BUREAU OF OCEAN ENERGY MANAGEMENT | **ENVIRONMENTAL STUDIES PROGRAM**

Studies Development Plan 2020–2022

Environmental research proposed to begin in FY2020 to FY2021 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

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CHAPTER 1 OVERVIEW

1.1 Introduction

1.1.1 Bureau of Ocean Energy Management (BOEM) Mission

The Department of the Interior's (DOI's) 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 minerals.

1.1.2 Environmental Studies Program (ESP) Vision & Background

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

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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 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 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 identify 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 definition of the regional socio-ecological systems[1] that it stewards. The ESP, together with environmental assessment and regulation, constitute BOEM's environmental program and ensure that environmental protection is a foremost concern and an indispensable requirement in BOEM's decision making. The environmental program as a whole

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

is a core component of BOEM, whose overall mission is to manage development of OCS energy and mineral resources in an environmentally and economically responsible way. The ESP's core values are responsible stewardship, decisions informed by science, and a commitment to integrity and ethics in all activities.

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 $35 million, although the expenditure level has varied over the years. The ESP funds are currently dispersed for defined projects through three vehicles: Interagency Agreements (IAs) with Federal agencies; cooperative agreements with state institutions; and competitive contracts. Irrespective of particular 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 2013 and 2019, the percentage of funds distributed for ESP studies includes (**Figure 1**):

- 44% of funds went to Federal agencies
- 28% to private organizations
- 24% to academic institutions
- 3% to state government agencies
- 1% to other researchers

The subject matter allocation of funds over fiscal years (FYs) 2013–2019 (**Figure 2**):

- 35% to habitat and ecology
- 28% to marine mammals and other protected species
- 13% to fate and effects
- 9% to physical oceanography
- 6% to information management
- 5% to social sciences and economics
- 4% to air quality

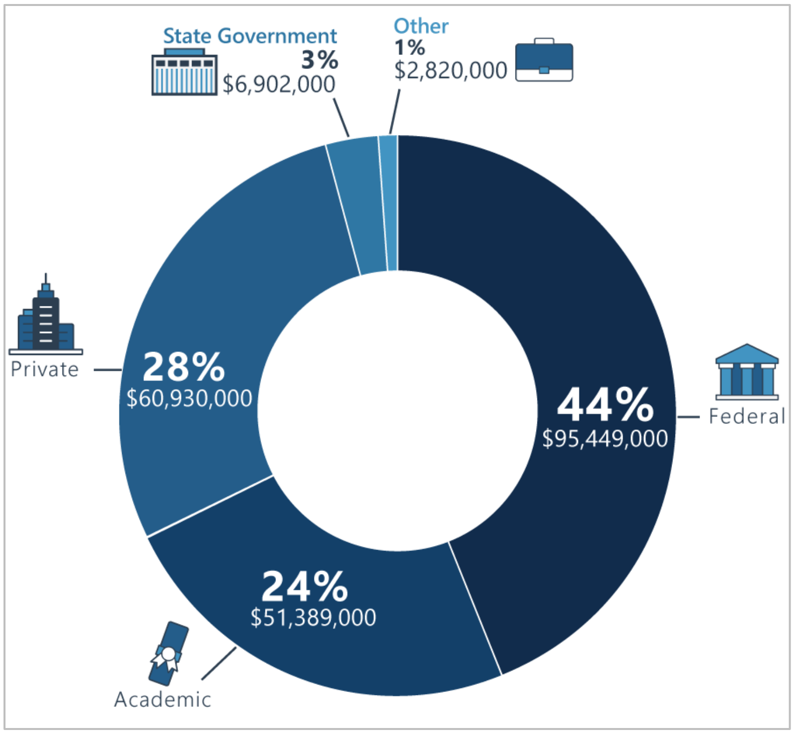

Figure 1. Cumulative ESP expenditures for FY 2013–2019 by vendor type.
Dollar amounts are rounded to the nearest thousand dollars.

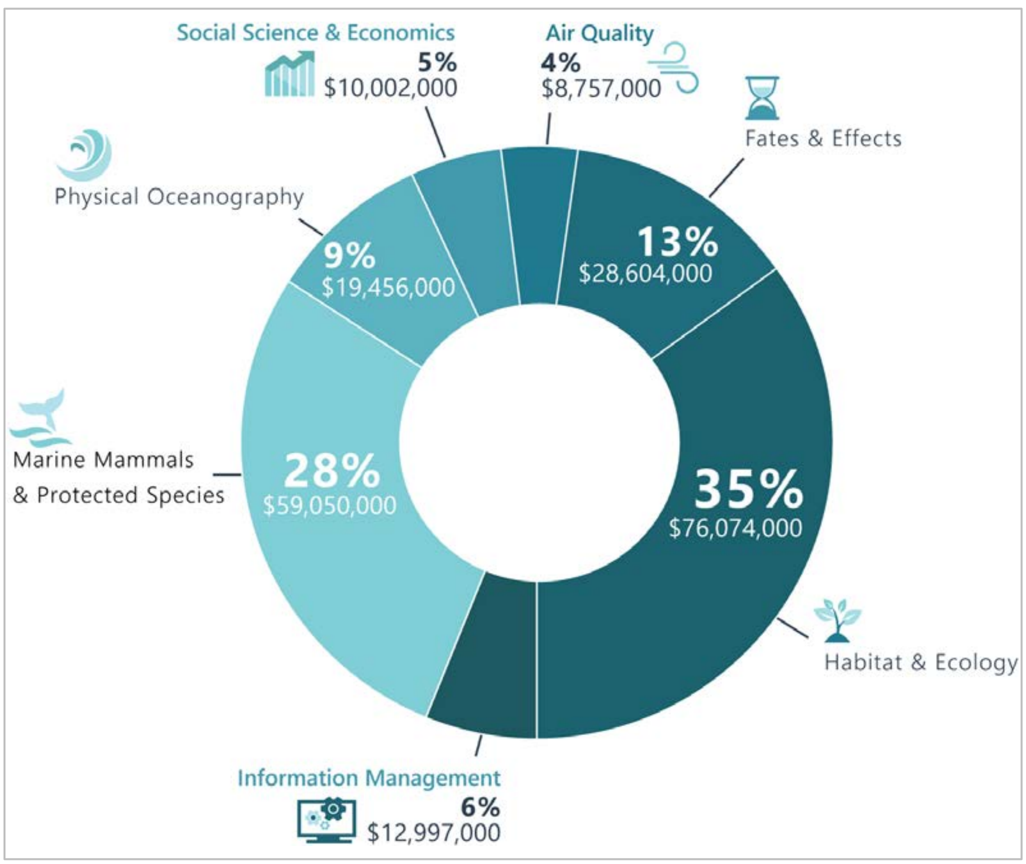

Figure 2. Cumulative ESP expenditures for FY 2013–2019 by discipline.
Dollar amounts are rounded to the nearest thousand dollars.

1.2 About the Studies Development Plan (SDP)

1.2.1 SDP Overview

The BOEM 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 annual National Studies Lists (NSLs) that describe ESP projects eligible for funding in a given FY. Proposed studies within the SDP are peer reviewed by selected BOEM subject matter experts (SMEs).

An overview of BOEM's proposed national and regional research is provided in Chapters 2–6. **Appendix I** includes tables summarizing new studies that are projected to begin in FY 2020 or FY 2021, and **Appendix II** includes the study profiles for each region. 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.

Additional information on BOEM's ongoing studies can be found at our studies website at http://www.boem.gov/Current-Research-Ongoing-Environmental-Studies/. Access to completed ESP products through BOEM's website is provided by the ESP Information System (ESPIS) at http://www.boem.gov/espis/.

1.2.2 What BOEM Needs to Know

1. **Effects of Impacting Activities:** Environmental impacts from activities (such as those listed below) 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

2. **Affected Resources:** 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 particular 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
- 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.*, explosive removal of platforms) 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 priority setting. 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 significantly to existing knowledge, and profiles should describe how the proposed work will fill gaps in information or will improve, confirm, or challenge current understanding.

3. **Research Concept, Design & 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.

Quality and innovation are important considerations evaluated in this criterion. Archiving data and curation of collected specimens are 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. However, costly studies are not necessarily 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 transfer of funds from or to BOEM, contributions to a shared account, or coordination of separately funded work towards 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-profit organizations. Partnering is encouraged with other Federal agencies, academic organizations, non-profits, or commercial enterprises to achieve shared mission needs.

7. **Multi-Regional & Strategic Utility:** Studies may gain priority if they support multi-regional or strategic needs. Locally focused 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 broader needs.

1.2.4 Strategic Science Questions (SSQs)

Historically, the ESP has not provided additional criteria to drive the ranking processes of the proposed studies. This is in part due to the highly collaborative and collegial nature of the process, a sufficient level of funding to allow all regions and programs to have their needed studies funded, and the highly diverse nature of information needs across the Bureau from regional perspectives.

Beginning in 2017, in response to internal and external reviews of the ESP, BOEM is developing a series of strategic questions 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 towards a more comprehensive understanding of those topics in the 5 to 10 year horizon. 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*:

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

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

1.2.5 SDP Development Process

ESP projects are developed by BOEM through internal and external review. Overall direction and coordination is provided by the Headquarters Office's Division of Environmental Sciences (DES) within the Office of Environmental Programs (OEP). Research projects are built by addressing BOEM's SSQs (https://www.boem.gov/Strategic-Framework-2017/) with input from BOEM's regional offices and stakeholders. 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 planning.

The ESP introduced an updated study profile format in 2018 to further improve each profile's scientific rigor and to enhance any potential statement of work. In the new 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 that guide ESP's broader research portfolio over the next 5 to 10 years.

The ESP manages applied science research with direct relevance to the agency's environmental assessment needs. BOEM's OEP conducts environmental reviews, including NEPA analyses, and produces compliance documents supporting decisions on the **Five-Year Oil and Gas Program, renewable energy development, and marine mineral leasing activities**.

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

- **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

1.2.6 Conventional Energy

OCSLA (43 U.S.C. § 1344) requires the DOI to prepare a Five-Year 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 2017–2022 program addresses OCS oil and gas exploration, development, and production in the Gulf of Mexico (GOM), Pacific, and Alaska (BOEM, 2016a).

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 yet producing energy on the U.S. OCS, 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. Four construction and operations plans are under review, and seven more are expected within the next year.

1.2.8 Marine Minerals

OCSLA assigns DOI (delegated to BOEM) responsibility for developing non-energy minerals on the OCS, such as sand, and ensuring related environmental protection. Section 8(k) of OCSLA sets forth specific requirements for this activity. To date, all of the leases and agreements issued by the Marine Minerals Program (MMP) have been negotiated noncompetitive agreements for sand. The MMP is also 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 [FR] 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, and there are no pending lease requests at this time. In addition, Executive Order (EO) 13817 (*A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*) has provided a focus on the need to identify domestic sources of these minerals that include potential offshore sources.

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

Figure 3 depicts, as of May 2017, those areas of the OCS that are (or could potentially be) under the purview of BOEM for development of conventional and renewable energy resources and extraction of marine minerals. Currently, approximately 16 million of these acres are actively leased by BOEM (BOEM, 2017) and provide for about 4% of the Nation's natural gas production and about 18% of domestic oil production. BOEM's MMP has executed 56 leases since 1995 and conveyed rights to approximately 146 million cubic yards of sand for coastal restoration projects along the coast of multiple states in the Atlantic and GOM OCS Regions. These projects have resulted in the restoration of approximately 321 miles of the Nation's coastline, protecting billions of dollars of infrastructure and important ecological habitats.

The polygonal areas shown in **Figure 3** are bounded on the terrestrial side by the Submerged Lands Act boundary, which divides state and Federal ownership of submerged lands and waters. The polygons are bounded on the seaward side by the limit of the U.S. EEZ, which lies 200 nautical miles (NM) from the coastal baseline of the U.S., or by international treaty boundaries. Areas of the OCS within the GOM OCS Region (GOMR) that are located seaward of 200 NM are subject to treaties between the U.S., Mexico, and Cuba, and were included in the polygons. Subtracted from the polygons are the acreages of Federal Marine Protected Areas, which are currently unavailable for leasing of energy resources.

Located outside of the polygons are areas of the OCS that are offshore of the U.S. territories and possessions. The OCSLA, as currently enacted, does not apply to this category of Federal submerged lands and waters for purposes of leasing. Also outside of the polygons are areas of the OCS shown on BOEM Official Protraction Diagrams (https://www.boem.gov/Official-Protraction-Diagrams/) that are located seaward of 200 NM. These submerged lands and waters fall within the boundaries of BOEM planning areas and are part of the U.S. Extended Continental Shelf. As the U.S. has not yet asserted jurisdiction over the Extended Continental Shelf, these areas are for planning purposes only, with all activities subject to approval by the U.S. State Department.

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 towards 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 stakeholder and public educational outreach for quality assurance, peer review planning, and data dissemination.

ESP at Headquarters, overall, provides leadership and general program support for all of BOEM's ESP studies.

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.

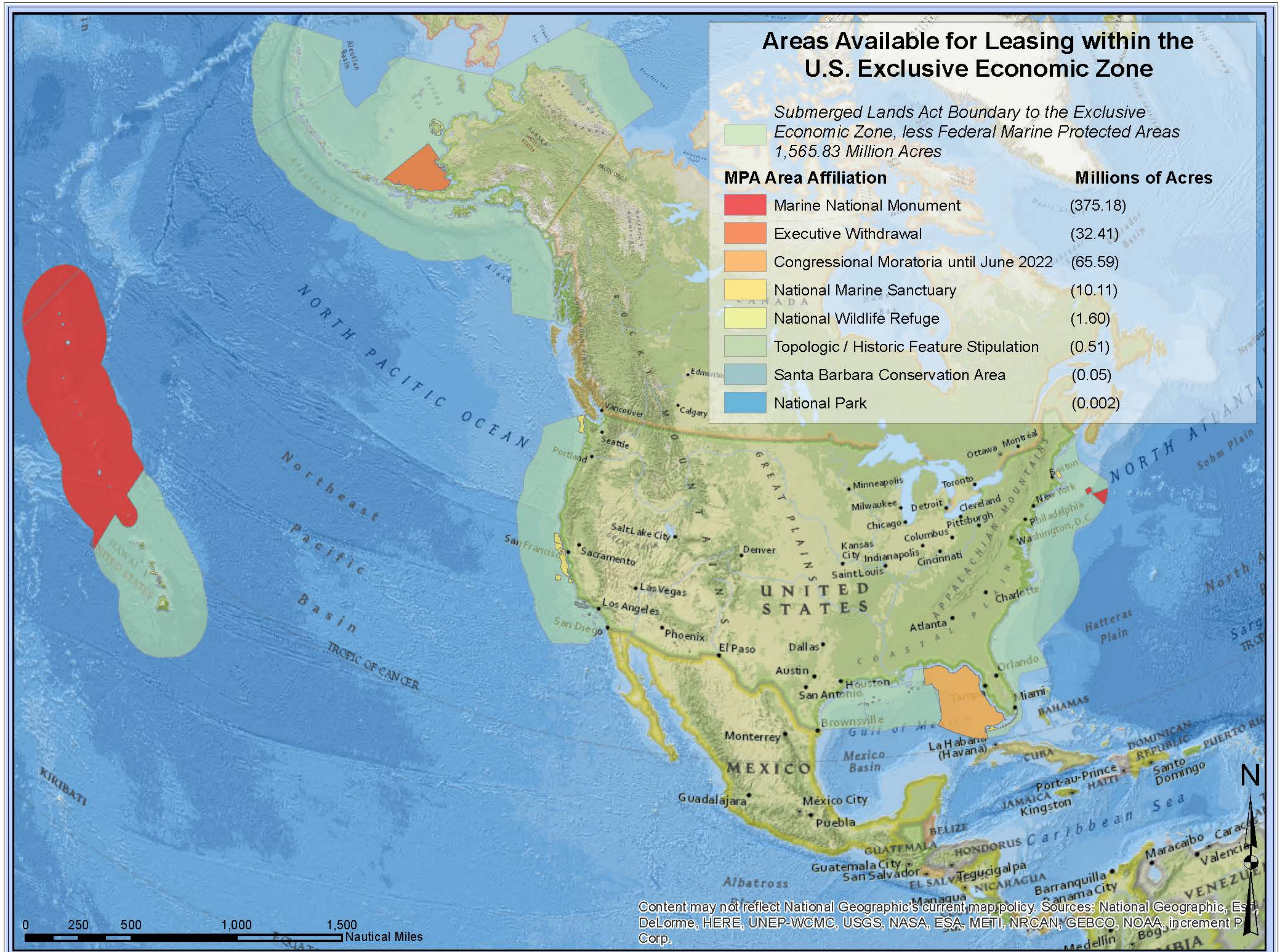

Figure 3. Areas available for leasing within the U.S. EEZ.
Marine Protected Areas (MPAs) are excluded from leasing. The Geospatial Services Division of the BOEM Office of Strategic Resources generated this map. All data used for the map came from authoritative sources (National Oceanic & Atmospheric Administration [NOAA], U.S. Geological Survey [USGS], U.S. Fish & Wildlife Service [USFWS], National Park Service [NPS], and BOEM), and all acreage calculations were performed using ArcGIS® software (Esri, Inc.).

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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. The policy and supporting information can be found at: http://www.doi.gov/scientificintegrity/index.cfm.

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 towards the ESP's performance measures and accountability. The ESP Performance Assessment Tool (ESP-PAT) ensures that 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 OMB, 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 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
- National Academies of Sciences, Engineering, and Medicine (NAS) peer review panel of study findings and 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 the course of 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 agency partners, and many of BOEM's important and award-winning research efforts were completed through the cooperation with agencies such as the USGS, NOAA, and the United States Navy's Office of Naval Research. BOEM also 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 BOEM to efficiently establish cooperative agreements with state-owned institutions.

BOEM coordinates its efforts with research programs such as the National Oceanographic Partnership Program (NOPP). NOPP is a collaboration of Federal agencies providing 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 the Bureau's participation, and its investments have grown dramatically in recent years. The ESP has funded research through NOPP focused on chemosynthetic communities, biological habitats supported by shipwrecks, high-frequency (HF) radar mapping of surface circulation in Alaska, improving cetacean electronic data loggers, and renewable energy. Several studies have received the NOPP Excellence in Partnering Award and DOI's Partners in Conservation Award.

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.

ESPIS presents information about ongoing and completed BOEM ESP studies. 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 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. ESPIS can be accessed at http://www.boem.gov/espis/.

The results of BOEM-funded research are presented 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 many projects have opportunities for educational components. BOEM also publishes its own magazine *Ocean Science*, accessible at https://www.boem.gov/Ocean-Science/, and quarterly *Science Notes* newsletters, available at https://www.boem.gov/Science-Notes/.

Information concerning ongoing research supported through the ESP is accessible at https://www.boem.gov/Ongoing-Environmental-Studies-by-Region/. 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. Affiliated websites, presentation abstracts, and papers are provided where applicable.

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 a number of 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: (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. To achieve these goals, the ESP undertakes a number of activities aimed at increasing ocean literacy and building a strong 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 network with the pre-college community and help students to become 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.

CHAPTER 2 HEADQUARTERS STUDIES

2.1 Introduction

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

To meet national assessment needs, OEP considered the areas of information that BOEM needs to know as posed in the BOEM Strategic Framework (BOEM, 2016b). Comparison of these areas with the historical knowledge of national scientific needs identified through either the development of the 2017–2022 Programmatic Environmental Impact Statement (BOEM, 2016c) or other NEPA analyses and associated consultations led to the development of this year's 21 study profiles.

2.2 Alignment With SSQs

At the national level, BOEM's ESP focuses on a few of the SSQs that support BOEM and ESP operations as a whole (**Table 1** and **Table 2**; see also previous SDPs at https://www.boem.gov/Environmental-Studies-Planning/). 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 understanding the air emissions impacts of BOEM-regulated activities to the human, coastal, and marine environment.

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 for species monitoring; using existing satellite resources to better detect and track large marine organisms; and an OCS Genomic Sampling Strategy for marine invertebrates. The ESP has also funded key interagency programs that are seeking to develop data and metadata standards for oceanographic data required by many Federal agencies to support science informed decisions. ESP has also conceptualized and funded studies to better quantify the dynamics of natural and anthropogenic sounds in the marine environment, and to understand the potential impacts of noise on marine life. These studies have covered a range of noise types (*e.g.*, pile driving, seismic airguns, explosive removals) and a variety of species (*e.g.*, marine mammals, fish, invertebrates).

BOEM is 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. 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. Alignment of proposed FY 2020 Headquarters studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
HEADQUARTERS—FY 2020

Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM-regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Addressing Data Gaps in Spatial and Acoustic Ecology of Understudied Endangered Species Act (ESA) Listed Marine Mammals	✓	✓	✓	✓			✓				✓	✓
Augmenting Monitoring Surveys with Environmental Deoxyribonucleic Acid (eDNA) Sampling to Improve Species Detection	✓	✓	✓								✓	✓
Continued Partnership with National Museum of Natural History, Department of Invertebrate Zoology (NMNH-IZ) for a Voucher-based, Genomic Reference Facility for Ocean Biodiversity	✓	✓	✓				✓				✓	✓
Continued Support for the Animal Telemetry Network (ATN)	✓	✓	✓	✓	✓						✓	✓
Deepwater Atlantic Habitats III: Continued Exploration and Analysis of Potential Impacts from Energy and Minerals Activities	✓		✓	✓			✓				✓	✓
High Resolution Modeling of the Gulf of Mexico	✓							✓				
Installing Offshore & Coastal Dispersion (OCD) Platform Downwash Algorithms in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD)	✓									✓	✓	✓
Marine Biodiversity Observation Network (MBON) Special Issue of *Oceanography* Magazine	✓	✓	✓	✓	✓		✓				✓	✓
Marine Mammal Bioenergetics Workshop	✓	✓	✓	✓			✓				✓	✓
Next Generation of Animal Telemetry: Pathway to Implementation	✓	✓	✓								✓	✓
Oil in the Sea IV: National Academies of Sciences, Engineering, and Medicine (NASEM)	✓			✓		✓	✓	✓	✓		✓	✓
Outer Continental Shelf (OCS) Wind Energy: Socioeconomic Baselines, Trends, and Impacts		✓					✓		✓			✓
Phase III Development of the Tethys Passive Acoustic Monitoring (PAM) Metadata System	✓	✓	✓		✓						✓	✓
Responding to the National Academies of Sciences, Engineering, and Medicine's (NAS's) Comments on the Air Quality Modeling in the Gulf of Mexico (GOM)	✓			✓						✓	✓	
Sea Turtle Hearing Sensitivity and Impacts of Sound	✓	✓	✓		✓		✓					
Sustained Observations of Marine Biodiversity for Coordinated National Monitoring of Marine Ecosystem Responses to Outer Continental Shelf (OCS) Environmental Impacts	✓	✓	✓	✓	✓		✓				✓	✓
Updating Offshore Emissions Factors Scoping Study	✓			✓						✓		✓
Updating the Emissions Exemption Thresholds (EETs) Using Classification and Regression Tree (CART) Analysis	✓			✓						✓	✓	

Table 2. Alignment of proposed for FY 2021 Headquarters studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
HEADQUARTERS—FY 2021

Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING** ?
Assessing the Use of Satellite Data for Offshore Air Quality Applications	✓			✓						✓	✓	✓
Mortality Risk for Whale and Basking Sharks During Energy and Mineral Operations	✓	✓	✓	✓			✓				✓	
World War II Shipwrecks in the Atlantic and Pacific: a Microbiological, Archaeological, and Geochemical Baseline Study	✓	✓	✓	✓		✓	✓					✓

2.3 Headquarters Decision Context

Within the next 5 to 10 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 geological and geophysical (G&G) permitting decisions, or internal policy that is agency-wide, including issues such as potential acoustic effects. In addition, Headquarters needs to address potential cumulative impacts due to multi-regional impacts or program-level concerns, and air emissions concerns on a national level. 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 demonstration 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) consultations for G&G permitting decisions
- National OCS Oil and Gas Leasing Program
- Air Quality Rule

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 OCS planning areas where leasing does not currently occur. With the potential for expansion, 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, surrogate species are used 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. There is also a need for BOEM to support a database of fish vocalizations to make better use of existing and future PAM data, and to create an integrated database of visual and genomic information for marine mammals to more efficiently monitor population levels and assess environmental threats. 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 Rule, which will require more detailed information such as updated emissions exemption thresholds to protect all NAAQS for all averaging times for both the GOM and Alaska OCS Regions. In addition, BOEM needs to evaluate which emission factors need to be updated or developed for offshore oil and gas activities for all regions and to ensure that the

NAAQS of any state are not impacted. Another air quality critical need for BOEM 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. 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.

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 includes impacts from offshore oil and gas, as well as G&G activities. 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 2020–2022 SDP, BOEM Headquarters NEPA and consultation needs focus on the acoustic environment, air quality, ecological concerns for marine mammals and large-bodied fishes, 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. All of this information will enable BOEM to conduct more comprehensive NEPA analyses and associated consultation.

CHAPTER 3 ALASKA OCS REGION STUDIES

3.1 Introduction

The Alaska OCS encompasses 15 planning areas in the Arctic, Bering Sea, and Gulf of Alaska sub-regions (**Figure 4**). BOEM's Alaska 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, including 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 4. Alaska OCS Region Planning Areas.

Since the ESP began more than 45 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 at http://www.boem.gov/ESPIS/. An alternate location for browsing Alaska OCS Region study reports by year is http://www.boem.gov/AKpubs. 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.

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 Alaska's OCS. In its first 25 years, the Alaska CMI has funded approximately 110 studies and leveraged over $20 million of agency funds into $40 million of relevant marine-based research, with non-Federal matching funds from more than 50 different organizations.

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, as well as bird and fish species that live on, below, or near the ice. 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 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.

Currently, the Alaska OCS Region has 54 active leases from previous lease sales. There are 14 in the Cook Inlet Planning Area and 40 in the Beaufort Sea Planning Area.

As directed in EO 13795 (April 28, 2017) and DOI Secretary's Order 3350 (May 1, 2017), BOEM is in the process of developing a new National OCS Program that, if approved, will supersede the 2017–2022 Program. The first of three proposals for the National OCS Oil and Gas Leasing Draft Proposed Program (BOEM, 2018), was released on January 4, 2018. This Draft Proposed Program proposed new lease sales to occur in all Alaska OCS planning areas except the North Aleutian Basin.

On April 13, 2018, BOEM approved a revision to the Exploration Plan (EP) 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. Exploration activities are expected to be concluded in spring 2019.

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 6 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.

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 February 2019 is more than 173 million barrels, with the Federal portion comprising more than 30 million barrels.

3.2 SSQs Unique to the Alaska OCS Region

In addition to the programmatic SSQs identified in **Section 1.2.4**, the Alaska OCS 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 potential exploration activities on existing leases within Cook Inlet, as well as future lease sales in this area under the National Program currently being developed. 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, is needed to support NEPA analyses, especially evaluation of cumulative effects. Other particular interests for information include, but are not limited to

- An improved understanding of distribution and geographic range of the endangered Cook Inlet beluga whale stock
- Obtaining further baseline information about potential impacts from oil and gas-related activities to the economy and subsistence use of lower Cook Inlet
- Assessment of variability and long-term trends in oceanographic conditions and biological communities, including the distribution and habitat use of sea otters in Cook Inlet and the presence and distribution of the critically endangered North Pacific right whale around Kodiak Island

Information about variability and long-term trends in oceanographic conditions and biological communities is also needed in the Arctic. Updated information about river overflood on sea ice and locations of strudel scours in the Beaufort Sea will provide valuable insights regarding potential hazards in relation to placement of oil and gas infrastructure, including subsea pipelines and ice roads used to access Federal leases. Additional data is needed about habitat use of marine birds, as well as effects on their productivity from environmental changes. Another issue of concern relates to the threat of introductions of non-native marine species in the Arctic and the need for establishment of monitoring plans. Furthermore, a synthesis of the large amount of existing information related to potential direct, indirect, and cumulative effects on marine mammals from oil and gas activities in Alaska will provide an enhanced understanding of how these effects relate to the overall impact of anthropogenic activities.

The Alaska OCS Region has considered the SSQs identified above together with these specific information needs in developing our list of studies proposed for FY 2020. The studies proposed for the Alaska OCS Region inform a broad repertoire of knowledge and address each of the SSQs to varying extents. **Table 3** and **Table 4** show the strongest intersections between each study proposed for FY 2020 and FY 2021 with the strategic questions.

Appendix I includes tables of proposed studies for the Alaska OCS Region, and **Appendix II** includes the study profiles. See previous SDPs on BOEM's website at https://www.boem.gov/Environmental-Studies-Planning/.

3.4 Alaska OCS Region Decision Context

3.4.1 Current/Relevant Issues

A new National OCS Oil and Gas Leasing Program may lead to increased levels of oil and gas activities in the Alaska OCS Region. This could expand BOEM's need for information in these areas, as well as in other Alaska OCS planning areas that might be included in the additional sales.

In implementing EO 13795 and EO 13817, BOEM is evaluating expansion of its program in Alaska to include renewable energy, as well as marine minerals. Relevant issues to evaluate include the renewable energy potential for the OCS off Alaska, distribution of marine mineral deposits in the Region, and environmental considerations associated with the development of these programs.

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

Table 3. Alignment of proposed FY 2020 Alaska OCS Region studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
ALASKA OCS REGION—FY 2020

Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									ALASKA REGION QUESTIONS		
	Conventional Energy	Renewable Energy	Marine Minerals	How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?	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**?
Comprehensive Synthesis of Impacts to Marine Mammals from Oil and Gas Activities in the Alaska Outer Continental Shelf (OCS), 2000–2020	✓			✓	✓	✓									
Cook Inlet Beluga Acoustic Monitoring in Lower Cook Inlet (LCI) Rivers	✓			✓	✓		✓				✓	✓			
Determining Important Nearshore and Marine Sites for Post-breeding Shorebirds, Beaufort Sea	✓			✓			✓	✓			✓			✓	
Early Detection Plan for Marine Non-native Species on the Arctic Outer Continental Shelf (OCS)	✓			✓			✓					✓			
Gulf of Alaska and Bering Sea Coupled Ice-ocean Circulation Model	✓							✓					✓		
The Impact of Marine Fish Communities on Red-throated Loon Productivity in the Beaufort Sea	✓			✓			✓							✓	
Improvements to the Oil Spill Risk Analysis (OSRA) Input Quality Assurance/Quality Control (QA/QC) and Validation	✓										✓		✓	✓	
Integrated Oil-spill Occurrence Estimator (OSOE) Model for Alaska, Atlantic, Pacific, and Gulf Outer Continental Shelf (OCS) Regions	✓										✓		✓		
Kenai Peninsula Borough (KPB) Economy, 2008 to 2018	✓								✓						
Monitoring the Recovery of Seabirds and Forage Fish Following a Major Ecosystem Disruption in Lower Cook Inlet (LCI)	✓			✓				✓			✓	✓			
Quantifying Sea Otter Abundance, Distribution, and Foraging Intake in Cook Inlet, Alaska, Using Unmanned Aircraft Systems (UAS) Technology	✓			✓			✓				✓	✓			
Subsistence Harvest and Iñupiaq Knowledge of Beluga Whales for Kaktovik, Alaska	✓						✓		✓						
Update of River Overflood on Sea Ice and Strudel Scour Database	✓							✓			✓		✓		

Table 4. Alignment of proposed FY 2021 Alaska OCS Region studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
ALASKA OCS REGION—FY 2021

Study Title	BOEM PROGRAMS: Conventional Energy	Renewable Energy	Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?	ALASKA REGION 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 distribution, affected by **REDUCED SEA ICE CONDITIONS**?	How do cold temperatures and presence of sea ice **ALTER THE FATE OF SPILLED OIL**?
Acoustic Detection of Critically Endangered North Pacific Right Whales in the Gulf of Alaska (GOA)	✓			✓			✓								
Offshore Renewable Energy Potential on Alaska's Outer Continental Shelf (OCS)		✓									✓				

3.4.2 NEPA/Consultation Information Needs

Due to the significant differences between Alaskan environments and other OCS areas, Alaska has some unique issues that influence BOEM mission and decision making needs. These must be considered within the context of varying industry interest in OCS exploration, 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 particular 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.

CHAPTER 4 GULF OF MEXICO OCS REGION STUDIES

4.1 Introduction

Ongoing activities in the GOM consist of conventional oil and gas development as well as 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, the former Minerals Management Service (MMS), now BOEM, entered into a partnership with Louisiana State University (LSU) to establish the first CMI. This partnership, which continues today between BOEM and LSU, was developed as part of an initiative to cultivate new state-Federal 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 between BOEM and the USGS initiated in 1996 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.

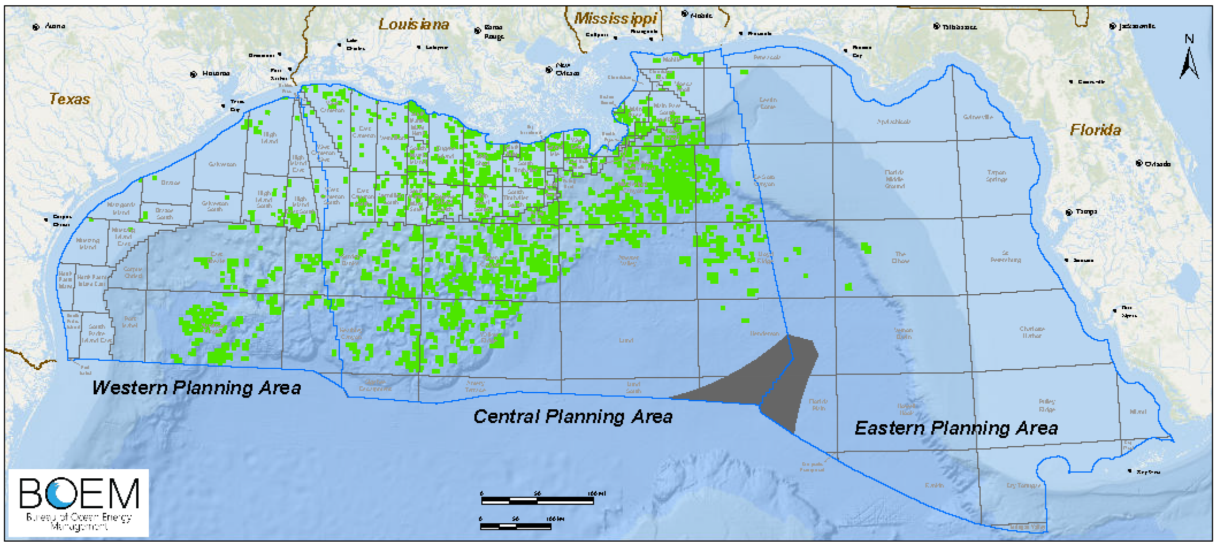
In 2010, BOEM joined the Gulf Coast Cooperative Ecosystem Studies Unit (GCCESU) as a Federal partner. Membership in the GCCESU creates additional opportunities for interdisciplinary and multi-agency research, technical assistance, and education through collaborations within a network of member Federal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

4.1.1 Conventional Energy

As of March 1, 2019, there are more than 2,500 active oil and gas leases on the GOM Federal OCS (Error! Reference source not found.). 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, proposed in the FY 2017–2022 Five-Year Program, were held in 2018 and two more lease sales are scheduled for 2019. The new Draft Proposed Program proposes GOMR lease sales in the Central Planning Area, Western Planning Area, and some portions of the Eastern Planning Area. Final decisions on the extent of leasing areas in the GOMR that will be available in future lease sales are yet to be made. For more information on the GOMR please visit http://www.boem.gov/Gulf-of-Mexico-Region/.

In April 2010, the *Deepwater Horizon* (*DWH*) incident caused a massive oil spill that released millions of barrels of crude oil into the GOM. In addition, millions of gallons of chemical dispersants were used to mitigate the spill among other response measures. The degree and extent of offshore and onshore environmental impacts to natural and cultural resources, as well as socioeconomic impacts from the spill and spill response, will continue to be topics of study even though the Natural Resource Damage Assessment (NRDA) was settled in 2016. The NAS established a research grant program (the Gulf Research Program) to study environmental science and human health impacts in the wake of the oil spill in the GOM. BOEM staff are involved in coordinating with the Gulf Research Program and other funding sources, including the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2011 (RESTORE Act), for future projects occurring over the next 30 years.

BOEM Gulf of Mexico OCS Region
Blocks and Active Leases by Planning Area
June 3, 2019



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	294	1,677,908
Central	12,409	66,446,351	2,139	11,195,188
Eastern	11,537	64,357,859	18	103,680
Sub-Totals	29,186	159,381,023	2,451	12,976,776
CPA / EPA Shared Blocks*	(86)		0	
Totals	**29,100**	**159,381,023**	**2,451**	**12,976,776**

Active Lease
Exclusive Economic Zone Northern Portion of the Eastern Gap
Planning Area Boundary

* CPA and EPA contain 86 shared blocks. These blocks are given both a CPA and EPA designation in the data which may account for a higher block total.

Figure 5. GOM OCS planning areas and active oil and gas leases (June 3, 2019).

4.1.2 MMP

The MMP is actively leasing OCS sediment in the GOM, some of which are for restoration projects proposed to repair natural resources damaged during the *DWH* oil spill or storm-related events. Projects recently completed in the GOM include Caminada Headland Beach and Dune Restoration Project (**Figure 6**) and Cameron Parish Shoreline Restoration Project. More than 10 million cubic yards of material has been authorized to be dredged from the OCS for these two projects. 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, and conserve sensitive areas for wildlife while enhancing the natural protection that these landforms provide from storms. The Gulf provides a unique environment of complex competing use challenges resulting from sand resource areas that may also be optimum sites for oil and gas platforms and associated pipelines (**Figure 7**). These potential access and environmental resource conflicts are becoming more complex and deserving of rigorous and integrated environmental study, monitoring, and management.

Figure 6. Aerial photograph of Caminada Headland construction, September 6, 2013.
Photo credit: Patrick M. Quigley (www.gulfcoastairphoto.com).

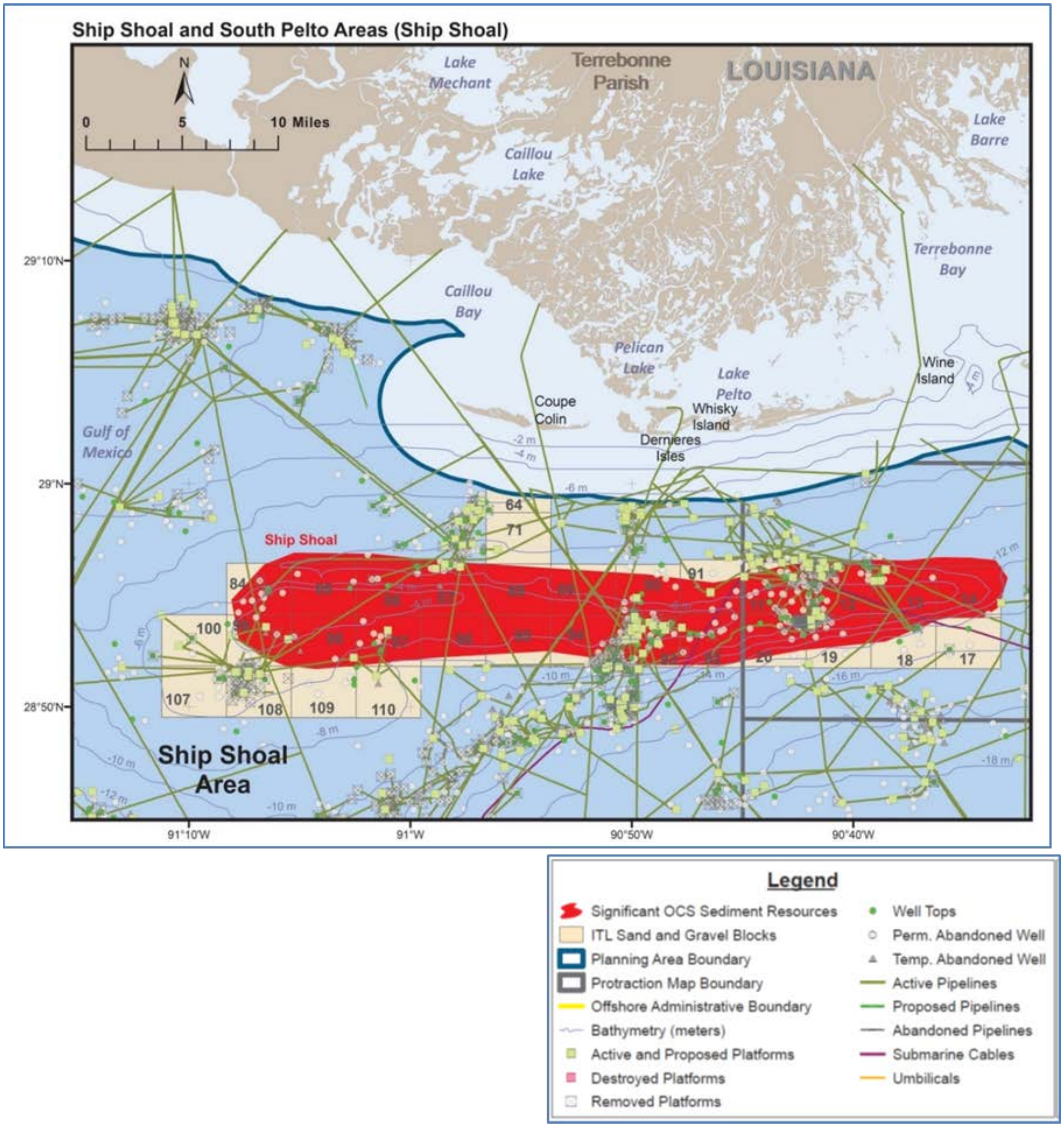


Figure 7. Complex competing use challenges with respect to oil and gas platforms, pipelines, and the Ship Shoal significant OCS sediment resources in the GOM.

Increase in demand for OCS resources within the GOM was also caused by the conversion of more than 200 square miles of Louisiana coastal land to open-water habitat as a consequence of Hurricane Katrina and other named storms that followed. Sediment resources needed to repair the damaged coastlines and barrier islands within Alabama, Mississippi, Louisiana, and Texas are estimated to be from 250 to more than 300 million cubic yards. A Memorandum of Agreement signed between BOEM and the U.S. Army Corps of Engineers (USACE) Mobile District authorizing use of up to 19.6 million cubic yards of OCS sand was executed on December 1, 2016. This project will support the long-term recovery of the Mississippi Gulf

Coast from the devastation caused by Hurricane Katrina and other storms. The project represents the largest volume of OCS sediment authorized for an individual project to date and reflects an ongoing trend within the GOM of increasing OCS sediment needs to support larger coastal restoration projects.

Major restoration efforts, including the RESTORE Act and NRDA, are requiring the use of OCS sediment resources to restore coastal wetlands and barrier islands along the Gulf Coast. Additionally, future Gulf projects are planned out to 50 years as the GOM Energy Security Act contribution to restoration budgets increased starting in 2017. These multiple funding streams will ensure that these projects will be constructed, and, in turn, the MMP will continue to provide OCS sediment as a vital component to these restoration programs. In order to strategically manage use of significant OCS sediment resources (as defined by BOEM) among other use conflicts in the GOM, the MMP supports strengthening a GOM regional sand resource inventory, including investing in ongoing resource evaluation offshore of Mississippi and Texas. Although shoreline restoration is often pursued in response to storm events, knowing the location and volume of sizeable sediment resources could support proactive measures to reduce risk of substantial damage to habitat, infrastructure, and communities in advance of future storms. Further developing a GOM sand resource inventory is consistent with the overarching goal of the MMP to pursue a national sand resource inventory in support of future coastal resiliency needs while effectively balancing environmental stewardship responsibilities.

4.2 Alignment With SSQs

With a robust conventional energy program spanning several decades, the GOMR continues to identify information needs related to actual and potential impacts from conventional energy-related activities that will inform cumulative impacts and other NEPA analyses, environmental consultations, mitigations, and oil-spill modeling. Collection of baseline data in areas currently devoid of oil and gas activities will inform future decision making as well as 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.

Appendix I includes tables of proposed studies for GOMR, and **Appendix II** includes the study profiles. See previous SDPs on BOEM's website at https://www.boem.gov/Environmental-Studies-Planning/.

4.2.1 Conventional Energy

The GOMR is proposing 14 study profiles for the FY 2020 NSL. All of the profiles address at least one national SSQ, while several of the profiles address two or more questions (**Table 5** and **Table 6**). All profiles will inform the conventional energy program; several profiles will additionally inform the Marine Minerals and Renewable Energy Programs.

