 322-336.

Raimondi, P., 2015. Internal BOEM report: Wave Climate Analysis.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Maritime Heritage of the U.S. Pacific Islands
Administered by	Pacific OCS Region
BOEM Contact(s)	Dave Ball (david.ball@boem.gov)
Procurement Type(s)	Cooperative Agreement (possible Interagency Agreement)
Performance Period	FY 2021–2024
Date Revised	May 8, 2020
PICOC Summary	
Problem	No baseline cultural resources/heritage information (including database of underwater cultural heritage) currently exists for the U.S. Pacific Island territories of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI).
Intervention	Compile baseline data of underwater cultural heritage and potential viewshed historic property concerns and identify best practices for consultation with indigenous communities.
Comparison	This effort will be similar to the recently completed Maritime Cultural Resources Site Assessment in the Main Hawaiian Islands study, as well as baseline and best practices efforts that were completed for the Pacific, Atlantic, and Gulf of Mexico outer continental shelf (OCS).
Outcome	Compile baseline information and identify best practices for consultation with indigenous communities in support of National Historic Preservation Act (NHPA) consultation and National Environmental Policy Act (NEPA) analysis to support agency decision-making.
Context	This is a baseline effort for the U.S. Pacific Island territories and OCS waters. Information from this study will support BOEM's Renewable Energy Program and has the potential to support the Marine Minerals Program.

BOEM Information Need(s): U.S. Pacific Island territories are highly dependent on imported fossil fuels to provide electricity to the islands. American Samoa, Guam, and the CNMI have each set aggressive renewable energy goals to lessen this dependence. In support of this transition, the U.S. Congress is considering an amendment to the OCS Lands Act to authorize offshore wind energy leasing within the U.S. exclusive economic zone (EEZ) adjacent to U.S. territories.[19] BOEM needs to gather baseline information on archaeological and cultural

[19] Offshore Wind for Territories Act, H.R. 6665, was passed originally by the U.S. House of Representatives on 12/10/2018. It was reintroduced as H.R. 1014 on 2/6/2019 and in the Senate as S. 499 on 2/14/2019. As currently written, the text of this proposed legislation directs the Secretary of the Interior to conduct a feasibility study for conducting wind lease sales on the OCS of U.S. territories and submit the results of that study within 18 months. The American Energy First Act, H.R. 4294, was introduced on 9/11/2019.

resources that could be affected by these activities. This information will directly support NEPA and NHPA assessments and consultation.

Background: Baseline desktop cultural resources studies and updates have been completed for the Atlantic OCS (TRC Environmental Corporation, 2012), Gulf of Mexico OCS (Pearson et al., 2003), Hawaii (NOAA Maritime Heritage Program, 2017; Watson et al., 2017; Van Tilburg et al., 2017), and Pacific OCS (ICF International et al., 2013). The information resulting from these previous studies has been crucial for NHPA Section 106 consultations across all BOEM program areas. The U.S. Pacific Island territories have an extensive maritime history, dating back thousands of years. The islands and surrounding waters also saw substantial military activity during World War II, including the Battles of Saipan and Guam. As a result, potentially hundreds of underwater cultural heritage sites, as well as unexploded ordnance sites, may be located around these islands. Currently, no synthesized baseline dataset is available for the U.S. Pacific Island territories.

Objectives: The objective of this study is to acquire and synthesize archival data on submerged and terrestrial archaeological resources and traditional cultural properties that could be affected by offshore wind energy development.

Methods: The proposed study will accomplish the following:

1. Compile data from archival and secondary sources of known, reported, and potential underwater sites on the Pacific OCS within the EEZ of American Samoa, Guam, and the CNMI, and synthesize this information into a geo-referenced database.
2. Collect data from archival and secondary sources to develop a geo-referenced database of terrestrial properties listed and potentially eligible for listing on the NRHP.
3. Compile and summarize ethnographic information from indigenous communities regarding traditional use and traditional cultural properties that could be impacted by offshore development.
4. Working with indigenous communities (Carolinian, Chamorro, and Samoan), develop guidance documents that identify best practices and protocols for incorporating traditional knowledge into indigenous cultural landscape analyses for NHPA and NEPA reviews.
5. Prepare a final report(s) of findings that details these efforts and provides an historic context of site types that can be expected in the project areas.

Specific Research Question(s):

1. What are the types and potential locations of underwater cultural heritage sites within the EEZ of the U.S. Pacific Island territories?
2. What types of terrestrial archaeological sites or historic properties could be affected visually by offshore wind development?
3. What is the best way to consult with the indigenous communities of American Samoa, Guam, and the CNMI?

4. What types of traditional cultural properties need to be considered in relation to offshore wind development?

References:

ICF International, Davis Geoarchaeological Research, and Southeastern Archaeological Research, 2013. *Inventory and analysis of coastal and submerged archaeological site occurrence on the Pacific Outer Continental Shelf.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2013-0115. 280 p. plus appendices. https://espis.boem.gov/final%20reports/5357.pdf

NOAA Maritime Heritage Program, 2017. *The unseen landscape: inventory and assessment of submerged cultural resources in Hawai`i.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2017-021. 240 p. with appendices. https://espis.boem.gov/final%20reports/5620.pdf

Pearson, C.E., James, Jr., S.R., Krivor, M.C., El Darragi, S.D., and Cunningham, L., 2003. *Refining and revising the Gulf of Mexico Outer Continental Shelf Region high-probability model for historic shipwrecks: Final Report. Volume II: Technical Narrative.* U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-061, 195 p., 3 volumes. https://espis.boem.gov/final%20reports/3034.pdf

TRC Environmental Corporation, 2012. *Inventory and analysis of archaeological site occurrence on the Atlantic outer continental shelf.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-008. 324 p. https://espis.boem.gov/final%20reports/5196.pdf

Van Tilburg, H., Watson, T.K., Faria, K., Hoomanawanui, K., Ho-Lastiama, I., Ritte, W., Maly, K., Nahoopii, M., Horcajo, K., Kaupiko, K., and Ball, D., 2017. *A guidance document for characterizing native Hawaiian cultural landscapes.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2017-023. 208 p. with appendices. https://www.boem.gov/BOEM-2017-023/

Watson, T.K., Hoomanawanui, K., Thurman, R., Thao, B., and Boyne, K., 2017. *Na ʻIkena I Kai (Seaward Viewsheds): inventory of terrestrial properties for assessment of marine viewsheds on the eight Main Hawaiian Islands.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2017-022. 137 p. with appendices. https://espis.boem.gov/final%20reports/5619.pdf

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Partners in Offshore Wind Environmental Research – California (POWER–California)
Administered by	Pacific OCS Region
BOEM Contact(s)	Jeremy Potter (jeremy.potter@boem.gov), Cathie Dunkel (catherine.dunkel@boem.gov)
Procurement Type(s)	TBD (likely one Cooperative Agreement and one Interagency Agreement)
Performance Period	FY 2021–2023
Date Revised	May 8, 2020
PICOC Summary	
Problem	Wind energy development offshore California is on the horizon. BOEM and the State of California need to better understand the potential environmental effects and appropriately plan development. Many stakeholders also recommend increased Federal-State coordination on scientific research.
Intervention	BOEM and select State and Federal agencies will jointly develop a funding solicitation for research focused on potential environmental effects as well as monitoring methods/technologies associated with prospective offshore wind energy development.
Comparison	N/A
Outcome	Improved understanding of the potential environmental effects of offshore wind energy development and enhanced collaboration/cooperation between Federal and State agencies interested in California offshore wind energy development.
Context	The geographic scope is focused on California. If the model is successful, we will consider expanding in the future to include Oregon and Hawaii.

BOEM Information Need(s): BOEM Pacific Region needs authoritative baseline and monitoring data to inform offshore wind energy leasing decisions offshore central and northern California. This information would also support stakeholder outreach anticipated future site and impact characterization.

Background: The State of California has ambitious renewable energy goals including relying on zero-emission energy sources for its electricity by 2045. BOEM has been actively working with the State of California for years on the development of offshore wind energy. Stakeholders recommend additional environmental studies as well as increased Federal-State coordination in their planning and execution. At an October 2019 California Energy Commission (CEC) hearing, State Commissioners highlighted the need for enhanced scientific cooperation with BOEM.

Objectives:

1. Address subset of environmental information needs raised by stakeholders.
2. Improve Federal-State coordination of environmental effects research on offshore wind energy.

Methods: There are multiple potential models for this new Federal-State effort. Based on preliminary discussions with representatives from the California Ocean Protection Council (OPC), CEC, and several Federal agencies, BOEM is considering a joint funding solicitation for environmental studies to inform prospective California offshore wind energy management decisions. The process would include third-party peer review. Funding decisions would be made in coordination with all funding partners; but each agency would choose which proposal(s) to fund. That approach is modeled after the National Oceanographic Partnership Program (NOPP) Broad Area Announcement (BAA) process.

The most aggressive timeline for implementation would be publication in fall 2020 with projects selected for funding in early 2021.

Specific Research Question(s):

1. What are the potential environmental effects associated with prospective wind energy development offshore California?
2. What emerging technologies are under development to better monitor the potential effects?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Scaling the Possible Adverse Effects of Offshore Renewable Energy Projects on Marine Mammals of the Pacific OCS: Developing and Applying a Vulnerability Index (SPERMM)
Administered by	Pacific OCS Region
BOEM Contact(s)	Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	TBD (likely an Interagency Agreement)
Performance Period	FY 2021–2023
Date Revised	May 8, 2020
PICOC Summary	
Problem	There are currently no large-scale floating wind farms in areas of high marine mammal species diversity/occurrence. This makes it difficult to quantify the vulnerabilities of these species to this infrastructure.
Intervention	Collate a comprehensive database to inform the design of a vulnerability/sensitivity index to describe (qualitatively or quantitatively) marine mammal vulnerability to offshore wind energy infrastructure.
Comparison	This analysis will form the 'pre-construction' database and analysis for update and comparison/validation with future conditions.
Outcome	This vulnerability analysis can be applied to inform the siting of offshore call and wind lease areas, as well as inform mitigative strategies.
Context	Central and Northern California, Washington-Oregon and Hawai'i

BOEM Information Need(s): BOEM has already received three unsolicited applications to install floating wind turbines, one offshore Oregon and one each offshore northern and central California. While data exist on the distribution of marine mammal species along the west coast of the US, there is currently no collated vulnerability assessment available on which to appropriately scale the potential impacts to these species from this nascent industry. BOEM needs to acquire this information to support the environmentally responsible development of any permitted offshore renewable floating energy siting and leasing. Impact assessment information is required under the NEPA, ESA, and MMPA. This profile addresses or supports 3 of the 5 BOEM Strategic Information Needs and at least 4 of the 7 Strategic Framework Criteria for Study Development and Approval.

Background: The overarching challenge with the development of new industries or technologies is trying to anticipate their effects on the environment.

Vulnerability to effects (e.g., displacement, entanglement etc.) will vary between species because of where and when they occur along the Pacific OCS and what they are doing (migrating, feeding etc.). Species sensitivity to climate change has been discussed in the

literature (Hossain et al., 2018; Dickinson et al., 2014; Foden et al., 2013) and similar approaches can be undertaken to assess the vulnerability of the different species to proposed floating wind activities in the Pacific OCS. Impacts to marine mammals is always of high concern to stakeholders. This study will allow for the collation of all available and applicable marine mammal data which will then be used to rank and assess the vulnerability of the different species to proposed floating wind activities in the Pacific OCS. This information will feed directly into BOEM's environmental assessment and decision documents and will help BOEM identify species of concern, as well as topics for future studies related to floating wind impacts on marine mammals.

BOEM has funded, and continues to fund, studies related to the distribution and abundance of Pacific OCS marine mammals (OCS Study #s 2019-042; 2018-044; 2018-025; 2016-035; 2014-003; Barlow et al., 2014). This study will allow for the collation and further analysis of the data collected from BOEM's past efforts to inform current and future decisions related to offshore renewable energy development in the Pacific OCS. Information from this study with allow for the potential avoidance of areas of high overlap with species of interest, as well as identifying potential mitigative strategies, for example, opportunities to require seasonal installation to reduce the potential for impacting certain species.

Objectives:

1. Collate existing marine mammal distribution and habitat relationship data into a database.
2. Develop an offshore floating windfarm sensitivity/vulnerability index for marine mammals on the Pacific OCS and Hawai'i.
3. Apply the index to areas where floating offshore renewable energy development is most likely to occur.
4. If practicable, summarize marine mammal vulnerability on digital maps with a grid size that matched offshore survey data.
5. Develop levels of concerns (for example, a red-orange-green geospatial overlay) that could act as a basis for selection of offshore renewable energy sites.

Methods: Species vulnerability would be assessed using a trait-based approach (Foden et al., 2019; 2013; Adams et al., 2017; Laidre et al., 2008), potentially using a risk assessment framework that presents a biologically based and scientifically current process with logical elements to integrate relevant biological, acoustical, ecological, and environmental contextual variables to evaluate the significance of floating wind farm development within a marine mammal population context.

The sensitivity index will be developed by ranking key vulnerability factors including species distribution, species density estimates, species population, species population status (i.e., threatened, endangered or not), strong seasonal patterns in distribution and/or density (species habitat use), as has been done to evaluate risk to marine mammals from seismic surveys by Southall et al. (2018) and to birds by Adams et al. (2017). The ranking of each factor for all species will be independently evaluated by a selected group of experts per factor.

Species evaluated in the index will include all marine mammal species expected to regularly occur on the Pacific OCS and Hawai'i (Costa and Kendall, 2016). At a minimum, these will include blue, fin, humpback, gray, sperm, melon-headed and short-finned pilot whales; pan-tropical spotted, common bottlenose, rough-toothed and spinner dolphins, and harbor porpoise; monk seals, sea otters, and California sea lions.

Specific Research Question(s):

1. Are marine mammals in the Pacific OCS and Hawai'i vulnerable to impacts from offshore floating wind development?
    a. If so, which species are most vulnerable?
    b. Where are the specific areas of vulnerability?
2. What are potential mitigations that could reduce species vulnerability/development impacts?

References:

Adams, J., Kelsey, E.C., Felis, J.J., and Pereksta, D.M., 2017. Collision and displacement vulnerability among marine birds of the California Current System associated with offshore wind energy infrastructure (ver. 1.1, July 2017): U.S. Geological Survey Open-File Report 2016-1154, 116 p., https://doi.org/10.3133/ofr20161154.

Barlow J, Henry A, Ballance LT. 2014. 2014 California Current Cetacean & Ecosystem Assessment Survey (CalCurCEAS): final report to Bureau of Ocean Energy Management regarding surveys of Windfloat and Wave Energy Areas. Report submitted by NOAA Fisheries to the Bureau of Ocean Energy Management. April 28, 2014. https://www.boem.gov/PR-14-OBS/. 6 pg.

Costa, B.M., and Kendall, M.S. (eds.), 2016. Marine Biogeographic Assessment of the Main Hawaiian Islands. Bureau of Ocean Energy Management and National Oceanic and Atmospheric Administration. OCS Study BOEM 2016-035 and NOAA Technical Memorandum NOS NCCOS 214. 359 p.

Dickinson, M.G., Orme, C.D.L., Suttle, K.B., and Mace, G.M., 2015. Separating sensitivity from exposure in assessing extinction risk from climate change. Sci. Rep. 2015;4:6898. doi: 10.1038/srep06898.

Laidre, K.L., Stirling, I., Lowry, L.F., Wiig, O., Heide-Jorgensen, M.P., and Ferguson, S.H., 2008. Quantifying the sensitivity of arctic marine mammals to climate-induced habitat change. Ecological Applications. 18(2): 1-29, S97-S125 p.

Foden, W.B., Butchart, S.H., Stuart, S.N., Vié, J.C., Akçakaya, H.R., Angulo, A., DeVantier, L.M., Gutsche, A., Turak, E., Cao, L., Donner, S.D., Katariya, V., Bernard, R., Holland, R.A., Hughes, A.F., O'Hanlon, S.E., Garnett, S.T., Sekercioğlu, C.H., and Mace, G.M., 2013. Identifying the World's Most Climate Change Vulnerable Species: A Systematic Trait-Based Assessment of all Birds, Amphibians and Corals. PLoS One. 2013;8:e65427. doi: 10.1371/journal.pone.0065427.

Foden W.B., Young, B.E., Akçakaya, H.R., Garcia, R.A., Hoffmann, A.A., Stein, B.A., Thomas, C.D., Wheatley, C.J., Bickford, D., Carr, J.A., Hole, D.G., Martin, T.G., Pacifici, M., Pearce-

Higgins, J.W., Platts, P.J., Visconti, P., Watson, J.E.M., and Huntley, B., 2018. Climate change vulnerability assessment of species. Wiley Interdiscip. Rev. Clim. Chang. 2019;10:e551. doi: 10.1002/wcc.551.