Table 5. Alignment of proposed FY 2020 GOM OCS Region studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
GOM OCS REGION—FY 2020

Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
	Conventional Energy	Renewable Energy	Marine Minerals	How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Analyzing Anthropogenic/Physical Impacts to Cultural Resources in Deepwater	✓			✓			✓		✓			
Assessing the Impact of Seismic Airguns on Commercially and Recreationally Important Fish	✓									✓		✓
Broken Wings: A Consolidated Inventory of Submerged Aircraft in the Gulf and Atlantic Outer Continental Shelf (OCS)	✓				✓							
Comparison of Community Structure Between Artificial and Natural Reefs Using Environmental Deoxyribonucleic Acid (eDNA): A Proof-of-Concept Study	✓	✓	✓				✓					
Data Gap: Shipwrecks in the Mesophotic Zone and Their Benthic Communities	✓	✓		✓								✓
Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, & Archaeology Project II (GOM-SCHEMA II)	✓	✓	✓									✓
Host and Serve the Bureau of Ocean Energy Management's (BOEM's) Meteorological Data on the Gulf of Mexico Coastal Ocean Observing System (GCOOS) Website	✓			✓		✓	✓					✓
Impacts of Drilling on Biological and Archaeological Resources: Revisiting Resource Avoidance Guidance for Well Site Surface Locations	✓			✓		✓						
Integrated Analysis of Submarine Mudslides in the Mississippi Delta Front and the Potential Impacts to Historic Shipwrecks	✓		✓					✓				✓
Investigation of an Ancient Bald Cypress Forest in the Northern Gulf of Mexico: Phase 2	✓		✓				✓				✓	
Islands in the Deep—A Biological Review of Shipwreck Investigations	✓											✓
Meeting the Challenge: Developing Socioeconomic Baseline Data Collection and Rapid Response Research Plans	✓			✓					✓			
National Register Eligibility Potential of Oil and Gas-Related Archaeological Sites in the Gulf of Mexico	✓								✓			
Shallow Water Pipeline Long-term Stability Assessment	✓			✓				✓				✓

Table 6. Alignment of proposed FY 2021 GOM OCS Region studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
GOM OCS REGION—FY 2021

Study Title	BOEM PROGRAMS: Conventional Energy	Renewable Energy	Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Outer Continental Shelf (OCS)-Related Transportation Infrastructure in Louisiana and Texas	✓			✓					✓			

Study results would inform future site-specific environmental reviews and environmental analyses such as cumulative impacts. Several profiles propose to assess anthropogenic impacts on sensitive resources and ecosystems, better understand physical processes and their impacts in a dynamic environment, or assess long-term pipeline stability within shallow water. 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 sites and in areas with little existing information. Finally, other profiles will address the effectiveness of current mitigations developed for resource protection and propose an alternative means of archiving data to enhance accessibility by operators and stakeholders.

4.2.2 MMP

BOEM's MMP consistently strives to understand the uncertainty and environmental risk of individual and cumulative leasing decisions and promotes a "science strategy" that contributes to existing knowledge and aligns future investments with anticipated high-priority information needs. MMP has no new study profiles proposed in the GOM for FY 2020. However, work will be starting in FY 2020 on the "Ecological Function and Recovery of Biological Communities within Sand Shoal Habitats within the GOM" (NT-17-04) study. In addition, a second study "Fine-scale dive profiles and activity patterns of sea turtles in the GOM" (MM-19-03) will be continuing. Both the studies align with SSQs related to (1) the effect of habitat or landscape alteration on ecological resources and (2) use of existing or emerging technologies to achieve more effective or efficient scientific results.

In support of SSQ (1), NT-17-04 is investigating the long-term recovery of benthic and fish communities following dredging sand resources within Ship Shoal in the GOM. BOEM needs to observe prolonged biological, physical, and chemical recovery of borrow areas located within Ship Shoal to understand the importance of dredged habitats to benthos, fish, and trophic structure/bioenergetics.

In support of SSQ (2) (*i.e.*, new technology applications), the MMP is continuing to take advantage of telemetry technology to better understand the behavior patterns of threatened and endangered sea turtles within OCS borrow areas. Sea turtles are at risk of entrainment and mortality associated with offshore hopper dredging activities. Despite the impressive body of research available on sea turtle movements, there is still little known about their fine-scale activities and behavior due to limitations in technology and accessibility. Ultimately, high-resolution behavior data from individual sea turtle satellite telemetry study investments will and have been integrated into the recently completed study (NT-15-02) titled "Review of Sea Turtle Entrainment Risk by Trailing Suction Hopper Dredges in the U.S. Atlantic and GOM and the Development of the ASTER [Analyzing Sea Turtle Entrainment] Decision Support Tool" (BOEM 2017-084).

4.3 GOM Decision Context

4.3.1 Current/Relevant Issues

In the GOMR, one current issue is BOEM's inability to host and serve on our website a sizeable meteorological database—information that is critical for oil and gas operators to perform air dispersion modeling. Finding a more efficient means of archiving this dataset on a publicly accessible platform, such as the GOM Coastal Ocean Observing System (GCOOS), will enhance access to this dataset by operators as well as other interested stakeholders.

With the potential for future conventional energy exploration and development within the Atlantic and Eastern GOM, baseline information is needed. 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 and historic structures associated with the early development of the oil and gas program in the Gulf. Under BOEM's National Historic Preservation Act (NHPA) responsibilities, assessment of cultural resource eligibility for listing on the NRHP is an important component. BOEM also needs to better understand the biological communities inhabiting different types of sites and in areas where little previous information exists.

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 and sensitive ecosystems, including anthropogenic impacts such as seismic air guns, oil spills, and drilling-related activities. Continuing previous efforts and initiating new ones will provide time series data and allow BOEM to more effectively assess the cumulative impacts of oil spills and drilling activities in the deepwater environment. These studies will additionally provide BOEM with the information needed to conduct long-term monitoring to understand the effects of BOEM's programs on the coastal and marine environments per OCSLA. Other information needs include the effectiveness of current mitigation practices that were developed to reduce or eliminate impacts to various resources from conventional energy-related activities and best practices and protocols for collecting socioeconomic data after catastrophic events. Information provided by these studies will enable BOEM to conduct more comprehensive and informed environmental impact assessments and associated NEPA analyses.

BOEM needs a better scientific understanding of the physical processes occurring in the highly dynamic Mississippi River Delta Front and their impacts, including events such as submarine mudslides. Within the shallow water environment, BOEM also needs to assess the displacement of pipelines and their long-term stability, which can affect benthic habitats, cultural resources, oil and gas infrastructure, and access to existing sediment resources.

CHAPTER 5 PACIFIC OCS REGION STUDIES

5.1 Introduction

BOEM's Pacific OCS Region includes the OCS areas offshore California, Oregon, Washington, and Hawaii (**Figure 8**). 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 OCS Region in 1973. Over its 46-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's 2020–2022 SDP, BOEM Pacific OCS 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. BOEM Pacific OCS Region received and considered 41 study ideas from stakeholders, including universities, consultants, Federal agencies (NOAA, USFWS, USGS, and the National Renewable Energy Laboratory [NREL]), state agencies (California and Oregon), non-profit organizations, and a tribal organization. Additionally, eight BOEM Pacific OCS Region staff proposed 20 study ideas. Regional managers and staff considered all relevant and mission-oriented studies; those found to be of direct relevance and timely were prioritized by regional managers and staff, and are proposed in this SDP (see **Appendix I** and **Appendix II**).

5.1.1 Conventional Energy Activities

As directed in EO 13795 (April 28, 2017) and Secretary's Order 3350 (May 1, 2017), BOEM is developing a new National OCS Oil and Gas Leasing Program to, upon completion, replace the current 2017–2022 Program. The new Program includes consideration of new lease sales in the Washington/Oregon, Northern California, Central California, and Southern California Planning Areas (**Figure 8**).

The current Five-Year OCS Oil and Gas Leasing Program does not include new oil and gas lease sales for the Pacific OCS Region. Currently, there are 34 active oil and gas leases in the Region, all of which are in the Southern California Planning Area (**Figure 9**). 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, 2018, cumulative production was nearly 1.4 billion barrels (bbls) of oil and 1.9 trillion cubic feet (cf) of gas; annual production was 4.9 million bbls of oil and 3.4 billion cf of gas (C. Baver, personal communication). The substantial decline in production since 2015 is due to 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. In 2018, production further declined due to the bankruptcy of the operator of two platforms (Gail and Grace) in the eastern Santa Barbara Channel; production has now ceased at these two platforms.

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 the Bureau of Safety & Environmental Enforcement and other Federal, state, and local permitting agencies throughout the decommissioning process.

Ongoing and proposed 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.

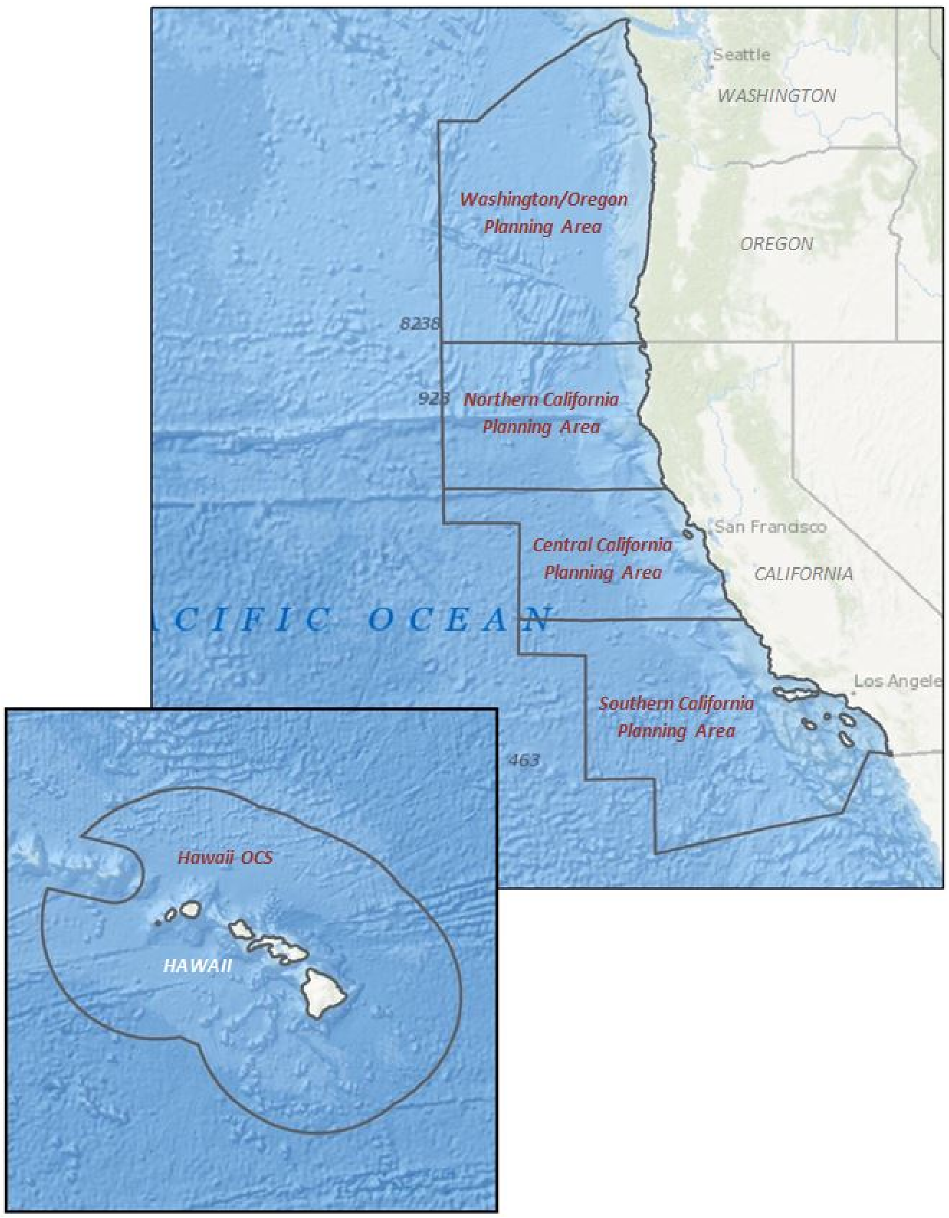


Figure 8. OCS planning areas in the Pacific OCS Region.

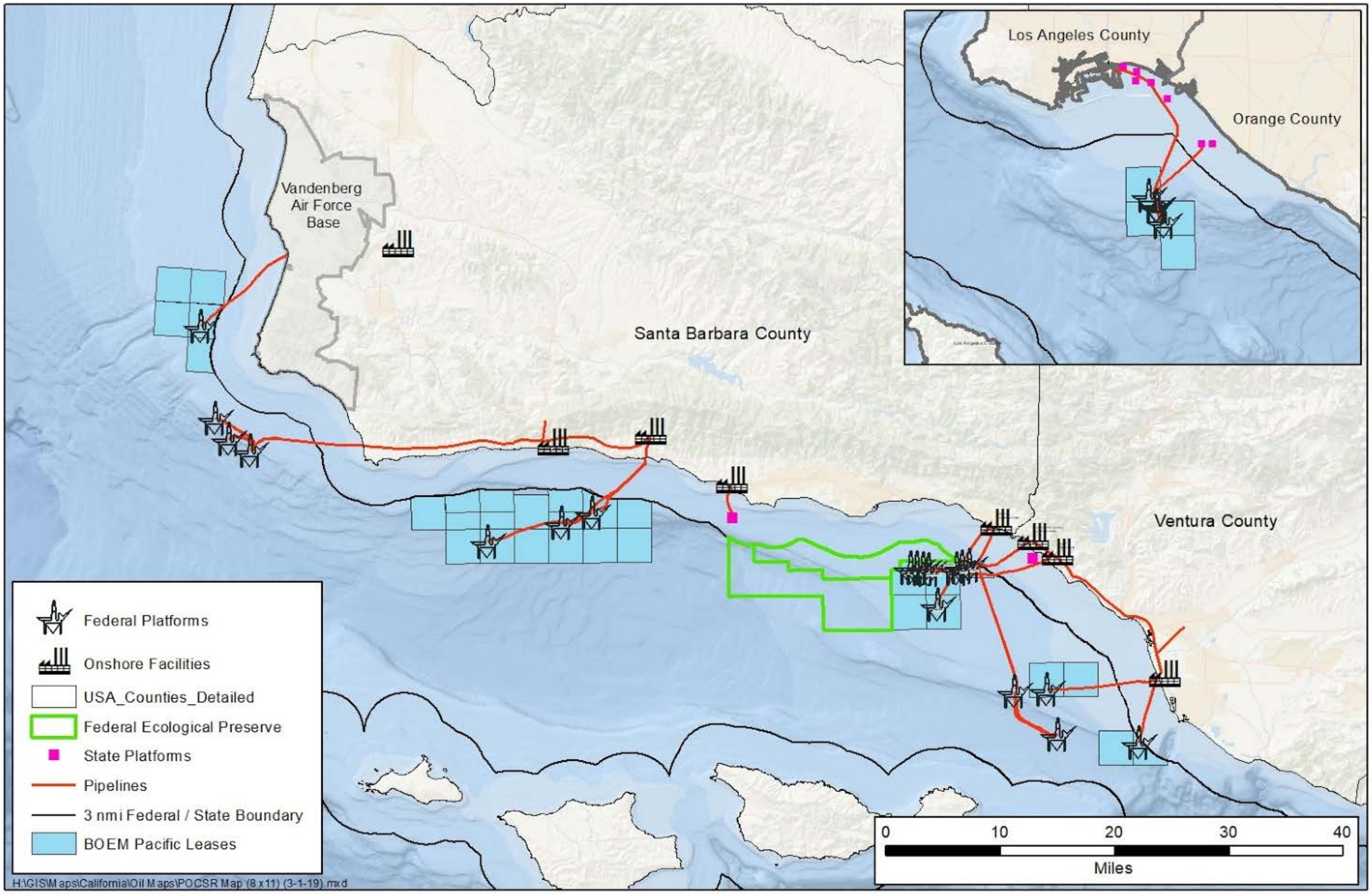


Figure 9. Oil and gas leases and facilities in the Pacific OCS Region.

5.1.2 Renewable Energy Activities

Substantial wind and wave potential along the U.S. West Coast and offshore Hawaii (**Figures 10–11**) has stimulated interest from renewable energy developers. Deepwater floating wind and wave energy projects have been proposed offshore California, Oregon, and Hawaii. Currently, wind energy projects are proposed in the California and Hawaii OCS, and a wave energy project is proposed in the Oregon OCS. 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 12**).

Ongoing and proposed studies will provide important information for offshore planning efforts, NEPA reviews of construction & operation plans (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.

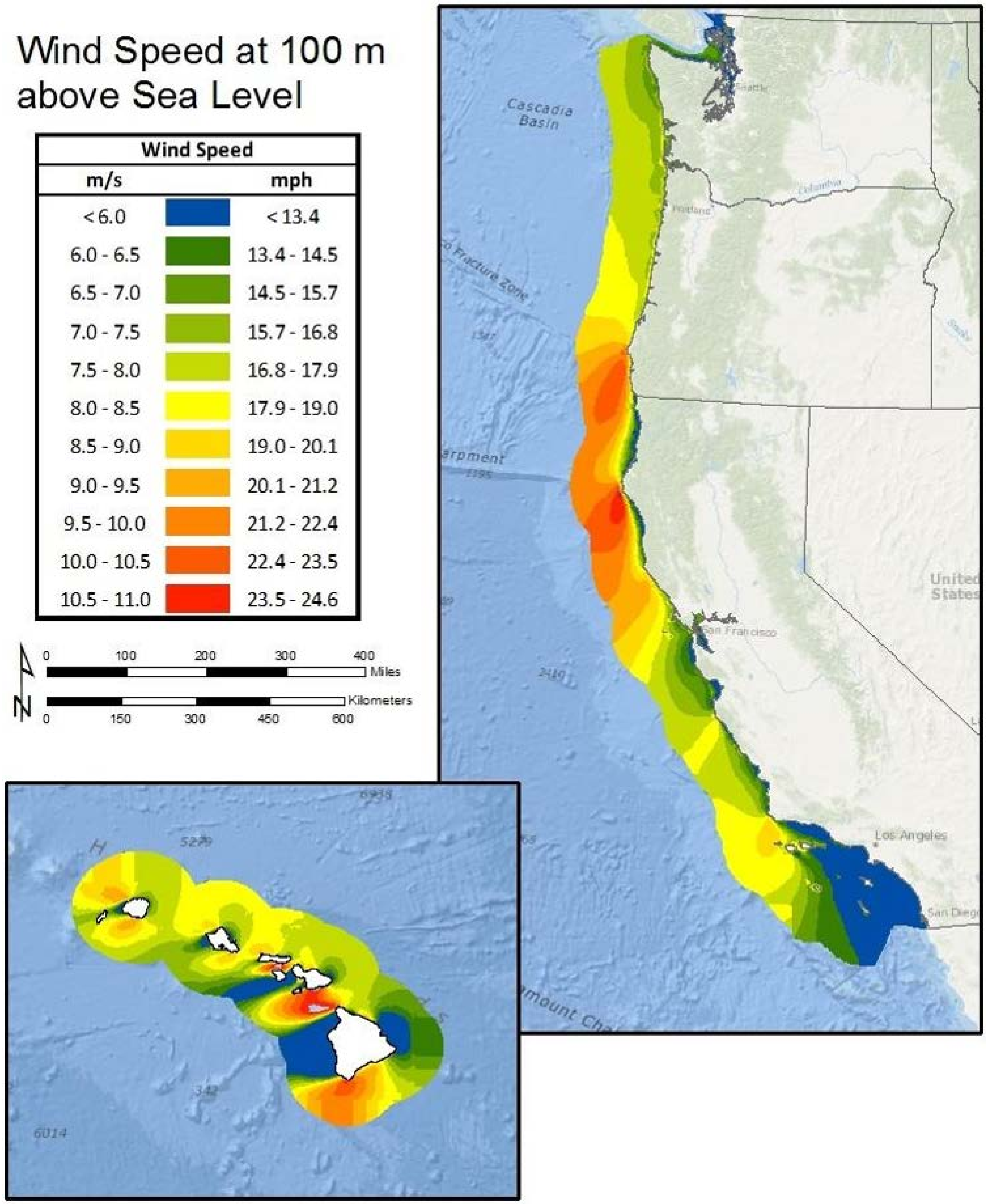


Figure 10. Annual average wind speed offshore the U.S. West Coast and Hawaii.
Maps based on NREL's assessment of offshore wind energy resources (Musial, et al., 2016). Data available at https://maps.nrel.gov/wind-prospector.

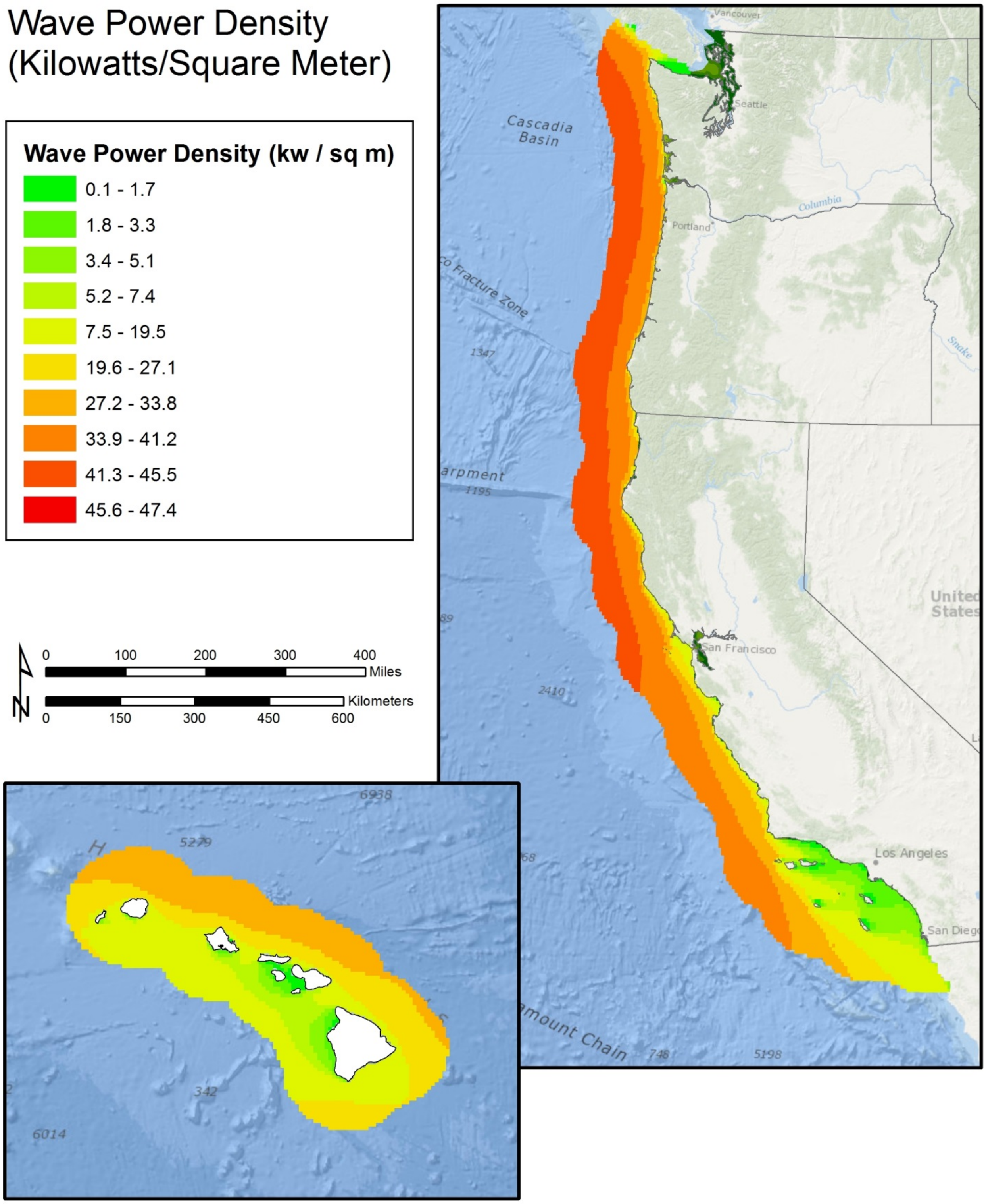


Figure 11. Annual average wave power density offshore the U.S. West Coast and Hawaii.
Maps based on Electric Power Research Institute's assessment of ocean wave energy resources (EPRI, 2011). Data available at https://maps.nrel.gov/mhk-atlas.

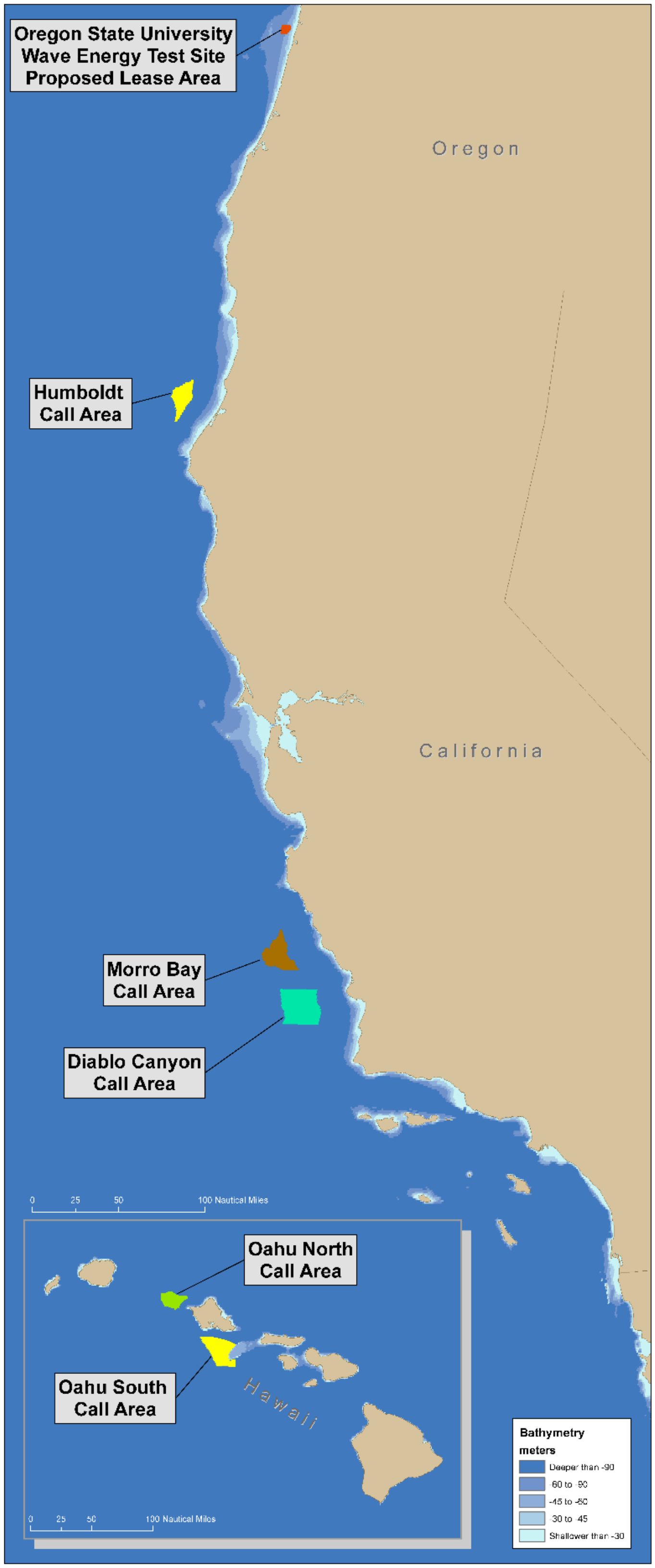


Figure 12. Areas of interest and proposed leasing for renewable energy in the California, Oregon, and Hawaii OCS.

5.1.3 Marine Minerals Activities

Marine minerals (*i.e.*, sand and gravel, critical minerals) are not currently being extracted from the Pacific OCS Region, although the State of California has expressed interest in offshore sand resources for remedial nourishment of severely eroded coastal beaches. The management of coastal sediment resources is under consideration by the Coastal Sediment Management Workgroup, a collaborative group of Federal, state, and local agencies. BOEM, USGS, and the California National Resources Agency are currently sponsoring a USGS evaluation of offshore sand resources near critical erosion hotspots; the four-year study is scheduled to be complete in 2020. Although there has been no major recent industry interest expressed to BOEM related to deepwater critical minerals in the Region, BOEM is beginning to consider environmental studies to inform potential future critical minerals interest.

Because any potential marine minerals activity is in an early stage of development, proposed studies to characterize environmental conditions, biological communities, and archaeological resources in the offshore environment will provide important baseline information that will inform offshore planning efforts and impact assessments associated with NEPA reviews.

5.2 Alignment With SSQs

Current and forecasted activities in the Pacific OCS 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 OCS Region studies proposed for FY 2020, four will inform conventional energy, seven will inform renewable energy, and three will inform marine minerals. Of the eight proposed studies in the portfolio, five have potential applicability to more than one program (**Table 7**).

As shown in **Table 7**, each proposed study addresses one or more of BOEM's SSQs (themes), including:

- Assessing cumulative impacts (6 studies)
- Determining effects of sound (1 study)
- Determining effects of habitat or landscape alteration (6 studies)
- Determining how future ocean conditions and dynamics may mask effects of OCS activities (1 study)
- Using social science research in impact assessment (3 studies)
- Using existing or emerging technology to improve research results (6 studies)
- Determining which resources, measures, and systems are best used for long-term monitoring (5 studies)

Appendix I includes tables of proposed studies for the Pacific OCS Region, and **Appendix II** includes the study profiles.

Table 7. Alignment of proposed FY 2020 Pacific OCS Region studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
PACIFIC OCS REGION—FY 2020

Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Distribution and Abundance of Biodiversity Associated with U.S. Exclusive Economic Zone (EEZ) Critical Minerals Within the Pacific Ocean			✓	✓			✓		✓		✓	
The Environmental Status of Artificial Structures Offshore California	✓	✓		✓			✓		✓			
Fostering a Cohesive Interagency Offshore Mapping and Hard Bottom Habitat Characterization Program	✓	✓					✓				✓	✓
A Marine Biodiversity Observation Network (MBON) for the California Current System (CCS)	✓	✓	✓	✓				✓			✓	✓
Maritime Heritage of the U.S. Pacific Islands		✓	✓	✓			✓		✓			✓
Over Water Migration Movements of Black Brant		✓		✓			✓				✓	✓
A Three-Dimensional (3-D) Assessment of West Coast Continental Shelf Seabird Density: Species Composition at Different Heights Above the Sea Surface		✓					✓				✓	
Understanding the Seasonal Distribution of Cetacean Species in the Northern and Central California Call Areas Using Archival Passive Acoustic Monitoring (PAM)	✓	✓		✓	✓						✓	✓

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5.2.1 Conventional Energy Science Strategy & Decision Context

For new studies proposed for FY 2020, the strategy to support the Pacific OCS 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, proposed 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 within the Southern California Planning Area related to understanding cumulative impacts to affected resources and assessing effectiveness of lease stipulations and mitigation measures
    - Environmental impacts of ongoing and potential oil and gas activities
    - Potential environmental 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.*, acquire 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

5.2.2 Renewable Energy Science Strategy & Decision Context

For new studies proposed for FY 2020, the strategy to support the Pacific OCS Region's renewable energy program is centered on refining information about environmental conditions and biological communities in areas of potential renewable energy development offshore the West Coast. 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 offshore California, Oregon, and Washington
    - Potential environmental impacts of renewable energy development for floating wind, wave energy, and hybrid technologies

- *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, provide 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

5.2.3 Marine Minerals Science Strategy & Decision Context

For new studies proposed for FY 2020, the strategy to support the Pacific OCS Region's MMP is centered on (1) refining information about environmental conditions and biological communities within and adjacent to potential sand borrow areas offshore California and (2) collecting baseline information about environmental conditions and biological communities associated with deep-sea minerals in the Pacific EEZ. As such, proposed studies informing marine minerals address these key information needs and applied uses for informed decision making by BOEM:

- *Information needs:*
  - Baseline environmental conditions within the Southern California and Central California Planning Areas
  - Potential environmental impacts of marine mining activities on the OCS
- *Applied uses for informed decision making:*
  - Decisions and actions related to issuance of leases for marine minerals offshore California (*e.g.*, perform offshore planning, develop lease stipulations and mitigation measures, provide information to affected stakeholder groups)
  - Environmental review and analysis of marine mineral development activities, as required under NEPA
  - Compliance with other environmental statutes, regulations, and EOs (*e.g.*, ESA, MMPA, MSFCMA, MBTA, NHPA, and Environmental Justice)

CHAPTER 6 ATLANTIC OCS REGION STUDIES

6.1 Introduction

The Atlantic OCS extends from Maine to Florida and is divided into four planning areas (**Figure 13**). The OCS planning areas extend from the state/Federal boundary at 3 NM out to the outer boundary of the EEZ at approximately 200 NM. Although not by design, these planning areas roughly coincide with the large marine ecosystems (LMEs) along the Atlantic as defined by NOAA (https://www.st.nmfs.noaa.gov/ecosystems/lme/). On the Atlantic OCS, the Renewable Energy Program and MMP are actively managing leases, while the conventional energy program is planning for potential lease sales as part of a new National OCS Oil and Gas Leasing Program.

6.1.1 Conventional Energy Program

On May 1, 2017, an EO was signed directing BOEM to develop a new five-year plan for oil and gas exploration in offshore waters, including full consideration given to leasing in the mid- and south Atlantic. The Draft Proposed Program was released in January 2018 and considers nearly every leasing area on the Federal OCS for potential oil and gas development including the Atlantic OCS. The final decision as to which areas will be available for oil and gas development is pending. In the meantime, 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 Five-Year Programs. BOEM currently has several studies underway that fill data needs across program areas, including for conventional energy. These studies include:

- Providing updated baselines of soundscapes in the mid- and south Atlantic through the ongoing Atlantic Deepwater Ecosystem Observatory Network field and modeling program
- Synthesizing existing datasets and advanced predictive modeling of deep coral and hardbottom habitats in the southeast Atlantic to guide efficient discovery and protection of sensitive benthic areas
- Anticipating a new field program "Deepwater Atlantic Habitats III" to continue Atlantic research and exploration in deepwater ecosystems with focus on coral, canyon, and seep communities

Environmental research and knowledge related to OCS activities can take years to develop but is a necessary component of mapping new habitats and understanding the relative sensitivity of ecosystems to potential anthropogenic and natural stressors.

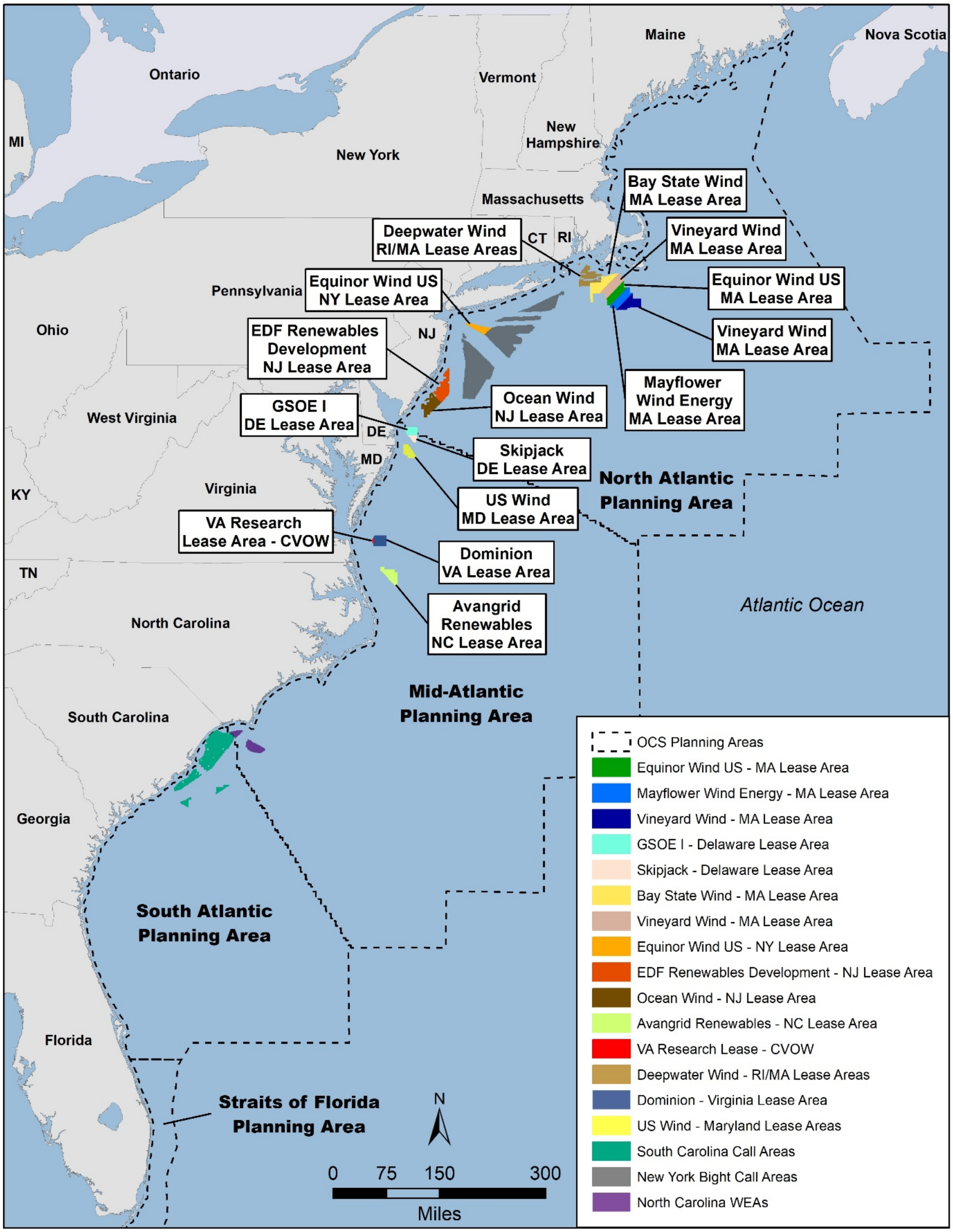

Figure 13. Atlantic Planning Areas for Renewable Energy and Renewable Energy Areas.

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 13**). 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 and 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 construction & operation plans (COPs) by industry for these lease areas. BOEM is reviewing four COPs and anticipates up to seven more during 2019. The areas for development include Massachusetts, Rhode Island, New Jersey, Delaware, Maryland, and Virginia. The detailed development plans will undergo environmental review, which may include identification of mitigation measures as well as post-construction monitoring requirements.

6.1.3 MMP

Since the inception of its MMP in the mid-1990s, BOEM has issued 39 agreements for greater than 73,000,000 cubic yards of Federal sand for beach nourishment and coastal restoration projects along the Atlantic Coast. BOEM has issued agreements in New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Florida. There is a developing interest in the use of Federal sand especially offshore Long Island, New York, and in New England. OCS sand has been used to protect valuable Federal and state assets and infrastructure such as the National Aeronautics and Space Administration's (NASA's) Wallops Island Flight Facility in northern Virginia (Error! Reference source not found.).

Figure 14. NASA's Wallops Island Flight Facility, Virginia before and after restoration using OCS sand.

Following the extensive damage caused by Hurricane Sandy in 2012 and subsequent hurricanes Matthew in 2016, Irma in 2017, and Florence in 2018, response efforts along the Atlantic Coast have focused on a more proactive regional approach to building coastal resilience rather than responding to sand renourishment needs at the individual project scale or in the aftermath of a natural disaster. These storms emphasize the need for all Atlantic coastal states to evaluate storm readiness and the integrity of their natural coastal infrastructure, such as beaches and dunes. As a result, there is a need for BOEM to proactively identify offshore sand resources to support quick recovery. Many of the Federal and non-Federal projects along the Atlantic Coast need

OCS sediment resources to support their short- and long-term needs, and require MMP authorization before proceeding. MMP's current pursuit of a National Offshore Sand Inventory of OCS sand resources to support future coastal resiliency projects is precedent-setting for future decision making.

In support of regional partnerships in the Atlantic OCS Region, the MMP participates in the Northeast Regional Ocean Council, Mid-Atlantic Regional Council on the Ocean, Governor's South Atlantic Alliance, and other organizations supporting regional initiatives that identify and prioritize sand resource needs. Currently, BOEM is undertaking efforts along the Atlantic Coast to identify potential new sand resources through state cooperative agreements. A sand resource inventory in the Atlantic OCS Region will provide a regional perspective and strategy for identifying sand resources available for coastal projects and evaluating proactive opportunities to minimize and/or avoid environmental impacts. Upon completion of developing this framework of Atlantic OCS sand resources, the MMP will be better positioned to assess the long-term cumulative footprint of dredging activities relative to geomorphologic features and associated habitat types. Coupled with ongoing environmental monitoring initiatives, these efforts will facilitate a regional sediment resource management perspective and support strategic planning and management of OCS sand resources.

MMP utilized approximately $2.35 million in Disaster Relief Appropriations Act funds following Hurricane Sandy to support two collaborative studies with NASA, the University of Florida, and the Navy to investigate the long-term recovery of benthic and fish communities following the dredging of a borrow area offshore central Florida at Canaveral Shoals. In addition, the ESP has supported further efforts in both of these studies to expand the fish surveys and continue this monitoring into the long term. The comprehensive nature of these collaborative studies is the first of its kind in evaluating dredging impacts within offshore shoal habitats. These studies are ongoing, and initial data sets are providing valuable information on resident and transient fish communities and their habitat use pre- and post-dredging.

6.2 Alignment With SSQs

Appendix I includes tables of proposed studies for the Atlantic OCS Region, and **Appendix II** includes the study profiles.

6.2.1 Conventional Energy Program

Table 8 shows how the Atlantic OCS Region studies focused on conventional energy address the SSQs. As a result of the released Draft Proposed Program, which considers potential leasing for oil and gas development in the Atlantic OCS, BOEM is proposing new studies to address air quality through monitoring and impact assessments. Although BOEM does not have air quality jurisdiction in the Atlantic OCS, air quality impact assessment are still required for NEPA purposes. One new study proposes to establish a monitoring program to collect data on ambient air quality at the shoreline prior to offshore oil and gas development. This information will inform estimates of impacts from new incremental emissions related to oil and gas activities offshore. Another study proposes to conduct a modeling impact assessment of air quality from potential oil and gas development using existing meteorological datasets, onshore emissions estimates, and scenarios developed for the Draft Proposed Program.

6.2.2 Renewable Energy Program

Tables 9–10 show how the Atlantic OCS Region studies focused on renewable energy address the SSQs. As offshore wind development along the Atlantic 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 the addressing concerns raised by the public. Through the *Real-time Opportunity for Development Environmental Observations* (RODEO) study, observations were made 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 2 turbines for research purposes to over 100 for commercial production. The scientific concerns that are at the forefront for FY 2020 are the impacts from sound on fish, sea turtles, and marine mammals, which is a primary concern during construction activities.

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 (please see §*Birds and Bats* at https://www.boem.gov/Renewable-Energy-Completed-Studies/). BOEM, in partnership with USFWS and NOAA, has created a database of observations that are used to generate maps of relative abundance. The aggregation of all existing 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

The effects of renewable energy development on fish and shellfish range from physical modification of the seafloor habitat to behavior modification due to noise. Fundamental to protecting fish species is an understanding of the physical habitat and the fish use of these habitats during particular times of the year and during crucial times during the animals' life history. 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, sea bass), locations (leased areas), and impact-producing factors (seafloor disturbance, sound, electromagnetic field [EMF]). To date, these priorities are identified through intergovernmental task forces, public meetings, formal information solicitations via the FR, and recommendations made in BOEM-funded studies. 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. Species that BOEM has invested in to date include 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). High-priority areas for study are driven often 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 2020, the focus is on sound and its implications to fish.

Protected Species

Marine mammals on the Atlantic seaboard are generally highly migratory and use a wide amount of the outer shelf. As a result, they may be impacted from all three of BOEM's leasing programs. With the installation of offshore wind turbines anticipated over the next three years, BOEM will be focusing on designing and conducting experiments to better understand how sound from construction and surveys will impact both marine mammals and sea turtles. The first installations will offer opportunities to conduct field experiments to determine the level of impact and inform future development.

6.2.3 MMP

Although the proposed MMP studies address more than one of the ESP's key questions (**Table 11**), for clarity and brevity, only the most pertinent questions are linked to a given study. For FY 2020–2022, the proposed MMP studies in the Atlantic OCS Region primarily align with the SSQs related to (1) cumulative effects assessments, (2) the effect of habitat or landscape alteration on ecological resources, and (3) the affected resources, measures, and systems best for long-term monitoring. The specific studies proposed test hypotheses related to the geological, physical, and biological aspects of both removing sediment from the OCS and placing it within the nearshore system.

Valuable information on resident and transient fish communities and their habitat use pre- and post-dredging has been gathered in ongoing studies in the southeast U.S. and GOM, but is lacking in the mid-Atlantic. These needed data will particularly address the ESP SSQ of habitat alteration effects on ecology. Offshore New Jersey and New York—collectively the New York Bight (NYB)—limited information exists on the ecological function and biological significance of sand waves, ridges, swales, shoals, and other OCS features, especially in response to dredge-related disruptions to economically important fish and related industries. Based on state initiatives and recent discussions with recreational and commercial fishermen in New Jersey, the MMP is executing a literature and data review in FY 2019 (MM-19-02) as the first phase of gathering baseline information. The results of this review, particularly data gaps and methodology recommendations, will then inform a follow-on field work phase proposed for FY 2020–2022, "New York Bight (NYB) Fish, Fisheries, and Sand Features: In the Field". This is a comprehensive multi-year field study to monitor conditions before, during, and after dredging, in order to understand mesoscale and microscale habitat use, species assemblages, biodiversity, and habitat associations. Outreach would gather local stakeholder knowledge (*e.g.*, fisheries industry, sport fishing, diving) to highlight issues, strengthen partnerships, and further inform study methodology. These data and continued engagement with stakeholder communities in the NYB will help the MMP better plan for OCS demands within the region.