Hossain, M.A., Lahoz-Monfort, J.J., Burgman, M.A, Böhm, M., Kujala, H., and Bland, L.M., 2018. Assessing the vulnerability of freshwater crayfish to climate change. Divers. Distrib. 2018;24:1830–1843. doi: 10.1111/ddi.12831.

Southall, B.L., Amaral, J., Clark, C.W., Ellison, W., Joy, R., Tollit, D., and Pinorakis, D.W., 2018. A risk assessment framework to evaluate the potential relative effects of noise on marine mammals. Effects of Sound on Marine Mammals Conference, Den Hague, The Netherlands.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Tribal Cultural Landscapes of the California Coast
Administered by	Pacific OCS Region
BOEM Contact(s)	Dave Ball (david.ball@boem.gov), Sara Guiltinan (sara.guiltinan@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	May 8, 2020
PICOC Summary	
Problem	BOEM needs a better understanding of the types of Tribal cultural landscapes that could be affected by wind energy development offshore California for consideration in leasing decisions, National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) reviews, offshore wind plan reviews, and in direct response to recommendations from Tribes.
Intervention	BOEM Pacific OCS Region will work with local Tribal communities to develop Tribal cultural landscape assessments near Humboldt Bay and Morro Bay, including the coast and offshore.
Comparison	This effort will provide BOEM with the needed Tribal cultural landscape assessments for its decision-making, and an opportunity to further implement the Guidance Document for Characterizing Tribal Cultural Landscapes (Guidance Document) (Ball et al. 2015) and identify opportunities for revision.
Outcome	Tribal cultural landscape assessments for several Tribes with ties to the Humboldt Bay and Morro Bay coast and offshore areas.
Context	The geographic domain is the area of effect relevant to the potential wind energy leasing areas offshore the northern and central California coast (Humboldt, Morro Bay, and Diablo Canyon Call Areas, and five negotiated discussion areas off Morro Bay, as of the date of writing).

BOEM Information Need(s): Proper and effective consultation on federal actions with Tribal implications requires a considerable amount of time, and typically more time than is available under the streamlined environmental review processes (EO 13807). BOEM needs to document areas and resource types of importance to Native American Tribes that could be impacted by future BOEM actions offshore California so that impacts and adverse effects can be resolved in a timely manner. Information developed through this effort will help streamline and directly support BOEM's NEPA and NHPA reviews and Government-to-Government consultations on BOEM actions and undertakings related to wind energy leasing and development offshore California.

Background: BOEM is currently considering potential wind energy development in multiple areas offshore California (Humboldt, Morro Bay, and Diablo Canyon Call Areas, and five

negotiated discussion areas off Morro Bay, as of the date of writing) (California Energy Commission 2020). Multiple Native American Tribes are known to have current or ancestral ties to these areas. During information meetings with California Tribes for offshore wind energy planning, Tribes requested that BOEM and its planning partners identify archaeological and cultural resources and areas of cultural sensitivity well ahead of project siting. Specifically, Tribes recommended: that such work be carried out via ethnographic and oral history inquiries with Tribal people; that any model for cultural resource data collection should accommodate many Tribes; and that analysis of Tribal cultural resources be non-invasive and culturally-sensitive (Kearns & West 2018).

Understanding the types and locations of significant archaeological and cultural resources is essential to their preservation and consideration during planning for offshore renewable energy development. As planning and development for offshore renewable energy projects off the California coast increases, the potential for impacts to coastal and marine areas and resources of significance to Pacific Region Tribal communities will increase as well. These impacts can include physical disturbances to archaeological sites and traditional use areas, as well as viewshed impacts to sacred places through offshore siting. This effort will implement a holistic cultural landscape approach, which integrates environmental science with historical, archaeological, and traditional knowledge. The cultural landscape approach recognizes that places and resources can have different or multiple meanings and levels of significance based on how people from different cultures, times, or backgrounds have interacted with the respective landscapes. Implementing this approach increases the likelihood that cultural heritage resources will be found, recognized, and appropriately resolved as decisions are made about the siting and potential effects of offshore renewable energy projects.

Objectives: The overarching goal of this effort is to develop cultural landscape assessments of areas of Tribal significance that need to be considered in the offshore wind energy planning process. Information from this effort will help facilitate decision-making processes that may impact these locales while enhancing adherence to federal regulatory timelines.

Methods: The Principal Investigator will work with California Tribes and the BOEM Pacific OCS Region to identify Tribes who claim ties to the Humboldt Bay and Morro Bay coast and offshore regions. The Principal Investigator will facilitate the establishment of a working group for each area, led by a Tribal Facilitator and consisting of Tribal representatives. The BOEM project officer and BOEM Pacific Tribal Liaison will also be included in these working groups. Each working group will host inter-tribal workshops in its respective area with the goal of bringing together Tribal partners to identify best practices and general resources significant to Tribal communities that would enhance any future offshore wind project-scale assessments. BOEM's Guidance Document (Ball et al. 2015) will then be used by individual participating Tribes to identify Tribal cultural landscapes within their individual communities. Protocols will be identified and implemented to address potentially sensitive information and any sensitive information will be excluded from the final report.

Specific Research Question(s):

1. What Tribes claim ties to the Humboldt Bay and Morro Bay coast and offshore regions?

2. What areas and types of resource areas are of significance to Tribes?
3. What types of traditional cultural properties need to be considered in relation to offshore wind development?

References:

Ball, D., Clayburn, R., Cordero, R., Edwards, B., Grussing, V., Ledford, J., McConnell, R., Monette, R., Steelquist, R., Thorsgard, E., and Townsend, J., 2015. A Guidance Document for Characterizing Tribal Cultural Landscapes. US Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2015-047. 32 p. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2015-047.pdf

California Energy Commission, 2020. Notice of Availability of Outreach on Additional Considerations for Offshore Wind off the Central Coast of California. Docket Number 17-MIC-01, 02/07/2020. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=17-MISC-01

Executive Order 13807 – Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects. 82 FR 40463, August 15, 2017.

Kearns & West, 2018. Outreach Summary Report: California Offshore Wind Energy Planning. 42 p. https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/CA/Outreach-Summary-Report-September-2018.pdf

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Using Marine Protected Area Restrictions to Predict Potential Socioeconomic Impacts of Offshore Energy Development to Commercial Fisheries
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	Cooperative Agreement or Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	May 8, 2020
PICOC Summary	
Problem	Most commercial fishery sectors will be excluded from OCS leases when development of floating wind or marine hydrokinetic energy occurs (creating de facto marine protected areas), and potential consequences of these closures are not well understood.
Intervention	Use established marine protected areas as an analog to offshore energy installations to estimate the potential socioeconomic consequences to the commercial fishing industry of reducing access to fishing grounds.
Comparison	Impacted fisheries with unimpacted fisheries.
Outcome	Identification of a suite of socioeconomic indicators that can be used to estimate of the intensity of potential impacts to fishing industry from offshore energy, and a better understanding of how to mitigate these impacts.
Context	All Planning Areas in the Pacific Ocean and potentially some planning areas within the Atlantic Region.

BOEM Information Need(s): Most commercial fishery sectors will be excluded from OCS leases when development of floating wind or marine hydrokinetic energy occurs. The potential socioeconomic consequences of these closures represent a challenge to understand, predict and mitigate them due to a variety of factors, including the confidentiality of fishing data and the challenge of determining what an appropriate control might be in an experimental design. Enhancing the predictive capacity of managers to determine the scope of potential impacts from offshore energy to other users of the OCS will have widespread utility, and aid BOEM in identifying potential lease areas, informing NEPA documents, designing appropriate mitigation measures, and communicating with stakeholders, including affected State governments and renewable energy task forces.

Background: Given the ubiquity of fishing activity on the OCS, any site selected for offshore energy development will overlap with areas currently used by one or more commercial fishing sectors. Although BOEM does not specifically prevent fishing within OCS leases, the marine infrastructure associated with offshore energy facilities often obstructs the ability of fishers to use certain gear or harvest methods (e.g., trawl, pot/trap, longline, nets, etc.), and this space-

use conflict between industries creates, in effect, a marine protected area (MPA). For example, reef fishes that inhabit marine energy infrastructure offshore southern California show typical ecological responses to MPA protection, such as larger mean sizes and higher densities, when compared to unprotected areas (Schroeder and Love, 2004). Ashley et al. (2014) suggest that this MPA effect may also occur at offshore wind and wave energy installations.

Clearly, offshore energy structures may function as de facto MPAs in an ecological context. However, a full accounting of potential commercial fishing impacts from offshore structures must also include socioeconomic consequences and not just ecological ones, and, to date, studies focusing on this aspect have been in short supply. However, datasets and opportunities exist to examine this question for various MPA implementation campaigns, particularly on the US west coast. Even though there is the potential for such analyses, the short-term economic consequences of MPAs to fisheries have rarely been examined. Some scholars predict economic consequences will be roughly equivalent to the value of species harvested in the restricted area (e.g., Leeworthy and Wiley, 2003) while others demonstrate no detectable effects of large closures (Lynhan et. al., 2020). Understanding what factors may the determine the direction and intensity of potential effects of offshore energy development to fisheries remains a high priority information need for BOEM.

Objectives: The objective of this study is to describe the detectable socioeconomic consequences experienced by the commercial fishing industry from implementing marine protected areas.

Methods: Researchers will first identify socioeconomic indicators most likely to be useful to measure potential effects of prospective offshore wind energy developments in the Pacific, and include commercial, recreational and tribal sectors. Sources of data to determine relevant indicators will be existing literature, case studies of current OWFs and their outcomes, and analogs of offshore closures (e.g., military activities, MPAs, offshore conventional energy, offshore aquaculture, etc.) that have generated space-use conflicts.

When disentangling the causal effect of MPAs from other drivers in fishery socioeconomic outcomes, researchers will focus on relevant metrics (e.g., total landing revenues, catch per unit effort, number of trips, kilometers traveled, etc.) derived in the previous task, and establish proper treatment and control datasets. To estimate effects between these two groups, investigators may employ difference-in-differences regressions (analogous to a Before-After-Control-Impact design commonly used in ecology) or a modified approach of event attribution that is used in climate change science (e.g., Knutson et. al., 2017).

Specific Research Question(s):

1. Given available sources of data and analysis techniques, what socioeconomic indicators (e.g., number of trips, distance traveled, catch per unit effort, etc.) will best measure potential impacts to commercial, recreational and tribal fishing from offshore wind and wave energy development, and how do these indicators vary by region, sector, gear, and management framework? Which ecological, cultural, and governance indicators enhance the interpretation of socioeconomic indicators?

2. What are the short-term socioeconomic consequences of MPA implementation to commercial fishing sectors?

References:

Ashley, M.C., Mangi, S.C., and Rodwell, L.D. 2014. The potential of offshore windfarms to act as marine protected areas – A systematic review of current evidence. *Marine Policy* 45:301-309.

Leeworthy, V.R., and Wiley, P.C. 2003. Socioeconomic impact analysis of marine reserve alternatives for the Channel Islands National Marine Sanctuary. NOAA, NOS, Special Projects, Silver Spring, MD. https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/science/socioeconomic/channelislands/pdfs/2003_analysis.pdf.

Lynham, J., Nikolaev, A., Raynor, J., Vilela, T., and Villaseñor-Derbez, J.C. 2020. Impact of two of the world's largest protected areas on longline fishery catch rates. *Nature Communications* 11(1):1-9.

Knutson, T., Kossin, J.P., Mears C., Perlwitz, J., and Wehner, M.F. 2017. Detection and attribution of climate change. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J. et al. (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 114-132, doi: 10.7930/J01834ND.

Schroeder, D.M., and Love, M.S. 2002. Recreational fishing and marine fish populations in California. *California Cooperative Oceanic Fisheries Investigations Report* 43:182-190.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Data Synthesis and Advanced Predictive Modeling of Deep Coral and Hardbottom Habitats in the Mid and North Atlantic: Guiding Efficient Discovery and Protection of Sensitive Benthic Areas
Administered by	New Orleans Office
BOEM Contact(s)	Michelle Nannen (michelle.nannen@boem.gov), Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 10, 2020
PICOC Summary	
Problem	Baseline data on deepwater benthic communities, which is needed to inform NEPA-required environmental assessments relevant to potential conventional energy lease sales in the Mid (MAPA) and North Atlantic Planning Areas (NAPA), is lacking. If one of these Planning Areas is removed from the announced OCS Oil and Gas National Program, this study could be reduced accordingly.
Intervention	NCCOS will acquire and compile all available deepwater benthic ROV videos from the MAPA and NAPA and will annotate the presence and absence of all sessile benthic organisms into a geodatabase. All relevant environmental covariates will also be included in the deliverables.
Comparison	Seafloor observation data for deepwater benthic communities (e.g., presence, presence-absence, abundance) will be related to a range of environmental covariates using proven spatial statistics modeling methods, and the relationships applied to estimate and map the predicted distributions of biota of interest.
Outcome	This study will deliver a new geodatabase of recorded deep-sea taxa locations and the environmental covariate layers, consistent with other regional model products, along with static maps of the multiple predicted taxa distributions. These results could inform EIS's, programmatic leasing decisions, and potentially some mitigations.
Context	Mid and North Atlantic Planning Areas. These methods match those used in two ongoing predictive modeling studies (Gulf and SE Atlantic). Therefore, results could be compared across these regions and strengthen National Program decision-making.

BOEM Information Need(s): BOEM proposed several conventional energy lease sales in the Atlantic in the 2019-2024 Draft Proposed National OCS Oil and Gas Leasing Program, but the Program was paused due to litigation involving (in part) the inclusion of the Northeast Canyons and Seamounts National Monument in the proposed lease areas. This monument contains a

high number of sensitive deepwater benthic species and habitats that provide important ecosystem functions. The U.S. Government needs accurate, vetted information about these sensitive species/habitats (including their controlling environmental conditions) to inform environmental assessments, programmatic leasing decision-making, and appropriate post-lease management practices.

BOEM and NCCOS have three ongoing studies for deepwater benthic community predictive modeling, one each in the Gulf of Mexico,[20] South Atlantic Planning Area,[21] and along the Pacific coast,[22] which can all be used to inform future decision-making. As with those, the results of this proposed model predicting the probability of deepwater coral and hardbottom habitats in the Mid (MAPA) and North Atlantic Planning Areas (NAPA) would provide information about their likely distributions in data-poor areas, exactly where such information is most needed to inform pre-lease NEPA analyses and associated decision-making. Should oil and gas leasing go forward in the Atlantic, the information obtained from modeling results could be combined with that acquired through the permit process' required site-specific hazard surveys to inform potential conditions of permit approval and/or lease stipulations. If the Final Program only includes one of these two Planning Areas, this study could focus on just that area, at greatly reduced cost.

Background: Biogeographic data about sensitive benthic biota are limited by the high costs and difficulties of deep-ocean surveys. Well-constructed predictive models using confirmed observations can help fill the gaps over large areas without requiring new surveys. Previous BOEM-funded exploration and research (especially the Mid-Atlantic Canyons study[23]) has provided valuable information in parts of the Mid and North Atlantic, yet much of the area remains unexplored and poorly understood. An older, more limited presence-only predictive model was created for this region and was used by the Regional Fishery Management Council, but it was created prior to recent multibeam and ROV surveys and does not include absence data which dramatically improves predictions about probability of occurrence, and allows for use of a wider range of statistical modeling approaches.[24] Unlike presence-only models, these can account for sampling effort and provide predictions of probability of occurrence rather than just a relative measure of occurrence (e.g., habitat suitability).

---

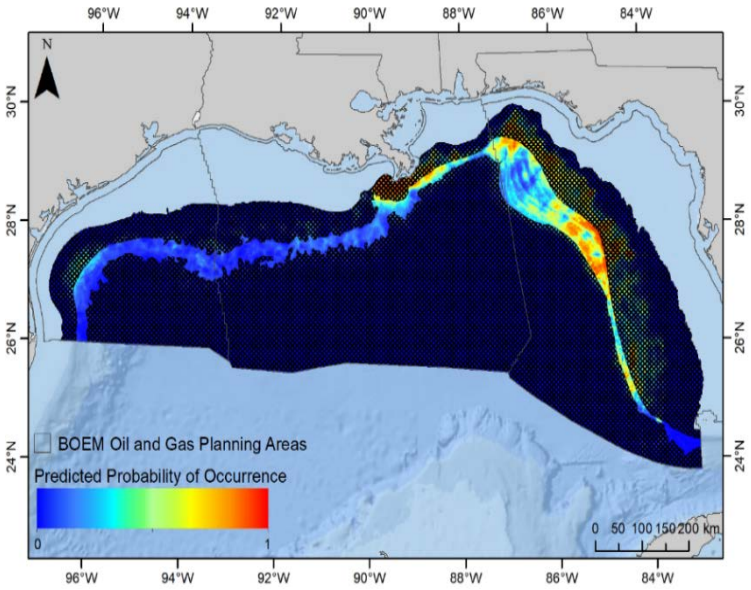
[20] Deepwater Coral And Chemosynthetic Atlas And Modeling Program: Gulf Of Mexico. IAA M15PG00020. Internet website: https://marinecadastre.gov/espis/#/search/study/100154

[21] Data Synthesis And Advanced Predictive Modeling Of Deep Coral And Hardbottom Habitats In The Southeast Atlantic: Guiding Efficient Discovery And Protection Of Sensitive Benthic Areas. IAA M16PG00010. Internet website: https://marinecadastre.gov/espis/#/search/study/100144.

[22] Cross-shelf Habitat Suitability Modeling. NSL #PC-15-07. Internet website: https://marinecadastre.gov/espis/#/search/study/100171.

[23] Exploration And Research Of Mid-Atlantic Deepwater Hard Bottom Habitats And Shipwrecks With Emphasis On Canyons And Coral Communities. Internet website: https://marinecadastre.gov/espis/#/search/study/100016.

[24] Kinlan, B.P., Poti, M., Drohan, A.F., Packer, D.B., Dorfman, D.S., Nizinski, M.S. In press. Predictive modeling of suitable habitat for deep-sea corals offshore the northeast United States. Deep-Sea Res. I. https://doi.org/10.1016/j.dsr.2020.103229



Predicted probability of occurrence for *Lophelia pertusa* in the US Gulf of Mexico. Cross-hatched overlay denotes the area outside the expected depth range (300–900 m) for *Lophelia pertusa*.

Objectives: This study will predict the distributions of deep-sea coral within the MAPA and NAPA via state-of-the-art and cost-effective statistical modeling methods that greatly improve management usability. This example map created in the Gulf of Mexico study is representative of the products anticipated. The results of the ongoing BOEM/NCCOS Gulf of Mexico, South Atlantic, and this proposed model can be directly compared because they use the same presence/absence methods. When considered collectively, they will greatly facilitate consistent, national level decision-making. These studies build on and update important lessons learned from the Pacific Cross Shelf presence-only model, the results of which can be also be used and compared to the others, albeit less directly.

Methods: NCCOS will leverage the considerable benthic survey and environmental data collected over the past decade (e.g., taxa observed by remotely operated vehicles, multibeam bathymetry) to better predict deep-sea coral distributions within the MAPA and NAPA using advances in the statistical modeling methods. NCCOS will request, compile, and evaluate all available historic and current data from field surveys and use it to extract georeferenced presence, absence and abundance for deep-sea corals by reviewing the raw survey imagery (a semi-automated, but very labor-intensive process). This observation data will be related to a range of relevant environmental covariates (also updated from previous versions) in selecting the best fit. The selected models will be validated and run for biota of interest and combined to produce region-wide, high-resolution GIS layers and maps depicting the probability of occurrence for numerous deep-sea coral taxa.

Specific Research Question(s): Based on compiled presence/absence data for deepwater benthic communities, where in the MAPA and NAPA are there likely diverse and/or spatially

extensive “hotspots” of coral and/or hardbottom that are considered especially sensitive and important to the U.S. Government?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Bioenergetic Model for North Atlantic Right Whales
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 14, 2020
PICOC Summary	
Problem	A lack of information regarding the bioenergetics of North Atlantic right whales due to the construction and operation of wind farms limits robust impact assessments and results in uncertainty regarding bioenergetic consequences of disturbance.
Intervention	Convening workshops and meetings to review existing information, develop a report and predictive model for the bioenergetic consequences of behavioral disturbance, and identify future research and monitoring needs that would address the problem.
Comparison	Compare the baseline condition of North Atlantic right whales to bioenergetic consequences from anthropogenic impacts.
Outcome	A review, predictive bioenergetic model, and assessment of data needs to test the model for North Atlantic right wales.
Context	Areas along the Atlantic where North Atlantic right whales occur in wind energy areas.

BOEM Information Need(s): BOEM integrates information into assessments for activities it authorizes with cumulative effects on threatened and endangered species. Many of these assessments consider the effects of disturbance on North Atlantic right whales but have largely been limited to qualitative analyses. This study will allow BOEM to conduct a more robust quantitative assessment of disturbance from renewable energy activities. BOEM has an obligation to understand how activities that it authorizes may impact threatened and endangered species. The information from this study will help in BOEM's environmental assessments under the National Environmental Policy Act and the Endangered Species Act.

Background: Disturbance to wildlife populations can have repercussions on individuals. These disturbances could result in effects that have potentially population-level consequences. In particular, threatened and endangered species may be more susceptible to environmental stressors at the population level. The population consequences of disturbance (PCoD) has received recent attention, but most models have focused on odontocetes (Booth et al. 2014; Farmer et al. 2018; King et al. 2015; Natural England 2017; Pirotta et al. 2015) and pinnipeds (Costa 2012; Noren et al. 2009). Only recently have some bioenergetic models for mysticetes

been developed (Pirotta et al. 2019; Van der Hoop et al. 2017; Villegas-Amtmann et al. 2015). Offshore wind development could result in long-term noise from pile driving of wind turbine foundations. The pile driving could occur for one or more projects in any given year along the Atlantic. Depending on the size of the area impacted, geographic region, duration, and time of year different life stages and important behaviors of North Atlantic right whale can be affected, for example, displacement during migration or feeding, and interrupted nursing of calves. Such disturbances have unknown bioenergetic consequences that could be of possible concern to right whale management.

This study will assess the bioenergetic requirements of different right whale life stages and develop a bioenergetic model to assess the possible consequences of disturbance from pile driving and other anthropogenic activities.

Objectives: The objective of this study is to develop a predictive bioenergetic model to assess the consequences of disturbance to North Atlantic right whales. There is a potential for collaboration with and expansion of NMFS and USGS efforts to develop a population viability analysis for North Atlantic right whales.

Methods: The model should be developed through the best available information from peer-reviewed literature, gray literature, and expert elicitation. This model must be peer reviewed and developed collaboratively with partners such as BOEM, marine mammal physiologists, and population modelers.

Specific Research Question(s):

- What are the vital rates for North Atlantic right whales?
- What are the energetic requirements for different life stages of North Atlantic right whales?
- How much bioenergetic disturbance is required to result in an individual fitness-level impact during migration, feeding, displacement, or nursing of calves?
- How can non-lethal impacts of disturbance be incorporated into existing population models to assess a population-level consequence?

References

Booth C, Burgman M, Donovan C, Harwood J, Thomas L, Schick R, Wood J. 2014. Pcod lite - using an interim pcod protocol to assess the effects of disturbance associated with us navy exercises on marine mammal populations. Office of Naval Research.

Costa DP. 2012. Environmental perturbations, behavioral change, and population response in a long-term northern elephant seal study. Office of Naval Research.

Farmer NA, Baker K, Zeddies DG, Denes SL, Noren DP, Garrison LP, Machernis A, Fougères EM, Zykov M. 2018. Population consequences of disturbance by offshore oil and gas activity for endangered sperm whales (physeter macrocephalus). Biological Conservation. 227:189-204.

King SL, Schick RS, Donovan C, Booth CG, Burgman M, Thomas L, Harwood J, Kurle C. 2015. An interim framework for assessing the population consequences of disturbance. Methods in Ecology and Evolution. 6(10):1150-1158.

Natural England. 2017. Using the interim pcod framework to assess the potential impacts of offshore wind developments in eastern english waters on harbour porpoises in the north sea. Natural England Joint Publication JP024.

Noren DP, Rea LD, Loughlin TR. 2009. A model to predict fasting capacities and utilization of body energy stores in weaned steller sea lions (eumetopias jubatus) during periods of reduced prey availability. Canadian Journal of Zoology. 87(10):852-864.

Pirotta E, Harwood J, Thompson PM, New L, Cheney B, Arso M, Hammond PS, Donovan C, Lusseau D. 2015. Predicting the effects of human developments on individual dolphins to understand potential long-term population consequences. Proc Biol Sci. 282(1818):20152109.

Pirotta E, Mangel M, Costa DP, Goldbogen J, Harwood J, Hin V, Irvine LM, Mate BR, McHuron EA, Palacios DM et al. 2019. Anthropogenic disturbance in a changing environment: Modelling lifetime reproductive success to predict the consequences of multiple stressors on a migratory population. Oikos. 0(0).

Van der Hoop J, Corkeron P, Moore M. 2017. Entanglement is a costly life-history stage in large whales. Ecol Evol. 7(1):92-106.

Villegas-Amtmann S, Schwarz L, Sumich J, Costa D. 2015. A bioenergetics model to evaluate demographic consequences of disturbance in marine mammals applied to gray whales. Ecosphere. 6(10):1-19.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Comparative Study of Aerial Survey Techniques
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2021–2023
Date Revised	January 5, 2020
PICOC Summary	
Problem	With the installation of offshore wind turbines, the traditional method of aerial surveys will not be possible in those areas.
Intervention	Adjust survey techniques to use cameras
Comparison	Comparison of aerial surveys with observers to those with camera systems
Outcome	Change in methodology that can be integrated into historical data bases
Context	The region of focus will be the Atlantic where construction may occur in the foreseeable future

BOEM Information Need(s): Future offshore wind development will include wind turbines with a height of 850 feet or more. These turbines will interfere with survey methods that are used to develop population estimates for protected species. BOEM, NOAA and FWS use aerial surveys as part of consultations, to determine population levels and make take estimates which is important across all BOEM programs. BOEM has a need to execute survey requirements in a safe and cost-effective manner while considering current and future constraints. Development of new techniques will enable BOEM to have the information needed for protected species consultations with NOAA and FWS, which support all BOEM programs.

Background: With the future construction of offshore wind facilities that will extend over many square miles, areas that were previously surveyed for marine species using observers will no longer be able to be surveyed by this traditional method. Historical surveys used for marine observations for protected species and avian species have flown at heights of 200 to 300 meters. New camera systems allow for flight heights of 1500 m or more. NOAA has raised the concern to BOEM that they have decades of survey data using protocols that involve observers in planes. Although new techniques have been in use for over a decade, NOAA has not moved to adopting these new techniques. They have cited that offshore wind development will result in a significant impact to their surveys and their ability to collect the data used to determine stock assessments of marine mammals and to closely monitor the highly endangered North Atlantic Right Whale.

BOEM has conducted some comparison surveys and examined the use of high-definition surveys in a previous study (Normandeau Associates, Inc. 2012) and determined that for sea turtles, using a higher flight height, significantly increased the number of sea turtles observed.

Objectives: The objective is to develop a methodology for aerial surveys that is compatible with offshore wind farm presence and can be used to integrate with historical data sets.

Methods: While BOEM funded a comparative study (Normandeau Associates, Inc. 2012) and is pursuing methods to process the large volumes of data collected through aerial surveys. NOAA has not adopted this new methodology primarily because of the cost of equipment and the challenges of integrating historical data. The methods will include conducting comparison surveys using old and new methodologies and developing a means to integrate the data collected from aerial surveys using cameras with those using observers.

Specific Research Question(s): Can camera systems at higher flight heights replace the current observer methodology?

References:

Normandeau Associates, Inc. 2012. High-resolution Aerial Imaging Surveys of Marine Birds, Mammals, and Turtles on the US Atlantic Outer Continental Shelf—Utility Assessment, Methodology Recommendations, and Implementation Tools for the US Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M10PC00099. 378 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Linking Multiple Data Sources to Better Describe Fishing Vessel Activity on the Atlantic OCS
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 9, 2020
PICOC Summary	
Problem	Fishing activity within areas planned for renewable energy development is underestimated.
Intervention	Link the time and location Automatic Identification System (AIS) and Vessel Monitoring Systems (VMS) tracking data to observations of commercial fishing vessels from concurrent scientific wildlife and whale surveys to estimate the proportion of vessels not tracked.
Comparison	Activity based on AIS and VMS track lines vs activity from wildlife surveys
Outcome	A correction factor that could be used to adjust annual estimates of activity by fishery within lease areas, Wind Energy Areas (WEAs), and call areas.
Context	Atlantic OCS

BOEM Information Need(s): BOEM is responsible for the approval of a construction and operations plan (COP) submitted by developers for wind facilities on the Outer Continental Shelf (OCS). Describing fishing activity in areas identified for wind development is a high priority. The results from this study will inform and reduce uncertainty in economic impact assessments of offshore energy development to commercial fisheries under the National Environmental Policy Act and Coastal Zone Management Act. Although this is developed in the context for renewable energy, it also applies to oil and gas energy development.

Background: Assessments regularly use Automatic Identification System (AIS) and Vessel Monitoring Systems (VMS) data to describe fishing activity. Yet, fishing activity within areas planned for energy development is underestimated because not all commercial fishing vessels (particularly small vessels <65 feet) are outfitted with AIS or VMS transponders, and some vessel operators turn off their transponders. Although integrating data from these different tracking devices has led to significant improvements to assessments (e.g., Russo et al., 2016), linking data from sources independent of tracking data may also yield a clearer picture of fishing activity on the Atlantic OCS. Once linked, the magnitude of the underestimate can be quantified, and then a correction factor could be applied to adjust estimates of fishing activity.

Wildlife surveys conducted on the OCS often contain detailed records of fishing vessels. This is because many wildlife species are associated with fishing activity; observers often record the date, time and location, and activities of the fishing vessels. The time and location information from the wildlife surveys and AIS/VMS track lines can be used to link the two data sources together to find out whether the boats that are seen by wildlife observers are transmitting their position. If an observed boat was transmitting its position then it would be in the AIS/VMS data. However, if an observed boat was not transmitting its position then there will be no record of it in the AIS/VMS data. The primary metric of interest is the proportion of observed boats that are not transmitting. If hypothetically 20% of the observed fishing vessels are not transmitting then we could say that fishing activity is underestimated by 20% when it is based solely on AIS/VMS data.

Objectives:

- Explore how observations of fishing vessels from wildlife surveys can enhance the characterization of fishing vessel activity derived from AIS/VMS data.
- Link existing fishing vessel tracking data to observations of fishing vessels from concurrent scientific wildlife and whale surveys.

Develop a method to estimate fishing effort (adjusted for vessels not tracked by AIS/VMS) by fishery, year, and season within lease areas, WEAs, call areas, regions, and other appropriate spatial or temporal scales.

Methods: The existing AIS and VMS data on the Atlantic will be integrated (see Russo et al., 2016). Next, each geo-spatial referenced vessel observation from a wildlife survey will be compared with AIS/VMS tracking data for the same time interval and general location. Each vessel observation will be assigned to one of two categories: 1) vessel transmitting or not transmitting its position; thus linking the datasets. Once linked, the proportion of observed vessels using or not using AIS/VMS can be easily calculated by fishery across multiple spatial and temporal scales.

There are multiple datasets that are readily available with years of temporally and geo-spatially referenced observations of fishing vessels. For example, the BOEM-funded Northwest Atlantic Seabird Catalog has nearly two thousand records of fishing vessels throughout the Atlantic. Additional data sources include the New York State Energy Research Development Authority's (NYSERDA) high-resolution imagery from seasonal wildlife surveys in the NY Bight, the BOEM-funded high-resolution imagery from seasonal baseline surveys in the south Atlantic ,and high-resolution imagery from developers. Another rich source of data are Massachusetts Clean Energy Center's (MASSCEC) seasonal whale surveys that have 659 records of fishing vessels from 2012 to 2015 (Krause et al., 2016). In addition, BOEM will work with the North Atlantic Right Whale Consortium to obtain data from their databases and offshore wind developers to obtain observations of fishing vessel activity from their wildlife surveys. The information from the databases will be combined for analyses and would be made available for future analyses.

Given that wildlife survey data includes observational information that directly describes vessel activity (e.g., fishing, transiting, etc.). This observational information could also be used to

validate and assess the accuracy of vessel activities derived AIS/VMS data. This validation could then be used to refine how AIS/VMS data are used to characterize fishing vessel activity.

Specific Research Question(s): How do non-fishery survey efforts enhance our understanding of fishing activity?

References:

Kraus, S.D., S. Leiter, K. Stone, B. Wikgren, C. Mayo, P. Hughes, R. D. Kenney, C. W. Clark, A. N. Rice, B. Estabrook and J. Tielens. 2016. *Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles*. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054. 117 pp. + appendices

Russo, T., L. D'Andrea, A. Parisi, M. Martinelli, A. Belardinelli, F. Boccoli, I. Cignini, M. Tordoni, and S. Cataudella. 2016. *Assessing the fishing footprint using data integrated from different tracking devices: Issues and opportunities.* Ecological Indicators (69): 818-827.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Cody (mary.cody@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2021–2025
Date Revised	February 26, 2020
PICOC Summary	
Problem	A lack of information regarding the distribution and abundance of gray seals (*Halichoerus grypus atlantica)*.
Intervention	Developing baseline information about gray seals and their use of the marine environment.
Comparison	Compare the baseline condition of gray seals before and after wind development.
Outcome	An understanding of the level of impact from offshore wind on gray seals.
Context	Areas along the Atlantic where gray seals occur near current and proposed wind energy areas.