Mid-Atlantic sand features also include Sandbridge Shoal off of Virginia. This shoal has been the source of sediment for multiple nourishment events for two different projects over the last 30 years and will be used again in a project in fall 2019. This multiple-use borrow area supports diverse fish species, including highly migratory species (HMS) such as tuna, sharks, and billfish. HMS, a group with many data gaps and often of high economical value, have Essential Fish Habitat (EFH) within Sandbridge Shoal. MMP proposes to study HMS use of the shoal, particularly for spawning or pupping, in “Highly Migratory Fish Use of Shoal Habitat” by leveraging ongoing research efforts and existing telemetry arrays for any acoustic fish tagging. This information will help MMP analyze the impacts of dredging, as well as appropriate mitigation measures for long-term management of the shoal. Because dredging is expected to continue at Sandbridge Shoal, research on biological activity, biophysical coupling, and geomorphology will complement the geological data, and strengthen habitat alteration and cumulative effects analyses from dredging impacts; this information is relevant to both NEPA and EFH consultations.

The recently ESA-listed species *Manta birostris* overlaps spatially and temporally with activities associated with MMP borrow areas. Giant manta have been observed during preventative trawling operations within offshore sand resource areas. However, their fine-scale behavior and implication to risk associated in the vicinity of sand shoals is largely unknown. MMP proposes a study to understand that overlap and the risk of interaction with these activities, particularly the Canaveral Shoals borrow area offshore east central Florida. Although some information on the presence of manta off the southeast U.S. exists, the information does not have sufficient detail to understand population demographics; also, the behavioral ecology information is not fine-scaled enough for understanding the interaction with marine mineral operations. This effort leverages the extensive investment in monitoring occurring at Canaveral Shoals borrow area. Results of this study would be applicable to the Marine Minerals, Renewable, and Oil & Gas Programs across the Gulf and Atlantic OCS Regions.

6.3 Atlantic Decision Context

6.3.1 Current/Relevant Issues

In the Atlantic OCS, conventional energy-related issues focus on air quality information needs. With the potential for future conventional energy exploration and development within the Atlantic OCS, baseline information is needed. BOEM needs information on the background concentrations of air pollutants and their precursors prior to conventional energy development. A monitoring program for air quality will provide this information. In addition, a modeling impact assessment of air quality from potential oil and gas development using existing datasets 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 issues are potential conflicts with fishing, especially in the mid-Atlantic region, as well as potential emerging concern with entrainment of the recently listed endangered giant manta ray.

6.3.2 NEPA/Consultation Information Needs

BOEM needs to assess the potential impacts on air quality from future conventional energy development in the Atlantic OCS Region. However, no air quality impacts assessments have been conducted for oil and gas-related activities to date. Existing datasets and emissions estimates will be needed along with modeling efforts to inform these impact assessment for NEPA analyses and other environmental considerations.

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, BOEM continues to need baseline information on the fish and benthic communities that utilize sand potential resource areas such as sand shoals and ridges. BOEM also needs information on potential conflicts with other uses such as fishing, oil and gas pipelines, submarine fiber optic cables, and transmission cables.

Table 8. Alignment of proposed FY 2020 Atlantic OCS Region conventional energy studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
ATLANTIC OCS REGION CONVENTIONAL ENERGY—FY 2020

Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Air Quality Impact Assessment for the Atlantic Outer Continental Shelf (OCS) Energy Development	✓									✓		
Atlantic Coastal Ambient Air Quality Monitoring Program	✓									✓		

Table 9. Alignment of proposed FY 2020 OREP studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
RENEWABLE ENERGY PROGRAM—FY 2020

Study Title	BOEM PROGRAMS: Conventional Energy	Renewable Energy	Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Anticipating Shifts in Marine Bird Distributions for Planning, Leasing, and Assessment of Energy Development on the Outer Continental Shelf (OCS)	✓	✓		✓			✓	✓			✓	✓
Atlantic Marine Assessment Program for Protected Species (AMAPPS) III B and C—Photogrammetric Aerial Surveys to Improve Detection and Classification of Seabirds, Cetaceans, and Sea Turtles	✓	✓	✓	✓								✓
Behavioral Response of Sea Turtles from Controlled Exposures to a Mobile Impulsive Sound Source		✓		✓			✓	✓			✓	✓
A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot	✓	✓	✓		✓			✓				
Fish Auditory Thresholds—Part 2 Field Component	✓	✓	✓	✓	✓							
Implementation of Mitigation for Offshore Wind Turbine Interference on High-Frequency (HF) Coastal Oceanographic Radar		✓		✓				✓			✓	✓
Real-time Opportunity for Development Environmental Observations (RODEO) II	✓	✓	✓	✓			✓				✓	

Table 10. Alignment of proposed FY 2021 OREP studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
RENEWABLE ENERGY PROGRAM—FY 2021

Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Behavior and Habitat Use of Marine Protected Species During Construction of an Offshore Wind Farm		✓		✓	✓						✓	✓
Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning (II)	✓	✓	✓	✓			✓	✓				✓

Table 11. Alignment of proposed FY 2020 MMP studies with BOEM programs and SSQs, alphabetized by title.

BOEM ESP Proposed Studies
MARINE MINERALS PROGRAM—FY 2020

	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Study Title	Conventional Energy	Renewable Energy	Marine Minerals	How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
Behavioral and Spatial Ecology of the Endangered Giant Manta Ray (*Manta birostris*)		✓	✓	✓			✓					✓
Highly Migratory Fish Use of Shoal Habitat		✓	✓	✓			✓	✓				✓
New York Bight (NYB) Fish, Fisheries, and Sand Features: In the Field	✓	✓	✓	✓			✓	✓				✓
Seafloor Critical Mineral Deposit and Habitat Mapping in the Arctic and Aleutian Arc Large Marine Ecosystems	✓		✓	✓			✓					✓

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APPENDIX I. TABLES OF PROPOSED STUDIES FOR FY 2020 AND FY 2021

Table 12. Headquarters studies proposed for the FY 2020 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
71	PS	Addressing Data Gaps in Spatial and Acoustic Ecology of Understudied Endangered Species Act (ESA) Listed Marine Mammals
74	BIO	Augmenting Monitoring Surveys with Environmental Deoxyribonucleic Acid (eDNA) Sampling to Improve Species Detection
77	BIO	Continued Partnership with National Museum of Natural History, Department of Invertebrate Zoology (NMNH-IZ) for a Voucher-based, Genomic Reference Facility for Ocean Biodiversity
83	PS	Continued Support for the Animal Telemetry Network (ATN)
87	FE	Deepwater Atlantic Habitats III: Continued Exploration and Analysis of Potential Impacts from Energy and Minerals Activities
92	PO	High Resolution Modeling of the Gulf of Mexico
95	MAQ	Installing Offshore & Coastal Dispersion (OCD) Platform Downwash Algorithms in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD)
98	PS	Marine Biodiversity Observation Network (MBON) Special Issue of *Oceanography* Magazine
100	PS	Marine Mammal Bioenergetics Workshop
106	BIO	Next Generation of Animal Telemetry: Pathway to Implementation
109	FE	Oil in the Sea IV: National Academies of Sciences, Engineering, and Medicine (NASEM)
112	SSE	Outer Continental Shelf (OCS) Wind Energy: Socioeconomic Baselines, Trends, and Impacts
116	IMO	Phase III Development of the Tethys Passive Acoustic Monitoring (PAM) Metadata System
120	MAQ	Responding to the National Academies of Sciences, Engineering, and Medicine's (NAS's) Comments on the Air Quality Modeling in the Gulf of Mexico (GOM)
122	PS	Sea Turtle Hearing Sensitivity and Impacts of Sound
126	PS	Sustained Observations of Marine Biodiversity for Coordinated National Monitoring of Marine Ecosystem Responses to Outer Continental Shelf (OCS) Environmental Impacts
130	MAQ	Updating Offshore Emissions Factors Scoping Study

Profile Page #	Discipline	Study Title
133	MAQ	Updating the Emissions Exemption Thresholds (EETs) Using Classification and Regression Tree (CART) Analysis
Discipline Codes		
BIO = Biology IMO = Information Management & Other PO = Physical Oceanography SSE = Social Science & Economics		FE = Fates & Effects MAQ = Meteorology & Air Quality PS = Marine Mammals & Protected Species

Table 13. Headquarters studies proposed for the FY 2021 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
135	MAQ	Assessing the Use of Satellite Data for Offshore Air Quality Applications
138	BIO	Mortality Risk for Whale and Basking Sharks During Energy and Mineral Operations
143	AR	World War II Shipwrecks in the Atlantic and Pacific: A Microbiological, Archaeological, and Geochemical Baseline Study
Discipline Codes		
AR = Archeological Resource Protection MAQ = Meteorology & Air Quality		BIO = Biology

Table 14. Renewable Energy Program studies proposed for the FY 2020 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
146	BIO	Anticipating Shifts in Marine Bird Distributions for Planning, Leasing, and Assessment of Energy Development on the Outer Continental Shelf (OCS)
149	PS	Atlantic Marine Assessment Program for Protected Species (AMAPPS) III B and C—Photogrammetric Aerial Surveys to Improve Detection and Classification of Seabirds, Cetaceans, and Sea Turtles
152	PS	Behavioral Response of Sea Turtles from Controlled Exposures to a Mobile Impulsive Sound Source
156	BIO	A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot
159	BIO	Fish Auditory Thresholds—Part 2 Field Component
162	PO	Implementation of Mitigation for Offshore Wind Turbine Interference on High-Frequency (HF) Coastal Oceanographic Radar
164	FE	Real-time Opportunity for Development Environmental Observations (RODEO) II
Discipline Codes		
BIO = Biology PO = Physical Oceanography		FE = Fates & Effects PS = Marine Mammals & Protected Species

Table 15. Renewable Energy Program studies proposed for the FY 2021 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
71	PS	Behavior and Habitat Use of Marine Protected Species During Construction of an Offshore Wind Farm
169	BIO	Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning (II)
Discipline Codes		
BIO = Biology		PS = Marine Mammals & Protected Species

Table 16. Marine Minerals Program studies proposed for the FY 2020 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
171	BIO	Behavioral and Spatial Ecology of the Endangered Giant Manta Ray (*Manta birostris*)
174	BIO	Highly Migratory Fish Use of Shoal Habitat
177	BIO	New York Bight (NYB) Fish, Fisheries, and Sand Features: In the Field
181	BIO	Seafloor Critical Mineral Deposit and Habitat Mapping in the Arctic and Aleutian Arc Large Marine Ecosystems
Discipline Codes		
BIO = Biology		

Table 17. Alaska OCS Region studies proposed for the FY 2020 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
184	PS	Comprehensive Synthesis of Impacts to Marine Mammals from Oil and Gas Activities in the Alaska Outer Continental Shelf (OCS), 2000–2020
186	PS	Cook Inlet Beluga Acoustic Monitoring in Lower Cook Inlet (LCI) Rivers
189	BIO	Determining Important Nearshore and Marine Sites for Post-breeding Shorebirds, Beaufort Sea
192	BIO	Early Detection Plan for Marine Non-Native Species on the Arctic Outer Continental Shelf (OCS)
195	PO	Gulf of Alaska and Bering Sea Coupled Ice-ocean Circulation Model
197	BIO	The Impact of Marine Fish Communities on Red-throated Loon Productivity in the Beaufort Sea
200	FE	Improvements to the Oil Spill Risk Analysis (OSRA) Input Quality Assurance/Quality Control (QA/QC) and Validation
202	FE	Integrated Oil-spill Occurrence Estimator (OSOE) Model for Alaska, Atlantic, Pacific, and Gulf Outer Continental Shelf (OCS) Regions
204	SSE	Kenai Peninsula Borough (KPB) Economy, 2008 to 2018
207	BIO	Monitoring the Recovery of Seabirds and Forage Fish Following a Major Ecosystem Disruption in Lower Cook Inlet (LCI)
210	PS	Quantifying Sea Otter Abundance, Distribution, and Foraging Intake in Cook Inlet, Alaska, Using Unmanned Aircraft Systems (UAS) Technology
213	SSE	Subsistence Harvest and Iñupiaq Knowledge of Beluga Whales for Kaktovik, Alaska
216	PO	Update of River Overflood on Sea Ice and Strudel Scour Database
Discipline Codes		
BIO = Biology PO = Physical Oceanography SSE = Social Science & Economics		FE = Fates & Effects PS = Marine Mammals & Protected Species

Table 18. Alaska OCS Region studies proposed for the FY 2021 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
219	PS	Acoustic Detection of Critically Endangered North Pacific Right Whales in the Gulf of Alaska (GOA)
221	IMO	Offshore Renewable Energy Potential on Alaska's Outer Continental Shelf (OCS)
Discipline Codes		
IMO = Information Management & Other		PS = Marine Mammals & Protected Species

Table 19. Atlantic OCS Region studies proposed for the FY 2020 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
224	MAQ	Air Quality Impact Assessment for the Atlantic Outer Continental Shelf (OCS) Energy Development
226	MAQ	Atlantic Coastal Ambient Air Quality Monitoring Program
Discipline Codes		
MAQ = Meteorology & Air Quality		

Table 20. GOMR studies proposed for the FY 2020 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
228	AR	Analyzing Anthropogenic/Physical Impacts to Cultural Resources in Deepwater
231	BIO	Assessing the Impact of Seismic Airguns on Commercially and Recreationally Important Fish
237	AR	Broken Wings: A Consolidated Inventory of Submerged Aircraft in the Gulf and Atlantic Outer Continental Shelf (OCS)
240	BIO	Comparison of Community Structure Between Artificial and Natural Reefs Using Environmental Deoxyribonucleic Acid (eDNA): A Proof-of-Concept Study
244	AR	Data Gap: Shipwrecks in the Mesophotic Zone and Their Benthic Communities
247	AR	Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, & Archaeology Project II (GOM-SCHEMA II)
250	MAQ	Host and Serve the Bureau of Ocean Energy Management's (BOEM's) Meteorological Data on the Gulf of Mexico Coastal Ocean Observing System (GCOOS) Website
252	FE	Impacts of Drilling on Biological and Archaeological Resources: Revisiting Resource Avoidance Guidance for Well Site Surface Locations
257	AR	Integrated Analysis of Submarine Mudslides in the Mississippi Delta Front and the Potential Impacts to Historic Shipwrecks
261	AR	Investigation of an Ancient Bald Cypress Forest in the Northern Gulf of Mexico: Phase 2
264	AR	Islands in the Deep—A Biological Review of Shipwreck Investigations
267	SSE	Meeting the Challenge: Developing Socioeconomic Baseline Data Collection and Rapid Response Research Plans
270	AR	National Register Eligibility Potential of Oil and Gas-Related Archaeological Sites in the Gulf of Mexico
273	BIO	Shallow Water Pipeline Long-term Stability Assessment
Discipline Codes		
AR = Archeological Resource Protection FE = Fates & Effects SSE = Social Science & Economics	BIO = Biology MAQ = Meteorology & Air Quality	

Table 21. GOMR studies proposed for the FY 2021 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
276	SSE	Outer Continental Shelf (OCS)-Related Transportation Infrastructure in Louisiana and Texas
Discipline Codes		
SSE = Social Science & Economics		

Table 22. Pacific OCS Region studies proposed for the FY 2020 NSL, alphabetized by title.

Profile Page #	Discipline	Study Title
279	BIO	Distribution and Abundance of Biodiversity Associated with U.S. Exclusive Economic Zone (EEZ) Critical Minerals Within the Pacific Ocean
282	BIO	The Environmental Status of Artificial Structures Offshore California
285	BIO	Fostering a Cohesive Interagency Offshore Mapping and Hard Bottom Habitat Characterization Program
287	BIO	A Marine Biodiversity Observation Network (MBON) for the California Current System (CCS)
290	AR	Maritime Heritage of the U.S. Pacific Islands
293	PS	Over Water Migration Movements of Black Brant
296	PS	A Three-Dimensional (3-D) Assessment of West Coast Continental Shelf Seabird Density: Species Composition at Different Heights Above the Sea Surface
299	PS	Understanding the Seasonal Distribution of Cetacean Species in the Northern and Central California Call Areas Using Archival Passive Acoustic Monitoring (PAM)
Discipline Codes		
AR = Archeological Resource Protection BIO = Biology PS = Marine Mammals & Protected Species		

APPENDIX II. FY 2020-FY 2021 STUDY PROFILES ORGANIZED BY REGION

Title	Addressing Data Gaps in Spatial and Acoustic Ecology of Understudied Endangered Species Act (ESA) Listed Marine Mammals
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Jennifer Bosyk (jennifer.bosyk@boem.gov), Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	T.B.D.
Performance Period	FY 2020–2022
Date Revised	February 20, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Information on availability bias is lacking for some ESA-listed whale species leading to uncertainty in these species density estimations. Additionally, the lack of data on the spatial and acoustic behavioral ecology of these species limits our ability to comprehensively analyze passive acoustic monitoring (PAM) data.
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 U.S. 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 currently unknown 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 Outer Continental Shelf (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 Marin Mammal Protection Act (MMPA) but also making every effort to maintain the health and stability of marine mammals and their ecosystem; and
4. fulfill Federal assessment and consultation responsibilities.

Additionally, BOEM is required to design and implement mitigation measures to reduce or eliminate impacts from regulated activities on protected and managed species.

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 and the analysis of data from PAM, which is one of BOEM's primary mitigation and monitoring tools. BOEM relies on density and abundance data (Roberts *et al.*, 2016) to assess the potential impacts on protected species from BOEM-permitted activities. However, several species of cetaceans occur in each of the program areas whose acoustic behavior, particularly cue rates, as it relates to habitat usage, is poorly understood or completely unknown. For example, North Atlantic right whales have dramatically different acoustic behavior in the southeast *versus* northeast parts of their range; however, their acoustic behavior in the mid-Atlantic, where we now know they are located year-round, has never been studied. This adds tremendous uncertainty into the density and abundance data models.

Traditional survey methods for cetaceans 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 because it can only be obtained under appropriate survey conditions (*e.g.*, good visibility). Therefore, although aerial and broad-scale 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. This information will 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 National Academies of Sciences, Engineering, and Medicine (NASEM) Committee (NASEM, 2016).

The data collected during this study will assist in improving the analytical robustness and biological meaningfulness of acoustic data collected during BOEM-funded studies (*i.e.*, Atlantic/Pacific/Gulf of Mexico Marine Assessment Program for Protected Species [AMAPPS/PacMAPPS/GoMAPPS]), as well as improving 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:

- Describe acoustic and foraging ecology of understudied and/or ESA-listed whale species (*e.g.*, sei, fin, right whales and Mesoplodonts) where significant data gaps in cue rates exist (*e.g.*, species identified in the BOEM 2018 workshop report from Spatial and Acoustic Ecology of Marine Megafauna [SPAM]-I);

- 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;

- Update uncertainty analysis for OCS to inform planning and mitigation design in all BOEM's regions;

- Aid in validating acoustic propagation models by having multiple receiving nodes operating simultaneously;

- 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 three-dimensional (3-D) PAM. Vessel and autonomous underwater vehicle (AUV)-based PAM will provide ground-truthing and guidance for the stationary PAM;
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.
3. Vessel-based environmental deoxyribonucleic acid (eDNA) and biopsy sample collection will provide additional information on stock structure and distribution.

Specific Research Question(s):

1. What are the species/regions/life stages where acoustic behavioral information is needed to support detection and mitigation?

2. Are density models improved upon by reducing availability bias?

3. What is the overlap of understudied endangered and at-risk cetacean species with areas of interest to BOEM for offshore energy development?

4. What is the importance of these areas of overlap to endangered and at-risk cetacean species?

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Title	Augmenting Monitoring Surveys with Environmental Deoxyribonucleic Acid (eDNA) Sampling to Improve Species Detection
Administered by	Headquarters
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Procurement Type(s)	U.S. Geological Survey, National Oceanic & Atmospheric Administration, U.S. Fish & Wildlife Service, Smithsonian National Museum of Natural History
Performance Period	FY 2020–2024
Date Revised	May 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The use of eDNA will enhance options for surveillance and monitoring on ships of opportunity and targeted at-sea surveys. However, with limited access to research vessels for single-purpose studies, eDNA shows promise as an easy-to-use tool that can broaden the spectrum of species detected via opportunistic water samplings on at-sea stations. The research community has also identified a lack of completed genetic reference libraries, particularly of species of interest to BOEM's planning and mitigation processes.
Intervention	Coordination of parallel sampling of water for eDNA with traditional sampling methods (*e.g.*, visual sampling; fisheries net hauls). Sampling will occur on systematic at-sea surveys and targeted surveys: as a means to expand the detection of species of interest to BOEM, and to improve species-specific occupancy maps. Identify and add missing genetic sequences to reference libraries of species relevant to BOEM's planning strategy.
Comparison	This study builds on completed and ongoing monitoring surveys (*e.g.*, Atlantic Marine Assessment Program for Protected Species [AMAPPS], Deep Sea Exploration and Research of Coral/Canyon/Cold seep Habitats [DEEP SEARCH]) by comparing the results of eDNA collected at sea with concurrently collected *in situ* samples and known species' distribution and abundance patterns.
Outcome	By quantifying these comparisons, and adding to genetic databases, this study will improve seasonal occurrence maps of rare and cryptic species, in addition to gaining spatial inference regarding ecological communities and hotspot areas.
Context	The Atlantic Coast and Outer Continental Shelf (OCS).

BOEM Information Need(s): As energy development increases along the OCS, integration of monitoring methods will enhance scientific insight. Augmentation of monitoring surveys with eDNA harnesses potential to broaden the spectrum of detection, particularly of elusive, rare, and cryptic species often undersampled or misidentified by traditional sampling techniques. Because eDNA sampling is as simple as collecting a liter of water, integration should be nearly effortless on research cruises and ships of opportunity designed for ecosystems monitoring and broad-scale sampling.

Background: eDNA sampling is a monitoring technique designed to identify species and taxonomic groups by their genetic material shed in the water column and general environment. When free, deoxyribonucleic acid (DNA) may degrade in a few hours to a few days, offering a contemporaneous snapshot of species occurrence in the study area (Lafferty *et al.*, 2018). Systematic Stratified and Random survey designs tested eDNA against trawl catches, the results of which found positive correlations with estimated biomass from trawls (Thomsen *et al.*, 2016); and known species' distributions (Knudsen *et al.*, 2019); as well as the identification of a potentially rare species not known to occur in the study area (Foote *et al.*, 2012). Seasonal monitoring of fish communities with eDNA corroborated known species phenology and community composition despite freshwater inputs where freshwater species inhabit (Stoeckle *et al.*, 2017). However, in some cases, detection may only be possible during specific life history events, for instance, molting green crabs *vs.* hard-shell green crabs, (Watts and Yednock, 2019); and dependent on the availability of species-specific primers. When combined with traditional sampling methods (*e.g.*, broadband acoustics, trawls, and visual observations) eDNA can improve the overall resolution of ecosystem character (Watts and Miksis-olds, 2018), but may not provide valuable information without sound genetic libraries to reference.

Objectives: The objectives of this study are to:

- Conduct a pilot study of eDNA sampling on targeted and ongoing marine wildlife surveys by BOEM and partners (*e.g.*, AMAPPS). Compare results with coordinated observations and collections on these surveys to establish a baseline assessment of eDNA for future BOEM studies;
- Identify where gaps exist in genetic reference libraries of relevance to BOEM and take action to address them with appropriate sequences;
- Compare eDNA sampling results with broad- scale baseline maps of known species' distribution, hotspots, and community structure.

Methods:

- Collect water for eDNA analysis at sampling stations on BOEM-related marine wildlife surveys and ships of opportunity to establish a baseline eDNA data set;
- Sample water at different depths to target multiple communities;
- Compare observers' visual observations (surface), optics (benthic), and trawl catches with eDNA community profile in an area. Ground-truth by targeting locations and seasons with high likelihood of encountering species of interest (hotspots) to validate eDNA with known distributions, and communities;
- Develop species-specific primers for high-priority species if they are non-existent.

Specific Research Question(s):

1. How can BOEM integrate eDNA in monitoring surveys to improve confidence in species detections and to augment nets, cameras, visual observations, and acoustics?

2. Can eDNA be used as a tool to detect and monitor species at known hotspots?

3. Can the use of eDNA improve community-level inference, and provide insight into potential trophic-level interactions?

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Watts, A and Yednock, B. 2019. New technology for old problems: Exploring the use of eDNA in the reserve system. Collaborative Science for Estuaries Webinar Series.

Title	Continued Partnership with National Museum of Natural History, Department of Invertebrate Zoology (NMNH-IZ) for a Voucher-based, Genomic Reference Facility for Ocean Biodiversity
Administered by	Headquarters
BOEM Contact(s)	Jonathan Blythe (jonathan.blythe@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2024
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Marine invertebrates from benthic and pelagic habitats that are impacted by Outer Continental Shelf (OCS) energy development and federally permitted marine minerals mining are an important economic resource for OCS fishing communities and play a significant role in the ecological function of these habitats.
Intervention	Marine invertebrates have been used for over 100 years as a proxy to assess environmental conditions and cumulative effects, and detect natural and anthropogenic impacts. BOEM's expanding OCS development activities across all of its program areas will need this rigorous collections based research to facilitate better understanding of biological diversity and help characterize ecological impacts from these OCS activities.
Comparison	BOEM's OCS regions are largely unique for their marine fauna. Some marine invertebrates that were previously thought to be pandemic throughout more than one OCS region may in fact include a cryptic species in part of this range. Marine animal distributions are shifting in response to global climate change. Invasive species are a growing component of OCS invertebrate communities. These comparisons of OCS marine fauna can only be deciphered if researchers are able to accurately classify biological samples.
Outcome	Cumulative knowledge of marine invertebrate taxa developed through collections based research will improve the rigor of BOEM's studies of ecosystem functions and assessments of species diversity.
Context	All OCS regions.

BOEM Information Need(s): This study leverages capabilities and resources provided by NMNH-IZ to improve the rigor of biological specimen identification on Environmental Studies Program (ESP) studies. This occurs directly through NMNH-IZ staff assisted curation of biological specimens from ongoing studies. Expanded acquisitions of OCS specimens from these and other sources will improve the baseline of biological materials and enable innovation in OCS research and monitoring approaches. NMNH-IZ will champion ESP's OCS sampling strategy that will specifically target key OCS invertebrate taxa that are invasive species, species critical to seafloor impact assessment, and to fill important taxonomic knowledge gaps that have been identified about the OCS environment (NMNH-IZ, 2019).

Background: Over the past 35 years, while the ESP has been conducting intensive environmental studies on the OCS, the NMNH-IZ has partnered with the ESP to provide professional collection management services for the long-term curation of marine invertebrate specimens. For example, the NMNH-IZ houses biological specimens collected on many baseline surveys that ESP conducted on the U.S. Atlantic and Gulf of Mexico OCS, and the U.S. Pacific and Alaskan OCS. In this time period, more than 383,000 lots of sorted and identified material and 20,000 lots of unprocessed samples or mixed taxa have been received. These specimens represent one of the most extensive collections of marine organisms from the U.S. continental shelf and slope in terms of geographic coverage, sampling density (spatial and temporal), number of phyla represented, and associated data collected concomitantly (other organisms, chemical, hydrographic, geologic).

NMNH-IZ specimens collected under this partnership are useful for a wide variety of taxonomic, evolutionary, and ecological applications. For example, they provide for new species discoveries (*e.g.*, Desbruyères and Toulmond, 1998; Ivanov and Scheltema, 2008; Blake and Maciolek, 2018, *etc.*), refined taxonomic distribution data (*e.g.*, Kilgour & Shirley, 2008; Ellis *et al.*, 2011; Goddard *et al.*, 2014; Lauth & Conner, 2014; Reuscher & Shirley, 2014, 2017 Chaudhary *et al.*, 2017), and biodiversity baselines for ecological monitoring (*e.g.*, Pie *et al.*, 2015; Hawkins & Popper, 2017). However, over the last 15 years, genomic analyses have become an increasingly important use of biological samples in this collection. Genomic approaches can greatly enhance our ability to document and monitor biodiversity through space and time (*e.g.*, Radulovici *et al.*, 2010; Bucklin *et al.*, 2011). Comparative deoxyribonucleic acid (DNA) sequences provide objective, rigorous, and repeatable data for local and regional comparisons (*e.g.*, Jennings *et al.*, 2010), for presence/absence data (*e.g.*, Leray & Knowlton, 2015), and for monitoring patterns of change (*e.g.*, Comtet *et al.*, 2015).

NMNH-IZ provides a voucher-based comparative reference facility for biodiversity studies and monitoring programs that employ DNA barcoding (*e.g.*, Kress *et al.*, 2015; Costa & Antunes, 2012). This type of research analyzes a short, segment of genetic code that is homologous across a wide variety of biological specimens to provide more robust species-specific identification. This genetic technique enables researchers to sample biological diversity in a variety of ways that does not depend on the organism's phenotype (*e.g.*, gut contents analysis, tissue traps, morphologically indistinct specimens, or environmental DNA [eDNA]). However, future research with this collection will not be limited to this approach, as other research may focus on genetic loci to enhance the resolution of population or individual units, or analysis of functional genes, such as anti-freeze and nitrogen fixation proteins, to answer more targeted ecological questions. Therefore, genomic analyses of the NMNH-IZ collections are becoming an increasingly important contribution of ESP's investment in biological specimen archiving.

Despite the growing importance of genomic techniques in the marine sciences, DNA barcoding coverage of most marine taxa remains poor for a variety of reasons. First, invertebrates are very specious, and they represent a disproportionately large component of OCS biodiversity. Second, it is generally recognized that biodiversity has a long tail, and it is not typically possible to represent species biodiversity except for concerted efforts targeting specimens from habitats or from taxonomic groups that are of particular interest. Finally, in many cases, it can be logistically difficult to collect specimens and tissue samples from benthic and pelagic OCS environments (Templado *et al.*, 2010). Dedicated expertise and facilities for tissue collection, handling, and preservation will help ensure the viability of biomaterials from ESP field research. Further, continued stewardship and strategic expansion of the OCS collection will ensure that the ESP has the framework to effectively leverage innovative research and monitoring techniques in the future.

Objectives:

- Strategically reinvest in and modernize ESP's biological specimen collection to provide a reference facility for future OCS research and monitoring efforts.

- Ensure accurate and consistent scientific information from the biological sciences through contribution of specimens from ESP studies and strategic acquisition of specimens from other sources in the marine science community in order to address key information/knowledge gaps regarding OCS biodiversity.

- Provide the baseline of biological information needed to consider cumulative impacts of offshore energy and mineral resources decision making from issues of increasing environmental concern, such as climate change and invasive species.

Methods: Partner with Smithsonian to leverage expertise and facilities of the NMNH-IZ. Specimens archived through this study will be curated, using NMNH-IZ's taxonomic expertise in OCS invertebrate species; and preserved, using NMNH's world class collection facilities at the Museum Support Center in Suitland, Maryland (NMNH-IZ, 2014). Further, tissue samples will be subsampled from OCS invertebrate specimens, sequenced, and cryogenically preserved in the NMNH biorepository. NMHZ-IZ will work with regional institutions who have specific expertise in OCS invertebrates and establish memoranda of understanding (MOUs) to work effectively towards shared goals.

The ESP will strategically enhance OCS biological specimen collections at the NMNH-IZ, following ESP's genomic sample strategy (NMNH-IZ, 2019), including: 1) working with legacy collections at the NMNH and other museum repositories to subsample tissue for genomic sample preservation; and 2) pursuing targeted specimen acquisitions through collaboration with BOEM ESP researchers and other marine scientists.

This study will assure the quality of biological samples by preserving, curating and storing biological specimens and associated viable genomic tissue, following standards approved by the Global Genome Biodiversity Network (GGBN) and protocols required by the NMNH-IZ for biological sample curation and database documentation. Information about phenotypes and DNA barcodes of OCS invertebrates will be disseminated through NMNH-IZ and GGBN websites and scientific publication outlets. The ESP will contribute to oversight, study Principal Investigator collaboration, information dissemination, and the strategic focus of NMNH-IZ's OCS collection, particularly with respect to National Environmental Policy Act (NEPA) decision analysis support, to best leverage this facility for ESP's biological sample archive.

Specific Research Question(s):

1. How can ESP improve the quality of biological information used in environmental assessments of benthic and pelagic OCS habitats affected by agency activities by strategically collaborating on fieldwork campaigns from ongoing studies and quality assuring the identification of invertebrates?

2. How can the NMNH provide a baseline of information to facilitate the broader adoption of genomic techniques and enable faster and more effective use of taxonomic information in BOEM studies and assessments?

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Title	Continued Support for the Animal Telemetry Network (ATN)
Administered by	Headquarters
BOEM Contact(s)	James Price (james.price@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2024
Date Revised	March 11, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Observations obtained through animal telemetry are often research-based and owned/operated independently by multiple agencies and institutions with limited to no connectivity. This impedes effective collaboration within the scientific community and prevents the full utilization of the data to serve scientific and resource managerial needs.
Intervention	To solve this problem, upon the recommendation of the U.S. Interagency Ocean Observation Committee (IOOC), the national ATN was created to improve the coordination and collaboration among research projects using animal telemetry, facilitate access to data, and motivate the creation of data-derived products of value to scientists and resource managers. The ATN continues to perform these roles.
Comparison	The alternative is telemetry observations made through many individual research activities with particular objectives but conducted largely without coordination with others, possibly supporting research projects and with data stored in many different forms and formats and at many different facilities.
Outcome	We expect: continued and enhanced collaboration over many research efforts; the further development of the Data Assembly Center as a common data collection point with standardization metadata documentation and interface with the National Oceanic & Atmospheric Administration's (NOAA's) National Centers for Environmental Information (NCEI) data archive; closer collaboration between hardware manufacturers and the users; and possibly bulk purchases of satellite tracking services at reduced costs.
Context	All U.S. and Canadian research activities using animal telemetry.

BOEM Information Need(s): Animal telemetry has greatly expanded our knowledge of habit use and migratory behavior of many species, including threatened or endangered species. With the advent of multi-sensor animal tags, ancillary environmental information can be obtained, such as temperature, salinity, pH, *etc.* as well as recorded animal vocalizations. These kinds of observations add important context for better understanding of the roles that potentially impacted animals play in marine ecosystems. This, in turn, improves BOEM's impact assessments and, perhaps, the formulation of mitigation strategies.

As with other biological data, the information gleaned from animal telemetry is acquired in increments of individual observational projects designed to answer specific research questions. The ATN facilitates collaboration, data sharing, data preservation, data access, re-analyses of "historic" data, cost reduction, and technological improvements which in turn enhance the information return from present and future research using animal telemetry and, consequently, improves BOEM's impact analyses using these observations.

Background: The ATN was launched in 2016 with joint funding from BOEM, the Office of Naval Research (ONR), and the NOAA Integrated Ocean Observing System (IOOS) Office. It had been in preparation for a few years before that, with consultation with the IOOC and an *ad hoc* committee of government and university scientists experienced in the use of animal telemetry.

A top priority was outreach to the scientific community starting with the integrated ocean observing systems. The purpose was to build participation in the network, and the IOOS regional associations are natural partners. The ATN convened six workshops covering a total of nine U.S. IOOS regions: (1) Mid-Atlantic Regional Association for Coastal Ocean Observing System (MARACOOS), (2) Southeast Coastal Ocean Observing Regional Association (SECOORA) / Caribbean Regional Association for Coastal Ocean Observing (CARICOOS), (3) Alaska Ocean Observing System (AOOS), (4) Gulf of Mexico Coastal Ocean Observing System (GCOOS), (5) Pacific Islands Ocean Observing System (PacIOOS), and (6) Northwest Association of Networked Ocean Observing Systems (NANOOS) / Central & Northern California Ocean Observing System (CeNCOOS) / Southern California Coastal Ocean Observing System (SCCOOS). Workshops in the two remaining IOOS regions will be conducted in the spring and late fall of 2019. In all of these, the participating researchers were amenable to coordinate their observational programs and share data. Specific agreements were reached to:

1. identify and prioritize regional observational needs to meet the objectives of the wider community of scientists and Federal agencies with resource managerial responsibilities;

2. catalog the existing global telemetry observing assets and scientific capabilities;

3. document stakeholder use of telemetry data; and

4. identify data management challenges (*e.g.*, creating a central data repository for common data access), and showcase regional capabilities and tools with global linkages for data management, sharing and collaboration. Consider needs common to other regions, and discuss strategies for applied, collaborative research across geographies and disciplines.

In 2018, the ATN convened a joint meeting among the West Coast IOOS regional associations, SCCOOS, CeNCOOS, and NANOOS, the BOEM-co-funded Marine Biodiversity Observation Network (MBON), and the extensive Ocean Tracking Network home-based in Canada. The attendees examined the overlap in their respective missions and created a working group to establish regionally coordinated research and data sharing and to develop a vision and approach to implement a West Coast Biological Observing system which would complement the pieces already in place.

With SECOORA and MARACOOS, “data wrangler” (data manager) positions were created for the Florida Atlantic Coast Telemetry network (FACT), a component of SECOORA, and the Alliance for Coastal Technologies (ACT), a component of MARACOOS, to interface between telemetry projects and the newly created telemetry data repository, the Data Assembly Center (DAC).

The DAC derived from an existing, rich collection of animal tag data acquired through the Tagging of Pacific Predators (TOPP) / Census of Marine Life programs and subsequent projects housed at ATN participant (and co-founder) Stanford University. When it became clear that the repository at Stanford would not be able to handle the anticipated large volume of telemetry data, the ATN sought the services of Axiom Data Science to manage the aggregation of satellite, acoustic, and archival telemetry data with the ultimate goal of permanent archiving at NOAA/NCEI.

The ATN is additionally discussing with ARGOS (Advanced Research & Global Observation Satellite), the satellite tracking service for scientific telemetry, the possibility of bulk-buys of tracking services for the wider research community at a discount price and is now paying the ARGOS service costs for ATN researchers who agree to submit their data to the ATN DAC in real-time. The ATN is also having discussions with equipment manufacturers on wanted capabilities with the next generation of animal tags and the possibility of making bulk purchases for discounts to be shared among individual research projects.

BOEM’s funding partners, the NOAA IOOS office and ONR, have committed to a comparable level of support in this continued effort. In addition, the Marine Mammal Commission will continue as a non-co-funding partner, lending their expertise.

Objectives: The objective of this study is to build upon the working relationships and agreements described above to make the most productive use of the capabilities of animal telemetry research presently and going forward.

Methods:

1. Expand outreach to include researchers and other stakeholders not affiliated with the regional IOOS associations.

2. Expand participation in the ATN by other NOAA offices and other Federal agencies (*e.g.*, the National Science Foundation [NSF]), including use of the DAC for data management and Public Access to Research Results (PARR) compliance.

3. Expand multi-agency collaborative baseline observations and infrastructure support to facilitate long-term ecosystem monitoring using telemetry in conjunction with other monitoring tools like passive acoustic monitoring.

4. Promote focused research on animals as sentinels of climate-scale changes in the ocean.

5. Support and instigate innovative analytical and visualization tools and data products of value to animal telemetry research; support and instigate enhanced capabilities in animal tags and satellite tracking.

6. Promote cost savings to researchers through group purchasing.

Specific Research Question(s): The ATN will not itself address any research questions, but two questions that can be addressed by analyzing data pooled from multiple research projects using animal telemetry are:

1. How are migratory routes of marine animals changing in the face of a changing ocean climate?

2. How does expanded ocean energy development affect habit use, migration, and reproduction of marine animals resident in or transient through energy development areas?

References:

Title	Deepwater Atlantic Habitats III: Continued Exploration and Analysis of Potential Impacts from Energy and Minerals Activities
Administered by	Headquarters
BOEM Contact(s)	Michael Rasser (michael.rasser@boem.gov), Mark Mueller (mark.mueller@boem.gov), Alden Denny (alden.denny@boem.gov), Jason Chaytor (jchaytor@usgs.gov), Amanda Demopoulos, (ademopoulos@usgs.gov), Amy Gartman (agartman@usgs.gov), Rachel Medley (rachel.medley@noaa.gov)
Procurement Type(s)	Interagency Agreements with the U.S. Geological Survey (USGS) and National Oceanic & Atmospheric Administration (NOAA). Possible National Oceanographic Partnership Program (NOPP) sponsorship.
Performance Period	FY 2020–2025
Date Revised	June 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The Bureau of Ocean Energy Management (BOEM) needs to know more about the location of sensitive deep water habitats that may be impacted by oil and gas development. In addition, critical minerals are essential to the economic and national security of the United States, yet very little is known about their distribution on the United States Outer Continental Shelf (OCS), their associations with sensitive habitats and species (*e.g.*, corals, sponges) or environmental impacts of minerals mining.
Intervention	This study will support and continue ongoing baseline mapping and assessment of the location of sensitive marine habitats and critical minerals in the Atlantic. This will include the detailed mapping and analysis of a known area of historic mining. This analysis will improve agency efforts to study, plan, and manage for critical mineral mining and oil and gas development activities.
Comparison	Compare areas that contain critical minerals to other seafloor environments (*e.g.*, are critical minerals near biologically sensitive habitats?). Additional comparisons include examining natural change (*e.g.*, sediment dynamics), examining areas of past substrate removal, and conducting field experiments to compare control *versus* treatment areas.
Outcome	An improved understanding of the location and ecology of sensitive deepwater habitats (and associated critical minerals) that may be impacted by oil and gas development. An analysis and framework of the long-term environmental impacts of deep-sea mining using a known area where historic mining has taken place.
Context	Based on our current understanding, the focus of this study will be in U.S. OCS waters of the Atlantic. 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 continue gathering information on the location and extent of sensitive deepwater habitats and associated critical minerals in the Atlantic. The information gathered will help BOEM better understand the location, ecology, and sensitivity of deepwater habitats to support environmental assessments such as BOEM's National OCS Oil and Gas Leasing program and Marine Minerals Program. This information will be also be used to support any future BOEM activities related to the development of critical marine minerals on the OCS and is responsive to Executive Order (EO) 13817 "Presidential Executive Order on a Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals" and also EO 13840 "Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States".

Background: Authoritative baseline information about sensitive deepwater habitats in the Atlantic is required to inform the U.S. Department of the Interior (DOI)/BOEM decision making across program areas. Previous cruises have documented numerous new deepwater coral and chemosynthetic communities that have led to significant increases in our understanding of their geographic distribution and habitat associations. For example, the Deep Sea Exploration and Research of Coral/Canyon/Cold seep Habitats (DEEP SEARCH) project recently explored a never before described extensive *Lophelia* reef complex in the Atlantic that has significantly changed the understanding of this species' geographic distribution. There are still many potential sites that have not been explored, such as the Blake Plateau (BP) area offshore of South Carolina, Georgia, and Florida. BOEM requires additional information focused on species presence and their habitat preferences, habitat characteristics, biodiversity, ecology, and food-web dynamics of these communities.

On June 5th, 2019 the Department of Commerce released "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals." The strategy directs DOI to locate domestic supplies of those minerals, ensure access to information necessary for the study and production of minerals, and expedite permitting for minerals projects. EO 13817 calls for the Federal government to "identify new sources of critical minerals" and that the "United States will further this policy for the benefit of the American people and in a safe and environmentally responsible manner." The Outer Continental Shelf Lands Act assigns DOI (delegated to 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. Exclusive Economic Zone (EEZ), from continental margins to seamounts and mid-ocean ridges (Hein *et al.*, 2016). These EEZ deposits are not currently included in mineral resource assessments (Schultz *et al.*, 2017; Fortier *et al.*, 2018). This study will leverage deepwater seafloor habitat mapping efforts to collect further information on the distribution and geology of critical minerals and their association with ecologically sensitive habitats.

Diverse types of marine mineral-rich hard substrates (*i.e.*, crusts, nodules, and massive sulfides) support distinct benthic communities that may differ in their response and recovery from disturbance, including extraction activities. These areas can support diverse communities of rare species, including corals, sponges, and fishes, but basic ecological information is lacking, including the faunal composition, population sizes, distribution, and connectivity among these environments. Adequate understanding of potential ecological impacts of mineral extraction is constrained by limited observational data. Although a few studies have monitored changes during mining demonstration activities, they have suffered from a lack of knowledge regarding the local and regional seafloor environment before extraction activities began (Jones *et al.* 2018; also see International Seabed Authority https://www.isa.org.jm/scientific-activities).

This study will include a focused analysis of historic deep-sea mining on the BP (U.S. Atlantic Ocean). Geological and mineral distribution assessments on the BP began in the 1960's, leading to commercial manganese nodule extraction test activities (Deepsea Ventures, Inc.), and dedicated geologic and resource assessments in the early 1980's by the USGS and partners. This work provides a unique and invaluable time series of seafloor disturbances, enabling unprecedented recovery assessments across a range of substrates and habitat types.

These efforts will be coordinated with upcoming investigations planned at the Escanaba Trough (ET; U.S. Pacific Ocean) where previous work led by USGS (Morton *et al.*, 1994) represents one of the most comprehensive studies examining the geological, hydrothermal, and biological processes of this area. This research will coordinate with current and build upon past research programs including BOEM-led studies in the Atlantic (Atlantic Canyons [AT-17-03], DEEP SEARCH [AT-17-06], and ADEON [AT-16-08]) and in the Pacific (CALDIG [PC-17-02] and CALDIG II [PC-19-06]). The use of ships of opportunity and collaboration with other efforts such as ASPIRE (Atlantic Seafloor Partnership for Integrated Research and Exploration) will be critical to meet the information and data required in a cost effective manner. The proposed area of interest aligns with NOAA's Office of Exploration priorities and objectives concerning critical minerals and ocean exploration and will provide a robust data set to address known gaps in survey coverage. In addition, this project will support NOAA objectives to fully map and characterize the U.S. EEZ at depths greater than 200 m at a resolution of greater than 100 meters to meet modern survey standards.