BOEM Information Need(s): Information regarding the distribution and foraging ecology of the rapidly increasing gray seal population in northeast U.S. waters will provide insight into the role of this species in the marine ecosystem and allow BOEM to more effectively evaluate the potential for impacts to gray seals from offshore wind farms. It is important for BOEM to understand the distribution, abundance, and movements of gray seals on the Outer Continental Shelf (OCS) in order to assess any impacts from offshore wind development. Additionally, the study would meet the ESP goal of implementing more citizen science projects by supporting fishers to collect information from the bycatch of seals.

Background: The number of gray seals (*Halichoerus grypus atlantica*) in the Northeast has risen dramatically in the last 2 decades, with few being observed in the early 1990s to at least 25,000 on a single Massachusetts beach in 2016. They range from New Jersey north to Labrador. Gray seals use beaches and waters in the northeast to breed, pup, and forage in areas that overlap with BOEM WEAs based on a small satellite tagging study (Puryear et al. 2016) as well as NMFS bycatch estimates from commercial fisheries. Since 2001, NMFS has conducted aerial surveys to monitor gray seal pup production on Muskeget Island and adjacent sites in Nantucket Sound, and Green and Seal Islands off the coast of Maine (Wood et al. 2007). Previous surveys to monitor marine mammal distributions in WEAs off Massachusetts and Rhode Island did not survey seals (Krause et al. 2016, current AMAPPS efforts). The installation of foundations for

offshore energy structures can create foraging habitat for seals (Russell et al. 2014). Increases in the habitat use, distribution, or abundance of animals around foundations can increase the potential for human interactions with gray seals from offshore wind activities (e.g., construction) and fisheries (e.g., entanglement) in wind energy areas (WEAs). To better understand the population, ecological, and anthropogenic effects of the rapidly increasing population of gray seals, there is a pressing need to obtain basic demographic and ecological information of this increasing seal population in northeast Outer Continental Shelf (OCS) waters prior to further development of offshore wind facilities.

Objectives: The objectives of this study are:

- to collect baseline information on the distribution, abundance, and movements of gray seals, and
- support citizen science reporting of human interactions with seals in northeast OCS waters.

These seasonal and behavioral patterns form the basis for the implementation of strategies to monitor or reduce adverse interactions between seals and activities occurring within wind energy areas. Funding this project during the current time frame would provide some pre-construction baseline information, and additional comparative information during construction.

Methods: Survey and tracking data can provide much-needed distribution and abundance data on gray seals. Additionally, seal movements from satellite-tagged animals, combined with commercial fishing effort data can be used to predict times and areas of co-occurrence inside of the WEA's. Information collected will determine if the distribution of gray seals in WEAs changes throughout the year depending on the forage base, presence of predators, and other factors, or if it changes during construction. The study will provide information on changes in density over time, given the population appears to be growing rapidly with an uncertain trajectory. A multi-year study is proposed including satellite tagging of individual seals to understand their seasonal distributions and movements on the OCS, aerial surveys of haul-out areas combined with radio tagging efforts to correct for the portion of the population at sea during surveys would be used to estimate total abundance in the region. Additionally, an opportunity for citizen science is available to support commercial fishermen who have expressed interest in working with the scientific and regulatory communities to retrieve carcasses of animals in nets to improve diet information and to help inform solutions to reduce interactions between seals and fisheries. An additional fifth year would be dedicated to data synthesis and final reporting with minimal field operations.

The project would be completed over a four-year period plus an additional year for data analysis and reporting of results. Three years would be devoted to satellite tagging and tracking of individual seals to understand their seasonal distributions in the pelagic environment. One year would be dedicated to aerial surveys of haul-out areas and radio tagging to correct for portion of the population hauled out during the aerial surveys. Haul-out areas will be identified and abundance estimates derived through the aerial survey and radio tagging efforts. High-resolution photography may be used during surveys. A fifth year would be dedicated to synthesis, analysis, and final reporting. In addition to the above work, a citizen science

component from fishers would be integrated into the study to support the collection and transport of seals entangled in fishing nets. This dimension of the project will add baseline information on seal bycatch, the diet, and food-web interactions in WEA regions. Samples will be transported, stored, information collected on seals, and a diet analysis completed from stomach contents. Data synthesis, analysis, and preparation of a final report would occur in the fifth year of the study.

Specific Research Question(s): What are the important ecological areas for gray seals?

References:

Kraus, S.D., S. Leiter, K. Stone, B. Wikgren, C. Mayo, P. Hughes, R. D. Kenney, C. W. Clark, A.N. Rice, B. Estabrook and J. Tielens. 2016. Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054. 117 pp. + appendices.

Puryear, W.B., M. Keogh, N. Hill, J. Moxley, E. Josephson, K.R. Davis, C. Bandoro, D. Lidgard, A. Bogomolni, M.Levin, S. Lang, M. Hammill, D. Bowen, D.W Johnston, T. Romano, G.Waring, and J. Runstadler. 2016. Prevalence of influenza A virus in live-captured North Atlantic gray seals: a possible wild reservoir. Emerging Microbes and Infection 5, e81; doi:10.1038/emi.2016.77

Russell, D., S. Brasseur, D. Thompson, G. Hastie, V. Janik, B. McClintock, J. Matthiopoulos, S. Moss, and B. McConnell. 2014. Marine mammals trace anthropogenic structures at sea. Current Biology 24(14):638-639.

Wood, S.A., S. Brault and J.R. Gilbert. 2007. 2002 aerial survey of grey seals in the northeastern United States. Pages 117–121 in: T. Haug, M. Hammill and D. Ólafsdóttir, (eds.) Grey seals in the North Atlantic and Baltic. NAMMCO Sci. Pub. 6, Tromsø, Norway.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Pilot Renewable Energy Strategic Partnership Funding – Responsible Offshore Science Alliance
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker (brian.hooker@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2021–2023
Date Revised	May 6, 2020
PICOC Summary	
Problem	Pre-construction environmental monitoring, construction monitoring, and post-construction monitoring require flexibility to work with strategic partners like the Responsible Offshore Science Alliance (ROSA) to prioritize and execute important collaborative studies that support BOEM's environmental analysis and program-wide information needs.
Intervention	Partner with ROSA to identify and execute high priority fisheries-related research and monitoring projects in collaboration with state and private partners.
Comparison	BOEM would normally, through the Studies Development Plan process, select priority projects through internal subject-matter expert teams and the COSA process. This process does not directly engage fisheries scientists and constituents nor allow for public transparent collaboration with state and private partners.
Outcome	Collaborative fisheries-related environmental studies prioritized and executed through an open and transparent process leveraged with strategic partners.
Context	Atlantic Region, offshore renewable energy

BOEM Information Need(s): BOEM has a need to leverage studies funds and ideas across constituent groups, especially constituents in the fisheries sector. Studies developed through an open and transparent process via the Responsible Offshore Science Alliance will have public support and the benefit of a collaborative framework to prioritize studies for funding. These studies will address emerging topics for offshore renewable energy pre-construction environmental monitoring, construction monitoring, and post-construction monitoring that support BOEM's environmental analysis and program-wide information needs.

Background: Over the past few years BOEM has been participating in a collaborative process with state, Federal, renewable energy companies, fishing companies, and environmental non-governmental organizations to develop an Atlantic regional science strategy to monitor environmental impacts of different phases of offshore renewable energy development. One such entity, the Responsible Offshore Science Alliance, has recently named an Executive

Director and is empaneling a Steering Committee in anticipated of the executing collaborative studies by 2021. In order to participate in this collaborative science endeavor BOEM needs the flexibility to be responsive to supporting successful requests for proposals for fisheries-related studies over relatively short time periods. This effort will allow BOEM to leverage funds from other participating organizations to meet fisheries science needs of BOEM and its partners.

Objectives: The objective of this study profile would be to 1) pilot this innovative strategic partnership process with ROSA in FY21; and 2) execute constituent supported and prioritized fisheries-related environmental research and monitoring project(s).

Methods: If this study profile is selected, BOEM would develop a process for identifying studies that would be appropriate for these funds. Generally, these projects with strategic partners would be regarding emerging environmental issues in regards offshore wind development. This could include studies that focus on emerging technologies to monitor/assess environmental effects. Projects would be identified in the first and second quarter of each fiscal year. Any funds from the annual allocation that are not used would be returned to the general funds available for BOEM environmental studies. The actual procurement process would not differ from existing processes.

Specific Research Question(s): Projects funded under this program would address emerging issues in regard to environmental monitoring pre-construction, during construction, and post construction of offshore renewable energy projects. Many of the questions that will be addressed are discussed in the National Academies document linked in the reference section below. The regional science process allows for a collaborative process with external partners to prioritize these emerging issues. But specific research questions that may be addressed include:

- Does spatial and temporal distribution of fishing or revenue generation change as a result of offshore wind energy facility construction (what scale is detectable, meaningful)?
- Do key biological indicators (abundance/biomass/condition/community structure/spatial or temporal distribution) change as a result of offshore wind energy facility construction (what scale is detectable, meaningful)?
- Are fishing management processes/practices no longer effective in managing fishery resources in a multi-use marine environment (what adaptation strategies are necessary)?

References:

National Academies of Sciences, Engineering, and Medicine. 2018. Atlantic Offshore Renewable Energy Development and Fisheries: Proceedings of a Workshop—in Brief. Washington, DC: The National Academies Press. https://doi.org/10.17226/25062. https://www.nap.edu/catalog/25062/atlantic-offshore-renewable-energy-development-and-fisheries-proceedings-of-a

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Protected Species Application and Information Management
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov). Nicole Charpentier, (nicole.charpentier@bsee.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2022
Date Revised	April 14, 2020
PICOC Summary	
Problem	Protected species observer data collected across BOEM programs are not consistently collected, reported, and managed.
Intervention	Develop a common platform that data can be recorded and reported to BOEM. Develop an application that is freely available to industry protected species observers and other organizations to record and report data in a standardized way.
Comparison	Conduct an assessment of data requirements, develop common reporting fields for similar activities, and identify differences across common BOEM and BSEE program areas.
Outcome	Develop an application and data management system to record, report, and query information.
Context	National

BOEM Information Need(s): BOEM compiles protected species data through reporting requirements for geological and geophysical surveys conducted on leases and through other approved plans. Often, these requirements also satisfy reporting requirements under the Endangered Species Act (ESA) and Marine Mammal Protection Act. Survey vessels are often present for weeks, months, or over multiple years conducting survey activities depending on the purpose of the survey (e.g., sand resource characterization or oil and gas surveys). Both mandatory and voluntary reporting from a consistent platform to collect data on protected species and other information such as fishing vessel activity on the Outer Continental Shelf (OCS) would provide a valuable tool to the offshore community and to BOEM. Other federal agencies and non-governmental organizations have expressed interest in the value and analysis of such data. In the Gulf of Mexico, these data have been analyzed and applied adaptively in assessments under the National Environmental Policy Act and the ESA (Barkaszi et al. 2012; Barkaszi and Kelly 2019). Additionally, the National Marine Fisheries Service proposed the creation of standardized forms for seismic surveys within a year of the implementation of the Biological Opinion as part of their non-discretionary terms and conditions during the ongoing Section 7 ESA consultation process for the Gulf of Mexico.

Background: The protected species application will be designed for field data collection and will capture visual and passive acoustic observation data that will later be used to assess the occurrence and prevalence of offshore species, habitat, and anthropogenic activities. A goal is to more seamlessly integrate data collected across BOEM program areas into a standard format. The standardization of data collection will reduce errors and improve post-processing time by BOEM. Standardized data will be integrated into a cloud-based database and used for a decision and compliance tool for BOEM.

Objectives: The objective of the project is to create a software application and cloud storage solution for field captured data and photographs collected during offshore activities. A long-term application maintenance plan and data management strategy must be included.

Methods: The application should be developed through the best available information from peer-reviewed literature, gray literature, and expert elicitation of federal users, PSO providers, and industry. Existing platforms may be available to add on to or develop a separate application such as SeaScribe maintained through an existing BOEM contract, or through private software developed independently by Industry or PSO Providers.

Specific Research Question(s):

- What are the data fields required for each BOEM program area?
- What standardized data formats are required for visual and passive acoustic data?
- What are the operating and maintenance requirements for the software?
- What field tests are required for the application?
- What are data storage and access requirements for BOEM, industry, and other partners?

References:

Barkaszi MJ, Butler M, Compton R, Unietis A, Bennet B. 2012. Seismic survey mitigation measures and marine mammal observer reports. New Orleans, Louisiana: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region.

Barkaszi MJ, Kelly CJ. 2019. Seismic survey mitigation measures and protected species observer reports: Synthesis report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Using High-Resolution Imagery to Describe Fishing Vessel Activity on the Atlantic OCS
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 9, 2020
PICOC Summary	
Problem	Fishing activity within areas planned for renewable energy development is underestimated.
Intervention	Using existing high-resolution images from aerial surveys throughout the Atlantic OCS to identify fishing gear (e.g., crab pots, lobster buoys) to estimate fishing activity.
Comparison	Fishing activity across multiple spatial and temporal scales.
Outcome	Estimates of activity by fishery within lease areas, Wind Energy Areas (WEAs), and call areas.
Context	Atlantic OCS

BOEM Information Need(s): BOEM is responsible for the approval of a construction and operations plan (COP) submitted by developers for wind facilities on the Outer Continental Shelf (OCS). Describing fishing activity in areas with identified wind development is a high priority. The results from this study will inform assessments under the National Environmental Policy Act and Coastal Zone Management Act for areas under consideration for wind energy development and permitting COPs in existing leases on the Atlantic OCS.

Background: Assessments regularly use Fishing Vessel Trip Reports, Automatic Identification System (AIS) and Vessel Monitoring Systems (VMS) data to describe commercial fishing activity. Yet, fishing activity within areas planned for energy development is underestimated due to some fisheries not having a Federal reporting requirement (e.g., lobster and conch) where only 10% of Lobster/Johan crab landings in the New England lease areas are from vessels equipped with VMS (NMFS, pers. Comm). This negative bias is because small fishing vessels (<65 feet) are usually not outfitted with transponders. Other metrics, like counts of buoys used for lobster pots, could be used to help fill this information gap. For example, fishing gear is readily observable (e.g., lobster traps, crap pots, buoys) in aerial imagery. Federal and state agencies and developers are using high-resolution imagery from aerial surveys to identify and estimate the abundance of seabirds, turtles, fish, and mammals. These efforts have amassed tens of thousands of images (hundreds of terabytes of data) that span the Atlantic OCS where there is a

potential for offshore wind development. This rich source of imagery could be searched (manually or perhaps more efficiently with AI) for fishing gear used to assess the activity of underrepresented fisheries.

Objectives:

- Identify fishing gear from existing high-resolution imagery from aerial wildlife surveys.
- Estimate fishing effort (by fishery, year, and season within lease areas, WEAs, call areas, regions, and other appropriate spatial or temporal scales).

Methods: This study will focus on using existing imagery from the BOEM-funded seasonal baseline surveys in the south Atlantic and New York State Energy Research and Development Authority (NYSERDA) seasonal wildlife surveys in the NY Bight. In addition, BOEM will work with offshore wind developers to obtain data from their monthly wildlife aerial surveys. The existing imagery is readily accessible and standardized in its collection, format, and storage. The imagery will be inspected for fishing gear using existing AI and visual validation processes. . Types of gear will be identified and grouped by identifying marks and counted to estimate fishing activity by fishery within lease areas, WEAs, and call areas by season by year. Information on fishery and its management and fishing vessel trip reports will help interpret the counts based on images and relate to local and regional fishing efforts. Data layers produced from this effort will be distributed to the regional planning bodies (e.g., http://midatlanticocean.org/ and http://devel.northeastoceandata.org/) and http://marinecadastre.gov/.

This effort could be expanded to include other forms of imagery from other sources like the seasonal mid-Atlantic baseline study that was funded by Department of Energy or MASSCEC seasonal whale surveys. Using imagery from these efforts will likely increase the cost (not included in approx. cost), because the imagery are in different formats and are at lower resolution than the BOEM, NYSERDA and developer surveys.

Specific Research Question(s): How does fishing activity within areas planned for renewable energy development compare to other areas?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Baseline Tourism and Recreation along the Gulf of Maine
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022–2025
Date Revised	January 23, 2020
PICOC Summary	
Problem	The availability and quality of tourism and recreations activities and the revenues of tourism- and recreation- dependent businesses may be reduced due to the presence of offshore wind farms.
Intervention	Determine if offshore wind development negatively affects recreation and tourism and quantify the results.
Comparison	The study will document necessary baseline (i.e., before) tourism/rec data so that any changes after an offshore wind farm is installed can be measured and compared to determine if tourism/rec opportunities, quality, and/or associated revenues are reduced.
Outcome	Baseline tourism and recreation information before offshore wind farm construction to facilitate future comparison after wind farm construction
Context	Gulf of Maine, which is in the early stages of planning for a lease sale with only one task force meeting held thus far.

BOEM Information Need(s): The National Environmental Policy Act (NEPA) requires BOEM to consider the environmental impacts of proposed actions before making decisions, which includes understanding impacts on the Human Environment, such as "aesthetic, historic, cultural, economic, social, or health" impacts (40 CFR 1508.8). This study will provide empirical data regarding the impacts or non-impacts (e.g., recreation, employment, small businesses, property values, heritage tourism) from offshore wind development in the Gulf of Maine including Maine, New Hampshire, and Massachusetts. This information will also be critical when responding to the concerns of state and local governments, citizens, and various stakeholder groups (e.g., property owners, small business owners, boaters).

Background: Potential impacts to tourism and recreation are a concern expressed by coastal communities. Evaluation of the potential impacts requires baseline information about the recreation use in an area as well as post-construction information to determine the impacts. BOEM collected some baseline information about tourism and recreation to provide baseline information (ICF Incorporated, LLC. 2012), but this did not include the Gulf of Maine. The 2018 BOEM report, Methodology for Analyzing the Effects of Block Island Wind Farm (BIWF) on Rhode Island Recreation and Tourism Activities (Smythe et al. 2018), identifies an extensive list

of potential indicators of tourism and recreation impacts and notes the importance of establishing baseline data prior to development. BOEM held the first task force meeting for the Gulf of Maine in December of 2019 and anticipates offshore wind development to occur within the next decade in the area. Since BOEM is in the early stages of planning, this provides an opportunity to apply the methodology developed in the BOEM report.

Objectives: To enhance our understanding of impacts on the human environment through a longitudinal study of the areas surrounding the Gulf of Maine.

Methods: This research will enable observation, and documentation of the human environment in the Gulf of Maine pre-development, during construction and for several years after operations. These observations will establish baseline conditions and will characterize conditions of the human environment over multiple years, allowing BOEM to capture trends and gauge change through time.

This study would be organized into 3 phrases: study design, data collection & analysis, and closeout. The 'study design' phase would include a body of integrated and iterative activity, namely: site selection; stakeholder engagement; indicator identification, refinement, and testing; and development of a sensitivity assessment (vetting the accuracy and reliability measurement). The 'data collection and analysis' phase would include: collection of primary and secondary data capturing baseline conditions (pre-construction); conditions during construction and operations; and analysis—along with simultaneous sensitivity testing. The 'closeout' phase would include: final analysis; synthesis; and report writing.

Specific methods include:

- Identify and circumscribe the area/population of study that captures the area of impacts from two wind farm sites, and a representative control site, to ensure the pre-development observations are applicable to two or more of the upcoming projects in the development pipeline.
- Conduct stakeholder engagement to ground, vet, and refine indicators produced from the Block Island Study (Smythe *et al.*, 2018), and to ensure that local and regional concerns are identified in the study, and to consider additional indicators if needed. The specific approach to engage could include an advisory committee, focus groups, or outreach meetings.
- The anticipated domains or impact areas of study would include: recreation (fishing, diving, boating, sailing, beach going), visitation, property values/rental rates, wind farm specific commerce (i.e., merchandise, tours, employment), and cultural/historic sites.
- Collect secondary (e.g., local property values, rental rates, visitation rates, proprietary industry data) and primary data (i.e., direct observation and participant observation of historic sites, recreation areas) over four observation periods, covering pre-construction, construction, and operations.

Specific Research Question(s):

1. How does the construction and operation of a large OCS wind farm impact the human environment?
2. What is the nature of the impact (e.g., significance, persistence, qualitative change)?
3. Are the indicators valid (i.e., do they measure what they are intended to measure)? Are some indicators more sensitive than other indicators to development and/or operations activity?
4. Is there regional variation? Do impacts or relationships appear to be patterned? Does socioeconomic (i.e., social, cultural, historic, economic) context play a discernible role in the impacts?

References:

ICF Incorporated, LLC. 2012. Atlantic Region Wind Energy Development: Recreation and Tourism Economic Baseline Development. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2012-085, 35 pp. M11PD00223

Industrial Economics, Inc. 2012. Identification of Outer Continental Shelf renewable energy space-use conflicts and analysis of potential mitigation measures. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. OCS Study BOEM 2012-083. 414 pp. M09PC00037

Parsons, G., Firestone, J. 2018. Atlantic Offshore Wind Energy Development: Values and Implications for Recreation and Tourism. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-013. 52 pp. M12AC00017

Smythe, T., Smith, H., Moore, A., Bidwell, D., and J. McCann (2018). Analysis of the Effects of Block Island Wind Farm (BIWF) on Rhode Island Recreation and Tourism Activities. U.S. Department of Interior, Bureau of Ocean Energy Management. Sterling, VA. OCS Study BOEM 2018-068. 88 pp. M16PC00016

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Characterizing Habitat Utilization by Marine Mammals and Sea Turtles during Construction of Offshore Wind Farms
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov), Mary Cody (mary.cody@boem.gov)
Procurement Type(s)	Contract (possible pilot study for regional partnerships)
Performance Period	FY 2022–2024
Date Revised	April 14, 2020
PICOC Summary	
Problem	Offshore Wind is a nascent industry in the U.S. Atlantic. There is a high-level of concern that pile driving can negatively impacts the behavior of marine mammals and sea turtles. A firm understanding of these impacts will assist Renewable Energy decisions in the future.
Intervention	Conduct aerial and acoustic surveys to evaluate the habitat use before, during, and after wind farm construction.
Comparison	The habitat use and behavior of marine mammals and sea turtles during construction will be compared to use of the wind farm area before and after construction.
Outcome	The study will assist BOEM's understanding of marine mammal and sea turtle impacts from pile driving to inform analyses, monitoring needs, and decisions pertaining to construction activities authorized by BOEM.
Context	The field study will be conducted in the U.S. Mid and North Atlantic

BOEM Information Need(s): The May 2018 workshop and report *A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles Wildlife and Offshore Wind* workshop identified the most important impact issues to marine mammals and sea turtles from offshore wind development, developed hypotheses, and recommended specific research solutions to test those hypotheses. The impacts to marine mammals and sea turtles from construction and pile driving of offshore wind and oil and gas foundations is a major impact of concern on the OCS but is not well understood. Nationwide, BOEM needs information on the displacement of whales, particularly right whales, from offshore wind construction to inform environmental analyses, consultations, inform geographic and seasonal considerations for leasing decisions, and inform mitigation and monitoring needs. This information will fill identified data gaps and inform future research and monitoring programs associated with offshore leasing activities that are essential to the development of the offshore wind industry on the OCS.

Background: Considerable pre-construction baseline data from aerial and acoustic surveys have been collected on marine mammals and sea turtles over the last several years in the

Massachusetts and Rhode Island lease areas, through a collaborative effort between BOEM, MASSCEC, and the New England Aquarium (Kraus et al. 2016). Considerable coordination among stakeholders has occurred to establish a Regional Wildlife Science Entity (RWSE) to leverage partner funds for collaborative research. At a 2018 workshop, the impact issue of displacement in the Massachusetts and Rhode Island lease areas was classified as highly important, since numerous endangered species occur in the area, presumably attracted by feeding opportunities (Kraus et al. 2019). Displacement from feeding could lead to energetic losses that may have repercussions for reproduction and health. Pseudo-experimental exposure (PEE) studies have been done with studies of Navy sonar (AUTEC, SOCAL, Atlantic BRS, 3S) and seismic (3S, BRAHSS) activities (Southall et al. 2012). Generally, these are one event studies, looking at specific individual animal responses to a specific stimulus, so small sample sizes are the norm. Therefore, accompanying aerial with acoustic data, and telemetry studies would provide for a more robust data set for analysis to be able to detect changes to behavior and habitat use. Aerial surveys have been used in successful studies of harbor porpoise responses to pile driving in Germany (Dähne et al. 2013). Passive acoustic studies have also shown significant displacement (mean of 17.8km) of harbor porpoise from pile driving in the Danish North Sea, and the effect lasted as long as pile driving was underway (5 months) (Brandt et al. 2011). Aerial survey studies on acoustic disturbance displacement of large whales have been done to evaluate short-term bowhead responses to seismic activity (Richardson et al. 1999) and humpback responses to low frequency broad-band transmissions of the North Pacific Research laboratory (Mobley Jr. 2005). Based upon the potentially comparable acoustic disturbance from seismic airguns, there is reason to believe that displacement of large whales away from the pile driving source sounds may be likely, but the severity and magnitude of those responses is largely unknown.

Objectives: The overall purpose of the study is to initiate a pilot research program while the RWSE is formally established. The initial research focus would be to determine the relationship between marine mammal and sea turtle distribution, abundance, behavior, and habitat use in response to pile driving sounds and vessel operations during construction of offshore wind farms. Potential partners could include the National Fish and Wildlife Foundation to facilitate partner funds from industry and other partners.

Methods: Both visual and passive acoustic approaches are needed to test the hypothesis that whales are displaced during construction activities. Habitat use and behavior can be evaluated through aerial (observer or digital), acoustic monitoring, and tagging before, during and after construction activities. The advantages of visual surveys include the assessment of density information and direct observations of local displacement responses of animals as indicators of impacts observed correlated in other data sets. However, evaluating the distribution of animals both visually and acoustically, and through telemetry can provide a more robust analysis of possible impacts to whales. Passive acoustic recorders and prey sampling at a construction site and nearby important foraging areas for North Atlantic right whales can be assessed to determine if foraging is impacted. Such sites could include Nantucket Shoals, Cape Cod Bay and/or Stellwagen Bank. This study could leverage data from existing passive acoustic data from these important foraging areas. Passive acoustic recorders placed

throughout each of the core foraging areas at each site will provide year-round presence information. Telemetry and concurrent monthly prey sampling will be carried out throughout these areas in order to evaluate the animal movements and density of prey in the study areas. Existing visual sightings will be leveraged to add additional presence and density information. Monitoring is proposed to start, prior to construction activities and continue throughout the duration of these activities. Any changes in presence will be evaluated based on changes in food density and presence of noise.

Specific Research Question(s):

- Will construction activities result in displacement of whales from construction locations?
- Will construction displace right whales from preferred foraging areas?
- What are the ecological conditions associated with whale abundance during construction months?

References:

Brandt, MJ, Diederichs A, Betke K, Nehls G. 2011. Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series. 421:205-216.

Dähne, M, Gilles A, Lucke K, Peschko V, Adler S, Krügel K, Sundermeyer J, Siebert U. 2013. Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. Environmental Research Letters. 8(2):025002.

Kraus, SD, Kenney RD, Thomas L. 2019. A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles.

Kraus, SD, Leiter S, Stone K, Wikgren B, Mayo C, Hughes P, Kenney RD, Clark CW, Rice AN, Estabrook B, Tielens J. 2016. Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study(BOEM 2016-054):117.

Mobley Jr., JR. 2005. Assessing responses of humpback whales to North Pacific Acoustic Laboratory (NPAL) transmissions: Results of 2001-2003 aerial surveys north of Kauai. Journal of the Acoustical Society of America. 117(3):1666-1673.

Richardson, WJ, Miller GW, Greene Jr. CR. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. Journal of the Acoustical Society of America. 106(5):2281.

Southall, B, Calambokidis J, Tyack P, Moretti D, Friedlaender A, DeRuiter S, Goldbogen J, Falcone E, Schorr G, Douglas A, Stimpert AK, Hildebrand J, Kyburg C, Carlson R, Yack T, Barlow J. 2012. Biological and behavioral response studies of marine mammals in Southern California, 2011 ("SOCAL-11") final project report.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Ecological Baseline Study of the U.S. Outer Continental Shelf off Maine
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov)
Procurement Type(s)	Existing IDIQ Contract for AT 15-05
Performance Period	FY 2022–2024
Date Revised	April 16, 2020
PICOC Summary	
Problem	Baseline ecological data of wildlife species on the OCS are limited. Collection of these data are essential to understand the potential effects of activities associated with energy development on wildlife species.
Intervention	Conduct high-resolution aerial surveys and/or boat-based wildlife surveys to collect seasonal distribution and abundance data.
Comparison	These data will help form a baseline to assess post-development impacts to wildlife.
Outcome	Estimates of density and distribution of marine mammals, sea turtles, and seabirds on the OCS species.
Context	OCS off Maine where this potential for offshore wind energy development.

BOEM Information Need(s): Baseline information is needed on the distribution and abundance of marine mammal, bird, and turtle species to assist in the environmental review of sites for potential energy development on the OCS. The data collected from this effort will be used to inform NEPA analysis, region specific environmental assessments, review of applications for permits, and ESA consultations.

Background: Given the vastness of the United States OCS and variability in marine wildlife distributions, comprehensive baseline surveys like the ones conducted in the Mid-Atlantic for the Department of Energy (http://www.briloon.org/MABS) and in BOEM's regional efforts (e.g., AMAPPS, GoMMAPPS , South Atlantic Baseline) are critical to improving our understanding of seabird, marine mammal, and turtle distributions on the OCS.

There is interest in a regional approach to develop offshore wind energy in the Gulf of Maine, and in December 2019, an Intergovernmental Renewable Energy Task Force for the Gulf of Maine was convened to facilitate coordination and consultation among federal, state, local, and tribal governments.

The Contractor will develop a field plan to conduct High-Resolution Aerial and/or Boat-based Wildlife Surveys and will implement those surveys to obtain spatially explicit density estimates. The surveys will be conducted off the coast of Maine and will include potential BOEM "Call

Areas" for wind energy development and areas of biological interest. The approach shall be consistent with BOEM's Survey Guidelines (http://www.boem.gov/Survey-Guidelines/).

Objectives: The objective of this study is to design and conduct multi-season boat-based and/or aerial-digital marine wildlife surveys and to establish an ecological baseline describing the distribution and abundance of marine seabirds, mammals and turtles on the United States OCS off Maine.

Methods: The surveys will cover an area from the federal-state boundary (3 nautical miles) to 25 nautical miles from the shore and from the Mass-New Hampshire border to Acadia National Park, Maine. This effort creates the opportunity for partnering with other federal agencies and states to leverage costs and expand the survey effort in spatial-temporal coverage.

The aim is to enhance and fill in gaps from past effort while being careful not to duplicate existing efforts –like AMAPPS which uses boat surveys and conventional aerial surveys. The effort will coordinate with others that are doing similar work (like AMAPPS). Data collected from these baseline surveys will be added into databases like theNorthwest Atlantic Seabird Catalog and the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) as appropriate. Ultimately, the baseline data would then be used to update avian and other wildlife distributional maps like those developed through BOEM's interagency agreement with NOAA (Winship et al., 2018) and distributed to the regional planning bodies (e.g., http://midatlanticocean.org/ and http://devel.northeastoceandata.org/) and http://marinecadastre.gov/. This baseline information will be used to inform BOEM permitting decisions and planning decisions by developers and other stakeholders while providing a kickoff point for post-construction regional monitoring efforts.

Specific Research Question(s): How are wildlife species distributed on the OCS off Maine?

References:

Winship, A.J., B.P. Kinlan, T.P. White, J.B. Leirness, and J. Christensen. 2018. *Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning: Final Report*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2018-010. x+67 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Management Strategy Evaluation for NEFSC Surveys Impacted by Offshore Wind Development
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Ursula Howson, ursula.howson@boem.gov
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2022–2024
Date Revised	1/31/2020
PICOC Summary	
Problem	NMFS/NEFSC trawl surveys are used to develop stock assessments and quotas for the commercial fishing industry. Offshore wind development may impact trawl surveys.
Intervention	Determine the level of impact on trawl survey data.
Comparison	Compare the error in stock assessments between current methods and methods that do not include wind development areas
Outcome	Determine the impact of excluding wind areas on stock assessments
Context	Areas along the Atlantic where leases occur as of 2020

BOEM Information Need(s): The NOAA Fisheries MSE working group defines MSE as “a process designed to identify and operationalize strategies for managing fisheries that are robust to several types of uncertainty and capable of balancing multiple economic, social and biological objectives." This study will help to address questions regarding the impact of the placement of offshore wind turbines in BOEM offshore renewable energy lease areas in the Northeast on NMFS trawl surveys, which are used to set stock quotas for the commercial fishing industry. BOEM has an obligation to understand how activities that it authorizes may impact commercially and recreationally important fish. In addition to BOEM’s regulations under the Outer Continental Shelf Lands Act as amended by the Energy Policy Act of 2005, the information from this study will help in BOEM’s environmental assessments under the National Environmental Policy Act and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: The NOAA/NMFS Northeast Fisheries Science Center (NEFSC) conducts ship-based trawl and dredge surveys targeting federally managed fish and shellfish species. These surveys are based on a random-stratified design, where sampling locations are selected randomly within geographic strata; the strata segregate the Northeast U.S. continental shelf into along-shelf and cross-shelf blocks. Analyses from these surveys are used by the regional fisheries management councils to calculate annual stock quotas for federally managed species. The development of offshore wind projects on the outer continental shelf will result in areas in

multiple strata that may limit or exclude survey operations, thereby disrupting the statistical design used by the NEFSC trawl surveys and resulting in uncertainty in stock assessments. When uncertainty is introduced into stock assessments for federally managed species, the regional fisheries councils charged with determining stock quotas based on those stock assessments may recommend more conservative quota levels than may be necessary. Any reduction in stock quotas would result in economic impacts to the commercial fishing industry.