It is anticipated that this study will be developed through two interagency agreements with the USGS and NOAA, with potential sponsorship by NOPP. There are ongoing discussions about this potential study among BOEM, USGS, and NOAA. USGS has the scientific expertise (available staff) and access to existing relevant datasets to complete this work. BOEM has scientific expertise to contribute in marine ecology, benthic ecology, and critical minerals geology. NOAA's Office of Exploration and Research has confirmed NOAA Ship *Okeanos Explorer* will be mapping and exploring this region in Fiscal Year (FY) 2020/FY2021 and would be available for this study; other NOAA vessels of opportunity may become available in later years.

Objectives:

- Determine the current state of knowledge of the location of critical minerals and their associated geological characteristics and environmental conditions. Priority areas will be identified where further investigation of deep water sensitive habitats and critical minerals is needed.

- Create detailed, updated, and expanded maps of sensitive benthic habitats, seafloor geology, and geochemistry and the location of critical minerals. Improve the current understanding of the community structure, distribution, and connectivity of dominant faunal communities associated with targeted areas.

- Assess the potential impacts of mineral extraction/recovery activities on the seafloor environment using a historically impacted site.

Methods: This study will consist of three major components:

- *Analysis of Existing Data to Determine BOEM priority information needs.* Existing data and literature, archived samples, existing multibeam, and seafloor imagery datasets will be analyzed to identify data gaps and potential ecological/mineral 'hotspots.' <u>Outcome: A report detailing the current state of knowledge of the location of sensitive habitats and their associated species, critical minerals and their associated geological characteristics, environmental conditions and sensitive habitats and species. A detailed list of priority geographic "targets" where BOEM needs further data collected.</u>

- *Mapping and Analysis of High-priority Areas in the Atlantic.* Fieldwork that capitalizes on cruises of opportunity (*e.g.*, NOAA's *Okeanos Explorer*), as well as new platform commitments (*e.g.*, remotely operated vehicles [ROVs], autonomous underwater vehicles [AUVs]) will be used to collect information to meet knowledge gaps. Dominant invertebrates and fish habitat affinity will be quantified across targeted substrate types from video and digital still imagery and collections. Species composition and biodiversity surveys based on taxonomy, metabarcoding, and environmental deoxyribonucleic acid (eDNA) analyses will help identify representative indicator species, serving as sentinels to monitor for change and recovery. Population genetics will be used to address connectivity among these systems and the adjacent seafloor. Animal telemetry networks combined with eDNA provide a possible avenue to determine pelagic megafauna association with benthic habitats. <u>Outcome: Maps and other products based on improved predictive models of the distribution of sensitive habitats and species and critical minerals. A better understanding of the ecology of deep-sea communities including their sensitivity, distribution, and connectivity.</u>

- *An assessment of the impacts of deep sea mining for critical minerals.* Seafloor sample collections will be analyzed to characterize the composition and concentration of minerals within the targeted areas. High-resolution imagery and mapping over targeted environments, coupled with water-column characterization and georeferenced benthic habitat maps will provide information on the physical environment of control areas and disturbed areas and facilitate the tracking of temporal changes to these environments. <u>Outcome: A better understanding of the potential long-term impacts of deep sea mining for</u>

critical minerals. A "natural experiment" framework for examining deep sea mining impacts that is applicable to other BOEM planning areas.

Specific Research Question(s):

1. What is the location, composition, and characteristics of OCS deepwater sensitive habitats and what are the associations with critical minerals?
2. What are the relationships between habitats of interest such as canyons, corals, and cold-seep habitats? What is the degree of connectivity (spatial, population, and trophic) among these environments?
3. What are the potential environmental impacts of extraction of critical minerals?

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Title	High Resolution Modeling of the Gulf of Mexico
Administered by	Headquarters
BOEM Contact(s)	Jeff Ji (jeff.ji@boem.gov)
Procurement Type(s)	T.B.D.
Performance Period	FY 2020–2022
Date Revised	April 3, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	High resolution currents in the Gulf of Mexico (GOM) are needed to conduct oil spill risk analysis (OSRA). The accuracy of the current information, in terms of spatial and time resolution, is critical for the accuracy of the OSRA model results. Understanding the importance of ocean model resolution is also pertinent to analyzing the hydrodynamic and environmental processes in the GOM.
Intervention	This study will be conducted using the existing Hybrid Coordinate Ocean Model (HYCOM). The latest information on bathymetry, river inflows, satellite data, and meteorological fields will be incorporated into the HYCOM. The model grid will have a 1/100°-resolution in the GOM.
Comparison	Perform a 20-year data assimilative hindcast using a 1/100°-resolution HYCOM configuration of the GOM with accurate bathymetry and enhanced vertical resolution compared to the presently available 1/25°-resolution HYCOM hindcast.
Outcome	The output of this study will be directly used in the BOEM OSRA applications. The improved currents will enhance the accuracy of OSRA model results and help us understand the impact of spatial resolution on the performance of OSRA model.
Context	Gulf of Mexico and Caribbean Sea

BOEM Information Need(s): BOEM has been using 15 years (1993–2007) of Princeton Ocean Model results for the OSRA in the GOM. BOEM needs better and more accurate information on currents and eddy activities in the GOM (BOEM, 2014). Results from this study will expand BOEM's ability to assess oil spill risks in the GOM and improve its ability to estimate oil spill trajectories.

Background: Circulation in the GOM is dominated by the Loop Current (LC) and by Loop Current eddies (LCEs) that form at irregular multi-month intervals by separation from the LC. Comparatively small cyclonic eddies (CEs) are thought to have a controlling influence on the LCE, including its separation from the LC. Because the CEs are so dynamic and short-lived, lasting only a few weeks, they have proved a challenge to observe and to numerically simulate. The spatial scale of these eddies can be 20 km or less. With such small spatial scale, it is essential to have an ocean model that has sufficient spatial resolution to describe the LC and LCEs with confidence.

Accurate representation of the ocean dynamics in ocean models advecting the oil particles is crucial for simulating of the oil trajectories, because the location of mesoscale features largely determines local surface oil transport. This is also important for understanding ecological connectivity, adaptability, and changes of critical deep communities that are commonly found in regions with substantial small-scale topographic variability.

Objectives:

1. Enhance the HYCOM with a high grid resolution of 1/100°. The numerical schemes of the model should also be carefully examined to ensure that the high resolution and the schemes are consistent with each other. Statistical tools should be used for model verification and validation.

2. Examine interactions of the vertical circulation with the sub-surface hydrography and horizontal circulation fields. The goal is to provide information on the potential lateral displacement and sub-surface transport of oil released at depth.

3. Perform a 20-year simulation using a 1/100°-resolution HYCOM configuration of the GOM with accurate bathymetry and enhanced vertical resolution compared to the presently available 1/25°-resolution HYCOM hindcast.

4. Deliver the 20-year HYCOM model results to BOEM for OSRA applications in the GOM.

    a. Hourly surface currents and 3-hourly (or less) sub-surface currents.

    b. Domain estimated to cover GOM and eastward through the Caribbean.

Methods: HYCOM (Chassignet *et al.*, 2007; Chassignet and Srinivasan, 2015) was developed to improve the vertical coordinate scheme of earlier models. HYCOM is a primitive equation, general circulation model with vertical coordinates that remain isopycnic in the open, stratified ocean. This study will address the need for a new data assimilative ocean model that simulates characteristics of the deep Gulf consistent with new understanding gained from recent BOEM observational studies. The model would also provide a predictive tool to assess transport and impacts of oil spills throughout the Gulf from the surface to the seafloor.

Specific Research Question(s):

1. What are the potential impacts of different model grid resolutions to the simulation of eddies and other dynamic processes in the GOM?

2. How can the subsurface information from this high resolution modeling be used in BOEM's oil spill risk analysis?

3. Over the simulation period of 20 years, will the fine resolution HYCOM (up to 1/100°) always be sufficient to resolve the eddy and eddy shedding processes in the GOM?

References:

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Chassignet, E. P., and A. Srinivasan, 2015: Data Assimilative Hindcast for the Gulf of Mexico. BOEM 2015-035: https://www.boem.gov/ESPIS/5/5479.pdf

Title	Installing Offshore & Coastal Dispersion (OCD) Platform Downwash Algorithms in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD)
Administered by	Headquarters
BOEM Contact(s)	Holli Ensz (holli.ensz@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	February 28, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The U.S. Environmental Protection Agency's (USEPA's) preferred onshore dispersion model, AERMOD, does not have the necessary downwash algorithms for offshore platforms, which are porous in nature unlike onshore building structures. Modeling is one way BOEM determines possible air quality impacts caused by Outer Continental Shelf (OCS) oil and gas activities as required under the National Environmental Policy Act (NEPA) and Outer Continental Shelf Lands Act (OCSLA). Thus, improved modeling will lead to more realistic impacts. BOEM needs to incorporate necessary platform downwash algorithms into AERMOD for use offshore.
Intervention	The older offshore dispersion model, OCD, does have platform downwash algorithms, which are of good quality, but other aspects of OCD are outdated like not being able to use current operating systems to run and final results are based on outdated National Ambient Air Quality Standards (NAAQS) averaging times. Perhaps OCD would be compatible with AERMOD, and those OCD platform downwash algorithms could be installed into AERMOD.
Comparison	Running AERMOD pre-installation of platform downwash and post-installation of platform downwash will validate if the algorithms are compatible. Also validation of the algorithms can be performed post-installation using data from BOEM's wind tunnel study.
Outcome	Having necessary platform downwash algorithms in AERMOD is one step BOEM needs to replace OCD, according to USEPA. In 30 Code of Federal Regulations (CFR) 550, operators are required to use USEPA's Appendix W guidelines for modeling, thus BOEM needs to follow USEPA's lead on steps required to replace OCD with AERMOD.
Context	All Regions

BOEM Information Need(s): USEPA has listed AERMOD as a preferred dispersion model in Appendix W. However, for offshore usage, AERMOD does not have the necessary platform downwash algorithms. The older OCD dispersion model does have platform downwash algorithms, which are of good quality, but other aspects of OCD are outdated like not being able to use current operating systems to run and final results based on outdated NAAQS averaging times. BOEM needs to evaluate the compatibility of the OCD downwash algorithms with AERMOD to determine if the OCD platform downwash algorithms can be incorporated into AERMOD.

Background: The 1990 Clean Air Act Amendments (CAAA) require USEPA to set the NAAQS for widespread pollutants from numerous and diverse sources considered harmful to public health and the environment. OCSLA states that Outer Continental Shelf (OCS) oil and gas exploration, development, and production activities cannot significantly impact the NAAQS compliance of any state. Modeling is one way BOEM determines possible air quality impacts caused by OCS oil and gas activities as required under the National Environmental Policy Act (NEPA) and OCSLA. BOEM's regulations at 30 CFR 550 require modeling must be conducted according to the guidelines of the USEPA's Appendix W. Having necessary platform downwash algorithms in AERMOD is one step BOEM needs to replace the outdated OCD, according to the USEPA through discussions with Interagency Workgroup on Air Quality Modeling (IWAQM)-Overwater.

The current offshore dispersion model, OCD, has platform downwash algorithms, which are of sound science, but OCD not been updated in several years. BOEM needs to replace OCD with AERMOD, USEPA's preferred dispersion model for onshore. However, AERMOD does not have the necessary platform downwash algorithms. If OCD and AERMOD are compatible, perhaps the OCD platform downwash algorithms could be coded into AERMOD.

Objectives: The objectives of the study are to draft a scoping study assessing the compatibility of the OCD platform downwash algorithms with AERMOD and if found to be compatible, evaluate existing draft AERMOD code that incorporates the platform downwash algorithms from OCD. All types of platforms should be considered from all regions: drilling rigs; production platforms (small, medium, large); floating production, storage, and offloadings (FPSOs); *etc.*

Methods: This study would consist of four parts:

1. a scoping study assessing the compatibility of the OCD platform downwash algorithms with AERMOD;

2. if found to be compatible, review existing draft AERMOD code from a previous effort that incorporates the platform downwash algorithms from OCD;

3. based on review findings, make any needed changes to the existing AERMOD code to refine the integration of the OCD platform downwash algorithms; and

4. complete model intercomparisons and model evaluations.

    a. Note: Hermon Wong, formerly with USEPA Region 10, developed draft AERMOD code that incorporates the OCD platform downwash algorithms into AERMOD with limited testing and comparison to the OCD model. If the OCD platform downwash algorithms are determined to be compatible with AERMOD and the existing integration of the platform downwash algorithms is determined to be appropriate, BOEM's wind tunnel dataset (ongoing study) could be used as an evaluation dataset.

Specific Research Question(s):

1. Are the OCD platform downwash algorithms compatible with AERMOD?

2. Can the OCD platform downwash algorithms be coded into AERMOD?
3. Are these platform downwash algorithms consistent with Alaska's sources?

References:

Title	Marine Biodiversity Observation Network (MBON) Special Issue of *Oceanography* Magazine
Administered by	Headquarters
BOEM Contact(s)	James Price (james.price@boem.gov)
Procurement Type(s)	Purchase Order
Performance Period	FY 2020
Date Revised	March 10, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	how to most effectively transmit the results of the three MBON studies co-funded by BOEM and nearing completion
Intervention	produce a special issue of *Oceanography* magazine dedicated to the topic of marine biodiversity observing
Comparison	individual publications in various peer-reviewed journals are the alternative; but interested readers will not be able to easily see the connection among them and miss the big-picture story
Outcome	as with other special-issue publications, a comprehensive overview of marine biodiversity observing and its value scientifically and practically will be presented
Context	Community-wide among marine scientists and natural resource managers

BOEM Information Need(s): Biodiversity as a proxy for ecosystem health gives BOEM another measure for assessing environmental impact beyond the important considerations about individual species and individual populations. Presenting the big-picture story about marine biodiversity observing (monitoring) in the widely read *Oceanography* magazine gives BOEM analysts and the marine scientific community in general the opportunity to see the current results from the MBON projects in a well-integrated context.

Background: Together with the National Oceanic & Atmospheric Administration's (NOAA's) Integrated Ocean Observing System (IOOS) office and the National Aeronautics and Space Administration's (NASA's) biodiversity program, BOEM co-funded three studies to develop the means of observing changes to marine biodiversity in three different ecosystems (the Santa Barbara Channel [PC-15-05], the Chukchi Sea [AK-15-01], and the Florida Keys and Monterey Bay national marine sanctuaries [NOAA and NASA alone]). In addition, the projects were tasked with coming up with ideas about how a national program (in all U.S. waters) doing sustained observing of changes in marine biodiversity could be done.

Objectives: The objective of this study is to produce, edit, and publish a special-issue collection of research papers describing the results from the three MBON studies and how sustained biodiversity observing in U.S. waters could/should be done and why it is important for science and for the management of natural marine resources. Publication will be sought in *Oceanography* magazine.

Methods: The Principal Investigators (PIs) and representatives of the funding agencies will discuss among themselves a strategy for presenting the many research results in an integrated way and the overall story we want to tell. The PIs and co-investigators will write the articles to be published and an overview statement in the style and format of *Oceanography* magazine. The group of participating scientists as a whole will review all the text to be submitted. *Oceanography* magazine reviewers will review the draft we submit.

The requested funding for this study is to pay one-third of the publication cost. NOAA and NASA will each pay one-third.

Specific Research Question(s):

References: http://tos.org/oceanography/

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 2020–2021
Date Revised	April 30, 2018
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The problem addressed herein is how to practically and consistently assess the possible adverse physiological impacts to marine mammals from disturbances including lost foraging opportunities, energy-consuming avoidance behavior, increased foraging effort, or increases in allostatic loads.
Intervention	This study will convene a workshop of about 40 prominent researchers in bioenergetics to: review the state of information on marine mammal bioenergetics; identify the data gaps and approaches that can be used to fill them; and compare the different approaches to develop robust bioenergetic models. Improved models will facilitate improved impact assessments.
Comparison	There have often been different approaches to assess the net effects of adverse impacts on marine mammals as predicted by bioenergetics models. Filling gaps in the knowledge of model-sensitive parameters and improving the modeling of the relevant physiology should promote consistency and provide greater rigor in models that better agree with observable effects (to the extent that they can be observed).
Outcome	The workshop will address the state of knowledge of bioenergetics modeling and marine mammal physiology and recommend approaches to make the models more robust. The workshop will also seek consensus among the experts on the basic parameters and assumptions that are employed in the models.
Context	Improved marine mammal bioenergetics modeling is applicable everywhere marine mammals exist (*i.e.*, in all areas of BOEM's responsibility).

BOEM Information Need(s): BOEM analysts can make conclusions about the short-term effects on marine mammals from anthropogenic stressors associated with offshore energy development. However, the potential fitness level consequences of those effects are usually limited to a qualitative assessment. This workshop will provide an opportunity to build consensus on the type of approaches and information needed to best assess and/or monitor the energetic consequences of impacts to marine mammals. This study seeks to improve the determination of the longer-term, population-level impacts on marine mammals by improving the modeling of bioenergetics based upon the PCAD/PCoD (population consequences of acoustical disturbances / population consequences of disturbances) framework, which will facilitate future cumulative impacts assessments. This will in turn enable BOEM to make more rigorous assessments of possible adverse impacts to marine mammals from BOEM-related activities.

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 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). Although 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 approach 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 five 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 three bioenergetic models of prey intake for bottlenose dolphins using three different methods of inferring field metabolic rates. Although 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 modeling strategies and model inputs directed at studying the same phenomena.

Trying to tame the situation, a highly successful workshop on bioenergetics modeling 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 modeling and the many problems (and successes) therein (Huntley *et al.*, 1987). Much has been learned and accomplished since 1987. However, it is time now to revisit this topic, particularly because 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:

- to comprehensively assess the deficiencies in modeling the bioenergetics of marine mammals;

- to develop best practices guidelines for improving the models; and

- to identify the deficiencies in existing observations needed as model inputs and suggest observational studies to overcome the deficiencies.

Methods: This study will conduct a bioenergetics workshop in FY 2020 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.

The Marine Mammals Program of the Office of Naval Research (ONR) will partner with BOEM to co-fund and co-conduct the workshop. They will match BOEM funding to bring the total funding to $190,000, which is comparable to the cost of other similar workshops ONR has funded in recent past years.

Specific Research Question(s):

1. What are the deficiencies in the current modeling approaches of marine mammal energetics, and how can they be overcome to produce better models?

2. What are the deficiencies in the data available to drive the models, and what observational studies are needed to remedy the deficiencies?

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Title	Next Generation of Animal Telemetry: Pathway to Implementation
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov) and Jennifer Bosyk (jennifer.bosyk@boem.gov)
Procurement Type(s)	Interagency agreement/Contract
Performance Period	FY 2020–2022
Date Revised	March 19, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Spatial and temporal coverage limitation of telemetry receiving stations lead to data loss and cost ineffectiveness for animal movement studies.
Intervention	Leveraging growing small satellite industry, anticipated to be as many as 18,000 orbiting assets by 2028, to augment current limitations. Change is measured by increased accuracy and bandwidth available to telemetry needs.
Comparison	This is measured against the intervention. Think of hypothesis testing, control *vs.* treatment, and/or natural change.
Outcome	Improved data quality with reduced costs for animal telemetry needs
Context	Earth

BOEM Information Need(s): This study implements BOEM's Outer Continental Shelf (OCS) Lands Act mandate to monitor the marine environment adjacent to U.S. OCS operations. Understanding animal movement in the OCS is required for nearly everything under BOEM's purview. Telemetry is an important tool to support animal movement and behavior studies to supplement survey effort. Additionally, animal telemetry can be used to infer movements related to activities in the OCS, such as geophysical surveys, platform construction and demolition. Animal telemetry can provide relevant information for National Environmental Policy Act, Marine Mammal Protection Act, and Endangered Species Act consultations across program areas such as wind and hydrokinetic placement locations, oil/gas leasing, and even used in monitoring impacts of climate change. Internal reports, such as BOEM's *Effects of Offshore Energy Sound Producing Activities on Fish and Invertebrates*, as well as public comments on a variety of environmental impact statements, from the Arctic to Atlantic, call for a need for improved data on animal movement, behavioral, and foraging ecologies.

Background: Tracking of highly mobile marine megafauna is typically accomplished by Advanced Research & Global Observation Satellite (ARGOS). This study proposes development of supplemental/alternative method of OCS marine animal tracking by leveraging the National Aeronautics & Space Administration (NASA's) CubeSat Launch Initiative low earth-orbiting small satellite programs.

Animal movement studies face several technological factors due to proprietary technology, limited radio transmission range, overhead satellite time limitations and most importantly, cost. Cumulatively, these factors limit opportunity to gather information on animal movements throughout the U.S. Exclusive Economic Zone. An open-source receiving network, which does not depend on the ARGOS satellite system, significantly lowers costs by enabling use of a constellation of low-cost, open-source data relay CubeSats.

The CubeSat small-satellites community can be leveraged to invest in a CubeSat alternative to the current ARGOS system. CubeSats are a class of small research-class spacecraft. NASA's CubeSat Launch initiative (CSLI) provides opportunities for small satellite payloads to hitch-hike on rockets planned for upcoming launches. This program engages engineering schools across the United States to develop low-cost micro satellite experiments and has been developing and launching these CubeSats at an increasing rate each year. Additional transceivers can be placed easily on the future CubeSats, as well as autonomous underwater vehicles, ocean going vessels, aircraft, and existing buoys to create a truly wireless ocean.

Marine Mammals, fishes, and invertebrates of particular interest for impact analysis include those species that are commercially or recreationally important, are threatened or endangered, or are keystone (for example, important prey) species. Data collected by these tags can be relayed in real-time (or delayed mode) via satellite. Due to limited bandwidth in these transmissions not all of the data can be relayed. This results in a need for some data processing on the tag and only a subset or summary of the data being recovered. However, as the instrument does not have to physically be recovered, these tags can be deployed on animals not suitable for archival tags alone.

The planet is changing quickly, through this study BOEM can be a catalyst for a truly wired ocean. Though the implementation of this project, BOEM achieves improved tools for OCS monitoring and Science-Technology-Engineering-Mathematics partners are engaged in an innovative program, together leading to a tech savvy workforce while filling in gaps in OCS data cost effectively.

Objectives:

- Develop and demonstrate an OCS tracking/monitoring network for geographically and taxonomically diverse marine megafauna leveraging CubeSat open-source tracking through a near space balloon and software defined radio.

- Demonstrate multi-agency utility using a low earth orbit example vehicle.

- Convene workshop of agency stakeholders and chart path forward for implementation.

Methods: Using NASA's CubeSat launch initiative network we will utilize space-based transceivers aboard CubeSats and the International Space Station as well as ocean and terrestrial based transceivers to demonstrate the feasibility of tracking various marine megafauna. Accomplishing this will be done through the following:

- Develop and launch CubeSats for data link characterization

- Convene a workshop of the CubeSat community as well as ocean telemetry engineering experts to establish a standardized communication platform for low orbital pico-satellites

- Convene a public competition to create a coding algorithm for managing big data associated with visualizing movements accurately

- Ground-truth CubeSat animal tags in diverse scenarios

Specific Research Question(s): Can SmallSats be used as a cost-effective supplement improving improve ocean megafauna monitoring?

References:

Title	Oil in the Sea IV: National Academies of Sciences, Engineering, and Medicine (NASEM)
Administered by	Headquarters
BOEM Contact(s)	Brian Zelenke (brian.zelenke@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2021
Date Revised	March 6, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The comprehensive review and synthesis of the scientific understanding to date of the inputs of oil into the sea needs to be updated.
Intervention	The NASEM has developed a plan to update the Oil in the Sea synthesis report, to be entitled *Oil in the Sea IV*.
Comparison	The previous report, *Oil in the Sea III*, was completed in 2003 and, following the *Deepwater Horizon* disaster in 2010, the analysis needs to be updated.
Outcome	The study will publish a NASEM consensus report.
Context	The report will estimate the volume of hydrocarbon input to the marine environment worldwide from all sources, with an emphasis on North American waters.

BOEM Information Need(s): An inclusive review and synthesis of the scientific understanding to date of input of oil into the sea will give the Bureau of Ocean Energy Management (BOEM) the ability to make more comprehensive impact assessments. BOEM's National Environmental Policy Act (NEPA) analyses and compliance will be improved. The study will provide information on environmental impacts, specifically of oil into the sea—including natural seep, large, low-level, and chronic discharges—in the context of activities authorized by BOEM.

Background: In 1985 the U.S. Coast Guard requested that the Ocean Sciences Board of the National Research Council prepare a report, using data that had been acquired since 1975. Forty-six experts were invited to prepare summary reports on all aspects of petroleum hydrocarbon discharges into the marine environment and to evaluate the fates and effects of these discharges. The resulting report was entitled *Oil in the Sea: Inputs, Fates, and Effects* (1985). Subsequently, in 2003, BOEM precursor agency the Minerals Management Service approached the NASEM's Ocean Studies Board to undertake an update of the 1985 report. This effort produced the report *Oil in the Sea III: Inputs, Fates, and Effects* (2003). Since this time, the *Deepwater Horizon* disaster has spurred new research and renewed interest in the issues of this topic.

Objectives: Specifically the committee will:

- Assess and discuss the physical and chemical characteristics and behavior of these hydrocarbons, the transport and fate of various hydrocarbon mixtures in the marine environment, and review the effects of these mixtures on marine life and ecosystems.

- Evaluate, to the degree possible, the relative risk posed to the marine environment by fossil fuel hydrocarbon components or type of input, given the range of organisms, ecosystems, or cultural resources likely to be affected (Hamdan *et al.*, 2018; Haridas *et al.*, 2018; Mugge *et al.*, 2019; Salerno *et al.*, 2018).

- Review progress in implementing the recommendations from the 2003 report regarding fates and effects and identify priority recommendations that have yet to be implemented.

- Provide recommendations to improve understanding of the fates and effects of hydrocarbon inputs from human activities and strategies for reducing the more harmful effects (National Research Council, 2005).

Methods: NASEM will empanel an expert committee. The committee will provide an update of the previous report's (*Oil in the Sea III: Inputs, Fates, and Effects*, 2003) assessment of the state of the science on the fate and effects of fossil fuel hydrocarbons in the marine environment. To the extent possible, *Oil in the Sea IV* will identify, categorize, and quantify these sources of hydrocarbons (and their chemical composition) with an emphasis on North American waters. The committee will examine worldwide data in an effort to place numbers derived for North American waters into a global context. This examination will include identifying data sources, with input from BOEM and others, and working with supporting partners (*e.g.*, the Bureau of Safety and Environmental Enforcement) to access data.

Specific Research Question(s):

1. What are the sources, composition, and quantity of hydrocarbon inputs to the marine environment? How ought anthropogenic inputs be reduced?

2. What is the relative risk posed to the marine environment by fossil fuel hydrocarbon components or type of input, given the range of organisms or ecosystems likely to be affected?

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Title	Outer Continental Shelf (OCS) Wind Energy: Socioeconomic Baselines, Trends, and Impacts
Administered by	Headquarters
BOEM Contact(s)	John Primo (john.primo@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2026
Date Revised	April 12, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	BOEM lacks empirical data and a strong understanding of the impacts from OCS Wind Facility Development on the human environment (*e.g.*, tourism and recreation, recreational fishing, real estate, and employment).
Intervention	This effort builds on a previously completed study by applying a set of socioeconomic indicators to multiple sites to establish baseline characterizations, document trends, and possible effects.
Comparison	This study will involve longitudinal and cross-site comparison of observations collected from two sites within the area of impacts associated with one or more leases and a control site. The observations will support an experimental framework with pre- and post-development data (*e.g.*, property values, rental rates, visitation levels, facility associated commerce, and recreational fishing, diving, and boating).
Outcome	This study will provide a set of longitudinal data to further understand the potential socioeconomic effects of OCS Wind Facility development. Data and findings will support Federal environmental impact statements, reduce the uncertainty related to impacts, and address concerns heard from state and local governments.
Context	The information from this study will be useful to the Atlantic OCS Region, and secondarily to the Pacific OCS Region to enhance their understanding of effects. This study will also serve to further develop an indicator methodology that will have varied applicability to all of BOEM's regions.

BOEM Information Need(s): BOEM's Office of Renewable Energy Programs is currently projected to prepare up to seven environmental impact statements to analyze construction and operations plans for offshore wind energy facilities along the Atlantic Coast. As of June 2018 the Department of Energy calculated the U.S. as having a total offshore wind project pipeline of 25,435 MW, which could power approximately 8.9 million homes. Although offshore wind facilities number in the dozens overseas, the U.S. does not have *any* large commercial-scale facilities in Federal waters. In turn, though some of the scientific information related to offshore wind's impacts is transferable from the European experience, variation in cultural, social, economic, and policy contexts complicates transferability to the U.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) of what are projected to be some of the first, large commercial-scale offshore wind facilities in Federal waters in two or more of the following lease areas: Maryland, Massachusetts, Rhode Island, New Jersey, and/or Delaware. 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: BOEM has studied impacts or potential impacts on various aspects of the human environment, through studies on tourism and recreation, aesthetics and economics, and coastal and marine space use (ICF Incorporated, LLC 2012; Industrial Economics, Inc. 2012). Most recently, the Bureau funded the development of a set of socioeconomic indicators to help determine tourism and recreation impacts of offshore wind farms through a study on the Block Island Wind Farm (Smythe *et al.*, 2018). This facility, built in state waters, is the first U.S. offshore wind farm. This study is novel not only because the Block Island Wind Farm is the first offshore, but also due to the facility's relatively small footprint and proximity to shore. As such, the research team referred to the Block Island Wind Farm as a 'boutique' wind farm. This study identified 40 domains or resources that may be impacted by the development of an offshore wind farm and placed these in a socioeconomic indicator framework.

The proposed study builds off the Block Island Wind Farm research by selecting a subset of the domains produced from that study, but also allowing for the identification of other indicators as appropriate for the unique attributes of selected sites. These indicators will be applicable to several areas along the Atlantic Coast where projects are under development to document baseline conditions and further understand the potential impacts from constructing and operating a large-scale wind farm. Two sites will be selected based on leases that expect approval for construction in 2 to 3 years and other siting information (*e.g.*, state preferences, resource characteristics), along with a control site. Previous assessments have relied on information from simulation studies (*e.g.*, Parsons and Firestone 2018) and overseas research, and while current ones are utilizing what has been learned from Block Island Wind Farm (Smythe *et al.*, 2018). This study would be the first of its kind in the U.S., as it would use repeated 'real-time' observations to track resource trends over time in the areas surrounding several large-scale OCS commercial wind facilities.

Objectives: To enhance our understanding of impacts on the human environment through a longitudinal study of the areas surrounding, several large-scale OCS Wind Farms.

Methods: This research will enable observation, and documentation of the human environment in areas 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 three 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 insure 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 insure 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?

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Title	Phase III Development of the Tethys Passive Acoustic Monitoring (PAM) Metadata System
Administered by	Headquarters
BOEM Contact(s)	James Price (james.price@boem.gov), Jonathan Blythe (jonathan.blythe@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2020–2021 (two years) Partial duration; Navy funding will extend this period by two more years.
Date Revised	March 11, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Many scientists and resource managers who could benefit from historical, passive acoustic monitoring (PAM) observations archived at the National Centers for Environmental Information (NCEI) using the NCEI-adopted Tethys metadata system are not as familiar with or proficient with Tethys as are some PAM data collectors. In addition, Tethys is not fully compatible with some of the platforms on which PAM is conducted, *e.g.*, gliders, animal tags, and towed systems.
Intervention	This study will make Tethys more user friendly, educate new users, expand Tethys applicability by integrating it with PAMGuard, and explore adapting Tethys to acoustical observations from gliders and animal tags.
Comparison	Prior to having a community-wide metadata standard for passive acoustic data, there were numerous valuable data sets documented in different ways, some inadequate, in many different forms and formats, and stored in many different repositories. Tethys and archiving at NCEI will make secondary use of such data practical, saving users much time and grief.
Outcome	This study will take Tethys to a mature state, being able to incorporate data collected from different platforms, and make it a more user-friendly tool.
Context	Passive acoustic monitoring (PAM) is becoming ubiquitous in marine research and environmental protection conducted in many geographic locations of interest to BOEM for impact assessment and mitigation.

BOEM Information Need(s): There are many kinds of scientific investigations that can be conducted with "historical" (archived) data that cannot be done with shorter-term, geographically specific data acquisitions. Multi-year time sequences of PAM over extended ocean areas will enable assessing how a changed ocean climate amplifies or masks BOEM-regulated Outer Continental Shelf (OCS) activities (a BOEM *strategic science question*). PAM also addresses ecological issues relevant to assessing environmental impact such as behavior (*e.g.*, Simonis *et al.*, 2017), presence-absence, location, and geographic density (*e.g.*, Marques *et al.*, 2009; Širović *et al.*, 2015; Hildebrand *et al.*, 2019). In addition, PAM measures the sound intensities (noise) from energy development yielding estimates of sound exposure to fish, mammals, and invertebrates, which are key observations in studies of acute and chronic effects of BOEM-regulated activities (another BOEM *strategic science question*). The Tethys metadata system documents important details about these PAM efforts, permits the manipulation of these data in a uniform format, enables access to other types of data, and automates many routine processing tasks such as retrieving hydrophone calibration information (*e.g.*, Roch *et al.*, 2015), making PAM more valuable both as a scientific tool and for environmental impact analyses.

Background: Tethys is a PAM metadata system designed to organize and store acoustic metadata (http://tethys.sdsu.edu) (Roch *et al.*, 2013; Roch *et al.*, 2016). Tethys was developed through joint BOEM-Navy funding and is the community standard for recording details about PAM deployments, the data contained therein, and information learned from such deployments. The strategy of the Tethys project is to standardize the common data reporting needs of scientists and monitoring entities and to provide extensible data types for new discoveries that do not fit into the standard set of schemata. In addition, Tethys standardizes the documentation of the methods used to discover data, preserving information about the tools used in data discovery, settings provided to those tools, and supporting tool sets. The original Tethys development was designed for scientific studies of large data with a focus on programmatic interfaces. Recent directions have introduced tools for other types of users. Examples include web-based query generators that allow users to query and display information without knowledge of the underlying query language. These interfaces permit users with less technical knowledge to develop sophisticated queries that go beyond the limits of the original programmatic interfaces. The current developments in the project are focusing on data visualization tools and integration of Tethys into other projects such as Cornell's Raven X system that is being adopted by the Navy for large-scale processing.

Tethys is currently being applied for use in the generation of Navy reports and used by some of the National Oceanic & Atmospheric Administration (NOAA) National Marine Fisheries Science Centers (NMFSC) and universities. It is the starting point for an Acoustical Society of America/American National Standards Institute committee on passive acoustic metadata standardization with representation from government, industry, and academia. Although it has extensive applicability now, further development is needed to transition Tethys to a mature system serving the needs of the community of marine scientists and marine resource managers.

Objectives: The objectives of this study are to:

1. Make Tethys more user friendly;
2. Make Tethys accessible to more users through training;
3. Build a new component of Tethys that can interface with towed PAM data (*i.e.*, integrating it with PAMGuard), and, as time and money permit, adapt Tethys to interface with acoustical data from gliders and animal tags; and
4. Develop transition paths, considering alternatives to open source such as commercial platforms and service providers, for long-term maintenance of Tethys services.

Methods:

1. Improve end-user friendliness by refining the existing web-based graphical user interface.

2. Improve end-user friendliness by updating the existing user manual.

3. Conduct formal training classes to interested groups, *e.g.*, National Marine Fisheries Service (NMFS) Science Centers, Navy acoustics ranges, NOAA Integrated Ocean Observing System (IOOS) regions, multi-institutional research groups, *etc*. Inform these groups about the availability of training. Collect and compile user feedback during these training sessions.

4. Within funding and time limitations, address the issues raised by users offering comments, questions, suggestions, and requests regarding Tethys. These enhancements, based on real-life use cases, will contribute to extending the capabilities of Tethys.

5. Continue working relationships with PAM data collectors at the Scripps Institution of Oceanography and with NOAA, such as the NMFSC using Tethys and the NCEI pilot project for archiving PAM data. Engage users at NOAA NMFSC (*viz*. Sofie Van Parijs) to determine opportunities to increase usability.

6. Enhance PAMGuard, a widely used audio capture and processing tool, to produce data that can be directly imported into Tethys. PAMGuard is used for passive acoustic monitoring by both the oil industry and NOAA NMFSC. Modifying PAMGuard to produce data that can easily be added to Tethys would significantly reduce entry barriers to Tethys adoption. Modifications will be in collaboration with individuals who recently submitted a formal proposal to the Navy's Living Marine Resources Program recommending the integration of PAMGuard with the Tethys Database Workbench (confidential communication).

7. Investigate the possible integration of acoustical data collected by hydrophones on gliders and by Dtags. Assess the feasibility and labor and financial costs in doing so.

8. Develop design-level Tethys architecture documentation for software developers. The documentation should convey enough information to provide entry points into the system for an experienced developer without requiring outside consulting.

9. Begin developing a strategic plan for the continued maintenance and development of Tethys and to archive PAM data. This could include plans for a for-profit software company to maintain and improve Tethys and the creation of a data input facility for archiving similar to the Data Assembly Center (DAC) under development by the Animal Telemetry Network.

Specific Research Question(s): N/A

References:

Hildebrand, J. A., Frasier, K. E., Baumann-Pickering, S., Wiggins, S. M., Merkens, K. P., Garrison, L. P., Soldevilla, M. S. and McDonald, M. A. (2019). Assessing Seasonality and Density From Passive Acoustic Monitoring of Signals Presumed to be From Pygmy and Dwarf Sperm Whales in the Gulf of Mexico. Front Mar Sci 6, doi:10.3389/fmars.2019.00066.

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Title	Responding to the National Academies of Sciences, Engineering, and Medicine's (NAS's) Comments on the Air Quality Modeling in the Gulf of Mexico (GOM)
Administered by	Headquarters
BOEM Contact(s)	Holli Ensz (holli.ensz@boem.gov)
Procurement Type(s)	Contract; sole source
Performance Period	FY 2020–2021
Date Revised	March 25, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Because of the delay in awarding the NAS Indefinite Delivery/Indefinite Quantity (IDIQ) contract and the 12/22/2018–1/25/2019 U.S. Federal government shutdown, the NAS will be providing comments to the *Air Quality Modeling in the GOM* OCS Region study by December 2019. This modeling study has a period of performance that ends in August 2019. BOEM needs a sole source contract so that ERG/RAMBOLL can respond to the NAS comments and other comments.
Intervention	Conduct a separate study so that ERG/RAMBOLL can respond to the NAS concerns of the Air Quality Modeling Study that was conducted by ERG/RAMBOLL.
Comparison	The NAS comments with the ERG/RAMBOLL response will complete all aspects of the modeling study.
Outcome	Under the original study, BOEM will have the *Air Quality Modeling in the GOM* study report. NAS will finalize a report with their comments to the study. BOEM will have a separate report with responses to the NAS comments (this proposed study) and other comments.
Context	GOM

BOEM Information Need(s): BOEM needs a National Academies of Sciences, Engineering, and Medicine (NAS) peer review of the *Air Quality Modeling in the GOM Region* study (M14PC00007) because the study is deemed "highly influential". The NAS peer review document will be finalized after the date of conclusion of the Air Quality Modeling in the GOM study, so a separate study is needed to respond to NAS and other comments.

Background: The *Air Quality Modeling in the GOM Region* study has a period of performance that ends August 31, 2019. Because of the delay in awarding the NAS IDIQ and the 35-day government shutdown, the NAS cannot provide their peer review of the modeling report by August 31, 2019 deadline. Therefore, a separate sole source contract will be required so that ERG/RAMBOLL (the contractor for the Air Quality Modeling study) can respond to the NAS comments and other comments.

Objectives: Since ERG/RAMBOLL conducted the modeling and drafted the *Air Quality Modeling in the GOM* study, ERG/RAMBOLL will need to respond to NAS peer review comments (and any other comments received) of the modeling study.

Methods: BOEM will finalize the *Air Quality Modeling in the GOM Region* study report under the existing contract. BOEM will receive NAS peer review by December 2019. BOEM will award a sole source contract to ERG/RAMBOLL (the modeling contractors) to respond to the NAS peer review comments and other comments. Therefore, there will be a separate report of response to NAS peer review.

Specific Research Question(s):

1. Did NAS agree that the methodology, approach, and the results are of sound science?

2. How does BOEM respond to the NAS peer review?

References: https://marinecadastre.gov/espis/#/search/study/100048

Title	Sea Turtle Hearing Sensitivity and Impacts of Sound
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Douglas Piatkowski (douglas.piatkowski@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement, Internal Study
Performance Period	FY 2020–2022
Date Revised	February 5, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Sounds produced by BOEM-authorized projects may impact sea turtles; a current lack of knowledge about their hearing sensitivity may lead to inaccuracies in species impacts in consultations with the National Marine Fisheries Service (NMFS).
Intervention	Gather hearing data on targeted species to better inform Endangered Species Act (ESA) consultations
Comparison	Without additional data we will continue to estimate acoustic impacts using surrogate species which may be erroneous
Outcome	The outcome of this study would lead to an understanding of hearing sensitivity and acoustic behavioral ecology of sub-adult sea turtles for accurate impact assessments.
Context	Atlantic and Gulf of Mexico

BOEM Information Need(s): BOEM is required to estimate potential acoustic impacts from industry sources. To do that (for any species), we start with a hearing curve (an "audiogram"). When we do not have hearing curves for particular species, we have to use what is known from surrogate species, which may be erroneous. Given the relative lack of information on hearing in turtles (Popper *et al.*, 2014), we are forced to use such approximations; knowing hearing sensitivity for key species will allow us to better estimate acoustic impacts of BOEM-authorized activities.

Background: In a draft biological opinion on geological and geophysical (G&G) permitting in the Gulf of Mexico, NMFS identified a data gap regarding our knowledge of sea turtle hearing and impacts of sound: "Although all sea turtle species studied exhibit the ability to detect low-frequency sound, the potential effects of exposure to loud sounds on sea turtle biology remain largely unknown (Nelms *et al.*, 2016)". Relative to studies in other taxa, information on sea turtle hearing is in its infancy, as there are only published audiograms for a handful of species. An incomplete understanding of hearing sensitivity and physiological and behavioral impacts of sound across species and life stages may lead to incorrect estimates or assumptions about the magnitude of impacts from BOEM-permitted activities. This data gap is most apparent in BOEM's biological consultations related to geophysical permitting: the Draft Biological and Conference Opinion on BOEM's Oil and Gas Program Activities in the Gulf of Mexico consultation with NMFS produced an estimate of more than a billion sea turtle takes. Failing to address these significant data gaps may lead to similarly high numbers in the future.

Five ESA-listed species of sea turtles travel widely throughout the South Atlantic, Gulf of Mexico, and the Caribbean and may be exposed to BOEM activities in multiple planning areas or in other countries. Anthropogenic sounds can cause behavioral changes, physiological trauma, and even death in some vertebrate species depending on the sound source (Richardson *et al.*, 1995). Therefore, sounds from pile driving or G&G surveys could have impacts on these turtles. Sea turtles may use sound for navigation, locating prey or preferred habitat, predator avoidance, and environmental awareness (Piniak *et al.*, 2016). They occupy different ecological niches throughout their life cycle, each characterized by unique acoustic conditions—yet no one knows how their hearing capabilities change throughout their lifetime.

Previous studies on hearing in several species of sea turtles have demonstrated that they detect low-frequency (<1000 Hz) acoustic and/or vibratory stimuli in air and underwater (Lavender *et al.*, 2014; Piniak *et al.*, 2016). This range of maximum sensitivity overlaps with several low-frequency anthropogenic sound sources such as: seismic airguns, offshore drilling, pile driving, and vessel traffic (Hildebrand 2009). Variation in threshold levels and frequencies of maximum sensitivity (*i.e.*, the audiogram) between species and age classes exist. In addition, stress responses to anthropogenic sounds may vary throughout a turtle's lifetime. Breeding adult females may experience a lower stress response, as female loggerhead, hawksbill, and green turtles appear to have a physiological mechanism to reduce hormonal response to stress in order to maintain reproductive capacity at least during their breeding season, a mechanism apparently not shared with males (Jessop *et al.*, 2004). BOEM has already addressed data gaps in turtle hearing, however, several data gaps remain for various species and life stages. This study proposes to fill these gaps.

Little data exist on the behavioral responses of sea turtles to sound, however several studies have examined sea turtle behavioral responses to the sounds produced by seismic airguns with mixed findings (O'Hara and Wilcox 1990; Moein *et al.*, 1995; McCauley *et al.*, 2000; Weir 2007; DeRuiter and Larbi Doukara 2012). Studies conducted have largely focused on loggerhead sea turtles, and those that observed responses are often based on very few individuals. Additional controlled studies are needed to better determine the sound pressure levels predicted to cause significant behavioral responses in sea turtles.