Even if a new statistical design is developed, the development of wind energy areas will likely preclude current ship-based sampling approaches. Larger NOAA vessels will likely have movements restricted if deemed by NOAA ship personnel as too risky to operate in wind energy development areas.

This study will be a first step in addressing the issue of impacts of offshore wind on NEFSC stock assessments. Several federally managed stock assessment surveys will be evaluated.

Objectives: The objective of this study is to determine the magnitude of impact of excluding wind energy areas for stock assessment surveys.

Methods: This science must be peer reviewed and developed collaboratively with partners, such as fishery management councils, regional collaborative organizations, and stakeholders, with the goal of maintaining the highest quality of fisheries survey data in order to limit the level of uncertainty introduced into stock assessments for federally managed species.

A Management Strategy Evaluation (MSE) Framework will be developed for evaluating different survey designs and the effect on the precision and accuracy of scientific advice. The initial emphasis will be the NEFSC Bottom Trawl Survey. The MSE framework could then be modified for other regional surveys in future studies (e.g., Scallop Survey, Atlantic Surfclam and Ocean Quahog Survey, Ecosystem Monitoring Survey). The product of the MSE Framework will include revised designs for NEFSC surveys.

Specific Research Question(s):

- How do BOEM wind energy lease areas impact stock assessments?
- What is the strategy for NMFS ship-based stock assessments in survey strata occupied by offshore wind turbines?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Renewable Energy Strategic Partnership Funding
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker (brian.hooker@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022–2025
Date Revised	January 29, 2020
PICOC Summary	
Problem	Pre-construction environmental monitoring, construction monitoring, and post-construction monitoring require flexibility to work with strategic partners to execute important studies that support BOEM's environmental analysis and program-wide information needs.
Intervention	Develop a broad portfolio of projects with strategic partners to address the need for flexibility in leveraging funds with these partners that can be executed in a reasonable time frame.
Comparison	This would be compared to the normal time frame necessary to develop and execute projects through the BOEM Studies Development Plan process for individual projects.
Outcome	A studies execution process that can be responsive to emerging issues and opportunities to leverage funds with strategic partners.
Context	Atlantic Region, offshore renewable energy

BOEM Information Need(s): BOEM has a need to leverage studies funds and ideas across stakeholder groups. These studies will address emerging topics for offshore renewable energy pre-construction environmental monitoring, construction monitoring, and post-construction monitoring that support BOEM's environmental analysis and program-wide information needs.

Background: Over the past few years BOEM has been participating in a collaborative process with state and Federal agencies, renewable energy companies, fishing companies, and environmental non-governmental organizations to develop an Atlantic regional science strategy to monitor environmental impacts of different phases of offshore renewable energy development. One such entity, the Responsible Offshore Science Alliance (ROSA), has recently named an Executive Director and is anticipated to begin collaborative studies by 2021. Similarly, there is a more broad wildlife and ecosystem collaboration currently named Regional Wildlife Science Entity for Offshore Wind (RWSE) that will collaboratively address non-fisheries science issues. In order to participate in these collaborative science endeavors, leverage stakeholder funds while also ensuring that BOEM mission-based data are collected, BOEM needs the flexibility to leverage funds that are in synch with the requests for interests that are generating from these entities.

Objectives: The objective of this study would be to make funds available that would be used for strategic partnerships on emerging issues with state and federal agencies as well as regional science entities like ROSA and RWSE.

Methods: BOEM would develop a process for identifying studies that would be appropriate for these funds. Generally, these projects with strategic partners would be regarding emerging environmental issues in regards offshore wind development. This could include studies that focus on emerging technologies to monitor/assess environmental effects. Projects would be identified in the first and second quarter of each fiscal year. Any funds from the annual allocation that are not used would be returned to the general funds available for BOEM environmental studies. The actual procurement process would not differ from existing processes.

Specific Research Question(s): Projects funded under this program would address emerging issues in regard to environmental monitoring pre-construction, during construction, and post construction of offshore renewable energy projects. Many of the questions that will be addressed are discussed in the National Academies (2018) and Kraus et al. (2019) documents linked in the reference section below. The regional science process allows for a collaborative process with external partners to prioritize these emerging issues.

References:

National Academies of Sciences, Engineering, and Medicine. 2018. Atlantic Offshore Renewable Energy Development and Fisheries: Proceedings of a Workshop—in Brief. Washington, DC: The National Academies Press. https://doi.org/10.17226/25062. https://www.nap.edu/catalog/25062/atlantic-offshore-renewable-energy-development-and-fisheries-proceedings-of-a

Kraus, S.D., R.D. Kenney, and L. Thomas. 2019. A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles. Report prepared for the Massachusetts Clean Energy Center, Boston, MA 02110, and the Bureau of Ocean Energy Management. May, 2019. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/A-Framework-for-Studying-the-Effects.pdf

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Application of a Morphodynamic Model to Assist in Planning the Long-term Restoration and Maintenance of the Louisiana Barrier Island System
Administered by	New Orleans Office
BOEM Contact(s)	Barton Rogers (barton.rogers@boem.gov), Ana Rice (ana.rice@boem.gov)
Procurement Types(s)	Contract or Cooperative Agreement
Performance Period	FY 2021–2023
Date Revised	April 9, 2020
PICOC Summary	
Problem	BOEM manages OCS sediment resources for coastal restoration and long-term future estimates of stakeholder needs are currently uncertain. It is critical for BOEM to be able to estimate long-term (20-100 years) sediment needs for restoration efforts and assess the resilience of OCS sediments in preparation for meeting future stakeholder demands.
Intervention	This study will apply a morphodynamic model to a barrier island system that will assess long-term resilience and quantify OCS sediment resources needed to restore and maintain the system over the next 20-100 year time period. Louisiana's barrier island system has extensive data and modeling information over many decades and nearly all islands have been renourished in recent times. While this model will be developed and tuned to the Louisiana barrier island system, it would be designed so that it could be modified and applied for future use in other barrier islands along the Gulf and Atlantic coasts.
Comparison	Morphological models are typically tuned to provide morphological change predictions over the expected duration of a restoration project (up to 20 years). This study will apply and tune a previously developed model with capacity to provide long-term (20-100 year) predictions that will allow BOEM scientists and coastal managers to estimate volume requirements and cost effectiveness of OCS sediments for long-term restoration of barrier island systems.
Outcome	This study will provide critical information on the morphological evolution of the Louisiana barrier island system, including predictions of OCS sediment resilience and cost effectiveness, and quantification of future sediment needs over the next 20-100 years. Model results will assist coastal planning teams to develop efficient and effective restoration projects.
Context	Gulf of Mexico OCS with applicability to Atlantic OCS.

BOEM Information Need(s): The long-term sustainability of Louisiana's barrier island system depends on the availability and suitability of nearshore (NS) and OCS sediment to support restoration efforts. A recent BOEM study comparing the geomorphic and economic

characteristics of NS versus OCS sediments by Caffey et al. (2019) suggests that OCS sediment resilience could be greater than finer grain NS sediment past the short-term (up to 20 years) restoration project lifespan, and thus may be more effective than NS sediments at reducing long-term coastal erosion (Caffey et al. 2019, Kime, 2018). Moreover, as a result of diminishing NS resources in state waters, expected sea level rise, and the frequency and magnitude of recent storms along the Gulf of Mexico, the demand for OCS resources is projected to increase. Further research is needed for BOEM and its stakeholders to be able to fully understand the potential benefits of using the likely higher-quality and readily available OCS source materials in barrier island restoration over long-term time scales. Long-term estimates of future OCS sediment needs as well as predictions of sediment resilience are critical for BOEM to be able to meet the future sediment resource demands.

Background: Barrier island systems support critical habitat and provide coastal storm damage reduction. The hypothesis that OCS sediment would create long-term beneficial outcomes has been previously put forward (Georgiou et al. 2018; Kime 2018), but long-term estimates of future OCS sediment needs have not been calculated since morphological models are typically tuned to provide predictions over short-term (up to 20 years) time periods. Longer-term modeling predictions of morphological evolution past restoration project periods would be beneficial and allow for BOEM and its stakeholders (e.g., USACE, LA CPRA, TX GLO, coastal counties, etc.) to develop more cost-effective and resilient restoration projects. Suitable morphodynamic models for barrier island applications include complex 3D models (e.g., Lesser et al. 2004; Kime, 2018) or more simplified 2D models (e.g., Mariotti and Murshid, 2018). While 3D models require extensive computational capacity (thus limiting time scales of predictive capability), they tend to incorporate extensively validated hydrodynamic modules such as Delft3D and are therefore robust. On the other hand, 2D models incorporate more simplified hydrodynamic forcings, but are able to provide sound morphodynamic predictions with increased efficiency over larger spatial and longer time scales.

Objectives: Apply an operational morphological model to the Louisiana barrier island system over a 20–100 year period to estimate volume requirements and evaluate cost effectiveness of OCS sediment use for long-term coastal restoration.

Methods: This study will apply a previously developed 2D or 3D morphological model to predict the evolution of Louisiana's coastal barrier island system and provide quantification of future sediment needs over the next 20 to 100 years. The final deliverable will be a model that is: 1) efficient to operate, 2) has the ability to be updated as the barrier island system evolves, 3) is adaptable to and able to incorporate future changing conditions, such as coastal storms, sea level rise estimate changes, and inputs from new coastal surveys, and 4) has the ability to be modified to other barrier island systems for future applications. Model examples suitable for this analysis include a recent application of the *Delft3D* modeling suite developed by Kime (2018) that compared barrier geomorphic trajectories on the Louisiana coast nourished by OCS or NS sediments over a maximum 50 year prediction period, or a newly developed 2D model, CoastMorpho2D; Mariotti and Murshid (2018) which has the ability to provide predictions of barrier system evolution up to centennial time scales. Regardless of the model employed, model output parameters critical for predicting barrier island morphological evolution include

frequency of restoration, volume of sediment and initial allocation of sediment. Additionally, sediment (grain size) output parameters should be used to compare long-term resilience of NS and OCS sediments. The sediment cost to benefit ratio will be optimized by integrating the applied morphological model with the economic model of sediment costs by Caffey et al. (2019) to provide the greatest benefits per economic costs to restore and maintain the Louisiana barrier island system.

Specific Research Question(s): What is the volume of OCS sediment needed and cost to restore and maintain Louisiana's barrier island system over the next 20-100 years?

References:

Caffey, R.H., Petrolia, D., Georgiou, I.Y., Miner, M., Wang, H., and B. Kime. 2019. Economic and Geomorphic Comparison of OCS Sand vs. Nearshore Sand for Coastal Restoration Projects Final Report. New Orleans (LA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM. NSL 14-03-06 54p.

Georgiou, I.Y., Kime, B.L., Miner, M.D., 2018. The effect of sediment properties on restored barrier island morphodynamics: implications for using nearshore vs offshore sediments. Abstr. Coast. Sediment Conf.

Kime, B., 2018. The Effects of Sediment Properties on Barrier Island Morphology and Processes: A Numerical Modeling Experiment, Master's Thesis, University of New Orleans, 90 pp.

Lesser, G.R., Roelvink, J.A., van Kester, J.A.T.M., Stelling, G.S., 2004. Development and validation of a three-dimensional morphological model. Coast. Eng., Coastal Morphodynamic Modeling 51, 883–915. https://doi.org/10.1016/j.coastaleng.2004.07.014

Mariotti, G., and S. Murshid. 2018. A 2D tide-Averaged Model for the Long-Term Evolution of an Idealized Tidal Basin-Inlet-Delta-System. J. Mar. Sci. Eng. 6, 154.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Investigation of an Historic Seabed Mining Site on the Blake Plateau
Administered by	Headquarters
BOEM Contact(s)	Michael Rasser (michael.rasser@boem.gov), Mark Mueller (mark.mueller@boem.gov), Alden Denny (alden.denny@boem.gov), Paul Knorr (paul.knorr@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2023
Date Revised	April 10, 2019
PICOC Summary	
Problem	Very little is known about the environmental impacts of mining seabed minerals in the deep sea. Critical minerals are important to the economic and national security of the United States, yet there is inadequate information about their associations with sensitive habitats and species (e.g., corals, sponges, and infauna), and the environmental impacts of mining.
Intervention	This analysis will advance BOEM, USGS, and NOAA efforts to study, plan, and manage for potential environmental impacts of critical mineral mining activities on the OCS, as directed by Administration directives.
Comparison	Compare areas that contain critical minerals to other seafloor environments (e.g., what habitat/ecosystem role do critical mineral deposits serve?). Additional comparisons include evaluating natural change processes (e.g., sediment dynamics) and examining areas of historic substrate disturbance/removal. This study will also set the stage for conducting in situ field experiments to compare control *versus* treatment areas.
Outcome	An analysis of the long-term environmental impacts of deep-sea mining will be completed and provide a new framework for related future efforts.
Context	The initial spatial focus and fieldwork will occur in the U.S. Atlantic OCS in a defined 20 x 15 km area that experienced seabed mining disturbance 50 years ago, providing a unique opportunity to assess long-term recovery of a seabed mining operation. However, the environmental analysis approaches developed in this study will be broadly applicable to all BOEM planning areas.

BOEM Information Need(s): BOEM needs to better understand the environmental impacts of seabed mineral mining on the OCS. Information from this study will be used to support future BOEM activities, particularly those related to the development of critical marine minerals. This is responsive to Executive Order 13817, Executive Order 13840, and the recent Presidential "Memorandum on Ocean Mapping of the United States EEZ." The study will also inform NEPA-mandated environmental assessments for BOEM's national OCS oil and gas leasing program

and Marine Minerals Program by increasing our understanding of critical mineral-rich seafloor habitats and their associated fauna.

Background: On June 4th, 2019 the Department of Commerce released EO 13817,"A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals." The strategy directs the DOI to identify new domestic supplies of these minerals, ensure access to information necessary for the study and production of minerals, and expedite permitting for minerals projects, all “in a safe and environmentally responsible manner.” The OCSLA assigns DOI/BOEM responsibility for developing OCS non-energy minerals, including critical minerals, while ensuring environmental protection. Significant deposits of several critical minerals are found within the U.S. EEZ (Hein *et al.*, 2016) but are not currently included in mineral resource assessments (Schultz *et al.*, 2017; Fortier *et al.*, 2018).

Marine mineral-rich hard substrates (i.e., crusts, nodules) support benthic communities that may differ in their response and recovery from disturbances such as extractive activities. These areas can support diverse communities including some rare species, yet basic ecological information is currently lacking, including faunal composition, population sizes, distribution, and connectivity. A sufficient understanding of the ecological impacts of mineral extraction is constrained by inadequate observational and baseline data. While a few studies have monitored changes during seafloor mining demonstration activities, they were limited by a lack of knowledge regarding the local and regional seafloor environment prior to commencement of extractive activities (Jones *et al.* 2018, International Seabed Authority https://www.isa.org.jm/scientific-activities).

This study will be a focused analysis of an historic deep-sea mining test site at approximately 800 m depth on the Blake Plateau (BP) in the U.S. Atlantic Ocean. Geological and mineral assessments on the BP began in the 1960’s, leading to commercial manganese nodule extraction test activities by Deepsea Ventures, Inc. and dedicated geologic and resource assessments in the early 1980’s by the USGS and partners. From Deepsea Ventures, there is semi-quantitative information of nodule/pavement abundance, geochemical data, and some other associated records obtained from published sources. Deepsea Ventures published documentation about the systems they developed and utilized. The USGS also has seismic reflection data, deep tow camera images (thousands of images), samples (hundreds of pounds or more), and other associated records. This historical context provides a unique time series of seafloor disturbances, enabling an unusual ability to assess disturbance recovery across a range of substrates and habitat types.

BOEM, USGS and NOAA have been collaborating to learn more about this site and planning for this joint study. On June 29, 2019 NOAA Ship *Okeanos Explorer* performed a systematic multibeam survey surrounding the “Deepsea Ventures Site”. This initial mapping enabled a return visit by the *Okeanos Explorer* on November 11, 2019 to conduct an 8 hour exploratory Remotely Operated Vehicle dive guided by USGS and BOEM input (NOAA Ocean Exploration and Research 2019). The dive documented evidence of past activities including a “patio block” marker installed by the USGS and apparent seafloor disturbances from equipment consistent

with the types of seafloor mining equipment thought to have been used in the 1960's. This information was documented during a USGS-archival research visit to the Mariner's Museum in Newport News, VA, where copies were made of historical documents detailing the site's coordinates and historic activities. USGS has also been recovering important data from internal USGS records about their 1980's fieldwork at the site.