Objectives: Improve the impact assessments for sea turtle species/age classes for which limited or no underwater hearing sensitivity data is available. Specifically,

- Address hearing sensitivity in the following species to fill highest-priority data gaps: Kemp's ridley (juveniles), hawksbill, loggerhead (hatchling and young juveniles).

- Combine new data gathered from hearing sensitivity tests to determine which sounds (frequency and sound pressure level) are detectable by sea turtles and at what level they may elicit behavioral and hormonal responses.

Methods:

Objective 1: Electrophysiological techniques will be used to measure sea turtle hearing sensitivity. Auditory evoked potentials (AEPs) are commonly used to detect the neurological basis of sound detection. In this technique, sounds are presented to an animal, and the electrical signals produced by neurons in the auditory pathway are measured; when an animal detects the sound, there is a peak in neurological activity. By sequentially presenting sounds of different frequencies and amplitudes, it is possible to determine the lowest-amplitude sound (at each frequency) that an animal can hear, thus building the hearing curve (audiogram). Such methods have been used to measure sea turtle, marine mammal, and fish hearing (Ladich *et al.*, 2013; Harms *et al.*, 2009; Martin *et al.*, 2012; Lavender *et al.*, 2014; Piniak *et al.*, 2016). For animals that are easy to capture and restrain (*e.g.*, fish), sample sizes are typically in the 10s to 20s, for larger animals (*e.g.*, marine mammals), sample sizes may be as few as less than 10 individuals.

Objective 2: Using information on hearing, behavioral responses to sound will be examined by monitoring sea turtle behavior (visually and/or with bio-logging tools) in response to a variety of acoustic stimuli and simulated anthropogenic sounds (*e.g.*, airguns, pile driving, drilling, vessel noise, *etc.*).

Specific Research Question(s):

1. What is the hearing range of juvenile Kemp's ridley and hawksbill sea turtles, as well as hawksbill hatchlings, young juvenile loggerhead, and elderly green sea turtles?
2. What are the behavioral response/hormonal impacts of anthropogenic noise resulting from BOEM-authorized actions' sound on sea turtles?
3. What is the behavioral response of sea turtles to anthropogenic sounds?

References:

Richardson, W. J., C. R. Greene, C. I. Malme, and D. H. Thompson. 1995. Marine Mammals and Noise. Academic Press. San Diego, California, USA.

Turner, S., M. Zykov, and A. MacGillivray. 2006. Preliminary acoustic level measurements of airgun sources from Conoco Phillips' 2006 seismic survey in Alaskan Chukchi Sea. JASCO Research, Victoria, BC.

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Piniak WED, Mann DA, Harms CA, Jones TT, Eckert SA (2016) Hearing in the Juvenile Green Sea Turtle (*Chelonia mydas*): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. PLoS ONE 11(10): e0159711. https://doi.org/10.1371/journal.pone.0159711

Title	Sustained Observations of Marine Biodiversity for Coordinated National Monitoring of Marine Ecosystem Responses to Outer Continental Shelf (OCS) Environmental Impacts
Administered by	Headquarters
BOEM Contact(s)	Jim Price (james.price@boem.gov), Jonathan Blythe (jonathan.blythe@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2022
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The problem addressed herein is how to obtain greater realism in environmental impact assessments. Specifically, how can BOEM move beyond assessing impacts to individual organisms and populations and produce a nationally consistent assessment of environmental impact?
Intervention	This study builds upon three Marine Biodiversity Observing Network pilot studies that demonstrated how observational tools—like environmental deoxyribonucleic acid (eDNA), satellite-tracked animal tags, and satellite remote sensing combined with habitat models—could effectively and efficiently be used for long-term marine ecosystem monitoring at the regional scale. This study will expand these efforts to a national program coordinated in partnership with the National Oceanic & Atmospheric Administration's (NOAA's) U.S. Integrated Ocean Observing System (IOOS).
Comparison	Although impact assessments on individuals and populations will continue to be important for BOEM environmental assessment, this study will implement a national program to observe biodiversity components for systematic comparison of habitats and ecosystems across all OCS regions. This will provide a more rigorous scientific basis for assessment of cumulative impacts from BOEM managed activities, especially for BOEM's National OCS Oil and Gas Program, but the information produced will be equally applicable to Marine Minerals and Renewable Energy programs.
Outcome	Long-term, nationally coordinated monitoring of ecosystem health directly and indirectly through the proxy of biodiversity.
Context	Territorial waters of the United States, including Arctic Alaska, Pacific, Gulf of Mexico, Atlantic, and Hawaii Islands will be the focus of sustained monitoring.

BOEM Information Need(s): Adverse environmental impacts from offshore energy development can be of a transient (acute) nature or persistent (chronic). They can accrue through multiple exposures over extended periods of time subsequently manifesting as cumulative effects. They can be constrained geographically or be widespread. And, they can be impacting on a few individual organisms or on populations, or they can have chain-reaction effects spreading throughout entire ecosystems. Given the wide range of temporal and spatial exposures and possible adverse consequences, BOEM needs to monitor changes in the marine environment as continuously and as widely as is practical to perform the most comprehensive (realistic) environmental impact assessments. Further, BOEM needs this national network of monitoring efforts to be able to scale this biological information to its OCS management mandate.

This study addresses BOEM's strategic framework criteria: (1.) Effects of Impacting Activities; (2.) Affected Resources; (3.) Long-term Monitoring; and (4.) Cumulative Impacts.

Background: Biodiversity is defined as the variety of life, encompassing variation at all levels of complexity—genetic, species, ecosystems, and biomes—and including functional diversity and diversity across ecosystems. A growing body of research demonstrates that (1) the marine biodiversity is a determining factor for ocean productivity and moderates ecosystem sensitivity to environmental impacts from agency activities and cumulative impacts (*i.e.*, climate change), and (2) the condition of marine biodiversity components are useful proxies to study and understanding habitats and ecosystems that may be impacted by BOEM activities. Thus, managing marine resources in a way that is informed about ocean biodiversity supports BOEM's strategic goal for responsible OCS development. This study will also support NOAA's strategic goals to enhance biosecurity, protect ecosystem and public health, and ecosystem-based management. Through an interagency process, BOEM, NOAA, and the National Aeronautics & Space Administration (NASA) will pursue shared scientific objectives of predictive modeling, better informed environmental impact assessments, and adaptive monitoring of living marine resources.

The U.S. initiated three Marine Biodiversity Observation Network (MBON) projects in 2014 to demonstrate how an operational MBON could be developed for the Nation. These projects paved the way in terms of biodiversity monitoring, and have made advances in the methods and best practices for operational observing applications. Among the successes emerging from this initial effort is a commitment by NOAA CoastWatch to produce MBON dynamic Seascapes classifications (Kavanaugh MT *et al.*, 2016) and map animations for national and global users. Additionally, IOOS has committed to sustain the MBON Portal, which emerged from the demonstration effort as a platform where users can search and download real-time, delayed-mode, and historical data for *in situ* and remotely sensed physical, chemical, and biological observations; compare datasets across regions and disciplines; generate and share custom data views; link to information about protocols, methods and best practices for biological observing; and access a full suite of interactive infographics and other tools for research and management applications. Also, sound was included in the revised list of IOOS core biological variables in 2016, and NOAA significantly expanded its capacity to collect and archive passive acoustic monitoring data.

Objectives: BOEM will partner with NASA and NOAA as well as other ocean agencies across the U.S. Federal Government to sustain an MBON framework:

- building upon the foundation established by the existing MBON demonstration projects as part of an evolving integrated and operational biological observing capability for the U.S. oceans, coasts, and the Great Lakes from bays to deep ocean;

- advancing technologies for the efficient and/or automated collection of biological observations as part of the integrated and operational observing system; and
- designing and optimizing standardized biodiversity methodology for scalable deployment in a national MBON program.

This study will leverage matching funds from partner agencies through the National Oceanographic Partnership Program (NOPP) competitive process to award ten projects that expand MBON coverage across the Atlantic, Gulf of Mexico, Pacific, and Alaskan Arctic OCS lands under BOEM's jurisdiction. Topical expansions of MBON will also address the use of acoustical, eDNA, and animal tagging methodology.

Methods: MBON efforts funded under the NOPP competitive process provides proposals for MBON expansion that have been peer reviewed for scientific merit and innovative solutions to integrate information about individual species obtained from animal telemetry, repeated shipboard or aircraft surveys of presence/absence, passive acoustic monitoring, eDNA sampling. Research funded through this NOPP process will integrate:

- MBON-derived remote sensing Seascapes classifications
- organismal observations (*e.g.*, animal telemetry, traditional surveys, citizen science observers, passive acoustics, and other methods and technologies)
- innovative approaches (*e.g.*, eDNA, flow cytometry, and other environmental imaging and analysis techniques, *etc.*)

Additional criteria included in the NOPP announcement stipulate that research will:

- demonstrate how MBON activities/outcomes assist ecosystem-based management
- includes integrated ecosystem evaluations and improved management of protected areas,
- establish biodiversity baselines and track changes against these baselines
- integrate observations and data across multiple scales of diversity (genetic to ecosystem, microbes to whales), time, and space (from fine-grain data collected *in situ* to coarser-grain in-water, airborne, and satellite remote sensing information)
- integrate biological observations with environmental condition information

- ensure alignment of biological data to the Darwin Core standard and adherence of metadata to the ISO 19115 family of geospatial metadata standards that have been endorsed by the Federal Geographic Data Committee

- contribute all data to the MBON Portal

- develop ties to other selected projects and support the ongoing development of the integrated network

- emphasize integration with other U.S. MBON projects and make sufficient resources available to do so, *e.g.*, for travel, network building, knowledge sharing, joint developments, and databases, *etc.*

- identify at least one specific management need and describe the role of MBON methods, tools, or products in addressing this(-ese) challenge(s)

- conduct their work in conjunction with end users throughout the life of the project to develop, demonstrate and enable sustained uses of MBON to meet user needs

- include at least two of the following entities: academia, industry, and government

- include participation by one or more IOOS Regional Association(s) as an operational observing and/or data management partner

Funding of competitive proposals will be coordinated through the NOPP process and with the proposing agency, NOAA's IOOS, to leverage matching funding from NOAA, NASA, and U.S. Navy and incorporating high-priority BOEM regional needs (*i.e.*, Atlantic MBON [AMBON]) that are effectively achieved through this process.

Specific Research Question(s): How can we enhance U.S. ecosystem monitoring / biodiversity observing efforts to produce information useful in national assessments of environmental impacts from OCS energy and marine minerals development?

References:

Kavanaugh MT, Oliver MJ, Chavez FP, Letelier RM, Muller-Karger FE, and Doney SC. 2016. Seascapes as a new vernacular for pelagic ocean monitoring, management and conservation. ICES Journal of Marine Science, 73(7):1839–1850, available from DOI: 10.1093/icesjms/fsw086

Title	Updating Offshore Emissions Factors Scoping Study
Administered by	Headquarters
BOEM Contact(s)	Holli Ensz (holli.ensz@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	March 1, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The U.S. Environmental Protection Agency (USEPA) does not develop emissions factors specifically for offshore oil and gas exploration, development, and production sources. Many of the emission factors currently used to estimate emissions from offshore oil and gas activities may be outdated or were developed for onshore not offshore applications, and hence, may have limited validity for estimating offshore oil and gas emissions.
Intervention	Conduct research to assess and rank which emission factors for offshore oil and gas activities should be updated or developed, based upon their validity and impact of the activity as weighted by the current emissions inventory.
Comparison	Using the Gulf of Mexico (GOM) offshore inventories (estimates) and the Eastern GOM USEPA permits (actual monitoring data) plus literature searches, and USEPA's WebFIRE (Website for Factor Information Retrieval), rate the emission factors currently in use by BOEM for emission inventory development and rank the emissions factors in terms of priority for updating.
Outcome	Draft a scoping study suggesting the top five emissions factors in the GOM oil and gas sources that are outdated and/or would have the most impact when improved.
Context	All Regions

BOEM Information Need(s): USEPA develops and/or compiles emissions factors for source categories for usage in calculation of emissions inventories. However, USEPA does not develop emissions factors specifically for Outer Continental Shelf (OCS) oil and gas exploration, development, and production. Many of the emissions factors currently used by BOEM to estimate emissions from OCS sources have not been updated in years and were developed for onshore not offshore applications. BOEM needs to examine which emissions factors should be updated as BOEM assesses oil and gas source impacts (required under the Outer Continental Shelf Lands Act [OCSLA] and the National Environmental Policy Act) based on these emission inventories.

Background: The 1990 Clean Air Act Amendments (CAAA) requires 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. OCSLA states that OCS oil and gas exploration, development, and production activities cannot significantly impact the NAAQS of any state. BOEM assesses air quality impacts by calculation of emissions inventories and modeling. To calculate emissions inventories, activity data are multiplied by the appropriate emissions factor. An emissions factor is a representative value that attempts to relate the quantity of a pollutant emitted with an industrial activity.

The emission factors currently used to estimate emissions from OCS oil and gas exploration, development, and production sources have not been updated in years and many were developed for onshore not offshore applications. This study would conduct research to assess and rank offshore oil and gas sources emissions factors in both the GOM and Alaska OCS Regions that should be updated, and suggest appropriate recommendations on how to update those emissions factors.

Objectives: To assess and rank which offshore emissions factors should be updated in both the GOM and Alaska OCS Regions to more accurately provide emissions for BOEM's impact assessments as required by the National Environmental Policy Act (NEPA) and OCSLA, along with recommendations on how to improve those offshore emissions factors.

Methods: A review of the offshore emission inventories and emission factors should be conducted to determine what factors need to be addressed first—ranking the most significant factors—in terms of activity/emissions and the rating of those factors. For example, the USEPA and BOEM have no reliable factors for some activities, such as fugitives from offshore drilling muds. However, mud degassing emissions factors might not be significant overall. Cold venting and flaring emissions factors might have assumptions used to develop them that are not true. Likewise, valve and flange leaks are also likely significant, especially from the older facilities. With respect to engine operations on drilling rigs, the emission factors currently used may not accurately predict emissions at low loads of the prime engines, which are how the engines are generally operated 60% of the time. All offshore exploratory, development and production sources should be considered.

1. Inventory all offshore emissions and emissions sources (including fugitives, flaring, engines, cold venting, painting, welding, blasting, accurate # service vessels, well stimulation, *etc.*) and identify the current emission factors for those activities.

2. Identify what emission factors are not based on current valid scientific studies (*i.e.*, mud emission factors are from a 1970s study with limited dated and likely do not represent synthetic muds today). There may not be valid fugitive factors for older facilities that have not used routine Inspection and Maintenance.

3. Identify emission rates that depend on how the equipment is used (*i.e.*, average rates are okay for a large-scale inventory, but not for determining source-specific impacts). Multiple emission factors may need to be developed for some equipment or activities depending on the age, how it is used (*i.e.*, low load), *etc.*

4. Determine if there is an emissions factor in USEPA's WebFIRE and if there are limitations on the use of the emissions for offshore activity.

5. Identify what factors need updating through literature searches, verification, or need multiple factors (for example, USEPA has low load duty cycle data); however, the “average rate” may be based on how an engine is typically used, such as for transport at 80–90% load, rather than drilling (30–60% load). Consider USEPA rating factors or develop BOEM rating factors. Avoid using emission standards as emission factors.

6. Design plan for emissions factor development/update (*i.e.*, research, source test verification, *etc.*)

Specific Research Question(s):

1. What offshore emissions factors need updating?

2. If any offshore emissions factors needs updating, what recommendation is given to improve those emissions factors?

References:

Title	Updating the Emissions Exemption Thresholds (EETs) Using Classification and Regression Tree (CART) Analysis
Administered by	Headquarters
BOEM Contact(s)	Holli Ensz (holli.ensz@boem.gov); Cholena Ren (cholena.ren@boem.gov); Virgilio Maisonet-Montanez (virgilio.maisonet-montanez@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2023
Date Revised	April 4, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	BOEM's exemption thresholds in 30 Code of Federal Regulations (CFR) 550.303 are outdated and erroneously triggering air modeling requirements. Initial evaluations in the Gulf of Mexico Outer Continental Shelf (OCS) Region have indicated that CART analysis may be a suitable alternative approach to reduce the errors seen using the exemption thresholds.
Intervention	Replace exemption thresholds with CART decision trees, either national level or region specific (based on the analysis) to reduce errors.
Comparison	Compare the performance between exemption thresholds and CART approach to test the hypothesis that CART analysis will reduce errors.
Outcome	Evaluate whether CART decision trees would perform better than exemption thresholds to determine the most appropriate triggers for air modeling requirements. Provide decision trees to use in regulations, either one national set or region-specific sets depending on the best fit, to decide whether an operator should be exempt from air modeling for an Outer Continental Shelf (OCS) plan.
Context	Central Gulf of Mexico (GOM), Western GOM, Beaufort Sea and Chukchi Sea

BOEM Information Need(s): BOEM's current regulatory air emissions exemption thresholds (30 CFR 550.303) developed in the 1980's, are outdated and may be unreliable triggers when used to determine if more rigorous impact evaluation, air dispersion modeling, is needed. Therefore, BOEM needs to explore other methods such as the CART approach for use in evaluating proposed air emissions. The *Air Quality Modeling in the Gulf of Mexico Region* study included a preliminary examination of the current exemption thresholds and recommended a CART approach. This effort is a follow up to the information provided by the *Air Quality Modeling in the Gulf of Mexico Region* and the *Arctic Air Quality Impact Assessment Modeling* studies.

Background: BOEM has air jurisdiction over the Central and Western GOM and the Beaufort and Chukchi Sea in Alaska. When an operator proposed emission amount submitted in an OCS plan exceeds the exemption threshold at 30 CFR 550.303 the operator is required to perform air dispersion modeling. The modeled concentration is compared to the significant impact levels to demonstrate whether a proposed source will or will not contribute to a violation of a National Ambient Air Quality Standards (NAAQS) and if emissions must be reduced. These exemption thresholds were developed in the 1980's to help protect the NAAQS as required by the Outer Continental Shelf Lands Act (OCSLA) Section 5(a)(8). The NAAQS cover six common criteria air pollutants that are harmful to the public health and environment. It is also important to examine precursor pollutants like volatile organic compounds (VOCs) and oxides of nitrogen (NOx) as they contribute to criteria air pollutant levels. Since the 1980's, the NAAQS were updated and BOEM's exemption thresholds were not. In addition, BOEM's exemption thresholds do not address NAAQS with short-term averaging times such as 1-hour, 3-hours, 8-hours, and 24-hours. Both modeling studies' results showed that, under the current exemption thresholds, BOEM is not requiring modeling on sources that do impact short-term standards, but requiring more modeling than necessary in terms of the annual standards. BOEM needs a more balanced approach that protects the environment and also does not put unnecessary burden on industry.

Objectives:

- Evaluate the efficacy of a CART analysis as a replacement for the EET analysis currently codified in 30 CFR 550.303 for the GOM and Alaska OCS Regions.

- If appropriate, develop a CART analysis framework that BOEM can adopt as a replacement for the current exemption threshold(s).

Methods: The development of CART decision trees and performance evaluation of the developed CART decision trees and exemption thresholds would use data from the modeling studies.

Specific Research Question(s):

1. Does CART perform better than other alternatives (linear/exponential/*etc.*) for both GOM and Alaska OCS Regions?

2. Does the statistical analysis suggest that one national dataset or two regional specific datasets eliminates the most errors?

3. What CART if/then statements should BOEM use per pollutant per averaging time to have better performance than the EETs?

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Title	Assessing the Use of Satellite Data for Offshore Air Quality Applications
Administered by	Headquarters
BOEM Contact(s)	Holli Ensz (holli.ensz@boem.gov)
Procurement Type(s)	Interagency agreement (IA)
Performance Period	FY 2021–2023
Date Revised	February 4, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
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 does not have monitors offshore to track air emissions.
Intervention	The National Aeronautics & Space Administration (NASA) has provided BOEM a scoping study (through a past IA) that suggests existing satellites could monitor NO_2 offshore but these satellites only pass twice a day. New satellites (Tropospheric Emissions: Monitoring of Pollution [TEMPO]) will be able to monitor and track offshore air pollutants at all times. This IA will provide BOEM specific TEMPO satellite data for the year suggesting offshore hot spots (areas over the NAAQS), flaring events, and tracking air pollutants.
Comparison	NASA should compare TEMPO satellite data with existing emissions and modeling data.
Outcome	Ultimate goal would be having hourly/daily TEMPO satellite views to monitor and track air pollutants in near time in the Gulf of Mexico (GOM). Perhaps expand to Atlantic, Pacific, and Alaska for baseline air quality data pre- oil and gas development.
Context	All 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.

Background: The Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (USEPA) to set 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) perhaps should also be assessed as ozone is formed through photochemical reactions involving both NO_2 and VOCs.

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 GOM OCS Regions, and has issued leases in Alaska and Atlantic OCS Regions for oil and gas and renewable development respectively. 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 accessing visibility. Although this capability has been identified through BOEM's ongoing study, the hourly satellite data has not yet been employed in the offshore environment.

Objectives: The purpose of this IA is to continue the efforts between NASA and BOEM by conducting a scoping study:

- To assess the applicability of the TEMPO satellite datasets to support BOEM's air quality regulations and NEPA analyses. Specifically this scoping study would determine the feasibility of using satellite data in offshore environments in the GOM, Pacific, Atlantic and Alaska OCS 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 OCS Regions, along with estimating and monitoring background concentration data in the Alaska and Atlantic OCS Regions before oil and gas or renewables development.

- To validate the satellite data with offshore monitoring in a field campaign.

- To use the results of the above purposes to validate BOEM's existing air quality model output including the photochemical modeling results at multiple vertical atmospheric heights and pollutant concentrations in areas surrounding the largest emission sources in the GOM, relative to the quantity of inventory estimates.

- To collect satellite data in the GOM OCS Region during the same time as the BOEM's field tracer study in an effort to obtain a comprehensive offshore dataset.

Methods: The study will entail an ongoing partnership with NASA to assess the feasibility of using satellite data of various air pollutants to derive estimates for the criteria NAAQS, precursors, and visibility pollutants offshore. BOEM envisions two main parts of this interagency agreement: 1) a scoping study assessing current satellites ability to estimate offshore NAAQS, precursors, and visibility pollutants, and 2) an offshore monitor field campaign to validate the satellites.

The scoping study will consist of two parts. First, NASA will prepare a document summarizing the current state of observing air pollutants over open water. These pollutants include CO, NO_2, SO_2, and PM. Satellite data of O_3 and VOCs will likely not be useful as will be detailed in the report. The document will also include discussions on other useful satellite datasets, such as visible imagery, land vegetation, lights *versus* flares, and oil slicks. It will include information on current satellite capabilities and upcoming satellite datasets with an emphasis on their potential for BOEM objectives. Second, NASA will improve the operational NO_2 data product, addressing several issues that will likely improve the use of the data over open water. For example, the operational product relies on some parameters that are only available at coarse resolution. For smaller domains, higher-resolution inputs (*e.g.*, *a priori* NO_2 profiles, surface reflectivity) will be created to improve results of the standard satellite data. In addition, new improvements to the processing algorithms can detect smaller signals than are typically detected by the operational algorithm. With an improved NO_2 product, the study will 1) estimate NO_2 concentrations around offshore facilities, 2) determine the contribution of onshore emissions (*e.g.*, specific refineries, power plants, and cities) to offshore air quality and vice versa by analyzing wind flow patterns and daily NO_2 data, and 3) derive long-term trends over the last decade. Several of these improvements to NO_2 may also benefit other pollutant datasets as well if applied.

Second, validation will consist of observations using NASA equipment to measure the same constituents observed by satellite. A minimum set of species will include O_3, CO and NO_2, and column NO_2 determined spectrophotometrically. The latter is ground-truth for the specialized column NO_2 that NASA is producing. For this validation, a sampling platform with standard meteorological parameters (Automated Weather System [AWS]) for interpretation of transport and sources will be needed. Given the focus of the exploratory 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 ship operating in its normal supply route configuration for 10–15 days during peak O_3 production season (July–early October). The principal objective is to sample NO_2 and other trace gas gradients from coast to the shelf limit and back and to collect statistics over several complete supply legs without disruption to supply ship operations. Power requirements to operate standard Air Quality instruments are minimal; berthing is needed for two operators.

Specific Research Question(s): N/A

References:

Title	Mortality Risk for Whale and Basking Sharks During Energy and Mineral Operations
Administered by	Headquarters
BOEM Contact(s)	Deena Anderson (deena.anderson@boem.gov), Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement, Internal Study
Performance Period	FY 2021–2023
Date Revised	February 24, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	BOEM-authorized projects have been shown to cause mortality to large-bodied elasmobranchs that feed at a low trophic level. Although much work has been accomplished on commercially valuable species habitat use and relationship to oil 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 U.S. and internationally. Not pursuing this study will likely lead to continued mortality, which is not accounting 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 these two species are 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 U.S. 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 analyses 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 and mineral extraction 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 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, mineral extraction operations, and associated vessel traffic intersect with known aggregations of these species. Information from this study, focused on whale sharks, will better quantify the risk of entanglement and ship strikes associated with energy and mineral 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 and mineral 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 was reported to the Bureau of Safety & 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 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.*, in press), 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.

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 and mineral 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 non-governmental organization (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. 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, p. 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 and mineral operations using satellite linked telemetry;

- Use of available land and satellite based automatic identification system (AIS) receivers to characterize vessel traffic, specifically energy and mineral 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;

- 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.

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Title	World War II Shipwrecks in the Atlantic and Pacific: A Microbiological, Archaeological, and Geochemical Baseline Study
Administered by	Headquarters
BOEM Contact(s)	James Moore (james.moore@boem.gov); Melanie Damour (melanie.damour@boem.gov); David Ball (david.ball@boem.gov)
Procurement Type(s)	Cooperative Agreement; Interagency Agreement
Performance Period	FY 2021–2025
Date Revised	May 3, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Marine microbial community structure and associated metabolic activity have a direct role with influencing shipwreck corrosion behavior. BOEM, however, has no baseline data regarding the microbial communities inhabiting historically significant shipwrecks in the Atlantic and Pacific Oceans, such as vessels from World War II, nor does BOEM have information about these microbial communities' long-term impacts on archaeological site integrity.
Intervention	Microbe community structure and current shipwreck site integrity will be studied at several World War II shipwrecks through field sampling, lab experiments, and site mapping.
Comparison	Acquired data will be compared with results from BOEM's first Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, and Archaeology (GOM-SCHEMA) study, which determined that a major site disturbance has the capability of impacting microbial community structure, thereby increasing associated shipwreck corrosion rates.
Outcome	This will lead to understanding the natural, long-term formation of microbial communities on historically significant steel shipwrecks and their role in stabilizing the corrosion behavior of these historically significant sites before being potentially affected inadvertent disturbances from energy development in the future. This information will further inform National Environmental Policy Act (NEPA) cumulative impacts analyses and fulfill National Historic Preservation Act (NHPA) mandates regarding the consideration of potential impacts to archaeological resources from energy development in the Atlantic and Pacific.
Context	Atlantic Outer Continental Shelf (OCS) (North, Mid-Atlantic, and South) and Pacific OCS (Washington; Oregon; Northern, Central, and Southern California; and the Oahu South Wind Call Area). Study results will apply to other BOEM regions.

BOEM Information Need(s): BOEM has no baseline data regarding microbial communities associated with historically significant shipwrecks in the Atlantic and Pacific Oceans, nor the roles they play towards natural, long-term preservation before they may be adversely impacted by inadvertent structural disturbances from energy development. The study would also address BOEM's Strategic Science Questions concerning impacts to cultural resources from BOEM-regulated activities and the best measures needed for long-term monitoring.

Background: BOEM is required by NHPA to identify, evaluate, and preserve historic properties and archaeological resources that may be adversely affected by its approved actions. Section 110 of the NHPA also mandates that BOEM preserve historic properties that are not under its jurisdiction but may be adversely impacted by its planning and permitting actions, such as shipwrecks located in state waters or protected under the Sunken Military Craft Act. Marine microbial communities and their associated metabolic activities have a direct role in stabilizing the corrosion behavior of historic steel shipwrecks. Historic steel shipwrecks exhibit non-linear corrosion rates, and those rates become more stabilized over time due to the formation of biofilms and subsequent propagation of microbial communities that can self-regulate the amounts of iron they are metabolizing from the wreck structure (Little *et al.*, 2008; Moore 2015). A sudden influx of nutrients or temporary removal of the outer biofilm layer from structural disturbances, however, can cause an increase of metabolic activity, resulting in increased corrosion rates (Melchers 2014). BOEM's GOM-SCHEMA study demonstrated that the 2010 *Deepwater Horizon* (*DWH*) oil spill and associated distribution of dispersants had immediate impacts on the microbiological community structures on nearby shipwrecks and, at least in the short-term, increased the wrecks' corrosion rates; longer-term assessment of these sites is ongoing (Hamdan *et al.*, 2018; Salerno *et al.*, 2018; Mugge *et al.*, 2019). Renewable energy development is anticipated to expand along the Atlantic Coast and the Oahu South Wind Call Area off Hawaii, where shipwrecks from World War II are located, and these vessels could potentially be impacted from installation-related activities. This study would provide baseline data for the microbial community structure of World War II shipwrecks in the Atlantic and Pacific would serve as a reference in case any of these sites are adversely impacted by future energy development and associated activities.

Objectives:

- Collect baseline environmental data related to the community structure of microorganisms inhabiting selected World War II shipwrecks in the Atlantic and Pacific.

- Assess local environmental geochemistry to see whether any of the wrecks are themselves leaking oil and compare results from those sites with ones in which no oil is detected.

- Compare baseline data with results from the GOM-SCHEMA study.

Methods: The study will be conducted through a combination of remote sensing and diver-assisted surveying, wreck mapping and modeling, sediment collection and analysis, and laboratory work pertaining to microbe community structure, microbially influenced corrosion, and presence of hydrocarbons. Cost-leveraging is anticipated with interagency partners, which would reduce BOEM's contribution to the study's projected total cost.

Specific Research Question(s):

1. What is the current state of preservation of the shipwrecks chosen for this study?

2. What types of microorganisms are present at historic World War II shipwrecks in the Atlantic and Pacific, and how are they influencing the sites' long-term corrosion behavior?

3. Are any of the wrecks chosen for this study currently leaking oil, and if so, how does the microbe community structure and associated site corrosion behavior compare to those sites that are not leaking oil?

4. How do results from this study compare to those from BOEM's GOM-SCHEMA study?

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Title	Anticipating Shifts in Marine Bird Distributions for Planning, Leasing, and Assessment of Energy Development on the Outer Continental Shelf (OCS)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (david.bigger@boem.gov)
Procurement Type(s)	Interagency agreement with the National Oceanic & Atmospheric Administration (NOAA)
Performance Period	FY 2020–2022
Date Revised	April 8, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Marine bird distributions may shift within a 30 year lease due to regional changes in oceanographic conditions and could make certain species more vulnerable to energy-related activities.
Intervention	This effort would combine predicted changes in oceanographic conditions to predict marine bird range shifts.
Comparison	Current species distributions will be compared to future predicted distributions.
Outcome	Time series predictions illustrating shifts in marine bird distributions over the next 30 years; and an approach that is repeatable using other taxa from other BOEM regions.
Context	Atlantic OCS.

BOEM Information Need(s): To assist in the environmental review and evaluation of sites for new offshore energy development projects (including oil, gas, and renewables), BOEM uses maps illustrating the seasonal distribution patterns of bird species that use the Atlantic OCS. Predictions of future shifts in seabird distributions over the coming decades are needed to inform no-action alternative for National Environmental Policy Act (NEPA) analyses and risk assessments for the Endangered Species Act (ESA) consultation.

Background: Knowledge of marine bird distributions on the Atlantic OCS is important to planning, leasing, and environmental assessments related to offshore energy development. Predictive maps of marine bird occurrence and abundance, based on statistical models fit to large observational data syntheses (Winship *et al.*, 2018), have proven extremely useful in BOEM's energy planning and assessment efforts on the Atlantic OCS over the past five years. To date, modeling of marine bird distribution and abundance on the Atlantic OCS has focused on predicting the long-term average (multi-decadal average) distribution of marine birds based on the syntheses of historical and contemporary wildlife survey and environmental/oceanographic data.

To inform cumulative effects analyses for NEPA, information is needed to describe the impacts of past, current, and future activities on a natural resource. BOEM, with its partners (U.S. Fish & Wildlife Service and the National Aeronautics & Space

Administration), is working to conduct field surveys and use advanced modeling techniques to describe the current distribution and abundance of dozens of marine bird species on the OCS. Yet, it is common knowledge that marine bird distributions do change regionally over decades (*e.g.*, northern gannets on the Atlantic OCS have shifted more inshore since the 1980's [Viet *et al.*, 2011]). Given that BOEM's leases for offshore energy development can be up to 30 years, the distribution of some marine bird species may shift into or out of existing or future lease areas. Knowing when and where these shifts in species distributions are likely to happen will help inform analyses for NEPA and biological assessments for ESA.

Objectives: Describe how the distribution of several marine bird species may shift in or out of existing and potential lease areas within the next 30 years.

Methods: The study will use similar methods used to create seasonal distribution and abundance maps of key marine bird species along the Atlantic (Winship *et al.*, 2018). These models use a combination of habitat and oceanographic variables and other information to predict the seasonal distribution of almost 50 marine bird species on the Atlantic OCS (similar models are being used in other BOEM regions). There are now a substantial number of marine bird survey data for the Atlantic OCS from about 2000 onward contained in the Northwest Atlantic Seabird Catalog and other sources (Winship *et al.*, 2018), and new survey data are continuing to be collected (*e.g.*, aerial surveys off New York and the Carolinas). Many environmental datasets are available throughout this same time period (Winship *et al.*, 2018), which would allow a contemporaneous dynamic habitat-based modeling framework (Mannocci *et al.*, 2017).

Several marine bird species will be selected based on the strength of the relationship to oceanographic conditions and their distribution relative to leasing areas. This effort would combine predicted changes in oceanographic conditions to predict marine bird range shifts. The output will be a time series prediction illustrating shifts in seabird distributions over the next 30 years (the life of a lease). The timescale matches the predicted timeline of offshore energy development on the OCS. The information products will be specifically tailored to be incorporated into future NEPA analyses of energy development on the Atlantic OCS. The general approach could be expanded to include marine mammals and/or other BOEM regions.

Specific Research Question(s): How do predicted changes in oceanographic variables change the distribution of marine bird species on the Atlantic OCS?

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Title	Atlantic Marine Assessment Program for Protected Species (AMAPPS) III B and C—Photogrammetric Aerial Surveys to Improve Detection and Classification of Seabirds, Cetaceans, and Sea Turtles
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Procurement Type(s)	Intra-agency agreement with U.S. Fish & Wildlife Service (USFWS)
Performance Period	FY 2020–2023
Date Revised	February 25, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Observer accuracy when it comes to identifying and counting multiple species on marine wildlife aerial surveys varies widely. Frequently, distribution, and abundance datasets collected on aerial surveys are rife with records of unidentified species, and many classifications are grouped to lower taxonomic levels (*e.g.*, genus; family). Though abundant, these records are routinely unused in species-specific modeling exercises despite the tremendous amount of effort invested in acquiring these datasets at sea, and there is no way to reanalyze them due to the lack of photographic archive.
Intervention	Integration of airborne remote sensing (*e.g.*, high-resolution camera systems fixed to survey aircraft) as a primary data collection tool or as a means of reducing errors in counting and improved species detection.
Comparison	The study builds on a decade of AMAPPS observer-based aerial surveys conducted by the USFWS. BOEM has identified problematic species identification on these surveys (*e.g.*, > 90% of terns are not identified to the species level). We will compare the accuracy of species identification using high-resolution imagery with previous AMAPPS observer-based data to quantify the performance of both methods.
Outcome	Improved accuracy of distribution and abundance datasets and maps, particularly of species that aerial observers have difficulty with during the identification process while surveying at-sea transects. This project will conduct aerial surveys to collect georeferenced imagery to advance the accuracy of species detections and counts through the application of computer vision and automated detection and classification algorithms.
Context	Targeted locations off the Atlantic coast and offshore areas.

BOEM Information Need(s): As energy development increases along the Atlantic Coast and across the Outer Continental Shelf (OCS), BOEM requires robust species and site-specific information concerning the seasonal distribution and abundance of seabirds, marine mammals, and sea turtles. Frequent misclassification of marine wildlife to the species level on AMAPPS aerial surveys likely results from a combination of observer experience, high observer turnover rates, and species sharing similar morphologies. Despite new observer training, we do not foresee an improvement in observer detection and accuracy of classification on AMAPPS aerial surveys, which require observers to identify seabirds and marine mammals rapidly. BOEM can improve detection and the classification of species recorded on low-level aerial surveys through the collection of high-resolution imagery and the development of spatially explicit high-resolution photographic reference databases for automated deep learning algorithms to systematically process.

Background: Low-level aerial surveys can cover large areas in a relatively short time frame, and serve a critical component in BOEM's monitoring framework. Aerial operations can mobilize faster than ship-based surveys and possess the ability to reach locations hazardous to ships, but essential to marine wildlife. From 2010–2019 the USFWS, in coordination with BOEM, has conducted systematic high fixed-wing aerial surveys from Florida to Maine, focused on seabirds, sea turtles, and marine mammals. However, despite the enormous level of survey effort, bountiful records of low taxonomic classification exist in the Northwest Atlantic Seabird Catalog (NWASC) collected by USFWS for AMAPPS. Some areas with records of low ranking occur in areas with a high probability of encountering endangered species (*e.g.*, aerial observers classified > 90% of Cape Cod terns to the genus level, making it impossible to tease out the distribution of the endangered Roseate Tern from Common Terns). These inaccuracies frequently result in classification of endangered species to lower taxonomic levels than desirable for National Environmental Policy Act analyses.

Visual surveys involving multiple aircrews must include methods to minimize biases that are known to vary widely among observers such as detection (*i.e.*, perception), misclassification, group-size estimation, and sample area determination. Although AMAPPS aerial surveys conducted by the USFWS are spatially and temporally comprehensive and systematic, they suffer from high observer turnover and varying levels of observer experience. Collection and integration of high-resolution, spatially explicit photogrammetry as a primary data collection tool on AMAPPS and on other BOEM projects can maximize survey effort by improving detection and counts of all species encountered on at-sea transects. Automation of computer vision algorithms is currently in development through BOEM/U.S. Geological Survey (USGS) collaboration per study NT-19-04 (*Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery*). Archiving the proposed new collection of imagery will improve confidence in species-specific maps for planning purposes, and provide a permanent and open-source imagery archive for when advances occur in the fields of computer vision and unmanned aircraft systems (UAS).

Objectives: The primary aim of this study is to conduct photogrammetric aerial surveys in targeted areas to build a database of annotated photos that will train deep learning computer vision algorithms (currently in development by study NT-19-04) to count and identify all species of marine mammals, sea turtles, and seabirds encountered on at-sea transects coordinated by BOEM. Once trained, deep learning models will automatically detect and count species in new imagery. This approach was successfully applied to automated detection of individual endangered right whales with 87% accuracy (Bogucki *et al.*, 2018); birds (Chapbot and Francis, 2016); and sea turtles (Gray *et al.*, 2019). These tools will improve confidence in distribution and abundance data collected on broad-scale AMAPPS aerial surveys, and in similar photogrammetric projects across the Federal government and industry.

Methods:

- USFWS will conduct aerial surveys at least once per season to target breeding, wintering, staging, and migrating species and mixed-species groups during the study period.

- USFWS aircraft will use high-resolution camera systems to collect spatially referenced targeted imagery on marine mammals, sea turtles, and seabirds to increase the taxonomic and seasonal coverage of the imagery and annotation archive.

- USFWS will collect imagery in hotspot areas identified by BOEM using distribution and abundance data collected on AMAPPS I and II.

- BOEM and USFWS will continue to develop and annotate a digital aerial imagery archive with Upper Midwest Environmental Sciences Center-USGS under study NT-19-04 to train deep learning algorithms on imagery of seabirds, marine mammals, and sea turtles. Extending deep learning algorithms to include species in these taxonomic groups has advantages in making better use of archived data, as well as advancing the technology for future application and cost reduction. Annotation refers to the process of identifying individual birds and other wildlife to the species-level or the most refined taxonomic classification possible from the source imagery, and marking identified wildlife for future reference. The archive will include a range of pixel ground sample distances (GSDs) and environmental conditions affecting sea state and sun glare as the two principal factors affecting detection and classification at sea.

Specific Research Question(s): How and in what locations should BOEM and partners acquire new imagery to train species-specific computer vision algorithms, that are in development, to detect, classify, and count species recorded on at-sea aerial transects?

References:

Bogucki, R., Cygan, M., Khan, C.B., Klimek, M., Milczek, J.K. and Mucha, M., 2018. Applying deep learning to right whale photo identification. *Conservation Biology*.

Chabot, D., and C. M. Francis. 2016. Computer-automated bird detection and counts in high-resolution aerial images: a review. *Journal of Field Ornithology* 87:343–359.

Gray, P.C., Fleishman, A.B., Klein, D.J., McKown, M.W., Bézy, V.S., Lohmann, K.J. and Johnston, D.W., 2019. A convolutional neural network for detecting sea turtles in drone imagery. *Methods in Ecology and Evolution*.

Title	Behavioral Response of Sea Turtles from Controlled Exposures to a Mobile Impulsive Sound Source
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	April 5, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Low-frequency impulsive sounds produced during surveys and construction associated with BOEM programs can impact the behavior of sea turtles. Despite the frequent occurrence of these activities in the Renewable Energy, Conventional Energy, and Marine Minerals Programs, little is known of the impact to sea turtles.
Intervention	Conduct a controlled exposure experiment to measure the behavioral response of turtles exposed to impulsive sound sources.
Comparison	The behavior of field-tagged sea turtles in ambient noise conditions will be compared to tagged turtles exposed to impulsive sound sources.
Outcome	The study will assist BOEM's understanding sea turtle behaviors at different sound exposure levels to inform analyses, monitoring needs, and future applications around survey and construction activities authorized by BOEM programs.
Context	The field study will be conducted in the Atlantic and/or Gulf of Mexico.

BOEM Information Need(s): The November 2018 Wildlife and Offshore Wind workshop identified field studies to understand the impacts from the impulsive sounds produced from pile driving as *a priori*ty research and monitoring issue. The impacts to sea turtles from pile driving of oil and gas foundations and survey equipment across all BOEM program areas have also been an impact of concern, but are not well understood. Nationwide, BOEM needs information on the responses of sea turtles to impulsive sounds to inform environmental analyses, consultations, and inform geographic and seasonal considerations for leasing decisions, and inform mitigation and monitoring needs. This information will inform future siting of lease areas in sea turtle habitats, information needs, and inform research and monitoring programs associated with offshore leasing activities.

Background: Sea turtles generally hear 50 Hz to 2 kHz sounds (Dow Piniak *et al.*, 2012; Ketten and Bartol 2006; Lavender *et al.*, 2014; Lenhardt *et al.*, 1996; Lenhardt 1994; Martin *et al.*, 2012; Moein 1994; O'Hara and Wilcox 1990), but species-specific differences in hearing is poorly understood. That general range overlaps with frequencies produced by pile driving and geophysical survey equipment (*e.g.*, boomers, sparkers, airguns, sub-bottom profilers) that produce low-frequency impulsive sounds (BOEM 2018; Crocker and Fratantonio 2016). The behavioral and physiological responses of sea turtles to sound exposure is not well understood. There are some laboratory studies showing some avoidance responses to impulsive sounds (DeRuiter and Larbi Doukara 2012; McCauley *et al.*, 2000; Moein 1995; O'Hara and Kania 1981) as well as field observations from observers suggesting behavioral and avoidance responses may occur. Although tagging data is revealing essential information on the behavioral of sea turtles (Patel *et al.*, 2016; Smolowitz *et al.*, 2015), the response of tagged animals exposed to anthropogenic noise is not well understood. Recently, tags have been developed that can data log the received levels of sound of a turtle and the associated behaviors during those exposures (Tyson *et al.*, 2017). This study is designed to obtain acoustic and behavioral data from controlled exposure experiments to underwater noise. The current level of information is incomplete and inadequate to determine the relationship between exposure level and behavioral responses in sea turtles. Typically, loggerhead turtles are the most commonly studied species due to their availability, but opportunistic tagging of other species would also provide much-needed information to better understand inter-species variability. Tagged turtles not exposed to sound and before and after exposure field studies are needed to better understand the behavioral responses of sea turtles to sound exposure.

Objectives: The primary objective of this study is to identify the relationship between exposure level from impulsive underwater sounds and behavioral response in sea turtles such that a behavioral response curve can be developed.

Methods: Sea turtles will be field-captured and tagged with an audio and animal motion data logging tag. Tags will be used to record animal motion (*e.g.*, position, speed, and depth) and sound exposure simultaneously. Animal motion will be logged under ambient ocean noise conditions and during controlled exposures to impulsive sound sources. The tagging response of turtles will be obtained under control conditions by focally following turtles and retrieval of the tag during single day deployments. A release, floatation, and beacon system could allow the tag to be recovered to ensure behavioral data obtained from the recovered tag without recapturing the turtle. Impulsive sounds below 2,000 Hz will be generated by a mobile source (*e.g.*, boomers, sparkers, or bubble guns) deployed from a vessel. Opportunistic tagging will be allowed to take advantage of exposure/response opportunities from any coastal construction in the study area such pile driving, punch barges, dredging, scientific surveys, or sound-producing activities. Empirical data will be analyzed and variable responses of sea turtles determined for different exposure conditions (*e.g.*, sound pressure level). A final report, sample .wav files, and video of representative study methods and field activities will be submitted to BOEM for scientific, educational, and outreach programs.

Specific Research Question(s):

1. How do sea turtles behaviorally respond to controlled exposures to impulsive sound sources?

2. How do sea turtles behaviorally respond to sound exposure at different water depths?

3. What is naturally occurring sea turtle behavior in the study area (this could vary significantly between different regions)?

4. What is the tagging response of sea turtles in the study area?

References:

BOEM. 2018. Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf. Sterling, VA: DOI, Bureau of Ocean Energy Management, Office of Renewable Energy Programs.

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Tyson, R.B., Piniak, W.E.D., Domit, C., Mann, D., Hall, M., Nowacek, D.P., Fuentes, M.M.P.B. 2017. Novel Bio-Logging Tool for Studying Fine-Scale Behaviors of Marine Turtles in Response to Sound. Frontiers in Marine Science. 4.

Title	A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker (brian.hooker@boem.gov)
Procurement Type(s)	Cooperative Agreement/National Ocean Partnership Program/Interagency Agreement
Performance Period	FY 2020–2021
Date Revised	February 23, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Passive acoustic monitoring datasets detect a variety of marine species, but identifying each species or group of vocalizers requires audio profiles of each species. This study would address the problem of disparate datasets and a framework for cataloging acoustically active fish for analysis in passive acoustic monitoring datasets.
Intervention	This study would develop an acoustic catalog of fish sounds to identify various fish species recorded in passive acoustic data in a more efficient and accurate way.
Comparison	N/A
Outcome	The outcome will be a better understanding of passive acoustic monitoring data, as well as marine species distributions.
Context	BOEM currently collects passive acoustic data for a variety of research and monitoring needs. Unfortunately the data is only used for detecting a few marine mammals when it could be used for detecting sound-producing fish as well.

BOEM Information Need(s): BOEM needs to understand potential behavioral, physical, and physiological impacts to fish from offshore wind construction. One means of accomplishing this is by establishing a library of fish sounds to allow for analysis of existing sub-marine acoustic recordings and developing fish-specific acoustic detectors to monitor movement and identify important habitat areas via a non-invasive means. Currently there are many databases with underwater recordings that have not been analyzed outside a few focal species. This would allow that data to be analyzed more fully. This information will elucidate some marine fish distribution and behavior, which is integral to understanding potential impacts from BOEM activities, as analyzed (or required) under the National Environmental Policy Act (NEPA) and Magnuson-Stevens Fishery Management Conservation and Management Act compliance.

Background: Ocean passive acoustic recording has primarily focused on marine mammals, due to their broadly protected status. Acoustic recording has effectively monitored fish populations as well as the sounds of various marine habitats however, because the sounds of many species of fish have not been documented, much of the sounds in these recordings remain a mystery. Many long-term marine acoustic recordings have recorded sounds that are likely produced by fishes, but the species identity is unclear. As many as 50–70% of the fish species along the U.S. Atlantic Coast are potentially capable of producing sounds, but only a small number have been well documented. This means that a large portion of existing (and future) passive acoustic monitoring (PAM) recordings are not being used to their full potential, representing a substantial lost opportunity.

Many fish species produce species-specific acoustic calls in courtship and aggression that are strongly tied to seasonal patterns of movement and reproduction. Tracking these sounds provides the ability to remotely monitor changes in their normal behaviors allows them to serve as bioindicators of anthropogenic impacts and environmental changes. Understanding (1) which species of fishes are producing sounds and (2) the time of year and context in which they vocalize, allows for passive recordings of fish to serve as a mechanism for detecting changes in marine ecosystems. In addition, the information gleaned from other PAM data (that may be targeted at other species or habitats) will become much more useful with proper knowledge of the types of fish that are vocalizing. Fish acoustic behavior is strongly affected by anthropogenic noise, including seismic air guns and ship traffic. Additionally, the frequency range of ship propeller noise overlaps with the fundamental frequency component of many fish sounds (and likewise, hearing), creating a masking effect of fish calls. Once a baseline pattern of fish calling is established, effects of increased ship traffic or ordinance deployment on fish behavior and the environment may be more accurately and efficiently evaluated.

Much of the foundational work in understanding the sounds produced by fishes was published in 1970 by Marie Poland Fish and William H. Mowbray in Sounds of Western North Atlantic Fishes. Despite being over 40 years old, and the sounds recorded under laboratory conditions on analog equipment, this work is still largely the key reference in the field of fish acoustics. An updated, publicly available compendium of fish sound identification and reference would allow the public and private research community to use fish sounds to further understand the context of their acoustic recordings and examine the dynamics of fish populations across broad spatial scale. Sounds identified over the course of the project would be described in peer-reviewed publications, as well as made freely available as an online multi-media reference through Cornell University's Macaulay Library of Natural Sounds. At present, the Macaulay Library has a limited number of fish recordings (http://macaulaylibrary.org/browse/taxa/actinopterygii), but these sounds represent only a small fraction of the acoustically active species found along the Atlantic Coast. Our goal is to develop this approach along the U.S. Atlantic Coast, given the known species occurrence, previous acoustic work, and energy development potential, but similar approaches could also be applied to other areas under BOEM or National Oceanic & Atmospheric Administration (NOAA) jurisdiction.

Objectives: Identify the species-specific sounds produced by focal fish species along the U.S. Atlantic Coast. The species of interest would be targeted on the basis of their known or hypothesized degree of acoustic activity (*e.g.*, drumfish, toadfish), geographical occurrence, economic value (*e.g.*, cod, haddock), or population vulnerability (*e.g.*, sturgeon).

Methods: A team of fish sound experts would be assembled to query the research community for which species have been recorded, because many fish species' sounds exist in personal research collections. The list of acoustically active or hypothesized focal Atlantic fish species would be identified, and additional sounds would be captured through a combination of *in situ* observations or captive recordings in different locations. Recording efforts would focus on known spawning or aggregation sites of different species, and local marine laboratories with appropriate facilities for recording fish in captivity. All sounds would be digitally recorded and maintained in an online data catalog to maintain high-quality audio standards. Sounds from different behavioral contexts (spawning, aggression, feeding) would also be collected and identified.

Specific Research Question(s): How can sound-producing fish be better identified and evaluated by existing and new passive acoustic datasets in areas of offshore wind construction and operation?

References:

Lobel, P. S., I. M. Kaatz, and A. N. Rice. 2010. Acoustical behavior of coral reef fishes. Pages 307–386 in K. S. Cole, editor. Reproduction and Sexuality in Marine Fishes: Evolutionary Patterns & Innovations. Elsevier Academic Press, San Diego.

Title	Fish Auditory Thresholds—Part 2 Field Component
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker (brian.hooker@boem.gov)
Procurement Type(s)	Interagency agreement with the National Oceanic & Atmospheric Administration (NOAA); Cooperative Agreement
Performance Period	FY 2020–2022
Date Revised	February 22, 2018
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	There are several commercially and recreationally important fish that co-occur with proposed wind energy facilities. This study is principally addressing fisheries resource impacts from acoustic disturbance during offshore wind energy development. The temporary and longer-term physical and physiological impact of fish during and shortly after offshore construction activities is currently not well understood.
Intervention	This study would evaluate the physical and physiological impact to fish and/or mollusks during construction of an offshore wind energy facility.
Comparison	This second phase project will compare controlled (lab) studies to field trials in regards to both the acoustic environment (ambient *vs.* disrupted) and fish injury and/or behavior.
Outcome	The outcome will be a better understanding of the physical, physiological, and behavioral impacts to fish associated with offshore wind construction activity.
Context	The principal target for the investigation is commercially important fish in the North and Mid-Atlantic Planning Areas, principally black sea bass and longfin squid. The percussive action of pile driving offshore wind foundations has the potential to induce physical or behavior impact to fish. This study will evaluate that potential in a field setting.

BOEM Information Need(s): The information from this study will help in BOEM's noise impact assessments to commercial fish species and their associated fishing industries under the National Environmental Policy Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

Background: Auditory thresholds for some commercial fish species have been established, while for some species such as black sea bass data are lacking. Black sea bass in particular support valuable commercial fisheries in the North, Mid, and South Atlantic Planning Areas. Black sea bass show affinity for certain habitats within the wind energy lease areas and are thus not a temporary resident of these lease areas (Guida *et al.*, 2017). In addition, black sea bass produce sounds, such as grunts and thumps, which have been associated with feeding and escape. This species is known to utilize mid-frequency acoustic signals (100–1000 Hz) which may be used to communicate during spawning and feeding but their sensitivities to anthropogenic sounds such as pile driving noise, and their behavioral responses to them, is not understood.

Commercial and recreational fishermen have expressed concern that noise produced during sub-bottom surveys, pile driving, and operation of renewable energy facilities may have a negative effect on the behavior of black sea bass, potentially affecting a range of factors from catchability to long-term reproductive success. Sounds that are produced through offshore wind development could lead to acute or chronic sub-lethal effects due to the overlap in frequency between their hearing/communication range and direct particle motion generated by these anthropogenic sounds (Hawkins and Popper 2017). Black sea bass will be the first species tested because they are known to use acoustic cues to communicate and because their habitats overlap within renewable energy lease areas. If feasible, other species, such as squid, identified as *a priori*ty in Normandeau 2012 (BOEM Contract #M11PC00031), may be evaluated.

This study is divided into two parts. Part one is a laboratory study awarded in 2017 as an interagency agreement with NOAA's Northeast Fisheries Science Center; this profile describes part two, which is the companion field study. The Part 1 study, which will fully conclude in 2020, has demonstrated clear behavioral reactions to the playback of pile driving sound to black sea bass and squid and further established auditory evoked potentials for black sea bass. It is necessary to compare these lab based results with those in the field.

Objectives: The objective of this study is to understand black sea bass, and potentially other species' physical, behavioral, and physiological effects when exposed to anthropogenic sounds associated with offshore wind construction and operation. Thresholds for different effect levels (*e.g.*, injurious *vs.* behavioral) may be established.

Methods: Field studies would evaluate behavioral and physiological effects, as well as potential changes in habitat use during sound exposure. The exact methodology will be influenced by the results of phase one of the study. However, the likely methodology could include the following: mesocosm observations, videography, Adaptive Resolution Imaging Sonar (ARIS)/Dual-frequency Identification Sonar (DIDSON) (*e.g.*, ARIS Explorer 1200) monitoring applications, or other appropriate monitoring technologies such as active acoustic tags and passive receivers.

Specific Research Question(s):

1. How does sound generated during offshore wind construction affect important fish species like black sea bass and squid?

2. At what amplitude does pile driving or other project sounds induce a behavioral response?

3. At what amplitude do these sounds lead to physical or physiological damage internal and/or external organs of the subject fish?

References:

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Title	Implementation of Mitigation for Offshore Wind Turbine Interference on High-Frequency (HF) Coastal Oceanographic Radar
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov), Brian Zelenke (brian.zelenke@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	May 3, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Wind turbines interfere with HF radar (HFR) measurements. These measurements are used to produce data products such as surface currents, waves, winds, drifter simulations, and tsunami and vessel detections—which in turn have both scientific and practical applications.
Intervention	Implementing a software fix for CODAR Ocean Sensors SeaSonde® HFR instruments.
Comparison	Ocean surface current measurements with and without turbine interference would be used to evaluate the efficacy of the mitigation measure.
Outcome	The implementation will allow for accurate current measurements in areas where wind turbines are operating.
Context	HFR sensors are used along most U.S. coasts to provide ocean surface current measurements for research as well as activities like search and rescue.

BOEM Information Need(s): With wind turbines now operating offshore in U.S. waters, the Bureau of Ocean Energy Management (BOEM) must develop and deploy a real-time mitigation for the signal distortion turbines impart on the SeaSonde coastal oceanographic HFR network used operationally by the U.S. Coast Guard for search and rescue and by the National Oceanic & Atmospheric Administration (NOAA) for oil spill monitoring and response, among many other societal needs. This study proposes to implement a HFR signal processing software solution to mitigate adverse impacts of rotating wind turbines on ocean surface current mapping HF radars operating along the Atlantic Coast. Applying *in situ* data and simulations to the creation and deployment of real-time operational software tools that mitigate the negative impacts of wind turbine blade interference to HFRs will advance the interagency coordination needed for thorough National Environmental Policy Act analyses and review. The proposed software development, validation, and implementation study is needed in order to actively mitigate radar interference by wind turbines and provide solutions that allow the coexistence of wind energy facilities and radar infrastructure and services.

Background: BOEM funded the study “Impact Assessment and Mitigation of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar” (BOEM 2018-053), which characterized the interference and the wind turbine parameters, such as rotation rate, that contributed to this interference. The next steps are to (1) expand the mitigation algorithms to a large facility (100 turbines) of heterogeneously configured and rotating wind turbines spread across tens of kilometers through simulations and (2) provide an optimized real-time operational software remedy that can be used on SeaSondes for the next 10 years.

The first step will extend the simulations to include interference from an arbitrary number of turbines distributed within multiple range bins of the coverage area of a radar system. The turbines shall be simulated to allow for variation in all parameters associated with an offshore turbine, including, but not limited to, rotation rate, angle of the blades relative to the radar, height of the turbine hub, and length of the blades. The turbine locations shall encompass all possible ranges and azimuths with the nominal coverage area of the radar. All SeaSonde transmit frequency bands currently used (*i.e.*, 5, 12, 25, and 42 MHz), as well as International Telecommunications Union-approved bands, shall be tested. The second step will develop a deployable, lasting, real-time interference mitigation solution and software.

Objectives:

- Assess the impact of turbine interference, spread out in range-Doppler space, on radar-derived physical oceanographic measurements.
- Provide to the HFR community, within six months of this project's completion, a software package for mitigating interference that is capable of real-time integration with the existing operational SeaSonde data processing tool chain.

Methods: The code would incorporate and improve upon the successful mitigation algorithm subroutines reported in BOEM 2018-053. For example, by using Bayes theorem, both the temporal and spatial structures of the observed interference can be used to improve flagging of distorted radial currents and to attempt to reduce their impact on the data. The code will be specifically designed and optimized to run in real time on SeaSonde radar station computers, interfacing with the many other tasks that must run simultaneously on these operational systems. This would not be done in a language like MATLAB®, but likely in a version of "C". The development and validation of the code shall be done to allow mitigation to be attempted on existing systems in the NOAA Integrated Ocean Observing System national network. There is no source code of this nature available for compiling currently; it is a phase that must be undertaken by this study.

Specific Research Question(s): What is the optimal way to reduce interference in HF radar from wind turbines?

References:

Trockel D., Rodriguez-Alegre I., Barrick D., Whelan C. 2018. Impact Assessment and Mitigation of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar. Sterling, VA: U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-053. https://marinecadastre.gov/espis/#/search/study/100141

Title	Real-time Opportunity for Development Environmental Observations (RODEO) II
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2024
Date Revised	February 22, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Impact analyses are based on models and estimates rather than actual measurements or observations.
Intervention	Collect observations during the installation and early operation of offshore wind farms to improve predictions of impacts from future development.
Comparison	The observations will be compared to model estimates and used to improve those estimates.
Outcome	Results of the study will be used to improve impact analyses and mitigation.
Context	The geographic area is the Atlantic Coast from Maine to Georgia.

BOEM Information Need(s): BOEM is responsible for the approval of a construction and operations plan submitted by developers for wind facilities on the U.S. Outer Continental Shelf. The approval process includes the analysis of the environmental effects from the construction, operation, and decommissioning of these facilities. Real-time measurements of the construction and operation of the first facilities to be built will allow for more accurate assessments of the actual environmental impacts. Without real-time observations of the activities, best estimates based on perceived activities are used to make these determinations.

Background: The construction of the first wind facilities in the U.S. offshore environment offers an opportunity to address many of the environmental questions that are of concern to the public. Federal and state agencies have mandates to protect the environment and will need to evaluate the environmental impacts from wind development. Through a collaborative effort with other Federal and state agencies, the construction and operation of offshore wind turbines can be studied to gain insight into the actual disturbances to the environment. Without these real-time observations, analyses are based on best guesses and scenarios that are often conservative.

Analyses of the environmental consequences require knowledge or estimates of the duration and extent of the activity. For example, the extent of disturbance on the seafloor from anchors may be estimated to encompass a larger area than actually occurs. Vessels may use dynamic positioning, resulting in no disturbance from anchoring. An analyst relies on the best available information and assumptions about the activities based on previous experience. For offshore wind development, there is no previous experience in the U.S., so the analyses and subsequent mitigation measures are based on an educated guess. These analyses would benefit from real-time, independent observations during actual construction activities.

The example of anchoring is only one aspect that is estimated. A full environmental analysis includes estimates of air emissions, sound produced by the activities, sea floor disturbance by cabling, and potential discharges from vessels, to name a few. The duration of these activities is also included in the analysis. Better estimates of these activities will result in more realistic mitigation measures that appropriately reduce or eliminate the impacts. Without accurate information, developers may be required to take measures that are ineffectual.

This study is a follow-on to the first RODEO study that focused on the construction and operations at the Block Island Wind Farm (BIWF) off Rhode Island (HDR 2017; HDR 2018; and Elliot *et al.*, 2017). Lessons learned from the observations at BIWF will be extended to the monitoring at new sites. BOEM anticipates at least two to three wind farm developments to begin construction in 2021 to 2022 including the Vineyard Wind Farm located off the coast of Massachusetts and South Fork Wind Farm located off the coast of Rhode Island.

Objectives: The objective of the study is to improve impact analyses and mitigation of offshore wind construction and operation.

Methods: Observations will be made using appropriate monitoring equipment from survey vessels. The specific activities to monitor will be developed through discussions with subject matter experts, both within BOEM and other Federal and state agencies.

Specific Research Question(s): What are the actual impacts from construction and operation of wind facilities?

References:

HDR. 2018. Field Observations during Wind Turbine Foundation Installation at the Block Island Wind Farm, Rhode Island. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2018-029. 175 pp. https://marinecadastre.gov/espis/#/search/study/100084

Elliott, J., K. Smith, D.R. Gallien, and A. Khan. 2017. Observing Cable Laying and Particle Settlement During the Construction of the Block Island Wind Farm. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2017-027. 225 pp. https://marinecadastre.gov/espis/#/search/study/100122

HDR. 2017. Benthic Monitoring during Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2018-047. https://marinecadastre.gov/espis/#/search/study/100123

Title	Behavior and Habitat Use of Marine Protected Species During Construction of an Offshore Wind Farm
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	March 1, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Offshore Wind is a nascent industry in the U.S. Atlantic. There is a high level of concern that pile driving can negatively impact the behavior of marine mammals and sea turtles. A firm understanding of these impacts will assist the future of 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*) 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 whales and sea turtles from pile driving of offshore wind and oil and gas foundations is a major impact of concern on the Outer Continental Shelf (OCS), but is not well understood. Nationwide, BOEM needs information on the potential displacement of whales and sea turtles 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 inform future information needs, and inform research and monitoring programs associated with offshore leasing activities that are essential to the environmentally responsible development of the offshore wind industry on the OCS.

Background: Considerable pre-construction baseline data from aerial and acoustic surveys have been collected over the last several years in the Massachusetts and Rhode Island lease areas, through a collaborative effort between BOEM, Massachusetts Clean Energy Center (MassCEC), and the New England Aquarium. At the 2018 workshop, the impact issue of displacement in the Massachusetts and Rhode Island lease areas was classified as highly important, because numerous endangered species occur in the area, presumably attracted by feeding opportunities. Displacement from feeding could lead to energetic losses that may have repercussions for reproduction and health. Pseudo-experimental exposure (PEE) studies have used Navy sonar (Atlantic Undersea Test and Evaluation Center [AUTEC]; Southern California [SOCAL] Behavioral Response Study [BRS]; Atlantic BRS; Sea mammals, Sonar, Safety [3S]) and seismic (3S, Behavioural Response of Australian Humpback Whales to Seismic Surveys [BRAHSS]) activities (Southall *et al.*, 2012). Generally these are one event studies, looking at a specific tagged individual animal response to a specific stimulus, so small sample sizes are the norm. However, accompanying aerial and acoustic data 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 studies of harbor porpoise responses to pile driving in Germany (Dähne *et al.*, 2013). Passive acoustic studies have also shown distinct displacement (mean of 17.8 km) 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 broadband transmissions by the North Pacific Research Laboratory (Mobley Jr. 2005). Based upon acoustic disturbance from other broadband, impulsive noises, for example, seismic airguns, there is reason to believe that displacement of large whales away from the pile driving sound source is likely. Sea turtle responses to loud impulsive sounds are largely not well understood either.

Objectives: The objective of the study is to determine the regional impact on behavioral and habitat use of marine mammals and sea turtles from construction of an offshore wind farm.

Methods: Both visual and passive acoustic approaches are needed to test the hypothesis that whales and sea turtles are displaced during construction activities. Habitat use and behavioral responses can be assessed through aerial surveys (observer and/or digital) and acoustic monitoring before, during and after construction activities. Evaluating the distribution of animals (visually and acoustically) and the behavioral movements from tagged animals under each of the conditions can provide a robust analysis. Numerous surveys would be needed to obtain the statistical power needed to determine if displacement occurred.

Visual survey methods have proven effective in studies of harbor porpoise responses to pile driving in Germany (Dähne *et al.*, 2013). Aerial surveys have also been used to assess displacement of large whales from acoustic disturbance, for example, to evaluate bowhead responses to seismic activity (Richardson *et al.*, 1999) and humpback responses to low-frequency broadband transmissions by the North Pacific Research Laboratory (Mobley *et al.*, 2005). Visual aerial surveys can provide population-level data on abundance and distribution for most species, and occasionally individual-level responses for right whales. The advantages of this approach include information on density and local displacement responses of multiple animals, and evaluation of all species, and to some extent, all life history stages. Aerial surveys can also observe behavior (*e.g.*, feeding) and may be able to detect changes. Depending on the time of year of construction, certain species may need to be focused on to ensure an adequate number of animals will be present to detect an effect.

Specific Research Question(s):

1. How will species abundance and sightings per unit effort change compared to the years of aerial survey baseline data collected in the construction area?

2. Will pile driving activities result in displacement of marine mammals or sea turtles away from construction locations?

3. How will pile driving affect the short-term behavior of individuals?

References:

Brandt, M.J., Diederichs, A., Betke, K., and G. Nehls. 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., and U. Siebert. 2013. Effects of pile driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. Environmental Research Letters. 8(2):025002.

Mobley Jr., J.R. 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, W.J., Miller, G.W., and C.R. Greene Jr. 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., and A. Douglas. 2012. Biological and behavioral response studies of marine mammals in Southern California, 2011 (“SOCAL-11”) final project report.

Title	Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning (II)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (david.bigger@boem.gov)
Procurement Type(s)	Interagency agreement with the National Oceanic & Atmospheric Administration (NOAA)
Performance Period	FY 2021–2024
Date Revised	April 8, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Predicted densities and distribution of marine seabirds are based on highly uneven sampling efforts across the Atlantic Outer Continental Shelf (OCS), thus resulting in potentially unreliable predictions in areas with little survey effort.
Intervention	Develop new predictive models with recently available survey data from two underrepresented regions, the New York Bight and south Atlantic. In addition, the modeling effort will include recently acquired data from ongoing efforts (*e.g.*, Atlantic Marine Assessment Program for Protected Species [AMAPPS]) and from developers.
Comparison	The study fills a gap by incorporating new data from areas that were recently surveyed.
Outcome	Improved seasonal distribution maps of marine bird occurrence and density.
Context	Atlantic OCS.

BOEM Information Need(s): To assist in the environmental review and evaluation of sites for new offshore energy development projects (including oil, gas, and renewables), BOEM uses maps illustrating the seasonal distribution patterns of bird species that use the Atlantic OCS. To assist in the environmental review of wind energy areas and in the evaluation of sites for new offshore projects, BOEM needs maps illustrating the seasonal distribution patterns of bird species using the Atlantic OCS. The information will be used to inform environmental review for National Environmental Policy Act (NEPA) and Endangered Species Act consultations with the U.S. Fish & Wildlife Service.

Background: Experience from onshore wind development and wind development offshore in Europe suggests that siting of facilities is an important consideration for minimizing impacts to bird species. Predictive maps of marine bird occurrence and abundance, based on statistical models that fit large observational data syntheses (*e.g.* Winship *et al.*, 2018), have proven extremely useful in BOEM's energy planning and assessment efforts on the Atlantic OCS over the past 5 years.

Since the BOEM study Winship *et al.* (2018), the amount of available survey data in the OCS has been growing with large amounts of data from AMAPPS II, large survey efforts in the Carolinas and in the New York Bight plus data from developers. It is important that new information from these efforts be used to improve the resolution and confidence of the seasonal marine bird distribution maps, particularly in areas that have been identified with low survey effort. These maps have been used to assess the relatively risk (collision and displacement) of marine birds to offshore wind development.

Objectives: The objective of this study is to provide easily understandable information about the distribution of marine birds to aid offshore wind development siting decisions and reduce the risk of impacts to birds.

Methods: The models used by Winship *et al.* (2018) used a combination of habitat and oceanographic variables and other information to predict the seasonal distribution of nearly 50 marine bird species on the Atlantic OCS. This study will use a similar approach. The new datasets are available in the Northwest Atlantic Marine Bird Catalog. The new survey data will be used to “update” the models developed by Winship *et al.* (2018). The information products will be incorporated into future NEPA analyses of energy development on the Atlantic OCS. The mapping products will be served on the Northeast and Mid-Atlantic Oceans Data Portals where they will be used to inform decision making by multiple stakeholders.

Specific Research Question(s): What is the predicted distribution and abundance of marine birds along the Atlantic OCS?

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. 67 pp. https://espis.boem.gov/final%20reports/BOEM_2018-010.pdf

Title	Behavioral and Spatial Ecology of the Endangered Giant Manta Ray (*Manta birostris*)
Administered by	Marine Minerals Program
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Douglas Piatkowski (douglas.piatkowski@boem.gov)
Procurement Type(s)	T.B.D.
Performance Period	FY 2020–2023
Date Revised	December 25, 2018
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Bureau of Ocean Energy Management (BOEM) authorized projects may impact Endangered Species Act (ESA)-listed manta (*Manta birostris*). Information regarding the population on the Atlantic and Gulf Outer Continental Shelf (OCS) and the site fidelity within specific BOEM lease areas and will aid in consultations under the ESA.
Intervention	Gathering behavioral information on habitat use as well as synthesizing existing telemetry and genomic data (information on distinct population segments) inform assessment of risk associated with BOEM actions.
Comparison	The outcome of this study would a) provide for a better understanding of population demographics between ESA-listed and non-listed population mixing; and b) Describe behavioral ecology documented of select large pelagic species such as *M. birostris*.
Outcome	The outcome will be a reduction in data gaps related to manta sand shoal habitat areas, specifically improving our understanding of fine-scale movement, distinct population segments, and behavior that may be impacted by BOEM activities such as preventative relocation trawling.
Context	Atlantic and Gulf of Mexico (*e.g.*, Canaveral Shoals, Ship Shoals Borrow area)

BOEM Information Need(s): There is considerable risk to not knowing the answers to how the Giant Manta ray (*M. birostris*) use sand shoal ecosystems in the vicinity of borrow areas. Listing of this species on the ESA, as well as declining population, make for a pressing need in understanding risk of impact associated with BOEM managed activities. Direct observations of Manta species interaction with preventative trawling operations in 2017 and 2018 causes an additional level of risk which could potentially be mitigated through additional information. This study could better inform areas to be avoided or seasonal mitigation. Should this study not be funded, it is likely that adverse impacts to this endangered species will continue.

Background: The recent ESA listing of *M. birostris* overlaps spatially and temporally with activities associated with Marine Minerals Program (MMP) borrow areas. Giant manta have been observed during preventative trawling operations within offshore sand resource areas. However, their fine-scale behavior and implication to risk associated in the vicinity of sand shoals is largely unknown.

This study targets understanding of that overlap and risk of interaction with these activities, particularly the Canaveral Shoals borrow area. Although some information on the presence of manta off the southeast U.S. exists, it is not of sufficient detail to understand population demographics, nor the fine-scale behavioral ecology information required to understand interaction with marine mineral operations. This effort leverages the extensive investment in monitoring occurring at Canaveral Shoals borrow area. Results of this study would be applicable to the Marine Minerals, Renewable Energy, and Oil & Gas Programs across the Gulf and Atlantic OCS Regions.

K-selected species like manta exhibit life history characteristics such as matrotrophic reproduction, extremely low fecundity, and a high degree of site fidelity, making manta extremely susceptible to anthropogenic impacts (Dulvy 2008; Dulvy 2014). Additionally, manta are known to move between coastal and offshore waters of the U.S. Gulf of Mexico and Atlantic Coasts and have been shown to exhibit a high degree of site residency, increasing their susceptibility to highly localized anthropogenic impacts (Adams 1993; Dewar 2008; Marshall 2011).

Objectives: The purpose of this study is to understand site fidelity and behavioral ecology of *M. birostris*, and the relationship between their fine-scale behavior and risk from BOEM-permitted activities.

Methods: The study will collect new, and synthesize existing, data in the vicinity of MMP borrow areas to determine risk in relation to habitat use. It will leverage existing data sets collected by government, academia, and non-governmental organization studies. Additional telemetry data will improve fine-scale and site-specific information. Fine-scale habitat use has been described using inertial measurement sensor tags successfully deployed on manta outside the United States (Stewart *et al.*, 2018). Animal-borne sensors which sample at fine-scale 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. Tag data can be further analyzed with simulated dredge operations. This is similar to methods currently employed in several BOEM studies investigating fine-scale habitat use (Please see Fine-scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico, p. 160).

Specific Research Question(s): How does site fidelity and behavior of *M. birostris* impact risk of interaction with relocation trawling operations on the OCS?

References:

Braun CD, Skomal GB, Thorrold SR, Berumen ML (2014) Diving Behavior of the Reef Manta Ray Links Coral Reefs with Adjacent Deep Pelagic Habitats. PLoS ONE 9(2): e88170. https://doi.org/10.1371/journal.pone.0088170

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Use of the Manta Ray *Manta alfredi* at a Coral Reef. PLoS ONE 7(10): e46170. https://doi.org/10.1371/journal.pone.0046170

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Dewar H, Mous P, Domeier M, Muljadi A, Pet J, *et al.* (2008) Movements and site fidelity of the giant Manta ray, *Manta birostris*, in the Komodo Marine Park, Indonesia. Marine Biology 155: 121–133.

Dulvy NK, Baum JK, Clark S, Compagno LJV, Cortes E, Domingo A, Fordham S, Fowler S, Francis MP, Gibson C. 2008. You can swim but you can't hide: the global status and conservation of oceanic pelagic sharks and rays. Aquatic Conservation: Marine and Freshwater Ecosystems 18: 459–482

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Graham RT, Witt MJ, Castellanos DW, Remolina F, Maxwell S, Godley BJ, *et al.* (2012) Satellite Tracking of Manta Rays Highlights Challenges to Their Conservation. PLoS ONE 7(5): e36834. https://doi.org/10.1371/journal.pone.0036834

Title	Highly Migratory Fish Use of Shoal Habitat
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.Hansen@boem.gov)
Procurement Type(s)	T.B.D.
Performance Period	FY 2020–2023
Date Revised	April 11, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Dredging activities affect the physical and biological features of Sandbridge Shoal, which may in turn affect highly migratory fish use of the shoal.
Intervention	If we better understand the environmental setting, we can improve our National Environmental Policy Act (NEPA) analyses of impacts, as well as consultations that recommend mitigations.
Comparison	This study aims to compare highly migratory species (HMS) use of the shoal relative to other surrounding areas to help identify habitat preferences.
Outcome	We expect to improve the understanding of shoal use by highly migratory fishes across seasons and years.
Context	The study area would include Sandbridge Shoal, an active borrow area used by multiple stakeholders under the Bureau of Ocean Energy Management's (BOEM's) jurisdiction.

BOEM Information Need(s): Better understanding of fishes' use of habitats and sand features in the mid-Atlantic is important for BOEM's Marine Minerals Program (MMP) to evaluate the use and management of potential sand borrow areas in Federal waters. Sandbridge Shoal is a borrow area off of Virginia that has been used by multiple stakeholders to rebuild beaches. It is also an important habitat feature for many fishes, including HMS such as tunas, sharks, swordfish, and billfish (NMFS 2017). The National Oceanic & Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) manages HMS as a group, though habitat preferences for many species and lifestages are still unknown. Because dredging is expected to continue at Sandbridge Shoal, research on biological activity, biophysical coupling, and geomorphology will complement the geophysical and geotechnical data, and strengthen NEPA analyses that consider the potential effects of dredging.

Background: BOEM continues to investigate the ecological function of Outer Continental Shelf (OCS) geomorphic features, especially as it relates to dredge-related disruptions. Sandbridge Shoal off of Virginia supports multiple beach nourishment projects, and is expected to continue to support nourishment events for years. It also serves as Essential Fish Habitat (EFH) for many fish species, including HMS. BOEM consults with NOAA Fisheries on potential impacts to EFH. In a 2018 consultation, NOAA NMFS provided Conservation Recommendations (CRs) to consider potential effects on HMS, including spawning and rearing, resulting from dredging Sandbridge

Shoal. Many HMS are important to recreational, charter, and commercial fishing industries.

Objectives: Goals include obtaining data on the diversity and abundance of HMS on Sandbridge Shoal and nearby areas. The study should monitor how a variety of species and lifestages distribute on and around Sandbridge Shoal, and how that changes depending on temporal and abiotic factors (*e.g.*, currents, temperature, dissolved oxygen). Investigations should aim to characterize the importance of Sandbridge Shoal habitat to the reproduction, rearing, and foraging of HMS. This study should also monitor behavior and movements at a regional level and in relation to other geomorphic features along the U.S. Atlantic Coast. To better understand HMS distribution, this study should also investigate trophic interactions and prey preferences of HMS. If dredging occurs during the study, efforts should attempt to track behavior and distribution in response to construction.

The overarching hypotheses are that:

- Sandbridge Shoal is preferential habitat relative to other geomorphic features, and supports HMS throughout the year, though composition and abundance varies temporally;
- Atlantic shoals (including Sandbridge Shoal) are sites of reproductive activity for multiple HMS;
- HMS distribute according to both biotic (*i.e.*, prey resources) and abiotic (*e.g.*, temperature) forces; and
- if applicable, increased habitat variability and surface area has the potential to increase long-term diversity.

Methods: Surveys should be performed every season for two or three years. Monitoring approaches could include, at varying frequencies, biological sampling via plankton net, longline, and trawl surveys; water column profiles to measure current flow and direction and water chemistry (*e.g.*, temperature, salinity, pH, dissolved oxygen, turbidity, chlorophyll); direct observation using video cameras or remotely operated vehicles; acoustic surveys; and tagging.

These surveys would target multiple species and lifestages to gather a more comprehensive understanding of HMS shoal use. Data would then be modeled with abiotic factors to identify any environmental correlations with HMS occurrence. Sampling of fish distribution, composition, and biomass would occur before, during, and after dredging to investigate changes. Additionally, if available, a similar habitat not subject to dredging would be sampled as a control site, thus following a Before-After-Control-Impact (BACI) model.

BOEM will seek out industry and stakeholder knowledge, including local fishermen that target HMS off the mid-Atlantic. BOEM will also coordinate with NMFS to identify specific data gaps, survey methods, and challenges before field operations.

Opportunities may exist for leveraging ongoing surveys by other researchers, including other BOEM programs such as the Office of Renewable Energy Programs. BOEM will coordinate with other Federal, state, and academic entities currently researching HMS and other prey species, while also sharing data with other tagging efforts and existing telemetry arrays, as outlined in the Atlantic Cooperative Telemetry (ACT) Network.

Specific Research Question(s):

1. How do highly migratory species (HMS) use Sandbridge Shoal, particularly for reproduction and foraging? How does this compare to use of other available habitats in the mid-Atlantic?

2. How does HMS use of Sandbridge Shoal vary temporally? Which factors (biological, physical, or chemical) impact species' distributions most strongly?

3. How might dredging impacts (*e.g.*, turbidity, benthic prey removal, geomorphic shoal changes) affect HMS shoal use?

4. What best management practices and long-term management would maintain or improve Sandbridge Shoal habitat for HMS?

References:

National Marine Fisheries Service (NMFS). 2017. Final amendment 10 to the 2006 consolidated Atlantic highly migratory species fishery management plan: Essential Fish Habitat and environmental assessment. NOAA Fisheries Office of Sustainable Fisheries, Atlantic Highly Migratory Species Management Division. September 1, 2017. 442 pp.

Title	New York Bight (NYB) Fish, Fisheries, and Sand Features: In the Field
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (deena.hansen@boem.gov)
Procurement Type(s)	T.B.D.
Performance Period	FY 2020–2023
Date Revised	March 5, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The benthic environment in the NYB, both physical and biological features, will be affected by potential dredging activities (expected in the near future); this in turn will affect fishermen if landings are impacted.
Intervention	Characterize the potential impacts to the natural environment and fisheries from habitat alteration that may result from dredging activity.
Comparison	This study includes a before-after-control-impact (BACI) design to compare changes to the environment due to dredging with natural environmental changes.
Outcome	We expect to improve the understanding of the NYB ecosystem, including sand features, benthic infauna, fish composition, and fisheries dependence across seasons and years to improve our National Environmental Policy Act (NEPA) analyses of impacts, as well as consultations that recommend mitigations.
Context	The study area would include potential sand resource areas under the Bureau of Ocean Energy Management's (BOEM's) jurisdiction (*i.e.*, >3 nautical miles [nm] from shore) but no more than 50 m deep off of New York and New Jersey in the NYB.

BOEM Information Need(s): Better understanding of demersal and benthic organisms' occurrence in and use of sand habitats in the mid-Atlantic is important for BOEM's Marine Minerals Program (MMP) to inform and evaluate the use of potential sand borrow areas in Federal waters. This information would also support the Office of Renewable Energy Programs (OREP), because they are interested in understanding impacts and recovery of the benthic environment due to cable laying. BOEM anticipates that dredging may occur at multiple sites in Federal waters of the NYB (waters off of New Jersey and New York), in part to address the U.S. Army Corps of Engineers' (USACE's) projected sand deficiency for completing vital federally authorized shore protection projects in the next 5 years. Because dredging on the NYB Outer Continental Shelf (OCS) has been infrequent relative to other regions, research on biological activity, biophysical coupling, and geomorphology will complement the geophysical and geotechnical data, and strengthen NEPA analyses that consider the potential effects of dredging as well as inform consultations that recommend dredging mitigations.

Background: Limited information exists on the ecological function and biological significance of sand waves, ridges, swales, shoals, and other OCS features in the NYB, especially as it relates to dredge-related disruptions. Dredging activities under BOEM's jurisdiction generally occurs from 3 to 9 nm from shore. The NYB is inhabited by a diverse community of fishes and invertebrates, with both resident and transient species. Many of these species are economically important to commercial, recreational, and charter fishing industries. Additionally, strong seasonal fluctuations in abiotic factors are often linked to changes in biological diversity. Therefore the potential effects and recovery of sand dredging on ecosystem health and the abundance of fish and invertebrate communities may vary spatially and temporally. BOEM's current Cooperative Agreements with New York and New Jersey have gathered data on sand resources and resulted in delineations of potential borrow areas offshore in the NYB, and a current BOEM-funded study will identify existing data, as well as gaps. This research also aligns with state and regional research priorities that aim to identify and assess offshore sand resources, and improve sediment resource management strategies, especially as identified by USACE.

Objectives: Goals include obtaining baseline field data on the seafloor morphology, seabed and substrate sedimentary texture, and the diversity and abundance of demersal and benthic organisms which rely on sand habitats, specifically around potential sand resources off the NYB, from 3–9 nm offshore. The study should monitor conditions before, during, and after dredging, and should document biological activity and succession in these areas. A plan to gather local stakeholder and industry knowledge (*e.g.*, fisheries industry, sport fishing, diving), as well as state, Federal, and academic partners through appropriate and methodical outreach activities (*e.g.*, meetings, online forums, and fishing activity surveys) should be developed and implemented. The results of this effort should then be leveraged prior to activities to highlight issues and further inform study methodology. The MMP would also leverage OREP's experience and network within the region, and include them in outreach as appropriate.

Specific objectives include conducting studies focused on invertebrates, especially ecologically and economically significant shellfish, both demersal and pelagic fish species, and the presence of basal autotrophs. Data should be collected on species abundance, size composition, and distribution across the spatial continuum from the air-sea interface to the sea-sediment interface, in order to understand mesoscale and microscale habitat use, species assemblages, biodiversity, and habitat associations. If feasible and appropriate, BOEM would consider a BACI or Before-After-Control-Impact Paired-Series (BACIPS) design to compare dredged areas with non-dredged areas within the same region over time, so that temporal changes are observed. The overarching hypotheses are that:

- stakeholder and partner involvement strengthens BOEM's understanding of NYB, as well as the approach to gather additional information;

- areas with sand features and relief have greater habitat value for benthic invertebrate and fish species than flat areas with limited or no sand features, as determined by species' abundance, distribution, diversity, and assemblages;

- dredging results in changes to the aforementioned factors in the short-term, with faster ecological succession and recovery times with closer proximity to undredged areas; and

- increased habitat variability and surface area has the potential to increase long-term diversity.

Methods: Details of methodology will be informed by results of the NYB data and literature review currently funded in Fiscal Year 2019 (MM-19-02), as well as any new MMP research findings (*e.g.*, dredge pit evolution). Methods will be further refined by input provided from stakeholders (including academic, Federal, and industry sectors). Additional state partnerships will inform methods and scope, and identify any potential funding leverage.

General parameters are expected to be similar to methods outlined here. Surveys should be performed four to six times, both before, during (if practical), and after dredging, covering a timespan of two or three years. A control site should be monitored proximal to the dredge site, but outside of the expected zone of disruption (*e.g.*, a neighboring ridge-swale complex). Monitoring approaches could include, at varying frequencies:

- multibeam or side scan backscatter geophysical surveys to monitor seafloor morphology and characterize benthic substrate;

- biological sampling via grab samples, clam dredges, and trawl surveys;

- vibracore sampling of substrate;

- water column profiles to measure current flow and direction and water chemistry (*e.g.*, temperature, salinity, pH, dissolved oxygen, turbidity, chlorophyll);

- direct observation using video cameras or remotely operated vehicles; acoustic surveys; and

- tagging.

Organism distribution will be modeled with physical and chemical variables to identify any strong correlations.

Optimally, any monitoring approaches will employ a BACI design to obtain baseline data, and either verify the continued presence of pre-existing benthic and demersal organisms or identify changes. Opportunities may exist for expanding upon current BOEM funding through the Environmental Studies Program submittals from the New York Department of State for the National Oceanic and Atmospheric Administration's National Center for Coastal Ocean Science's substrate mapping which may include using an acoustic echosounder during shipboard surveys to quantify fish biomass, and from the New York State Department of Environmental Conservation for Atlantic sturgeon which could involve expanded species tagging and systematic receiver gate deployment for broader detection throughout BOEM's area of interest.

Specific Research Question(s):

1. What can the BOEM learn about OCS resources from NYB stakeholders and experts?
2. How do benthic and demersal organisms occur and use NYB sand resources? How does this distribution, composition, and biomass change temporally? What factors influence this distribution?
3. What are the effects (either theoretical or actual) of sand dredging on sand resources and associated resources? What are the recovery times?
4. What strategies might minimize impacts to fish resources associated with sand resources in NYB?

References:

Title	Seafloor Critical Mineral Deposit and Habitat Mapping in the Arctic and Aleutian Arc Large Marine Ecosystems
Administered by	Marine Minerals Program and Alaska OCS Region
BOEM Contact(s)	Jeff Reidenauer (jeffrey.reidenauer@boem.gov); MMP staff T.B.D.
Procurement Type(s)	Interagency agreement w/ U.S. Geological Survey (USGS) (contact: Dee Williams) and the National Oceanic & Atmospheric Administration (NOAA) through the National Oceanographic Partnership Program (NOPP)
Performance Period	FY 2020–2023
Date Revised	February 26, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Areas of the seafloor off Alaska, including the Arctic Ocean and Aleutian Arc, are likely to contain deposits of critical marine minerals that are essential to the economic and national security of the United States. In addition to identifying the locations of such deposits, information is needed to evaluate the potential environmental impacts associated with seabed mining in these areas.
Intervention	Multiple agencies, including BOEM, USGS, and NOAA, will work together to collect important baseline information on seafloor mineral deposits and the benthic ecosystems in which they occur. This should be conducted simultaneously with deposit assessments to initiate research needed prior to leasing or future development.
Comparison	This study would allow for comparison of the biodiversity and community composition associated with critical minerals in the Arctic and Aleutian Arc, as well as providing information to facilitate evaluation of differences between areas with and without these mineral deposits.
Outcome	The study aims to provide baseline and exploratory seafloor observations in areas of the Outer Continental Shelf (OCS) and Extended Continental Shelf in the Arctic and Aleutian Arc to aid in marine mineral discovery and extraction. This effort may also provide information on seafloor bathymetry, seep communities, and benthic ecosystems.
Context	This proposed work pertains to the Arctic Ocean and Aleutian Arc regions within the Alaska OCS, both of which contain permissive regions for marine minerals types that are of interest for base (Mn, Cu) and critical (Co, Sb, Sc, Te) elements.