The next step in this ongoing partnership will be to conduct higher resolution mapping of the seafloor in the study area to better identify and analyze specific locations of historic seafloor disturbance. USGS and BOEM can both provide staff with relevant scientific expertise in marine ecology, benthic ecology and critical minerals geology. USGS has access to their existing relevant datasets needed to complete this work. NOAA can provide a capable research ship and crew (likely the *Nancy Foster*, conveniently based in Charleston, SC) and lead education and outreach efforts.

Objectives: Provide needed information for future NEPA assessments by evaluating the potential environmental impacts from seafloor mineral extraction, including to any endemic fauna, to better inform understanding of disturbance recovery, leveraging unusual access to a historically impacted site.

Methods: This study will encompass the first two parts of a potential four-part approach:

1. Site mapping and characterization: High-resolution mapping of benthic habitats over targeted locations (likely with an autonomous underwater vehicle) coupled with water-column characterization will provide information about the physical environment of control areas and disturbed areas. The type of data that may be collected include imagery, multi-beam and side scan sonar. This work will require a ~14 day research cruise.

2. Develop a Field Survey Plan and Experimental Design: Using high-resolution imagery and maps, a detailed field plan for in situ data collection will be developed that includes 4-5 sample areas in both control and impact sites. A "natural experiment" framework will be developed for examining impacts that will be applicable to other BOEM planning areas. This plan is to determine the approach that can be used for a future study (see 3 and 4 below).

If successful, an additional study will be proposed for the 2021 National Studies List that will use the field survey plan and experimental design developed above and also include:

1. In Situ Data Collection: Geological, sediment, water and biological samples collection at a number of discrete locations in both the disturbed areas and control areas.

2. Data Analysis and Hypothesis Testing: Sample processing and analysis to characterize and statistically compare control and impacted sites.

Specific Research Question(s):

1. Can the impacts of experimental mining activities be identified, mapped and quantified using remote sensing technologies?

2. What is the extent, severity, and possible long-term recovery of the impacts of mining activities at the site?

3. How do impact areas compare to control areas that were not impacted by mining?

4. What is a cost-effective, useful sampling methodology/design for in situ data collection to examine environmental impacts?

References:

Department of Interior. Final List of Critical Minerals, 2018. Office of the Secretary of the Interior. 83 FR 23295. May, 18, 2018. https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018

Fortier, S.M., Nassar, N.T., Lederer, G.W., Brainard, Jamie, Gambogi, Joseph, and McCullough, E.A., 2018. Draft critical mineral list—Summary of methodology and background information—U.S. Geological Survey technical input document in response to Secretarial Order No. 3359: U.S. Geological Survey Open-File Report 2018–1021, 15 p., https://doi.org/10.3133/ofr20181021.

Hein, J.R. Koschinsky, A. Mikesell, M.; Mizell, K. Glenn, C.R. Wood, R., 2016. Marine Phosphorites as Potential Resources for Heavy Rare Earth Elements and Yttrium. Minerals, 6, 88. https://doi.org/10.3390/min6030088

Jones, D.O.B, Amon, D.J. and Chapman, A.S.A., 2018. Mining Deep-Ocean Mineral Deposits: What are the Ecological Risks? Elements 14:225-330

NOAA Ocean Exploration and Research 2020. Searching for Historic Deep-sea Mining Impacts on the Blake Plateau. https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/nov7/nov7.html Last Accessed February 3rd, 2020.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Modeling Benthic Recovery with Variable Dredge Conditions
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.Hansen@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 8, 2020
PICOC Summary	
Problem	Dredging activities directly remove benthos from the immediate dredge cut area, which may also have indirect food-web effects. The type of dredge, the frequency of dredging events, and the volume of sediment removed may affect the rate or phase of benthic community recovery. Field work at every site and for every dredge event is not feasible, so a model would allow for more accurate impact assessments.
Intervention	If we better quantify the rate of recovery relative to dredging conditions (considering natural fluctuations), we can improve our impact assessments and make better decisions on future dredge events.
Comparison	This study aims to model benthic recovery relative to different dredge activity measured by depth of dredging and frequency of events.
Outcome	We expect a model to create a formula that would allow BOEM to estimate the rate of benthic recovery for different dredge depths and frequency.
Context	The study area includes all Atlantic and Gulf of Mexico Outer Continental Shelf (OCS) waters up to 50 m depths.

BOEM Information Need(s): In order to inform assessments and decisions for dredge events in all MMP regions, BOEM needs to more accurately quantify how different dredge activity impacts benthic recovery when site-specific data is not available. In the process of excavating sediment, dredges remove benthic infauna, a source of biomass and prey for higher level animals. Many benthic infauna recolonize within months to years depending on operational and environmental factors, including the frequency (i.e., time between events) and depth of dredging (i.e., "cuts"). While some site-specific studies have quantified post-dredging recovery, benthic monitoring of every project site is inconsistent due to timing and funding. A model to quantify estimated recovery rates would improve benthic impact assessments, including cumulative impacts, for all potential dredging projects (currently in Atlantic and Gulf of Mexico OCS).

Background: Various studies have investigated the recovery of benthic infauna following a disruption like trawling or dredging (e.g., Crowe et al. 2016; see Michel et al. 2013 for a review). Most studies, however, have focused on how local physical and environmental conditions

impact the recovery to a pre-disruption state. In addition to this, the temporal spacing of dredge events may also affect how benthos recolonize. Hiddink et al. (2017) found that the depletion, and subsequent recovery, of seabed macroinvertebrates was correlated to the depth of disruption by different bottom trawls. We hypothesize that more frequent and deeper dredging leads to greater depletion of benthic infauna and longer recovery times. We also hypothesize that there will be a correlation, so that estimates of benthic depletion and recovery would vary in a predictable way with dredge depth and frequency. The results of a BOEM-funded study to characterize the intensity of site-specific dredging (OCS Study BOEM 2018-019) will also be incorporated when characterizing dredging operations.

Objectives: The main goal of this study is to model the potential depletion and recovery rates of benthic infauna based on different dredge depth and frequency for the many potential dredge areas that do not conduct site-specific benthic monitoring. The outcome would be a formula such that a BOEM analyst could input different dredging activity, characterized by depth and frequency (independent variable, x), and receive an estimate of time to benthic recovery (dependent variable, y). These estimates could be applied before dredging using estimates then again after dredging with actual values. At sites with repeat dredge events, these recovery rates could then be used to better characterize cumulative impacts. BOEM could then use these estimates to determine areas available (or unavailable) to leasing.

Methods: This model will investigate how benthic recovery is related to dredge depth and frequency using existing data from dredge projects. No new data or field work will be executed as part of this study. The study would start with a data synthesis of known recovery rates and processes, related to dredge depth and frequency when possible. Relevant data include benthic grabs, infauna composition, sediment profile imaging, grain size analysis, dredging activity, bathymetry, other seafloor profiling, and a variety of environmental variables. These data to inform the model are expected to be mined from BOEM-funded studies, the U.S. Army Corps of Engineers, academia, and state resource managers, among others. Because benthic recolonization occurs in several successional stages, recovery should be considered in two major respects: a return to pre-dredge biomass, and to pre-dredge biodiversity. These recovery data will be modelled to determine how dredge depth and frequency, with environmental covariates (e.g., season, latitude, and any site-specific conditions) influence benthic recovery rates.

In addition to the data synthesis, the final product will be a model that represents how benthic recovery varies with dredge depth and dredge frequency. The final formula will provide the ability to estimate recovery rates of dredge activity before and after dredging occurs at all sites that lack site-specific benthic monitoring.

Specific Research Question(s):

- How does dredge depth and frequency (i.e., timing between events) affect benthic recovery?

- What are the quantitative estimates of benthic recovery for different dredge depths and frequencies?
- How might dredge activity have cumulative effects on the benthic environment?

References:

Crowe, S.E., Bergquist, D.C., Sanger, D.M., and Van Dolah, R.F., 2016. Physical and biological alterations following dredging in two beach nourishment borrow areas in South Carolina's coastal zone. Journal of Coastal Research, 32(4), pp.875-889.

Hiddink, J.G., Jennings, S., Sciberras, M., Szostek, C.L., Hughes, K.M., Ellis, N., Rijnsdorp, A.D., McConnaughey, R.A., Mazor, T., Hilborn, R. and Collie, J.S., 2017. Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance. Proceedings of the National Academy of Sciences, 114(31), pp.8301-8306.

Michel, J., Bejarano, A.C., Peterson, C.H., and Voss, C., 2013. Review of biological and biophysical impacts from dredging and handling of offshore sand. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. OCS Study BOEM 2013-0119. 258 pp.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Seamount Benthic Mapping and Characterization for Deep-Sea Corals, Benthic Ecosystems, and Critical Minerals of the Aleutian Islands
Administered by	Marine Minerals Program and Alaska OCS Regional Office
BOEM Contact(s)	Alden Denny (Alden.Denny@boem.gov), Mark Mueller (Mark.Mueller@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2021–2024
Date Revised	4 March, 2020
PICOC Summary	
Problem	Seafloor areas along the Aleutian Islands are likely to contain seamounts with hydrothermal activity and associated benthic endemic populations. These hydrothermal systems are co-located with populations of deep-sea coral or other sensitive benthic species and are as yet unmapped. Hydrothermal systems in this region may be rich in critical minerals defined essential to the economic and national security of the United States in E.O. 13817.
Intervention	BOEM, USGS, and NOAA, will work together on an initial mapping and follow-on characterization mission to collect baseline information on benthic ecosystems and seafloor mineral deposits. BOEM proposes to map and evaluate the occurrence of seamounts to identify targets for benthic species and hydrothermal activity survey. The follow-on mission will return for direct observation to quantify both biological communities and mineral occurrence.
Comparison	This study would allow for comparison of the biodiversity and community composition associated with critical minerals in the Aleutian Arc and help facilitate evaluation of differences between areas with and without critical mineral deposits.
Outcome	The study aims to provide baseline and exploratory seafloor observations in areas of the OCS in the Aleutian Arc to aid in evaluation of biological communities and in discovery of marine minerals. These data, including bathymetry, seafloor acoustic and optical imagery, and direct sampling (initially CTD samples followed by ROV grab and suction and fluid samples), will inform NEPA-required analysis for potential future lease sales related to Aleutian Islands hydrothermal systems.
Context	This proposed work pertains to the Aleutian Arc regions within the Alaska OCS, which contains permissive regions for marine mineral types that are of interest for base (Zn, Cu), critical (Co, Mn, REE, Sb, Te) and precious (Au, Ag, Pt) elements.

BOEM Information Need(s): Executive Order 13817[25] and associated "Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals" requires "…increasing activity at all levels of the supply chain, including exploration, mining, concentration, separation, alloying, recycling, and reprocessing." This study would help implement this directive by providing baseline and exploratory seafloor observations in targeted areas of Alaska in the Aleutian Arc that hold potential marine minerals. Scientific understanding of the seamount communities and benthic ecosystems would be enhanced and would help inform NEPA-required analyses related to potential future lease sales, Exploration Plans, and Development and Production Plans.

Background: A recent Presidential Memorandum[26] "Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska" directs federal agencies to draft a Strategy to map the entire US EEZ. BOEM is already funding an ongoing IAA with USGS to identify critical mineral areas in Alaska which will help inform the target areas for this proposal. Within the OCS, the Aleutian Islands are a significant unmapped, ice-free priority region for critical mineral exploration. Mapping of target areas in the Aleutian Islands is of high importance in fulfilling both the requirements of both E.O 13817 and the Presidential Memorandum.

The Aleutian Islands are the only oceanic-arc subduction zone in the OCS, this type of plate boundary is highly permissive for critical minerals at seafloor hydrothermal systems. Seafloor hydrothermal fields in volcanic arcs may be particularly rich in antimony, an element important for corrosion resistance in alloys and batteries.

BOEM will partner with the USGS Coastal and Marine Hazards and Resources Program, a world leader in seafloor mineral science and mapping. Through this study, BOEM would build on this collaboration, with USGS providing in-kind contributions of data acquisition, sample processing, and personnel.

We will also partner with the NOAA Office of Ocean Exploration and Research to leverage its significant experience exploring similar environments along the Pacific ring of fire. NOAA's Deep-Sea Coral Research and Technology Program is also hosting an Alaska Initiative planning virtual workshop in May of 2020 with BOEM participation that will inform this study. NOAA OER intends to provide matching funds for mapping and anticipates additional matching NOAA NOPP funding for new autonomous mapping systems.

Objectives:

- Identify the location and distribution of seamounts and associated hydrothermal activity in priority regions of the Aleutian Arc.

[25] E.O. 13817 of Dec 20, 2017 "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals." https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals

[26] Nov 19th 2019 Presidential *Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska.* https://www.whitehouse.gov/presidential-actions/memorandum-ocean-mapping-united-states-exclusive-economic-zone-shoreline-nearshore-alaska/

- Subsequent investigation will explore benthic communities including deep sea corals and sponges and whether any are endemic to critical mineral habitats.
- Provide baseline biological/geological/chemical information regarding benthic habitats, endemic species, and critical minerals needed to evaluate the potential environmental impacts associated with seabed mining.

Methods: This study will visit up to six unexplored or poorly explored sites along the Aleutian Arc. The sites span a wide range of depths (100m-3600m) and extend 700 miles along the Aleutians from Kagamil Island in the east to Buldir Island in the west. The proposed project will begin with mapping and water column investigation using multibeam sonar collecting both water column and seafloor backscatter. Once seamounts are located the mission will use a continuous CTD deployment, or 'tow-yo,' to search for any neutrally buoyant hydrothermal plume. CTD instrumentation will include a transmissometer and methane sensor, and possible deployment of NOAA Miniature Autonomous Plume Recorders (MAPRs) along the CTD cable.

Where hydrothermal activity is located, the follow-on study will progress to direct seafloor observation and sampling from an ROV or human-occupied submersible. Observation will include video and acoustic recordings; sampling will include ROV biology and geology grab samples, push-cores, biology suction samples, hydrothermal fluid samples, and seawater samples appropriate for chemical and biological assessment.

This study is designed to potentially exploit new autonomous assets for multibeam mapping as these systems become available. Candidate systems include the iXblue DriX or Saildrone Surveyor Autonomous Surface Vessels. Either platform could provide a low-mobilization and lower risk survey option to collect multibeam in these remote locations. Any use of such assets will be in close collaboration with NOAA OER and Office of Coast Survey, with anticipated funding through NOAA NOPP matching contribution.

Specific Research Question(s):

1. Are there undiscovered inter-Island seamounts along the Aleutian Arc?
2. Are those seamounts host to seafloor mineral deposits? What types?
3. What types of biological communities exist at or near seafloor mineral deposits?
4. Are there specific biological communities endemic to the seafloor mineral deposits- and do they seem abundant throughout the region? Can any unique or unusual relationships be discerned?
5. What are some of the fauna that could potentially be impacted by marine mineral mining in these areas and what further information needs could be noted for follow-up studies?

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Shallow-water Geophysical Mapping by Autonomous Underwater Vehicle(s): Feasibility Assessment, Field Testing, and Best Practice
Administered by	Marine Minerals Program
BOEM Contact(s)	Geoffrey Wikel, (geoffrey.wikel@boem.gov), Jeffrey Waldner, (jeffrey.waldner@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, or Cooperative Agreement.
Performance Period	FY 2021–2024
Date Revised	April 10, 2020
PICOC Summary	
Problem	BOEM routinely funds shallow-water (order 10-30 m) geophysical mapping related to the identification and use of OCS sand and sediment resources in beach nourishment and coastal restoration projects. Traditional vessel-based surveying can be expensive and subject to scheduling and weather constraints, positional accuracy problems, and data quality issues. Recent advances in autonomous underwater vehicles (AUV) and geophysical sensor payloads can increase survey productivity, introduce cost savings, and minimize some environmental impacts. However, the technology, especially simultaneous deployment of multiple AUVs, has not been fully tested for scalability in shallow-water settings. This study will examine whether new AUV technology enables BOEM to accomplish its mission with increased productivity, faster response time, reduced cost, greater scale, equivalent or better data quality, and different environmental impact.
Intervention	This study proposes multiple phases of investigation to assess, test, and validate the viability of deploying commercially available AUVs for shallow-water geophysical mapping.
Comparison	The first phase proposes a desktop feasibility assessment and cost comparison of AUV deployment with traditional vessel-based surveying. The second phase (if warranted) will compare data collected via AUV and traditional methods in the same study area using similar acquisition parameters.
Outcome	If successful, the study will address advantages and disadvantages (including cost and productivity trade-offs) of geophysical mapping from single or multiple AUV deployment. The third phase of the study may result in a best practice protocol for AUV-based acquisition.
Context	Atlantic OCS. Potential implication for other OCS regions.