BOEM Information Need(s): Executive Order 13817 outlines a new Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals by “increasing activity at all levels of the supply chain, including exploration, mining, concentration, separation, alloying, recycling, and reprocessing.” This study would facilitate implementation of this directive by providing baseline and exploratory seafloor observations in targeted areas of the Arctic and Aleutian Arc that hold great potential for marine mineral discovery and extraction. Results specific to seep communities, bathymetry, and benthic ecosystems would also inform National Environmental Policy

Act (NEPA) analyses related to potential future lease sales, Exploration Plans, and Development and Production Plans.

Background: A recent report entitled "America's Oceans: A Decadal Vision" by the National Science and Technology Council identifies pressing research needs within the ocean science and technology enterprise for the decade 2018–2028. One priority, Assessing Marine Critical Minerals, included the objectives to "identify and quantify the location, size, and nature of important deep-sea minerals… and conduct basic and applied research to characterize the effects of deep-sea mining on vulnerable marine ecosystems, including documentation of deep-sea biodiversity, and improved prediction of the scale and extent of environmental impacts from deep-sea exploration."

The Arctic Ocean is likely to contain the three marine mineral deposit types generating the greatest global interest: manganese (Mn) (otherwise known as polymetallic) nodules, ferromanganese (Fe-Mn) crusts, and seafloor massive sulfides. Extensive Fe-Mn crust and Mn nodule deposits are known to exist, and are globally unique because of their high content of scandium, a very rare metal used to make fuel-efficient aircraft. However, the extent of these mineral deposits is poorly constrained. The Aleutian Arc also constitutes a permissive region for seafloor sulfides that has never been explored. Seafloor sulfides in arcs may be particularly rich in antimony, important for corrosion resistance in alloys and batteries. In addition, the Arctic Ocean is a unique biological and geochemical region that will become an increasingly competitive arena for resource exploration and development as shipping lanes open in tandem with melting sea ice.

The USGS Coastal/Marine Hazards and Resources Program is a world leader in seafloor mineral science and mapping whose activities support the current Department of the Interior priorities and Executive Order 13817. In support of the State Department, the USGS has recently completed seafloor maps that define the boundaries of the potential Extended Continental Shelf expansion. USGS is also currently working with BOEM, NOAA, and non-governmental organization partners such as Monterey Bay Aquarium Research Institute in the Pacific and Atlantic Oceans to develop new technologies and methods to detect and map mineral deposits.

Objectives:

- Identify the location and distribution of critical minerals and their associated biological communities on the seafloor in the Arctic and Aleutian Arc.
- Provide baseline information needed to evaluate the potential environmental impacts associated with seabed mining in these areas.

Methods: NOPP sponsorship and senior management support from all partner agencies will help ensure exceptional communication and collaboration between all parties, from initial planning stages to final report. Each agency will provide its unique expertise and capabilities: BOEM will focus on fulfilling management needs and regulatory responsibilities; NOAA will focus on ship/submersible logistics in support of seabed surveys, data management, education, and outreach; and USGS will focus on technical and multi-disciplinary geologic and ecologic scientific expertise.

To the extent practicable and convenient, relevant information about benthic ecosystems will be collected and methane and oil-seep communities will also be explored, mapped and assessed from the same research platform to provide additional information highly relevant to ongoing oil and gas leasing operations in the Beaufort and Chukchi Seas. Refined seafloor bathymetry data could also be strategically collected to improve resolution in specific areas.

Specific Research Question(s):

1. What are the location and types of significant mineral deposits in the Beaufort and Chukchi Seas, as well as the Aleutian Arc?

2. What types of biological communities exist at these unique seafloor mineral deposits?

3. What are the regional mechanisms of seafloor mineral development?

4. What is the viability of harvesting identified deposits?

5. What are the potential environmental impacts of marine mineral mining in these areas?

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

Title	Comprehensive Synthesis of Impacts to Marine Mammals from Oil and Gas Activities in the Alaska Outer Continental Shelf (OCS), 2000–2020
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	A large amount of information exists related to the potential effects of oil and gas exploration and development and production activities on marine mammals in Alaska. However, this information is dispersed throughout the body of scientific literature, or held by government agencies and other entities.
Intervention	This study will synthesize the relevant environmental analyses and reports to develop a summary document that is readily accessible.
Comparison	The synthesis will provide an enhanced understanding of how effects of oil and gas development relate to the overall impact of anthropogenic activities in Alaska.
Outcome	A synthesis of potential direct, indirect, and cumulative effects on marine mammals from oil and gas activities.
Context	Beaufort Sea, Chukchi Sea, Cook Inlet

BOEM Information Need(s): This study will provide BOEM, other Federal agencies, and industry analysts with a synthesis of potential direct, indirect, and cumulative effects on marine mammals from oil and gas activities. This will include a retrospective summary of mitigation measures that have been implemented to avoid or minimize adverse impacts to marine mammals based on Federal and state agency documents, as well as reports provided to BOEM, the National Marine Fisheries Service (NMFS), or the U.S. Fish & Wildlife Service (FWS) by industry. Information on the integration of local and traditional knowledge into mitigation measures (if available) from Alaska Natives and Alaska Native Organizations into the development of mitigation measures will also be summarized. Results from this study will support cumulative effects analysis under the National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA), and the Endangered Species Act (ESA) for future lease sales, exploration plans, and development and production plans in the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas.

Background: BOEM, as well as other Federal and state agencies (*e.g.*, FWS, NMFS, and the Alaska Department of Fish & Game) are required to understand the impacts of their actions on the natural environment as well as the human environment. BOEM, specifically, is required by Section 20 of the Outer Continental Shelf Lands Act (OCSLA), 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." Since 1973 BOEM has accomplished accumulating and archiving much of the information needed in Alaska through the Environmental Studies Program (ESP).

However, all agencies are required to review the effects of their actions under several environmental statutes including NEPA, MMPA, and ESA. The studies produced by FWS and NMFS as a result of these requirements are often not part of the ESP. This information sits not just within the ESP, or in peer-reviewed literature, but also in scores of other reports and impact analyses that are required for each permitted, funded, or authorized project by the above environmental statutes, and reside in agency files not readily accessible in many cases.

Objectives: This study will synthesize information from various environmental analyses about the direct, indirect, and cumulative impacts of oil and gas resource development in the Arctic and Cook Inlet on marine mammals and put these impacts in a context relative to overall impacts of human activities in OCS areas.

Methods: Researchers will work with BOEM subject matter experts (SMEs), and staff from other Federal agencies, to obtain and review pertinent literature (*e.g.*, reports to Federal agencies, MMPA authorizations, NEPA environmental impact analyses, biological opinions, produced by the Alaska regional offices of BOEM, FWS and NMFS, and the NMFS Office of Protected Resources, Silver Spring, Maryland). These studies have been in large part the result of Federal actions permitted, funded, and authorized since 2000 and have addressed impacts of oil and gas activities in the Alaska OCS. Researchers will also coordinate with staff from the State of Alaska to obtain similar information related to oil and gas activities in state waters. Information that addresses the aforementioned objectives in peer-reviewed literature, reports, and summary documents will be synthesized into concise statements that can be easily and readily used in future environmental analyses to describe the effects of oil and gas infrastructure and activities in context with other anthropogenic activities to support future planning and decision making.

Specific Research Question(s):

1. What are the direct, indirect, and cumulative effects on marine mammals of increased levels of anthropogenic noise from exploration and construction activities in Alaska from 2000–2020?

2. What are the direct, indirect, and cumulative effects on marine mammals of increased levels of other sources of disturbance including, but not limited to, construction and maintenance of ice roads, increased levels of traffic including vehicle, air support, and vessel traffic?

References:

Title	Cook Inlet Beluga Acoustic Monitoring in Lower Cook Inlet (LCI) Rivers
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2022
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Cook Inlet belugas (CIB) (*Delphinapterus leucas*) are an endangered and genetically distinct population in decline, with an estimated population size of only 328 whales in 2016. Although the reason for a lack of recovery is uncertain, one potential contributor is disturbance from anthropogenic noise, especially in critical foraging habitat such as river mouths.
Intervention	The year-round presence and habitat use of CIB in LCI near river mouths will be monitored for acoustically active whales, with a focus on quantifying feeding bouts. Changes in feeding activity or spatial displacement from feeding areas due to anthropogenic activities will be monitored.
Comparison	Study results will be evaluated in the context of recent and historical observations and assessments of CIB habitat use in LCI.
Outcome	Findings from this study would assist with formulating effective mitigation measures (*e.g.*, temporal, spatial) for oil and gas exploration and development activities in or near CIB critical habitat, to help in the recovery of the endangered population.
Context	Cook Inlet Planning Area

BOEM Information Need(s): BOEM needs information about the summer and winter range of CIB and how the range might overlap with areas of potential oil and gas activities. A better understanding of beluga movements, location and timing of important feeding areas, and characterization of the acoustic environment year-round will support BOEM's Oil Spill Risk Analysis, National Environmental Policy Act analyses, Endangered Species Act (ESA) Section 7 consultations, and development of mitigation measures related to future lease sales in Cook Inlet, as well as potential exploration and development on existing leases.

Background: The Distinct Population Segment of Cook Inlet beluga whales, which remains within Cook Inlet year-round, was listed as endangered under the ESA in 2008 following a major decline in abundance (~50%) in the 1990s associated with overhunting. Although hunting ended in 2000, the CIB population is not increasing, indicating that factors other than hunting currently impede recovery. The summer range of CIBs now occurs mostly in the Upper Cook Inlet (UCI), north of Kalgin Island, however prior to 1980, belugas ranged south of Kalgin Island and into Kachemak Bay. Their winter range is largely unknown but limited satellite telemetry data showed use of deeper water habitats farther from shore. Research efforts in 2018 (BOEM/ National

Marine Fisheries Service [NMFS] funded aerial surveys, NMFS supported citizen science efforts, NMFS/Sea Grant study) have demonstrated the presence of belugas through much of LCI, including along the coastline and in the rivers, as well as near or within the lease areas. Four belugas were also observed in Kachemak Bay for the first time in several years.

Historical accounts from Native hunters and local residents indicate that belugas have used river mouths such as the Kenai and Kasilof Rivers between April and November while feeding on anadromous fish species, notably eulachon and Pacific salmon. Although little contemporary work has focused on these LCI rivers, the presence of CIB has been noted in these areas through passive acoustic monitoring and sightings.

Beluga whales are highly dependent on sound to communicate, navigate, and find prey. Understanding natural ambient noise levels will allow noise from anthropogenic sources to be evaluated and provide insight about whether noise is a factor in beluga habitat use.

Objectives:

- Acoustically determine the seasonal foraging occurrence of CIB in LCI rivers.
- Characterize the type and level of noise from anthropogenic activities that have the potential to disturb CIB in LCI, and quantify the overlap with CIB distribution.
- Develop a range-wise evaluation of noise levels (natural and anthropogenic), potential feeding areas, and other relevant attributes.
- Assess correlations of CIB occurrence with currents, tides, and physical characteristics.
- Summarize acoustics recorded for other marine mammals.

Methods: Acoustic cetacean and porpoise detectors (C-PODs) will be deployed to monitor beluga presence and foraging at various river mouths, including the Kenai and Kasilof Rivers. C-PODs “listen” continuously for over 200 days and can detect beluga echolocation up to 900 m away. CIB presence will be identified by detection of echolocation signals and results will be analyzed to build seasonal presence plots. Foraging will be identified by the unique echolocation signature emitted by odontocetes when chasing prey (click trains ending in buzzes). The Kenai River would be monitored year-round while NMFS will monitor UCI locations only during the open-water season.

This project will also leverage NMFS’s citizen science efforts to incorporate visual observations to provide a quantified measure of the level and type of anthropogenic activities in and around the river sections monitored acoustically. NMFS will also collaborate with the Beluga Whale Alliance and Alaska Wildlife Alliance to collect additional visual observation data at the several acoustically monitored river locations. Helicopters or small planes may be needed to deploy C-PODs in difficult to access locations. This study can build upon previous experience acoustically monitoring river mouths in Cook Inlet (*e.g.*, Eagle River, Chickaloon River, and Little Susitna River).

Specific Research Question(s):

1. What rivers are used by CIB to feed and when?
2. Do CIB change behavior in the presence of anthropogenic activities and if so, is it due to certain levels or types of anthropogenic activities?
3. How do the acoustic data and visual data compare?

References:

Title	Determining Important Nearshore and Marine Sites for Post-breeding Shorebirds, Beaufort Sea
Administered by	Alaska OCS Region
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2023
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Shorebirds use nearshore and marine areas near proposed oil and gas exploration sites, including the planned Liberty development site. Impacts of industrial activity may affect shorebirds staging in this area, but more information is needed about the extent of shorebird use near these areas.
Intervention	This study will equip three species of shorebirds known to use the nearshore and marine areas of the Beaufort Sea with satellite tags to determine their timing, duration of stay, and movement among post-breeding staging sites.
Comparison	Data will be collected for three post-breeding periods to assess inter-annual variability and importance of sites near the proposed Liberty development site. Such data will allow for a comparison of relative uses and values of sites across the Beaufort Sea coast.
Outcome	Results will include detailed information on nearshore and marine area site use in relation to seasonal timing, weather, and species differences.
Context	Beaufort Sea

BOEM Information Need(s): Information on shorebirds that are using the nearshore and marine waters is needed to assess potential effects of the construction and operation of the Liberty development, and to improve Endangered Species Act (ESA) Section 7 Consultations and National Environmental Policy Act (NEPA) analyses pertinent to other potential oil and gas development on the Outer Continental Shelf.

Background: Many North American shorebird species are declining at alarming rates 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 migrate successfully to their non-breeding grounds (Connors *et al.*, 2009). These areas are experiencing large-scale environmental change and increased human activity. Receding Arctic pack ice is altering the distribution of marine food webs (Arrigo *et al.*, 2008), and unprecedented storm surges and glacial melt are affecting 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 increased the potential for oil and gas exploration, which could affect shorebirds directly or indirectly. More information is needed about shorebird distribution and movement among intertidal and marine areas in Arctic Alaska. Information is limited regarding densities or abundance in any one location due to difficulties encountered in coastal surveys related to correcting for detectability, trouble identifying individual birds to species from the air, and the lack of residency times for individual birds (Taylor *et al.*, 2010). This project proposes to target shorebird species breeding near the new Liberty Development site, as well as species breeding in the Arctic National Wildlife Reserve, where new oil and gas leasing is planned. These locations reflect the habitat preferences of the species in an unbiased way, and can then be georeferenced with landscape features to assess the local threats associated with potential oil spills and other environmental changes.

Objectives:

- Assess the use of nearshore and marine areas by three species of post-breeding shorebirds, including seasonal timing, residence time, and connectivity between marine areas and coastal breeding sites, at multiple locations across the Beaufort Sea.
- Compare use among years and evaluate the relative importance of different areas adjacent to and distant from the proposed Liberty Oil Development site.
- Evaluate potential threats to shorebirds, particularly in response to changing pack ice conditions, storms, increased vessel traffic, and offshore oil and gas development.

Methods: Shorebirds nesting in tundra areas or staging at nearshore areas will be captured during three field seasons in June and July. Birds will be trapped, processed, and equipped with solar-powered, 2 gram platform transmitter terminal (PTT) Advanced Research and Global Observation Satellite (ARGOS) tags using established protocols from prior studies. The small tags transmit data to ARGOS and thus do not require recapture of birds. Due to the polar orbit of the ARGOS and the 24-hour sun in the Arctic, each tag is anticipated to generate extensive datasets with high accuracy. Geographic information system (GIS)-based spatial analysis tools will be used to analyze PTT locations to generate track lines, determine probabilistic migration routes, timing of movements, site use, residence time, and connectivity, enabling researchers to pinpoint important habitats and linkages between breeding and migration sites. To distinguish stopover sites, researchers will overlap utilization distributions for multiple individuals (Kramer *et al.*, 2017). This process will be repeated to identify areas that are important to multiple species. Researchers will also calculate the proportion of total bird days spent at each hotspot for all individuals of a species.

Specific Research Question(s):

1. What migratory routes, important nearshore stopover sites, and marine habitats are used by post-breeding shorebird species in the Beaufort Sea?

2. Are some stopover sites more important than others, and why?

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Title	Early Detection Plan for Marine Non-Native Species on the Arctic Outer Continental Shelf (OCS)
Administered by	Alaska OCS Region
BOEM Contact(s)	Lorena Edenfield (lorena.edenfield@boem.gov), Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Interagency or Cooperative agreement
Performance Period	FY 2020–2023
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The threat of introductions of marine Non-Native Species (mNNS) in the Arctic is increasing with the uptick in Arctic shipping activity and infrastructure development. Coastal communities that are reliant on the services that marine ecosystems provide are particularly vulnerable. Early detection of mNNS is vital for potential control, eradication, and prevention of further spread.
Intervention	This project will create a baseline record of marine biodiversity, both by establishing monitoring plans and by collecting reference taxonomic and molecular samples of marine invertebrates, algae, and hard substrate community organisms in the Beaufort Sea and Chukchi Sea. The project will also capture the state of local traditional knowledge (LTK) on mNNS and establish long-term monitoring of the coastal ecosystem, offering a direct and cost-effective way to detect presence of mNNS.
Comparison	This monitoring complements ongoing measures by multiple organizations elsewhere in Alaska (*e.g.*, Prince William Sound, Cook Inlet, Boulder Patch & Kelp Communities) to establish a baseline record of plankton, algae and hard substrate communities, including those currently associated with existing infrastructure in state waters. Repeat monitoring in the future will enable detection of introduced species against natural variability.
Outcome	This study will create a baseline data record that incorporates LTK and establish continued monitoring involving local residents at offshore infrastructure.
Context	Beaufort Sea and Chukchi Sea, focusing on areas with existing or potential future offshore infrastructure.

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. Potential introductions of mNNS to the U.S. Arctic are a recognized issue in relation to increases in ship traffic, including vessels related to offshore oil and gas activities. During the Liberty project approval process the need for mNNS monitoring was emphasized during an Essential Fish Habitat Consultation with the National Oceanic & Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS). Results from this study will inform cumulative effects analyses under the National

Environmental Policy Act (NEPA) for future lease sales and may facilitate development of potential mitigation measures.

Background: New infrastructure on the Alaska OCS would create new habitats that could be optimal for establishment of mNNS. Ship traffic to support installations and ocean warming further increase the potential for the introduction of mNNS. Because of the remoteness of the Arctic Ocean, monitoring for mNNS has not been a primary focus, but the risk of introductions is increasing.

The project will complement BOEM-supported efforts in Cook Inlet (*e.g.* NT-x10; Expanded Guide to Some Common Fouling Invertebrates of Alaska with Focus on Known and Potential Marine Invasive Species Kachemak Bay Marine National Estuarine Research Reserve), contribute to AK-15-01 (Arctic Marine Biodiversity Observing Network [AMBON]), and augment AK-11-14 (Arctic Nearshore Impact Monitoring in Development Area [ANIMIDA] III: Boulder Patch and other kelp communities in the development area). Additionally, it will capture LTK and make it accessible to a global audience (*e.g.*, through the Alaska Ocean Observing System [AOOS] and Local Environmental Observer [LEO] network). This study also could help to extend the reach of PlateWatch (platewatch.nisbase.org), a citizen science network operational in southeast Alaska, and parallel efforts by the Prince William Sound Regional Citizens' Advisory Council to monitor plankton communities.

Objectives: This project will:

- establish a monitoring scheme for detection of attached and planktonic mNNS in the vicinity of offshore infrastructure in the Arctic;
- record LTK for comparison and inclusion into biological assessments; and
- establish a continued monitoring scheme that includes citizen science with participation by local residents.

Methods: Biological surveys will include deployment of settlement devices (ceramic panels) to monitor the fouling community, and plankton tows and collection of open-water environmental deoxyribonucleic acid (eDNA) samples to detect and quantify invertebrate assemblage composition. Taxonomic and genetic data will be verified by experts, compared with and submitted to public databases (*e.g.*, Ocean Biogeographic Information System [OBIS], GenBank) to establish identity and likelihood of mNNS. Species records will be published on the AOOS website, sequences will be accessible through GenBank. The data will also be linked with results from other relevant projects, such as the AMBON and the Arctic Shelf Growth, Advection, Respiration and Deposition Rate Experiments (ASGARD).

The status of LTK as it relates to marine invertebrates and introductions of non-native species will be captured via community and panel discussions (AK-15-05: *Traditional Knowledge Implementation: Accessing Arctic Community Panels of Subject Matter Experts*) and digitization of physical records. Local citizens will be involved with the field surveys and plans to establish a long-term monitoring scheme.

Specific Research Question(s):

1. What do marine invertebrate communities look like near proposed installations in the OCS?
2. Are marine species being introduced to the region in association with oil and gas exploration activities?
3. How can LTK inform mNNS monitoring and management?

References:

Title	Gulf of Alaska and Bering Sea Coupled Ice-ocean Circulation Model
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2020–2022
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The 2019–2024 National OCS Oil and Gas Leasing Draft Proposed Program identifies lease sales in 11 Alaska Outer Continental Shelf (OCS) planning areas throughout the Bering Sea and Gulf of Alaska. These lease sales are all currently proposed to be held in 2023. Prior to holding the lease sales, BOEM will need to conduct an oil spill risk analysis (OSRA) that requires information about the surface currents, winds and ice in these areas.
Intervention	Existing community-based numerical circulation models will be updated with modern forcing fields and boundary conditions to provide new estimates of the surface ocean currents in the Bering Sea and Gulf of Alaska.
Comparison	Modeled currents and water column hydrography will be assessed with respect to *in situ* observational (*e.g.*, moorings, shipboard hydrography) and remotely sensed (*e.g.*, sea surface temperature, satellite altimetry) data.
Outcome	The study will provide gridded data fields, including: ocean surface current, wind, and ice velocities and ice concentration.
Context	OCS planning areas in the Bering Sea and Gulf of Alaska from the Bering Strait to southeast Alaska, including the Aleutian Arc.

BOEM Information Need(s): OSRA is a cornerstone foundation for evaluating alternatives in OCS oil and gas leasing National Environmental Policy Act (NEPA) analyses and oil spill response plans. The results of this study will be used by BOEM to create the OSRA estimates of oil spill trajectories. The ocean models have been shown to have skill in estimating the near-surface currents. This study will result in a time series of simulated current and wind fields that will be compared to observational data and will be used in the OSRA calculations.

Background: Ocean currents in the Bering Sea and the Gulf of Alaska are forced by a combination of winds, tides, and horizontal density gradients. The Alaska Coastal Current is an important element of the nearshore circulation that flows along the edge of the northern Gulf of Alaska, through the Bering Sea, and into the Arctic Ocean. The Bering Sea experiences seasonal ice coverage. Ice also forms in Cook Inlet, but its effect on the overall circulation pattern has not been studied in detail.

The circulation of the Bering Sea and Gulf of Alaska has been studied through previous model simulations, with funding by the National Oceanic & Atmospheric Administration (NOAA), BOEM, U.S. Army Corps of Engineers (USACE), and others. The models were subjected to many sensitivity calculations and skill was assessed by teams of oceanographers and the models were shown to have significant skill in simulating the ocean surface currents. Many field programs that may provide observational data for assimilation and validation have also been conducted in this area.

Objectives: The objective of this study is to obtain simulations of the surface circulation in the Bering Sea and Gulf of Alaska for use in OSRA.

Methods: This study will adapt an existing community ocean model to produce a high-resolution hindcast of the current fields in the Bering Sea and Gulf of Alaska, using data assimilation methods whenever practical. The hindcast period will be determined by data availability, but shall be no less than 10 years. Skill assessment comparisons against historical field observations (*i.e.*, current meters and drifting buoy velocities) shall be performed. The simulations must have significant skill in reproducing the near-surface currents, compared to drifting buoy data, fixed current meters, Acoustic Doppler Current Profilers (ADCPs), and other data sets. The results of the model will provide environmental variability input into the OSRA calculations.

Specific Research Question(s):

1. How does flow from the Gulf of Alaska disperse upon passing through Unimak pass?

2. What are the freshwater pathways of the southeast Bering Sea and how do these vary with respect to freshwater forcing and winds?

3. What atmospheric, bathymetric, and sea ice conditions dominate the oceanic circulation response to variable forcing?

4. How closely do numerical ocean circulation models reproduce observed currents?

References:

Title	The Impact of Marine Fish Communities on Red-throated Loon Productivity in the Beaufort Sea
Administered by	Alaska OCS Region
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2023
Date Revised	March 1, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Red-throated loon populations have declined in the Beaufort Sea. Because adult red-throated loons have high survival rates, this trend suggests that reproductive success is poor. Red-throated loons depend on marine fish prey and availability and species composition are highly variable across Arctic nearshore areas and have shifted across decadal timescales concurrent with the negative population trend for red-throated loons.
Intervention	This study will evaluate factors affecting the reproductive success of red-throated loons nesting in two regions of the Beaufort Sea. Cameras at loon nests will be used to estimate nest success and chick survival. A subset of loons will be captured to acquire tissue samples for diet composition and to be outfitted with Global Positioning System (GPS) transmitters to provide fine-scale resolution of loon feeding habitat. Concurrent fish sampling will assess prey preferences by identifying the relative abundance and species composition of fish prey.
Comparison	This study will compare the reproductive success of red-throated loons nesting in two regions of the Beaufort Sea with contrasting fish communities. This study will sample at two study sites: one focused on the Colville River Delta with higher availability and diversity of whitefish prey (*e.g.*, least cisco, *Coregonus sardinella*) and the second near Kaktovik in a region without large rivers resulting in distinctly different prey communities.
Outcome	This project will examine the potential for differences in fish communities to drive changes in loon reproductive success and contribute to observed population decline. It will provide spatially explicit information for loon feeding habitats and a quantitative assessment of loon diet and prey quality to inform management of areas of ongoing and future oil and gas development.
Context	Nearshore Beaufort Sea

BOEM Information Need(s): BOEM requires information to assess cumulative impacts on red-throated loons due to potential disturbance and displacement around offshore and inshore industrial facilities, ecological changes in nearshore environments, or accumulation of contaminants exposure. Information from this study will support BOEM in assessing red-throated loon habitat use in marine waters and dynamics of predator-prey relationships of loons and their prey to evaluate the sensitivity of loon reproductive success to fish prey type and availability.

Background: The long-term population decline of red-throated loons in northern Alaska has continued, suggesting that ecological conditions are changing in the nearshore environment. Given their predilection for marine fish of high fat content, populations of red-throated loons are sensitive to the abundance and nutritional value of fish prey. Previous studies from other geographic regions have shown that some keystone fish species (*e.g.*, least cisco) are critical to enabling red-throated loon breeding success. Flight and dive costs to capture fish are high, thus perturbations or habitat differences that result in lower densities or quality of fish prey may have energetic consequences that could contribute to deficient breeding success. Ongoing nearshore fish community research in the Beaufort Sea, *Nearshore fish surveys in the Beaufort Sea: Examining long-term community change and the role of nearshore habitats*, provides recent (2017–2018) spatial contrast in fish communities and an understanding of temporal variation in the relevant fish communities by revisiting historic sample sites and drawing comparisons to previous decades.

Objectives: The main objective of this study is to assess the response of red-throated loon reproductive success to differences in the relative abundance, composition, and nutritional content of nearshore fish communities that vary in space and time.

Methods: Researchers will conduct an integrative study of fish and loons at two locations along the Beaufort Sea coast over three years. Time-lapse cameras will acquire images of nesting loons to estimate breeding success. GPS transmitters attached to adult loons during nesting or chick rearing will allow tracking flight patterns, which will indicate if the loon is in the water and at what depth to determine dive duration and energy expenditure of adult loons during foraging trips. Fat biopsies from adult birds and nearly fledged young will be used for fatty acid diet analysis and blood serum for stable isotope analysis to provide taxa-specific prey information through comparisons to a fish prey library. The combination of fatty acid and stable isotope indicators can provide stronger diet inferences than either technique alone. Fyke nets and 3 m beam trawls will be used to sample fish in nearshore habitats. Trawls provide access to habitat distant from the shoreline and comparable to collection methods used on BOEM-funded Transboundary cruise. These gear types allow for comparability to existing databases of fish abundance and species composition in nearshore and continental shelf habitats.

We anticipate this partnership will include some co-funding from the U.S. Geological Survey.

Specific Research Question(s):

1. What is the reproductive success of red-throated loons nesting along the Beaufort Sea coastline?

2. Where are the important Beaufort Sea nearshore and offshore feeding areas for red-throated loons?

3. What is the diet of red-throated loons during the breeding season?

4. What is the relative quality of common nearshore fish prey?
5. Is loon reproductive success related to diet composition?
6. Is loon diet composition similar to the fish community composition?
7. What are the potential differences in foraging activity budgets to acquire prey between study sites?

References:

Title	Improvements to the Oil Spill Risk Analysis (OSRA) Input Quality Assurance/Quality Control (QA/QC) and Validation
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov), Chase Stoudt (chase.stoudt@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2020–2021
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	General Circulation Model (GCM) inputs to the OSRA model do not have a standardized QA/QC check. Every contracted GCM is validated in a different way from the one previous. A need exists for standardized validation and QA/QC procedures.
Intervention	Model results need to be examined in detail for GCM quality and errors. Artifacts such as insufficiently radiative boundaries and grid issues need to be identified if present. Sea ice concentration, velocity, and water velocity need to be examined for reasonable values and to determine that the GCM is performing well.
Comparison	Sea ice concentrations and velocities will be compared with available passive microwave public products such as Special Sensor Microwave Imager (SSMI) ice concentration and the *Institut français de recherche pour l'exploitation de la mer* (IFREMER) ice drift velocity products. Surface current velocities will be compared to Acoustic Doppler Current Profiler (ADCP) data BOEM has already collected in the Alaska Outer Continental Shelf (OCS), subject to temporal and geographic limitations.
Outcome	A product will be created to compare GCM output to passive microwave and *in situ* ADCP data in a standardized way.
Context	Study products will be applicable to all Alaska OCS Planning Areas and may be extended to all OCS Planning Areas.

BOEM Information Need(s): Output from the OSRA model is used to drive National Environmental Policy Act (NEPA) analyses for OCS block sales. Refinements in GCM inputs are essential for keeping the OSRA model up to date. Understanding oil spill risk is essential to managing OCS resources.

Background: OSRA is a key component in driving NEPA analysis. Oil spill trajectories are essential when identifying impacts to important sociocultural, biological, and ecological resources. When offering up lease blocks for sale, it is vital that BOEM provides both the risk of an oil spill occurring and the chance a spill could contact these resources. GCM inputs are key in order to accurately forecast the chance of a spill contacting resources, thus it is pertinent to validate these data before input into the OSRA model. Currently we have no formal validation of this data and would like to standardize this process. Standardization of this process will apply to every part of the Alaska OCS and all OSRA runs.

Objectives:

- Streamline QA/QC of OSRA GCM inputs.
- Provide additional ground-truthing of OSRA GCM inputs with real world data.

Methods: SSMI sea ice concentration will be downloaded from the National Snow and Ice Data Center (NSIDC) using National Aeronautics & Space Administration (NASA) algorithm 51 (Cavalieri *et al.*, 1996). This dataset will be processed into the appropriate time and space bins for GCM comparison. Correspondingly the IFREMER sea ice drift dataset (Girard-Ardhuin and Ezraty 2012) will also be processed into the appropriate time and space bins for comparison to GCM output. An example of an ADCP dataset used to validate surface current vectors could come from OCS Study BOEM 2017-65 (Weingartner *et al.*, 2017). This dataset would also be processed into the appropriate time and space bins for comparison to the GCM. Other circulation studies would be used for various parts of the Alaska OCS. After processing into the appropriate time and space bins, statistics of fit will be performed by a linear regression for all three datasets.

Specific Research Question(s): How can validation of results from a GCM be standardized?

References:

Cavalieri, D. J., C. L. Parkinson, P. Gloersen, H. J. Zwally. 1996, updated yearly. Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data, Version 1. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/8GQ8LZQVL0VL.

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Weingartner, T.J., R. Pickart, P. Winsor, *et al.* 2017. Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas. Fairbanks, AK: U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-065. 221 p. https://marinecadastre.gov/espis/#/search/study/26869.

Title	Integrated Oil-spill Occurrence Estimator (OSOE) Model for Alaska, Atlantic, Pacific, and Gulf Outer Continental Shelf (OCS) Regions
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2023
Date Revised	March 2, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The Alaska OCS Region takes an OSOE approach that incorporates fault tree modeling in its oil-spill risk analyses. If other regions wish to conduct an OSOE and risk assessment, they will likely either develop a new model or attempt to modify and adapt the existing Alaska OCS fault tree model. In either case, there are likely to be different assumptions, algorithms, and hence results with different interpretations, making it difficult and time consuming to compare the results from one region to those of other regions.
Intervention	The solution of the problem is to develop an integrated set of models that can be applied, with appropriate input changes, to any region.
Comparison	Numerous trial runs would be conducted for each region. The results will be inspected and the methodology will be adjusted if needed.
Outcome	An OSOE modeling system that can be applied to any area of the OCS.
Context	The results will be applicable to all OCS Planning Areas.

BOEM Information Need(s): BOEM conducts oil-spill risk analysis (OSRA) to support environmental impact statements (EISs) that are completed before conducting the proposed lease sales and prior to approval of exploration or development and production plans. The estimated number of spills and the probability of oil-spill occurrence is a key piece of important information for National Environmental Policy Act (NEPA) analysis. As OCS leasing is expanded to more areas, BOEM needs a consistent approach for estimating oil-spill occurrence across different areas of the OCS to allow for comparison of results from one region to another.

Background: Estimates of occurrence rates for offshore oil spills are useful for analyzing potential oil-spill impacts and for oil-spill response contingency planning. With the implementation of the Oil Pollution Act of 1990, estimates of oil-spill occurrence became even more important to natural resource trustees, as well as to responsible parties involved in oil and gas activities.

The Alaska OCS Region takes an OSOE approach that incorporates fault tree modeling in its oil-spill risk analyses. If other regions wish to conduct an OSOE and risk assessment, they will likely either develop a new model or attempt to modify and adapt the existing Alaska OCS fault tree model. In either case, there are likely to be different assumptions, algorithms, and hence results with different interpretations, making it difficult and time consuming to compare the results from one region to those of other regions.

Objectives: This study will create an integrated OSOE and risk model that is applicable to all regions of the OCS.

Methods: Researchers will evaluate appropriate OSOE inputs for various regions of the OCS. A generalized modeling framework will be developed using the current OSOE used in the Alaska OCS Region as a starting point. Researchers will then integrate other regions one at a time. Results will be reviewed and validated at each phase.

Specific Research Question(s):

1. What are similarities and differences in oil spill causal factors for offshore oil and gas facilities or from subsea pipelines or other OCS crude oil transport methods between OCS planning areas?

2. What are the differences in OSOE structure and inputs for each of the regions?

References:

Title	Kenai Peninsula Borough (KPB) Economy, 2008 to 2018
Administered by	Alaska OCS Region
BOEM Contact(s)	Jim Lima (james.lima@boem.gov), Laura Mansfield (laura.mansfield@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	March 5, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The KPB is the area that bears the preponderance of costs and benefits of Outer Continental Shelf (OCS) development in the Cook Inlet Planning Area. The diverse communities of the area have been experiencing unprecedented changing economic conditions including an ongoing state-wide recession.
Intervention	The study will provide a qualitative and quantitative profile of the borough and its constituent villages, towns and cities over the study period. Information on the changes will come from primary and secondary sources in relation to trends in the State of Alaska, such as comprehensive land use and zoning plans, census data, *etc*. This typology distinguished effects between these types of communities in previous studies (Fall *et al.*, 2001) and BOEM Environmental Impact Statements for Cook Inlet (USDOI, MMS 2003; USDOI, BOEM 2016).
Comparison	The trend study will provide data to facilitate further comparison of the effects on communities in National Environmental Policy Act (NEPA) analyses.
Outcome	Documentation on the changes in the economic conditions of the KPB and constituent communities during the study period.
Context	The KPB adjacent to the Cook Inlet Planning Area.

BOEM Information Need(s): OCS Lease Sale 244 in 2017 leased 14 blocks in the Cook Inlet Planning Area and exploration activities are contemplated on those blocks. Lease Sale 258 is scheduled for 2021 under Five-Year Program 2017 to 2022. This study will provide information for the description of the existing environment and analysis of direct and cumulative effects for the economy, social systems, commercial and sport fishing, and tourism and recreation in the NEPA analyses for OCS actions. A similar study of the North Slope Borough Economy (Northern Economics, Inc. 2006) was invaluable in completing similar NEPA analyses for the Beaufort and Chukchi Sea OCS activities.

Background: BOEM needs updated baseline information on the economy and institutions of the KPB and its constituent communities (villages have primarily subsistence-based economies, towns have primarily commercial fishing-based economies, and cities have diverse economies predominantly in the oil and gas sector). Existing information collected and reported by a number of public-sector entities tends to be aggregated at the borough-level, which does not provide the finer detail to analyze community-level effects. The study period captures major changes experienced by communities caused by declining oil and gas revenues.

Objectives:

- Describe the structure of the KPB and constituent communities and how it has changed from 2008 to 2018, including: in- and out-migration, demographic trends, institutional analyses of local and regional government, non-profit and other entities, revenues and expenditures of the borough.

- Evaluate the role of the regional Alaska Native Claims Settlement Act (ANCSA) Regional and Village corporations in the KPB as a force for economic development and delivery of public services.

- Identify how the KPB and its communities, ANCSA and Village corporations, tribal entities and others used revenues from the oil and gas industry and establish a comparative basis for assessing social and economic effects of upcoming onshore and offshore oil and gas activity.

Methods: Researchers will assemble existing data sources to synthesize a quantitative and qualitative description of KBP economy by sector (*e.g.*, recreation and tourism, commercial fishing, oil and gas), borough revenues, and expenditures for each year of the study period, classifying local government services by level and department and other major categories. Using the typology of village, town, and city, they will describe how the KPB and local governments have adapted to the decline in revenues and how individuals, households, and communities have responded to changing conditions. Data from KPB, the State of Alaska and other organizations will be used to describe the structure of the economy (private, public, non-profit sectors including the regional and village Alaska Native corporations) from 2008 to 2018. Results will identify employment by sector of the economy and employer. An analysis of local jobs and the types of jobs and out-migration and in-migration of workers will include description of the flexibility of jobs in relation to subsistence and commercial fishing. Reviews with local industry, fishing, and tribal interests will also be coordinated as needed.

The study will note changes in the structure of the principal components of the economy including oil and gas, commercial fishing, and recreation and tourism. Researchers will make a quantitative and qualitative description of KBP borough revenue and expenditures for each year of the study period, classifying local government services by level and department and other major categories.

Specific Research Question(s):

1. What is the structure of the economy of the KBP and communities and institutions?

2. How has it changed and adapted during the study period?

References:

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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.

Title	Monitoring the Recovery of Seabirds and Forage Fish Following a Major Ecosystem Disruption in Lower Cook Inlet (LCI)
Administered by	Alaska OCS Region
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2023
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Monitoring of forage fish and seabird populations during and following the North Pacific marine heat wave indicates the Gulf of Alaska (GOA) marine ecosystem is undergoing dramatic changes, including massive seabird die-offs, breeding failures, low at-sea density, and depleted prey resources.
Intervention	Continued monitoring of seabird and forage fish populations at sea including using emerging technology such as Unmanned Aircraft Systems (UAS) is important to understanding the natural variability of the ecosystem and determine the status of resources in areas of oil and gas development.
Comparison	Data will be compared to the same measures collected in previous years.
Outcome	This study will inform resource assessments and facilitate an understanding of ecosystem resilience to development.
Context	LCI

BOEM Information Need(s): Monitoring of seabird populations and forage fish stocks in potential oil and gas lease areas is important to mitigate impacts of development and to assess the impact of potential oil spills and environmental change. Results from this study will support National Environmental Policy Act (NEPA) analyses for future oil and gas-related activities in Cook Inlet. The study will be especially useful for cumulative effects evaluation in the context of recent seabird die-offs in the GOA.

Background: The USGS has been monitoring seabirds and forage fish in LCI intermittently since 1995 (1995–2001, 2016–2018). Recently, a prolonged marine heat wave caused a major disruption in the GOA marine ecosystem. In 2015–2016, hundreds of thousands of common murres died from starvation, and seabirds failed to produce offspring at multiple colonies in the GOA, including several in LCI. Despite a return to normal water temperatures in 2017–2018 from the extremely high temperatures realized in 2014–2016, food webs still had not recovered in LCI by 2018. Forage fish were patchier and depleted, and densities of seabirds at sea were the lowest ever documented. Common murres failed to produce any young for at least the third year in a row, population counts at colonies remain well below historic levels, and emaciated murres were commonly observed at colonies—a heretofore unknown phenomenon. Predator disturbances at colonies were also unusually frequent. To date, there are no obvious explanations for all these aberrant observations, but their occurrence makes clear the need to monitor recovery (or failure) of these populations with greater precision to facilitate a better understanding of the mechanisms of change.

Traditional survey methods often include the visual census of marine birds and mammals on transects at sea, co-spatial trawl and hydroacoustic surveys of forage fish, aerial assessments of fish schools, and concurrent measurements of seabird population trends and breeding biology at nearby colonies (Piatt 2002). However, vessel-based survey methods for assessing seabirds and forage fish are costly and time consuming. Advances in seabird and forage fish survey methods using innovative technology such as UAS may provide cost-efficient, precise, and accurate indices of population abundance compared to traditional vessel-based surveys. Incorporating UAS capabilities into existing sampling methods will enable BOEM to leverage ongoing studies through increased data collection, while allowing for comparisons of efficiency and cost with traditional methods.

Objectives: The objectives of this study are to:

- Assess seabird and forage fish status, trends, and ecology in LCI.
- Develop UAS survey protocols to monitor seabird and forage fish populations in LCI.

Methods: Researchers will follow protocols for monitoring forage fish and seabirds in LCI developed during the 1995–2001 colony surveys for BOEM, including at-sea surveys for forage fish (hydroacoustics, trawling, seining and associated oceanographic measurements) and concurrent measurements of seabird breeding biology (egg and chick production, chick growth, population status and trends) and foraging behavior (diets, feeding rates, foraging time). At-sea work will be conducted along fixed transects within 50 km of two colonies, Gull Island and Chisik Island.

Researchers will develop UAS protocols for monitoring seabirds and forage fish in offshore areas of LCI and Kachemak Bay. UAS data collection will be tested for efficiency, safety, and comparability to ongoing vessel-based work. For at-sea seabird density estimates from UAS, various transect widths and viewing angles will be tested with the purpose of maximizing sampling efficiency. Concurrent sampling of Black-legged Kittiwake and Common Murre colonies with still photography and a UAS will allow a direct comparison of accuracy and precision between the two methods.

UAS automated techniques and the latest imagery software will be used to classify fish school characteristics (shape, color, size, *etc.*), which will help to reduce observer bias and uncertainty in species composition and school size estimates as compared to earlier techniques. Innovative digital image processing techniques, such as “fluid-lensing” to provide clearer images under the water surface, will also be evaluated.

Specific Research Question(s):

1. What analyses are best for contrasting the functional responses of seabirds to prey fluctuations and changes in the environment within and between decades?

2. What sources will be used to quantify natural variability to evaluate possible future trends to distinguish these from potential direct human impacts of OCS oil and gas exploration and development or oil spills in Cook Inlet?

3. What tests will be used to identify the utility of UAS surveys to provide at-sea and colony-based census data for seabirds to augment and/or replace traditional protocols in the future?

4. How will imagery be collected using a UAS in conjunction with traditional fisheries sampling methods to assess the ability of UASs to provide species identification, count forage fish schools, and quantitatively measure fish school surface areas?

References:

Piatt JF (Ed.) (2002) Response of Seabirds to Fluctuations in Forage Fish Density. Final Report to *Exxon Valdez* Oil Spill Trustee Council and Minerals Management Service. U.S. Geological Survey, Anchorage, AK. 406 pp.

Title	Quantifying Sea Otter Abundance, Distribution, and Foraging Intake in Cook Inlet, Alaska, Using Unmanned Aircraft Systems (UAS) Technology
Administered by	Alaska OCS Region
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov), Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2023
Date Revised	March 1, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	In Lower Cook Inlet (LCI), sea otter occurrence overlaps much of the Outer Continental Shelf (OCS) lease area (Garlich-Miller *et al.*, 2018). Currently, information is limited on the effects of oil and gas development activities (*e.g.*, seismic surveys and drilling infrastructure) on sea otter distribution and behavior. Additionally, more information is needed on the level of connectivity between the eastern and western LCI sea otter stocks.
Intervention	This study will assess spatial and temporal patterns of use by females with pups and the status of the LCI sea otter population relative to the available food resources as indexed by foraging energy intake rates. Genetic samples from a representative number of sea otters will be obtained from stocks in both eastern and western LCI to determine the level of variation between eastern and western stocks.
Comparison	Researchers will use UAS-based sea otter surveys to compare sea otter distribution patterns and quality of different areas of offshore foraging habitats between. Further, data from offshore foraging habitats will be compared with nearshore sea otter foraging data collected under separate U.S. Geological Survey (USGS) studies (Coletti *et al.*, 2016) including additional USGS/U.S. Fish & Wildlife Service (USFWS) work in the LCI that will begin in Fiscal Year (FY) 2019.
Outcome	Information gained from this study will inform incidental take authorizations under the Marine Mammal Protection Act (MMPA) for USFWS management needs and inform BOEM's National Environmental Policy Act (NEPA) analyses.
Context	LCI

BOEM Information Need(s): Sea otters are protected under the MMPA and one of the LCI stocks is listed under the Endangered Species Act (ESA). Scientists need to understand the effects of seismic activities and potential future oil and gas activities on sea otter behavior and habitat to minimize impacts. This study will provide data on sea otter (*Enhydra lutris*) distribution, abundance, habitat quality, feeding and resting habitats, and level of genetic isolation between eastern and western stocks in LCI. This research will provide baselines for monitoring sea otter responses to oil and gas development activities and will inform incidental take authorizations under the MMPA. Study results will support BOEM analysts and decision makers in relation to cumulative assessment for NEPA analyses for lease sales, exploration plans, and development and production plans.