BOEM Information Need(s): AUV technology makes for an attractive proposition to improve the productivity and cost-effectiveness of recurrent reconnaissance-scale and design-level (or project-scale) geophysical surveys already being performed using vessels. Although the Marine

Minerals Program and Environmental Studies Program have successfully deployed a passive, autonomous wave-glider to track acoustically-tagged animals in the Atlantic coastal ocean, there is less proof-of-concept for AUV geophysical mapping in shallow waters. AUV use in shallow water (order 10-30 m) is particularly challenging because of operating conditions and frequent downtime. Traditional towed-sensor surveying can be logistically challenging, can be susceptible to data quality problems from vessel noise and swell effects, and can contribute to different environmental impacts. BOEM needs to thoroughly assess trade-offs and feasibility of using AUVs for reconnaissance-scale geophysical surveys used to map sand resources, delineate habitat, or otherwise characterize the environment that are funded by the government.

Background: Advanced AUVs can be outfitted with various electromechanical and other geophysical sensor payloads (e.g., high-frequency chirp sonar, multibeam sonar, side scan sonar, experimental magnetometer; high-definition video; ADCPs) critical to seafloor mapping applications (Wynn et al., 2014). AUVs have been deployed for the study of geologic framework (<100-200 m sub-seafloor), seafloor morphology and morphodynamics, benthic habitats, shipwrecks, and seafloor hazards, including unexploded ordnance and pipelines (e.g., Smale et al., 2012; Campbell et al., 2015; Trembanis et al., 2019).

AUV use in deepwater, beneath ice, and other extreme environments is routine and considered optimal since vehicles fly at a relatively low altitude over the seabed and collect data at improved resolution. However, use in shallow-water environments is more challenging because of dynamic conditions, such as vehicle draft, endurance (i.e., payload vs. power requirements), and navigation in the presence of surface waves and strong coastal currents, variable ensonification swath in varying water depths, and risk of collision and entanglement. Near real time data recovery, data processing, and data quality control and management are also important factors to consider.

New advances in on-board, artificial intelligence have the potential to substantially improve the range, reliability, and flexibility of AUVs for shallow-water application. That is especially true if multiple AUVS can be deployed in concert on pre-programmed courses and potentially recovered every 24 hours of deployment in the case of high-endurance vehicles. Promising technology is also coming online for high-bandwidth transmission of data directly from AUVs to mothership, and from mothership to shore-based facilities; that combination allows for near real time data review and survey optimization.

Objectives:

1. Address the feasibility of single and multiple AUV geophysical mapping in the shallow-water environment and evaluate trade-offs with existing vessel-based methods.
2. Compare AUV sensor performance with traditional vessel-based tower sensor performance.

Methods: The study would be pursued in three phases; each successive phase would depend and build on the results of the prior one. The first phase involves a desktop study, including an assessment of the availability and reliability of AUV technology, costs, and acquisition protocols, including environmental impact considerations. Provided promising results from the desktop

assessment, the second phase would involve a field campaign in the Atlantic OCS. That phase would involve the deployment and testing of a single AUV and/or multiple AUVs with the geophysical payload of interest, as well as acquisition of vessel-based geophysics in the same footprint using similar operating parameters. Data quality and survey requirements, duration, and costs would be compared. Depending on available budget, the second phase may include sound source monitoring to improve our understanding of potential environmental impacts, including transmission loss of ultra-short baseline (USBL) acoustic communication systems. The third phase would be pursued if the results of the second phase demonstrated technical and economic viability. The third phase would develop a best practice guide for planning and conducting AUV geophysical surveys in shallow water environments, a guidance similar in nature to Fugro (2017).

Specific Research Question(s):

1. Are advanced AUV surveying capabilities a technical and economic alternative to traditional vessel-based surveying methods in shallow water environments?
2. Does specialized AUV equipment or protocols need to be developed, or can commercial-off-the-shelf equipment work?
3. What are the data quality and cost implications of this methodology?

References:

Campbell, K., Kinnear, S., and Thame, A. 2015. AUV technology for seabed characterization and geohazards assessment. *The Leading Edge*, 34(2), 170-177.

Fugro Marine GeoServices, Inc., 2017. Geophysical and geotechnical investigation methodology assessment for siting renewable energy facilities on the Atlantic OCS. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2017-049.

Smale, D., Kendrick, G., Harvey, E., Langlois, T., Hovery, R., Van Niel, K., Waddington, K., Bellchambers, L., Pember, M., Babcock, R., Vanderklift, M., Thomson, D., Jakuba, M., Pizarro, O., and Williams, S., 2012. Regional-scale benthic monitoring for ecosystem-based fisheries management using an autonomous underwater vehicle. *ICES Journal of Marine Science*, 69(6), 1108-1118.

Trembanis, A., Abla, A., Haulsee, K., and DuVal, C., 2019. Benthic habitat morphodynamics – using remote sensing to quantify storm-induced changes in nearshore bathymetry and surface sediment texture at Assateague National Seashore. *Journal of Marine Science and Engineering*, 7(10), 1-30.

Wynn, R., Huvenne, V., Le Bas, T., Murton, B., Connelly, D., Bett, B., Ruhl, H., Morris, K., Peakall, J., Parsons, D., Sumner, E., Darby, S., Dorrell, R., and Hunt, J., 2014. Autonomous Underwater Vehicles (AUVs): their past, present, and future contributions to the advancement of marine geoscience. *Marine Geology*, 352, 451-468.

Environmental Studies Program: Studies Development Plan | FY 2021–2022

Title	Turtle Avoidance Technology Solutions (TATS)
Administered by	Marine Minerals Program
BOEM Contact(s)	Jacob Levenson (Jacob.levenson@boem.gov), Doug Piatkowski (douglas.piatkowski@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, or Cooperative Agreement.
Performance Period	FY 2021–2023
Date Revised	April 3, 2020
PICOC Summary	
Problem	Federally protected sea turtle species may be at risk of entrainment and mortality when Trailing Suction Hopper Dredges (TSHD) are used to excavate sediment from the Outer Continental Shelf (OCS). Mitigation strategies to capture and relocate sea turtles (i.e., relocation trawling) from the project area to minimize dredge entrainment risk have been in place for decades. After over 20 years of implementation, no studies have been done to test the efficacy of relocation trawling in mitigating sea turtle entrainment risk or to assess the risk of incidental impacts to sea turtle behavior and physiology post release as well as impacts to bycatch. Emerging and innovative technological solutions and methods (e.g., sonar and advanced imaging and detection technologies, unmanned aerial vehicles (UAV)/aerial drones, sea turtle telemetry, and movement ecology/occupancy modeling, etc.) for real time in situ turtle detection and tracking have not been fully explored to study the efficacy of and make improvements to this practice.
Intervention	This study proposes to implement a suite of existing and new technological solutions and methods for analysis which, combined with BOEM's existing ASTER decision support tool investment (Ramirez et. al., 2017), may result in more informed and targeted use of relocation trawling activities. The efficacy and potential impacts of sea turtle relocation trawling practices will be tested to support future risk based tradeoff evaluations on when, where, and how to best implement this mitigation strategy
Comparison	Detection, localization, and behavior of sea turtles in the project area will be evaluated using innovative technologies relative to catch per unit effort of the relocation trawler and the rate of lethal entrainment by the TSHD.
Outcome	The results of this study will fill long standing data gaps on sea turtle relocation trawling efficacy and will inform future BOEM, NMFS, and USACE tradeoff decisions regarding the incidental risks associated with implementing the mitigation tool relative to the risk of lethal entrainment via a TSHD.
Context	U.S. Atlantic and Gulf of Mexico OCS

BOEM Information Need(s): After over 20 years of implementing relocation trawling as a mitigation practice for sea turtles, no studies have been done to test its efficacy in mitigating impacts relative to the potential incidental risk to sea turtles and other bycatch. This study proposes to advance emerging technology solutions (e.g., sonar, UAV/aerial drone, telemetry, and automated target identification using machine learning) for real time in situ sea turtle detection and investigate the efficacy and potential implications of current sea turtle relocation trawling mitigation practices associated with hopper dredging. Results from this effort will directly fill critical sea turtle distribution and abundance data gaps relative to project specific relocation trawling and TSHD operations and inform future tradeoff decisions at BOEM (Marine Minerals Program (MMP)), NMFS, and USACE. Sea turtle behavior and physiology information collected during this study will complement ongoing BOEM-funded sea turtle telemetry studies in the Atlantic and Gulf of Mexico ((Hart et. al., (ongoing study; NSL #MM-19-03)). These results will also inform protected species effects analyses associated with National Environmental Policy Act (NEPA) documents and Endangered Species Act (ESA) consultations. This study will strive to adhere to Executive Order 13840, Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States, by bringing together partners across the disciplines of machine learning, artificial intelligence and integration with autonomous systems.

Background: Federally protected sea turtle species are at risk of entrainment and mortality when TSHD are used to excavate sediment from the OCS. A suite of measures to mitigate entrainment risk including TSHD equipment and operational modifications, protected species observers, and relocation trawling were developed over 30 years ago and continue to be implemented today with limited consideration of recent technological advancements and opportunity for improvements. When sea turtles may be present in the project area and at risk of dredging entrainment, NMFS may require sea turtle relocation trawling operations (i.e., modified shrimp trawler) for two primary mitigative purposes: (1) to assess pre-dredging species abundance and distribution and (2) to physically capture and relocate from the immediate vicinity of dredging operations. However, though relocation trawling operations are intended to mitigate dredging entrainment risk, they may also expose sea turtles to other incidental risks and result in the capture of unintended species, known as bycatch. Concerns have recently been raised by NMFS, USACE, and BOEM regarding the incidental risk of this mitigation practice to sea turtles and other protected species. Specifically, it is unclear (1) how sea turtles redistribute after relocation, (2) what percentage of turtles at risk of TSHD entrainment are removed by relocation trawling and c) how are the behavior and physiological responses to stress evident across sea turtle species and age classes. Absent these data, BOEM, NMFS, and USACE lack the ability to make informed tradeoff decisions on whether relocation trawling serves as an appropriate project specific mitigation tool. Significant BOEM investments have already been made in the Atlantic and Gulf of Mexico at active and proposed OCS borrow areas to understand protected sea turtle species behavior and distribution which will be leveraged for the purpose of this study (Hart et. al., (ongoing study; NSL #MM-19-03)).

In addition to the risk of injury and mortality of protected species and other bycatch, relocation trawling may only provide a brief glimpse in time/space of sea turtle presence and abundance at a given site. However, in situ monitoring coupled with the trawling data may afford a more

comprehensive spatial and temporal view of animals present and their behavior. Implementing existing and new technological solutions for in situ monitoring can dramatically improve both the effectiveness and timeliness of animals observed while significantly reducing costs and risks associated with relocation trawling.

Objectives: The objectives of this study will be to a) Develop a comprehensive assessment of sea turtle abundance within an area to be trawled. b) Gather information on sea turtle movement during and after relocation trawling to identify the extent site fidelity/residency factors into relocation effectiveness. c) Determine the effectiveness of alternative detection methods d) Test the efficacy of current relocation trawling methods in reducing TSHD entrainment risk, and e) Develop/build upon open source computer vision for detecting sea turtles and other species of interest to decrease analysis time as a benefit to MMP operations nationally (Dickerson et.al., 2018).

Methods: This study will rely on integrating a tiered system of advanced technological solutions, which will address the objectives identified above. These methods include the use of unmanned vehicles for assessing sea turtle abundance (Goebel et al. 2015, Kiszka et al. 2016, and Fuentes et al. 2015). Understanding abundance at the surface will also be combined with testing the use of an acoustic imaging camera for presence/absence of sea turtles in the immediate vicinity of trawling activities based on prior studies done by USACE (Dickerson et al., 2018). Acoustic approaches have long been used for remote species identification, however, range of effectiveness varies. Various telemetry techniques, both acoustic telemetry and Fastloc® GPS telemetry will be used to understand the site fidelity of a relocated sea turtle (Witt et al. 2010). Fastloc® gps will afford an understanding of how likely the turtle is to reappear in a previously trawled area.

Computer vision, leveraging OpenCV and ground-truthed against visual observations for accuracy, will be used to expedite data analysis. Once in-water and/or aerial images are captured, they can be processed using a convolutional neural network. Neural networks are a means of implementing machine learning where the computer learns to perform tasks through the analysis of training examples. Neural nets have demonstrated reliability in the automation of object detection in imagery and can be applied to visual and acoustic target imaging analysis used in this study (Gray et. al., 2018; Carter et. al., 2014). These data will be further utilized in relevant ongoing BOEM studies that would incorporate the data into ecosystem modeling.

The proposed study sites include active or proposed OCS borrow areas and control sites. These sites are in areas where existing data on sea turtle abundance can be used to compare to autonomous vehicle and forward-looking sonar or high-resolution videography (provided water clarity). Observations will be analyzed via employing existing statistical procedures along with more complex statistical analyses and comparisons of spatial and temporal patterns of detection.

Specific Research Question(s):

1. What is the effectiveness of relocation trawling at reducing risk of sea turtle entrainment?

2. What is the impact of site fidelity on relocation trawling effectiveness?
3. How can alternative and emerging technologies be leveraged to detect abundance and distribution of sea turtles within a borrow area and in the path of active extraction?
4. Can alternative technologies mitigate for sea turtle entrainment and reduce impacts to associated species?

References:

Bevan E., et. al., Unmanned Aerial Vehicles (UAVs) for Monitoring Sea Turtles in Near-Shore Waters, *Marine Turtle Newsletter* 145:19-22, (2015) http://www.seaturtle.org/mtn/archives/mtn145/mtn145-4.shtml

Carter, Steven & Bell, Ian & Miller, Jessica & Gash, Peter. (2014). Automated marine turtle photograph identification using artificial neural networks, with application to green turtles. Journal of Experimental Marine Biology and Ecology. 452. 105–110. 10.1016/j.jembe.2013.12.010.

Dickerson, D., T. Welp, S. Willis, and D. Novy. 2018. Use of an acoustic camera to evaluate the performance of tickler chains and draghead deflectors for sea turtle protection during hopper dredging in the United States of America. US Army Corps of Engineers Engineering Research and Development Center Technical Report (ERDC TR-18-4).

Fuentes M.M.P.B., Bell I., Hagihara R., Hamann M. and others (2015) Improving in-water estimates of marine turtle abundance by adjusting aerial survey counts for perception and availability biases. J Exp Mar Biol Ecol 471: 77−83.

Goebel M.E., Perryman W.L., Hinke J.T., Krause D.J., Hann N.A., Gardner S., LeRoi D.J. (2015) A small unmanned aerial system for estimating abundance and size of Antarctic predators. Polar Biol 38: 619−630

Gonzalez L.F., Montes G.A., Puig E., Johnson S., Mengersen K., Gaston K.J. Unmanned Aerial Vehicles (UAVs) and Artificial Intelligence Revolutionizing Wildlife Monitoring and Conservation. Passaro VMN, ed. *Sensors (Basel, Switzerland)*. 2016;16(1):97. doi:10.3390/s16010097. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4732130/

Gray, Patrick & Fleishman, Abram & Klein, David & McKown, Matthew & Bézy, Vanessa & Lohmann, Kenneth & Johnston, David. (2018). A Convolutional Neural Network for Detecting Sea Turtles in Drone Imagery. Methods in Ecology and Evolution. 10.1111/2041-210x.13132.

Hart, K, et al., (ongoing study) Fine-Scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico (NSL #MM-19-03) https://marinecadastre.gov/espis/#/search/study/100243

Kiszka J., Mourier J., Gastich K., Heithaus M.R. (2016) Using unmanned aerial vehicles (UAVs) to investigate shark and ray densities in a shallow coral lagoon. Mar Ecol Prog Ser 560: 237−242

Ramirez A, Kot CY, Piatkowski D. 2017. Review of Sea Turtle Entrainment Risk by Trailing Suction Hopper Dredges in the US Atlantic and Gulf of Mexico and the Development of the ASTER Decision Support Tool. OCS Study BOEM 2017-084. Obligation No.: M15PG00019.

Witt, M.J., Åkesson, S., Broderick, A.C., Coyne, M.S., Ellick, J., Formia, A., Hays, G.C., Luschi, P., Stroud, S. & Godley, B.J. (2010) Assessing accuracy and utility of satellite-tracking data using Argos-linked Fastloc-GPS. *Animal Behaviour*, **80**, 571–581.

Ballorain, K.J., J. Wagner & S. Ciccione. 2014. Drone technology used for foraging sea turtle study. Proceedings of the 34th Annual Symposium on Sea Turtle Biology and Conservation, New Orleans, Louisiana, USA, April 10-17, 2014.

Gonzalez-Socoloske, Daniel, and Leon D. Olivera-Gomez. "Gentle giants in dark waters: using side-scan sonar for manatee research." *The Open Remote Sensing Journal* 5 (2012): 1-14.

Department of the Interior (DOI)
The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management (BOEM)
The mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program
The mission of the Environmental Studies Program is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM's Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).