Background: Traditional, manned aerial observer-based surveys are routinely used to estimate abundance (Bodkin and Udevitz 1999), and shore-based observations of foraging otters are a sensitive metric for population status and habitat quality (Dean *et al.*, 2002; Coletti *et al.*, 2016). The LCI presents unique constraints to the use of traditional research methods, and this study would apply innovative technology employing UAS to identify important sea otter feeding and resting areas in LCI, as well as address questions regarding seasonal differences in sea otter distributions. Sea otters appear tolerant of small vertical take-off and landing (VTOL) UAS, indicating that collecting offshore sea otter forage data from UAS in the OCS is achievable. In addition, a collaborative project involving USFWS and USGS will capture and radio tag sea otters in LCI in FY 2019, which will provide a sample of animals for targeted UAS work along with additional logistic support for this project.

Objectives:

- Document sea otter distribution and habitat use patterns relative to oil and gas development activities at appropriate temporal and spatial scales.
- Develop a cost effective and statistically defensible methodology to use UAS for multi-replicate, seasonal abundance surveys in LCI that also document annual changes in sea otter distribution and habitat use.
- Assess offshore habitat quality and sea otter foraging behavior for comparison with nearshore land-based foraging data.
- Evaluate the genetic variations between the eastern and western LCI stocks.

Methods: USGS researchers will work with the National Park Service (NPS) and USFWS partners to continue development of a photo-based survey plan that can be transferred to UAS platforms. The team will develop UAS protocols to collect survey imagery and foraging observation data, select UAS platforms (*e.g.*, marine capable fixed-wing platforms for surveys and VTOL platforms for foraging observations), select sensors (*e.g.*, forward-looking infrared [FLIR] thermal camera and digital single-lens reflex [DSLR] camera, lens and red-green-blue [RGB] filter combinations for surveys, and ultra-high definition [UHD] 1080p+ video camera for foraging observations), optimize flight patterns, and develop statistical procedures to account for diving sea otters (*i.e.*, availability bias) that will allow unbiased estimates of true abundance from photo-based surveys. During testing both manned and UAS platforms will be compared utilizing vessel-based observers to "ground-truth" results. In addition, UAS-based sea otter foraging observations piloted from vessels will provide estimates of energy recovery rates in offshore habitats that can be compared to traditional nearshore land-based foraged data. Blood samples will be collected from a representative number of sea otters from both the eastern and western LCI stocks for genetic analysis.

Specific Research Question(s):

1. What effect might oil and gas development activities have on seasonal sea otter abundance and distribution in LCI?

2. Where are sea otter resting and foraging habitats in LCI and which habitats are of highest quality based on use and prey quality?

3. Are UAS surveys a better alternative than manned aircraft surveys with respect to image quality and disturbance levels to sea otters?

4. How much genetic isolation exists between eastern and western stocks of LCI sea otters?

References:

Bodkin, J. L., and M. S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. Marine Mammal Survey and Assessment Methods:13-26.

Coletti, H. A., J. L. Bodkin, D. H. Monson, B. E. Ballachey, and T. A. Dean. 2016. Detecting and inferring cause of change in an Alaska nearshore marine ecosystem. Ecosphere 7:e01489-n/a.

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Garlich-Miller, J. L., G. G. Esslinger, and B. P. Weitzman. 2018. Aerial Surveys of Sea Otters (*Enhydra lutris*) in Lower Cook Inlet, Alaska, May, 2017. USFWS Marine Mammals Management Technical Report MMM 2018-01. Available at: https://www.fws.gov/alaska/fisheries/mmm/seaotters/pdf/2017_Cook_Inlet_Sea_Otter_Survey_Final_Report.pdf

Title	Subsistence Harvest and Iñupiaq Knowledge of Beluga Whales for Kaktovik, Alaska
Administered by	Alaska OCS Region
BOEM Contact(s)	Jeffrey Brooks (jeffrey.brooks@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2023
Date Revised	April 3, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	OCS resource developments could affect residents of Kaktovik and their subsistence way of life. Available information about where and when Kaktovik harvests beluga whales and associated traditional knowledge is either limited or dated, and tends to be scattered among multiple sources.
Intervention	BOEM proposes a comprehensive synthesis of knowledge about beluga hunting for Kaktovik to learn about changes and analyze potential impacts of resource developments. This will include documentation of past practices and conditions, including indigenous knowledge of how people hunt belugas, and the cultural significance of belugas and beluga harvest.
Comparison	BOEM will compare study results and insights with existing data and management plans of the Alaska Beluga Whale Committee and the North Slope Borough, Department of Wildlife Management (DWM). BOEM will also compare study results and insights with existing data from state and Federal studies, including previous BOEM studies examining subsistence practices.
Outcome	BOEM will learn how people in Kaktovik currently hunt belugas and the cultural importance of beluga harvest. BOEM will gain spatial, temporal, and contextual information about beluga hunting to support impact analyses.
Context	Offshore waters of the Beaufort Sea in and around Kaktovik.

BOEM Information Need(s): The National Oil and Gas Leasing Program proposes multiple lease sales in the Beaufort Sea between 2020 and 2023. BOEM needs up-to-date information on where, when, and how people in Kaktovik harvest beluga whales to inform National Environmental Policy Act (NEPA) analysis for these lease sales. BOEM will use the information to describe the affected environment, develop alternatives, and analyze potential impacts to the community from exploration and development activities. BOEM needs accurate harvest location and search data to define hunting areas for temporal and spatial mitigation measures.

Background: Beluga whales are the most abundant whale in the Beaufort Sea and provide an important source of food for people living in the North Slope Borough (NSB, 2014). Beluga is a core subsistence species for Kaktovik; in 2011, beluga was widely shared in the community; 76 percent of households reported using beluga whale for subsistence purposes; and households used on average 121 pounds of beluga in 2011 (Kofinas *et al.*, 2016).

To better understand this important resource, this study will tie into other efforts, including the Beluga Whale Management Plan (ABWC, 1995) and harvest monitoring programs of the Alaska Beluga Whale Committee, as well as research and management conducted by the North Slope Borough DWM. The study will complement and interpret existing information found in previous BOEM-funded studies of subsistence activities in the Beaufort and Chukchi Seas (*e.g.*, SRBA, 2010; SRBA, 2013; Kofinas *et al.*, 2016).

Objectives:

- Evaluate baseline temporal and spatial data about subsistence beluga hunting in Kaktovik.
- Document how the people of Kaktovik hunt belugas and how beluga is processed.
- Examine the cultural importance of belugas and beluga harvest for Kaktovik.

Methods: For the first phase of the study, researchers will review and synthesize existing information (*e.g.*, ethnographies and harvest reports) about beluga hunting in Kaktovik. They will coordinate with the Alaska Beluga Whale Committee and the North Slope Borough DWM to obtain harvest records. The researchers will work to establish a trusting relationship with hunters and other residents of the community. Following the principles of conducting research with indigenous communities (IARPC, 2018), they will meet with community members to discuss their research plans and obtain input for the project, including but not limited to: which methods are appropriate, potential key informants, and what type of study products the community would like to receive.

For the second phase of the study, researchers will be present at Kaktovik for two seasons to document to document all aspects of the hunts. They will record details about hunts and harvests, and may use the Global Positioning System (GPS) to collect locations for hunting tracks, beluga sightings, and strikes, similar to methods used by Galginaitis (2014). In addition, researchers will incorporate subsistence mapping, participant observation with field notes, and key informant interviews. Beluga hunters, elders, and other key informants will be selected using a referral technique called snowball sampling to participate in appropriate study activities (Bernard, 2006). Interviews will be audio recorded and modeled after established ethnographic techniques (Bernard, 2006; SRBA, 2010).

Study products will include a map of the subsistence use area for beluga searching, herding, and harvesting and a synthesis report that incorporates study findings, maps, transcripts, and photographs. Researchers will ask the community how to best develop audience-appropriate presentations and products such as written summaries in glossy brochure format and short videos in documentary format. The study will hire local residents to provide research assistance whenever practicable. Appropriate honoraria will be provided to project participants.

Specific Research Question(s):

1. What is the history of beluga hunting in Kaktovik?

2. How and why has beluga hunting changed over time?
3. Where and when do people hunt belugas?
4. How do people hunt and process belugas?
5. What is the cultural significance of belugas and beluga harvests for Kaktovik?

References:

Alaska Beluga Whale Committee (ABWC). 1995. Alaska Beluga Whale Management Plan. Kotzebue, AK: Alaska Beluga Whale Committee, 7 pp. (http://www.north-slope.org/assets/images/uploads/ABWC_Mngt_Plan.pdf)

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Kofinas, G., S.B. BurnSilver, J. Magdanz, R. Stotts, and M. Okada. 2016. Subsistence Sharing Networks and Cooperation: Kaktovik, Wainwright, and Venetie, Alaska. OCS Study BOEM 2015-023. Fairbanks, AK: University of Alaska Fairbanks, School of Natural Resources and Extension, 263 pp.

NSB. 2014. Kaktovik Comprehensive Development Plan. Barrow, AK: North Slope Borough, Department of Planning and Community Services, 103 pp.

SRBA. 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. OCS Study MMS 2009-003. Anchorage, AK: Stephen R. Braund and Associates, 349 pp.

SRBA. 2013. COMIDA: Impact Monitoring for Offshore Subsistence Hunting, Wainwright and Point Lay, Alaska. OCS Study BOEM 2013-211. Anchorage, AK: Stephen R. Braund and Associates, 268 pp.

Title	Update of River Overflood on Sea Ice and Strudel Scour Database
Administered by	Alaska OCS Region
BOEM Contact(s)	Warren Horowitz (warren.horowitz@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	River overflood on the sea ice occurs annually in the nearshore region of the Alaskan Beaufort Sea during a brief period in the spring when river break-up precedes the break-up of the landfast sea ice. River overflood constitutes a potential hazard to offshore oil and gas development, as it relates to facilities access, oil spill spreading and response, and the associated phenomenon of strudel drainage and potential seabed scouring, which can increase the possibility of an oil spill.
Intervention	The Department of the Interior commissioned a study in 2007 (Outer Continental Shelf [OCS] Study MMS-2009-017; Hearon, *et al.*, 2009) designed to map the annual extent of peak river overflooding onto the landfast ice of the Alaskan Beaufort Sea during the 13-year period from 1995 and 2007. The proposed study will update the original by incorporating an additional 12 years of overflood observations, nearly doubling the existing database. In addition, the database of industry-based strudel scour measurements developed during the initial study will be updated to the extent industry is willing to grant access to the information acquired since 2007.
Comparison	The overall goal of this study is to improve the knowledge of the spatial and temporal variability in overflooding and related pipeline and facility siting concerns. The results will be used for environmental assessment and hazard mitigation for present and future oil and gas facilities that may be located within or adjacent to the areas influenced by the overflood.
Outcome	The project will produce a more comprehensive geographic information system (GIS)-based dataset of river overflood boundaries and strudel scour characteristics. The results will include a probabilistic assessment of annual overflood extent, and evaluation of potential changes in river overflood associated with climate change.
Context	Alaska Beaufort Sea nearshore coastal areas.

BOEM Information Need(s): BOEM requires an improved understanding of the spatial and temporal variability in overflooding to evaluate environmental impacts and hazards associated with 1) subsea pipelines traversing through the zone of river overflood from offshore Federal leases and 2) ice roads used to access offshore Federal leases. Furthermore, BOEM needs an understanding of the potential impacts of climate change on the overflood phenomena. Because river overflooding marks the transition from winter to break-up, the study results will provide valuable information on the timing, length, and trends associated with the ice road season and the open-water season.

Background: River overflood constitutes a potential hazard to offshore oil and gas development in that it can impede access to facilities, disperse spilled oil, and expose buried subsea pipelines through scouring of the seabed below the landfast ice (strudel scouring). A comprehensive database of river overflood boundaries and strudel scour characteristics will allow BOEM to assess environmental impacts and hazards for present and future oil and gas facilities that may be located within or adjacent to the areas influenced by the overflood. The proposed study will update an earlier project by extending the record of overflood observations by more than a decade (Hearon *et al.*, 2009). Although the existing study provides critical information on river overflood, the expanded database will provide additional information on the statistical variability of the phenomena. In addition, because river overflooding marks the transition from winter to break-up, this study also will complement a recent investigation of sea ice break-up commissioned by the Bureau of Safety & Environmental Enforcement (Coastal Frontiers and Vaudrey, 2018).

Objectives: The overall goal of this study is to improve the knowledge of the spatial and temporal variability in overflooding and related pipeline and facility siting concerns. The specific study objectives are to:

- Expand the existing overflood and strudel scour database by documenting maximum river overflood boundaries and collating industry acquired strudel scour data from past surveys from Smith Bay to Camden Bay between 2008 and 2019.
- Evaluate isolines of annual overflood occurrence probability.
- Assess hazards associated with river overflood.

Methods: Researchers will map river overflood boundaries for all major rivers and streams in the study area for the 12-year period between 2008 and 2019 using satellite imagery. The 2009 study concluded that several imagery platforms are suitable for mapping river overflood boundaries. The study products will be incorporated into an ArcGIS® database that includes interpreted overflood boundaries, isolines of annual overflood occurrence probability, and available strudel drain and scour data.

Specific Research Question(s):

1. Has the seasonal timing of spring overflooding or the spatial extent of the overflooding changed over the last 12 years?
2. Have the ice roads from offshore development impacted the location and extent of overflooding events?
3. What is the severity of strudel scour occurrence associated with the zone of overflooding, areas of ice road construction, and the locations of offshore sub-seabed pipelines? Has this changed over time?

References:

Coastal Frontiers Corporation and Vaudrey and Associates, Inc. 2018. "2017 Break-Up Study of the Alaskan Beaufort and Chukchi Seas", report prepared for Bureau of Safety and Environmental Enforcement, U.S. Dept. of the Interior, Moorpark, CA, 143 pp. + appen.

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Title	Acoustic Detection of Critically Endangered North Pacific Right Whales in the Gulf of Alaska (GOA)
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2021–2025
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The eastern population of the North Pacific right whale occurs in areas of the GOA potentially affected by oil development activities in Cook Inlet, as well as potential future lease sales in the Cook Inlet, Kodiak, and GOA Outer Continental Shelf (OCS) Planning Areas.
Intervention	The year-round occurrence of right whales will be assessed through detections by passive acoustic recorders deployed in multiple locations off Kodiak Island. Co-located oceanographic moorings will provide associated oceanographic data on a similar spatial scale.
Comparison	The results of this study will be compared to the results of BOEM's oil-spill trajectory modeling efforts, which indicated that North Pacific right whales could be affected by a potential oil spill in Cook Inlet.
Outcome	This project will provide new baseline information regarding the habitat use of North Pacific right whales in the study area.
Context	Lower Cook Inlet and the National Oceanic & Atmospheric Administration (NOAA)-designated Critical Habitat for right whales on Albatross Bank off Kodiak.

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

Background: The eastern population of the North Pacific right whale is critically endangered, with abundance likely only in the tens of whales. Basic information on current abundance, trends, and distribution of this stock is needed. Although new information on right whale distribution has come from NOAA surveys of the Bering Sea, efforts in the Cook Inlet, Kodiak, and GOA Planning Areas have been more limited. Right whale habitat extended through the offshore waters of the GOA as recently as the 1960s when the Soviet Union was conducting illegal whaling activities. In July 2017, a North Pacific right whale was observed in the GOA between Sand Point and Kodiak at Kilokak Rocks.

The oil-spill trajectory modeling conducted by BOEM for the 2017 Cook Inlet Lease Sale 244 showed that potential right whale habitat including Kilokak Rocks could be affected by oil in the event of a spill in Cook Inlet. In addition, vessel traffic and other activity associated with oil and gas development pose threats to right whales in the region through noise, pollution, and/or ship collisions. With additional lease sales being considered for Cook Inlet, as well as the Kodiak and GOA Planning Areas, additional information is needed to identify the use of this area by right whales.

Objectives: This project will evaluate the current occurrence of right whales in the GOA around Kodiak Island and in Lower Cook Inlet and how their presence may correlate with oceanographic conditions. This will provide additional baseline information on this critically endangered species' occurrence in these Planning Areas, which would be needed to develop appropriate mitigation measures should leasing occur in this geographic area

Methods: In collaboration with NOAA, long-term passive acoustic recorder moorings will be deployed to provide year-round data on right whale spatial and temporal occurrence as well as ambient noise measurements. Researchers will review results and suggestions from recent similar efforts to monitor North Atlantic right whales off Maryland and Virginia to help refine their approach and improve the likelihood of detections.

Researchers will analyze acoustic data from these recorders to refine knowledge of the spatial and temporal occurrence of right whales in the GOA around Kodiak Island and near to the species' designated Critical Habitat on Albatross Bank. Density estimation may also be possible from these single-recorder moorings through the use of novel passive acoustic methods and integration with recent survey data, including results from the International Whaling Commission's Pacific Ocean Whale and Ecosystem Research (POWER) survey. As practicable, recordings will also be analyzed for information related to other species and include additional sensors on the moorings to collect information about oceanographic conditions. Recorders will be deployed for two or three years, with a scheduled maintenance each year. Deployments will take advantage of local proximity to human populations which will make logistics easier than an existing similar project in the Bering Sea.

Specific Research Question(s):

1. What is the temporal occurrence year-round of critically endangered North Pacific right whales in areas potentially affected by activities associated with oil and gas exploration and development on the OCS of lower Cook Inlet?

2. How does right whale presence in these areas correlate with oceanographic conditions?

References:

Title	Offshore Renewable Energy Potential on Alaska's Outer Continental Shelf (OCS)
Administered by	Alaska OCS Region
BOEM Contact(s)	Laura Mansfield (laura.mansfield@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	April 2, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
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 Alaska's OCS as well as 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 in the Alaska OCS Region. 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 Alaska's 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 (BOEM 2017)."

Background: A 2008 BOEM study titled *Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the OCS and Workshop* did not consider resources on the Alaska OCS, but 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 [exclusive economic zone] 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 Alaska's 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 Region.

Methods: This study will conduct a literature review compiling all available information about offshore renewable energy potential on Alaska's 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 required for National Environmental Policy Act (NEPA) analysis that would be needed should the Alaska OCS Region implement a renewable energy program. 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? Where are the areas most attractive for leasing?

2. 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.

3. How does this potential compare with offshore renewable energy potential and current activities in the Atlantic and Pacific OCS Regions?

4. 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?

5. 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?

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Title	Air Quality Impact Assessment for the Atlantic Outer Continental Shelf (OCS) Energy Development
Administered by	Headquarters
BOEM Contact(s)	Holli Ensz (holli.ensz@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2021
Date Revised	February 5, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Air quality impact assessments have not been conducted on potential OCS oil and gas activities and have been limited on potential OCS renewable activities for the Atlantic OCS Region.
Intervention	Utilize existing Weather Research & Forecasting (WRF) model meteorological datasets, National Emissions Inventory (NEI) onshore emission estimates, and proposed OCS energy development scenarios to examine potential OCS oil and gas exploration, development, and production, plus potential OCS renewable construction, emissions impacts as required under the National Environmental Policy Act (NEPA).
Comparison	Photochemical modeling would compare baseline (no action) *vs.* future modeling (with action).
Outcome	Determine possible air quality impacts caused by potential OCS oil, gas, and renewable activities in the Atlantic OCS Region as required under NEPA.
Context	Atlantic OCS Region

BOEM Information Need(s): BOEM is required under NEPA to assess the air quality impacts of potential OCS oil, gas, and renewable related sources. Photochemical modeling needs to be conducted to ensure that potential OCS oil and gas exploration, development, and production activities, plus potential renewable construction activities, proposed in the recent Draft Proposed Program (DPP) and OCS Renewable Energy Program in the Atlantic OCS Region do not impact air quality. This information will be used by BOEM in the NEPA documents.

Background: BOEM's recent DPP includes opening up a large portion of the Atlantic Federal waters for OCS oil and gas exploration, development, and production. In addition, BOEM's OCS Renewable Energy Program has several leases in the Atlantic OCS Region that has had some NEPA review, but not in connection with potential OCS oil and gas sources. Therefore, BOEM will need assessments on the air quality impacts from these OCS sources to consider in NEPA documents. In order to conduct air quality impact assessments, photochemical modeling should be conducted using the U.S. Environmental Protection Agency (USEPA) Appendix W.

Objectives: The overall purpose of the study would be to perform photochemical modeling in the Atlantic OCS Region to assess air quality impacts from potential OCS oil, gas, and renewable activities under the DPP and Renewable Energy Program for use in NEPA.

Methods: In order to conduct air quality impact assessments, photochemical modeling should be conducted using the USEPA's Appendix W. This study can utilize the USEPA's national WRF dataset that includes the Federal waters in the Atlantic OCS Region, existing Atlantic states emissions datasets from the USEPA's NEI, and onshore monitoring programs. This study would need to calculate potential OCS oil and gas emissions based on the DPP scenario and potential OCS renewable construction emissions based on the OCS Renewable Energy Program. Lastly, using all these datasets, photochemical modeling would be conducted to assess air quality impacts. The contractor should perform photochemical modeling using the Community Multi-scale Air Quality model (CMAQ) and/or the Comprehensive Air quality Model with extensions (CAMx) and post processing of the modeling results. Resolution grids over the Atlantic OCS Region should be established with finer, nested grids over non-attainment areas and the Class I areas. The modeling results would assist in defining the DPP scenario impacts, if any, of all potential oil, gas, and renewable development sources induced by OCS activity, including the formation of secondary fine particulate matter ($PM_{2.5}$) and ozone, plus visibility impacts analysis for Class I areas. Dispersion modeling (American Meteorological Society & USEPA Regulatory Model – Coupled Ocean Atmosphere Response Experiment [AERMOD-COARE] and/or California Puff [CALPUFF]) will be conducted, if needed, for any Prevention of Significant Deterioration (PSD) Increment Analysis and Conformity Determinations.

Specific Research Question(s):

1. Calculate a worse case Atlantic OCS Region OCS air emissions inventory with spatial allocation based on the DPP scenario and, if possible, based on the OCS Renewable Energy Program.

2. Perform photochemical modeling assessing air quality impacts from Atlantic OCS Region OCS activities, including assessing DPP scenario and OCS Renewable Energy Program impacts.

3. Conduct visibility analysis for the Atlantic OCS Region Class I areas.

4. Conduct PSD Increment Analysis and Conformity Determinations, as needed.

References:

Title	Atlantic Coastal Ambient Air Quality Monitoring Program
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Competitive Contract, Cooperative Agreement
Performance Period	FY 2020–2024
Date Revised	February 21, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Background concentrations of criteria air pollutants and their precursors along the Atlantic Coast are lacking prior to oil and gas development.
Intervention	Place ambient air quality monitoring stations along coastal areas of the Atlantic to monitor meteorological and air pollutant concentrations up to five years.
Comparison	Compare baseline concentrations of criteria air pollutants to National Ambient Air Quality Standards (NAAQS) to assess air quality before oil and gas development and to future measurements of air pollutant concentrations.
Outcome	Use the measured concentrations of criteria air pollutants and their precursors to determine background concentrations prior to oil and gas development and determine whether criteria air pollutants are below or above the NAAQS. Use meteorological and air pollutants concentration measurement data for future air dispersion modeling efforts.
Context	North Atlantic, Mid-Atlantic, South Atlantic

BOEM Information Need(s): BOEM is considering lease sales in the Atlantic and the National Environmental Policy Act (NEPA) requires BOEM to consider environmental impacts when proposing an action. Therefore, BOEM needs baseline air quality data to conduct environmental assessments to comply with NEPA.

Background: The NAAQS cover six common criteria air pollutants that are harmful to the public health and the environment, and precursor air pollutants that contribute to criteria air pollutant levels. Determining correlations and trends in air quality will demonstrate how emissions are changing over time during Atlantic development and the potential effects from Outer Continental Shelf (OCS) oil and gas activities. Emissions generated by future OCS oil and gas activities could cause air quality impacts on adjacent states in the Atlantic OCS Region. There are few criteria air pollutant monitors located along the coast; none of those stations located in New Hampshire, Rhode Island, New York, New Jersey, Delaware, Maryland, North Carolina, and Georgia measure nitrogen dioxide (NO_2) which is a high emitted air pollutant reported by sources in the Gulf of Mexico. Furthermore, those few stations are typically located near high-populated cities or high emitting onshore point sources, which limit their usefulness for studying air pollutant transport from OCS oil and gas activities. Near the Atlantic Coast, the U.S. Environmental Protection Agency (USEPA) reported only 12 active monitors for NO_2, 16 monitors for particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$), 16 monitors for sulfur dioxide (SO_2), 34 monitors for ozone (O_3), 7 monitors for carbon monoxide (CO), 2 monitors for lead (Pb), and 10 monitors for particulate matter less than 10 micrometers in diameter (PM_{10}). Thus, additional data would support BOEM's mission-critical activities for NEPA analysis. The Clean Air Act Amendments gave regulatory authority in the Atlantic on the OCS to the USEPA. BOEM would consult with USEPA and states in the design of this study so results would also support USEPA's regulatory needs. Furthermore, data from the study can be useful for Class I air quality areas, state implementation plans, and energy projects like the construction and decommissioning of wind energy facilities. The areas covered in this study would depend on the areas addressed in any new 5-year program.

Objectives: Determine concentrations of criteria air pollutants and their precursors to establish a baseline prior to oil and gas development.

Methods: This project would follow USEPA ambient air quality monitoring requirements as described in 40 Code of Federal Regulations (CFR) Part 58. Meteorological measurements at a minimum would include temperature, relative humidity, and wind direction and speed. Criteria air pollutants measurements include NO_2, CO, PM_{10}, $PM_{2.5}$, SO_2, Pb, and O_3 plus precursor measurements, which may include nitrogen oxide (NO), volatile organic compounds (VOCs), carbonyls, and ammonia. This project will consider potential collaborations with adjacent states, academic institutions, USEPA, National Parks Service, and Fish & Wildlife Service. The methods would include site assessments to determine placement of monitors.

Specific Research Question(s):

1. Where should the monitoring stations be placed at and why?
2. What are the criteria air pollutants and their precursor's concentrations along the coastal areas of the Atlantic?
3. What are the correlations between the meteorological and air pollutant concentration measurements?
4. What are the temporal and spatial trends of the criteria air pollutants concentrations and their precursors?
5. Are the measured criteria air pollutants below or above the NAAQS prior to OCS oil and gas activities?

References:

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https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors

https://www.epa.gov/sites/production/files/2017-12/documents/designated_reference.pdf

Title	Analyzing Anthropogenic/Physical Impacts to Cultural Resources in Deepwater
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Christopher Horrell (christopher.horrell@bsee.gov), Irina Sorset (irina.sorset@bsee.gov), and Douglas Jones (douglas.jones@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2024
Date Revised	March 1, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	BOEM and the Bureau of Safety & Environmental Enforcement (BSEE) lack information on the long-term anthropogenic/physical impacts that are a result of 1) permitted industry activities that have damaged submerged cultural resources and 2) activities associated with controlled archaeological excavations at deepwater sites. The comparative analysis of these two data sets along with newly acquired data will aid in testing the hypothesis that the effects of these types of impacts and their associated degradation continue long after the initial event occurs.
Intervention	Analysis of visual data previously acquired during investigations and damage assessments are to be compared with newly acquired coring data, three-dimensional (3-D) photographic datasets, and laser scans providing information as to the rate of continued degradation. Fieldwork will also include assessing the areas immediately adjacent to locations identified as having human impacts.
Comparison	Sampling and experiments are to occur at a total of seven shipwrecks sites (three sites impacted due to industry activities, three sites excavated archaeologically, and one undisturbed control site) all within water depths exceeding 2,000 feet. Analysis to determine if degradation continues, at what rate, as well as the amount of time that must pass for potential equilibrium and stabilization of these sites to occur.
Outcome	Studying these long-term impacts will provide information to BOEM and BSEE on how to better mitigate and reduce/eliminate impacts. By supplying baseline information to develop appropriate remediation measures, stronger mitigations could be developed to prevent future impacts. Furthermore, the study would establish the tools necessary that will improve how BOEM conducts National Environmental Policy Act (NEPA) cumulative effects analysis and applies mitigations. BSEE will benefit by having the information necessary to conduct impact assessments, enforcement actions, and improve mitigations applied to submerged cultural resources in deepwater in the Gulf of Mexico (GOM).
Context	GOM Outer Continental Shelf (OCS) (Western, Central, and Eastern). Study results will apply Gulf-wide and to other BOEM regions.

BOEM Information Need(s): Both BOEM and BSEE understand the non-renewable nature of submerged cultural resources. Both bureaus have consistently argued that anthropogenic/physical impacts to these sites are irreversible and in some cases may permanently alter the site in such a way that all information may be lost or its eligibility for listing on the National Register of Historic Places may be compromised. This study will inform both BOEM and BSEE about the cumulative impacts and rate of continued degradation occurring at deepwater shipwreck sites either because of industry-related activities/damages or previously conducted archaeological investigations. Results from the study will provide both bureaus information regarding the immediate and long-lasting duration of these impacts on a select number of deepwater shipwrecks. The results of the study will provide both bureaus new and important information regarding what occurs to these sites once they are physically impacted. These data will be incorporated into the Cumulative Impacts analysis sections of BOEM's NEPA documents allowing the Bureau the opportunity to make informed decisions when considering activities in the Area of Potential Effect (per Section 106 of the National Historic Preservation Act of 1966) during pre- and post-lease activities. BSEE will incorporate this information in making assessments regarding enforcement and corrective actions in the event future impacts to submerged cultural resources occur. In addition, this information will provide BSEE with the tools necessary to accurately measure long-term degradation and provide feedback regarding mitigation strategies to protect submerged cultural resources.

Background: Over the years, as industry has moved into ever-increasing water depths, physical impacts to submerged cultural resources have occurred. In an effort to better recognize the extent and long-lasting effects that the physical impacts may have on deepwater cultural resources, this study will acquire the necessary data to aid in understanding the continued degradation of these unique archaeological sites. For example, a wooden shipwreck was bisected with an anchor mooring chain during the drilling of a well. This impact was well documented when the site was first explored in 2004; showing a clean slice through the hull remains. Subsequent visits to the site over the last ten years has shown continual degradation of the hull structure at the location of the physical impact (Church and Warren 2008). Assessing these impacts and the data acquired during this study will provide BOEM additional information for managing submerged cultural resources near future offshore energy development on the OCS, while supplying BSEE improved enforcement actions and mitigation effectiveness assessments.

Objectives:

- Identify the type and size of anthropogenic impact to the study's shipwrecks and document their current state of preservation;

- Quantify any observable changes at the sites since the discovery of an impact or since the termination of an archaeological excavation at the site;

- Determine the duration at which these impacts continue to change the physical nature of the site and to what extent (*i.e.*, immediately adjacent to impact zone or throughout the site); and

- Determine if there is displacement and or redeposition of material culture related to the site over time.

Methods: Repeat data collection, mapping, sampling, experiments, sediment analysis, and analyses from initial discovery of the impact.

Specific Research Question(s):

1. What is the current condition of the site and how has it changed since the site was first impacted (either by industry or by scientific archaeological excavation techniques)?

2. How long do these impacts continue to change the site, its condition, and is there any evidence of the eventual stability of the site?

3. What long-term effects can be observed by looking at these data and how can the data be used to improve our ability to manage and protect these sites, develop effective mitigation measures, and apply meaningful enforcement actions that take into account the long-term effects of these impacts?

References:

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Title	Assessing the Impact of Seismic Airguns on Commercially and Recreationally Important Fish
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Mark Belter (mark.belter@boem.gov), Erica Staaterman (erica.staaterman@boem.gov)
Procurement Type(s)	Cooperative Agreement (but consider collaboration with industry)
Performance Period	FY 2020–2022
Date Revised	March 4, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Research into impacts to fish and fisheries from seismic surveys is limited, and conclusions are inconsistent. By necessity, our environmental analyses have relied on research with limited applicability and we have not had consistent conclusions about impacts to fish. It is important to obtain more information for species that occur on the U.S. Outer Continental Shelf (OCS) to better inform our analyses and management decisions.
Intervention	Observing the behavior of valuable reef fishes exposed to commercial seismic surveys would enable BOEM to better assess potential effects on biologically important behaviors. Such information would enable BOEM to meet statutory obligations to assess the level of impact and, as appropriate, propose mitigation measures to lessen or avoid such effects.
Comparison	Observe the movements of adult fish, and the potential physiological damage to larval fish, in response to a full seismic array.
Outcome	The outcome will address current gaps in our understanding of impacts to a commercially and recreationally important fish species: red snapper or grouper. Although the work would take place in the Gulf of Mexico (GOM), this research is relevant for both the Atlantic and GOM OCS Regions due to this species' wide geographic range. In addition, other snappers occur in other BOEM regions, so results may be extrapolated to similar species.
Context	Atlantic, GOM

BOEM Information Need(s): BOEM is required to consider the impacts of its activities on not just protected and managed species, but all species and ecosystems on the OCS. When it comes to seismic surveys, the most concerning impact-producing factor is noise. Noise can affect animals in a variety of ways—from physiological damage, to stress responses, to behavioral changes (Kight and Swaddle 2011). It is not clearly understood how fish (and their respective fisheries) are affected by such noise, particularly whether the effects are short term or long term. The fishing community has voiced its concern over pending seismic surveys, as they are unsure whether fish may vacate key fishing grounds or become damaged by the sounds. The International Association for Geophysical Contractors issued a statement assuring that impacts would only be short-term, but cite a lack of adequate research characterizing long-term impacts. Clearly this is a contentious issue and it would be prudent for BOEM to obtain a better understanding of this topic to ensure that its environmental reviews and assessments are adequate. It should be noted that a study of this nature was recently suggested by an external stakeholder. In addition, the Joint Industry Program announced in 2018 that one of their focal areas for the next phase of funding was "physical impacts to fish and larvae." Therefore, there may be possible avenues for collaboration with industry.

Background: Although initial concerns over noise were focused on marine mammals, there is mounting evidence that a wide range of marine taxa are sensitive to sound and could also be affected by anthropogenic noise. Early research on acoustic impacts focused on physiological effects, such as damage to air-filled structures or hearing loss. While such acute responses are indeed possible very close to the sound source, researchers are recognizing that other reactions, like a stress response or change in behavior, are more likely and would be more widespread. Repeated exposures to stressful events or disruption of key behaviors (*e.g.*, feeding) can have negative effects on critical life functions and overall fitness (Wright *et al.*, 2007).

The impacts of airgun noise on fish are potentially significant across all OCS regions. Impacts to fish with swimbladders are expected to be more widespread than those without, because the presence of this air-filled cavity can enable detection of acoustic pressure (a farther-range cue) rather than only particle motion (a shorter-range cue; Popper and Hawkins 2018). Red snapper, *Lutjanus campechanus*, is a common fish in the GOM and Atlantic, and supports important commercial and recreational fisheries. It serves as an ideal species for this type of study because it has a swimbladder, tends to aggregate in large groups, and is ecologically and economically relevant. Although sound production has not yet been demonstrated in red snapper, it is possible, considering that other snappers do produce sound (Fish and Mowbray 1952). If this is the case, it means that it may use acoustic signals to coordinate the timing of spawning (as in many other fish species), and such activities could be affected by the presence of airgun noise. Grouper would be another good candidate species group, as they too have a swimbladder and are known to be acoustically active (Sanchez *et al.*, 2017). The rest of this proposal focuses on red snapper, but a similar experimental design could be undertaken with grouper or other reef fish species. The decision about which species to focus on would depend on their prevalence at the sites that the seismic survey will cover.

Understanding the response of fishes to seismic airguns has important implications for the fishing industry, but research on impacts to commercial catch rates have generally focused on short-term impacts (*e.g.*, hours to days; Hirst and Rodhouse 2000). For example, Lokkeborg and Soldal (1993) found that catch rates of cod decreased near seismic surveys, but returned to pre-shooting levels within about 12 hours, suggesting that cod initially moved away from the survey area but were not permanently displaced. Skalski *et al.* (1992) showed an immediate significant decline in catch rates in a hook-and-line fishery, but the long-term reaction of rockfish was not measured. Engas *et al.* (1996) found that the density of cod and haddock decreased after seismic shooting, and while trawl catch rates did not return to pre-shooting levels within five days after acoustic exposure, longline catch efforts did begin to rebound. These studies demonstrate mixed results, and it is important to recognize that longer-term effects (*e.g.*, over weeks to months) have not been measured.

Finally, there has been little focus on potential effects of seismic airguns on fish larvae, and the research that has been done has not used a full-scale seismic array. Early studies examined the impacts of seismic airguns on fish eggs, larvae, and fry (*e.g.*, Booman *et al.*, 1996; Dalen and Knutsen 1987, Kostyuchenko 1996; Holliday *et al.*, 1987) but these studies generally focused on impacts at 10 m or less from the source (typically a single airgun). Given the recent finding that impacts to copepods may occur at > 1 km from an airgun, and the resurgence of attention on impacts to the planktonic community (McCauley *et al.*, 2017; Richardson *et al.*, 2017), this field warrants further study and additional research should focus on greater distances and/or water depths using a full-scale array.

Objectives: The objectives of this study are to:

- measure potential changes in behavior (*e.g.*, location, depth, schooling, duration of behavioral change) when free-swimming adult fish are exposed to seismic airguns;
- measure potential physiological changes to captive fish larvae that are exposed to seismic airguns; and
- frame these results in terms of potential impacts to the fishery.

Methods: Red snapper tend to aggregate at natural and artificial reefs in the GOM. We will focus this study on a reef that is expected to be surveyed or in the vicinity of a survey (within ~1–2 km) in the near future to measure impacts of a full-scale seismic array. Methods below could be replicated four times under the proposed budget.

<u>Method 1:</u>

An array of Vemco acoustic receivers will be deployed around the research site. Depending on water depth, some of these may be mounted on the bottom while some may need to be mounted on sub-surface buoys mid-way through the water column to maximize potential fish detections. These receivers can record data for approximately six months, so they will be deployed approximately three months before the survey is planned to take place. A passive acoustic recorder will be deployed within the approximate center of the Vemco array to measure the received level of the airguns at the center of the site. Although a single recorder cannot adequately sample the entire area, it can provide a basis of comparison for before-during-after the passage of the survey. A glider with a hydrophone can survey the entire site to help broaden spatial coverage of the sound field.

At least 50 adult snapper will be captured and tagged three months before the planned survey. Half of these animals will be tagged with traditional acoustic tags, which transmit their location when they pass within range of one of the receivers. The other half will be tagged with next-generation Vemco tags which transmit the fish’s history of acceleration and depth. This information will be critical for understanding fine-scale movements as the survey passes overhead.

Approximately three months after the survey concludes, the receivers will be retrieved and movement data will be analyzed. Data analysis will focus on the individual- and population-level movements before, during, and after the passage of the survey. The receivers may also detect the presence of fish tagged from other telemetry studies, and likewise, our tagged fish here may be detected by other receivers; which could reveal other additional animal movement patterns.

Method 2:

Using light-traps, larval fish will be captured in the days immediately preceding the survey. It is likely that a variety of reef species will be captured, including the target species, so an assemblage of species will be tested. Fish larvae will be immediately transferred to mesh traps which will be deployed at different depths (*e.g.*, 10 m, 20 m, 30 m) from the ocean's surface in the immediate vicinity of the main research site (the receiver array). At least five replicate trap arrays (each with several depths) will be deployed around the site. In addition, five trap arrays will be deployed at a similar habitat type that is out of the acoustic range of the survey. These samples will serve as the controls.

Immediately after the passage of the survey, traps will be collected and larval samples will be preserved using vital red stain and formaldehyde. This will allow investigators to count the number of larvae that were alive *vs.* dead at the time of retrieval. Samples will be examined under the microscope for mortality and gross anatomical damage. Data analysis will focus on comparisons between the exposed *vs.* control samples and potential variation in anatomical damage with water depth and taxa.

Specific Research Question(s):

1. Do fish, specifically red snapper, leave the study area when the seismic vessel approaches?
    a. If so, how long does it take them to return to the area (if ever)?
2. Do fish exhibit a change in schooling behavior or depth as the survey passes overhead?
    a. If so, how long does it take them to return to natural (pre-seismic) behaviors?
3. Do fish larvae experience physiological changes in response to airgun noise?
    a. If so, how does this differ with water depth or distance from the source?

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Title	Broken Wings: A Consolidated Inventory of Submerged Aircraft in the Gulf and Atlantic Outer Continental Shelf (OCS)
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov), James Moore (james.moore@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	FY 2020–2024
Date Revised	February 22, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	BOEM has a deficiency in information pertaining to submerged aircraft lost over the OCS. Much of BOEM's archaeological research has focused on shipwrecks and submerged landforms, neglecting efforts into the research and inventory of lost aircraft. BOEM is required under the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA) to assess potential impacts to historic and cultural resources that may be adversely affected by its approved actions.
Intervention	A comprehensive database will be created to present a Gulf of Mexico (GOM) and Atlantic historical and spatial analysis of sunken aircraft along the Federal OCS. The database will help fill a prominent information gap for BOEM's cultural resource assessments.
Comparison	Information from historic records and data from several separate databases will be compiled and integrated into BOEM's region-specific planning tools. This information will be compared with existing geophysical survey nearby the identified aircraft losses.
Outcome	This new and inclusive data source will enable BOEM to more effectively detect sunken aircraft along the OCS and to recommend more thorough surveying or ground-truthing in areas where these types of cultural resources may be located.
Context	The study area concerns the Federal OCS of the GOM and Atlantic.

BOEM Information Need(s): On February 20, 2019 a survey company operating in the GOM snagged a sunken aircraft with the umbilical of a Remotely Operated Vehicle (ROV) while in the process of deploying an Ocean Bottom Node. While attempting to free the vehicle, portions of the wreckage associated with a propeller were dislodged, causing damage to the site and undermining its integrity. Submerged aircraft are types of cultural resources that have been predominantly overlooked in planning considerations for Federal offshore industrial development. BOEM's databases have little consolidated information concerning the loss of historical aircraft over the OCS. An inventory, overview, and repository of general information regarding these resources will assist BOEM in the identification and preservation of these types of historic and cultural resources. This information will also help BOEM complete its assessments under NEPA and adhere to Section 106 and Section 110 requirements under NHPA. Many of these resources also are protected under the Sunken Military Craft Act (SMCA) and may contain human remains. These data and information will be most beneficial for BOEM's post-lease NEPA analyses to ensure the protection of these cultural resources and will directly aid in preventing another incident like the one described above.

Background: According to the National Park Service (NPS), "much of America's 20th century history is inextricably linked to aviation. At times, American inventors, scientists, engineers, pilots, and military and civilian leaders headed pioneering efforts to develop aviation technology and uses. In different periods, the United States lagged behind other nations and needed highly dedicated and costly efforts to catch up" (1998). BOEM's information management system is focused primarily on data relating to shipwrecks and prospective paleocultural sites on the OCS. A comprehensive overview of submerged aircraft would provide documentation, historical context, and loss data that could be integrated into new aircraft databases designed for the GOM and Atlantic OCS Regions. This will assist with preservation planning for historic aircraft located within Federal OCS waters. Upon the success of this undertaking, other regional offices may wish to later follow suit.

Objectives: The study's objective is to create an Atlantic and GOM specific historical and spatial database of sunken aircraft along the OCS that will assist with BOEM's space-use development planning and historic preservation mandates under NHPA, NEPA, and SMCA.

Methods: Historical research will be conducted to develop a comprehensive list of aircraft lost over GOM and Atlantic waters since their inception. Existing databases will be compiled and combined to provide BOEM with information concerning histories and locations of potential wreck sites located within regional planning areas (some suggested existing databases are referenced below). The study will conduct research into the potential locations of such aircraft and describe diagnostic or unique identifiers that will aid in the identification of such craft if located during BOEM's OCS program related infrastructure related survey, maintenance, or operations. This information will be specifically designed to integrate with existing region-specific planning tools and enhance BOEM's ability to detect and manage these resources.

- Potential Database Resources:
- Air Force Legacy Program
- Army Center of Military History
- Aviation Archaeological Investigation and Research
- Defense Prisoner of War (POW)/Missing in Action (MIA) Accounting Agency
- Department of Defense Legacy Resources Management Program
- Heritage Preservation Services Program
- National Air and Space Museum

- National Aeronautics and Space Administration
- National Parks Service
- National Register of Historic Places
- Naval Historical Center
- U.S. Coast Guard Museum

Specific Research Question(s): N/A

References:

NPS, Department of the Interior. 1998. National Register Bulletin 43: *Guidelines for Evaluating and Documenting Historic Properties*. Ann E. Milbrooke, ed. U.S. Government Printing Office, Washington, D.C.

Title	Comparison of Community Structure Between Artificial and Natural Reefs Using Environmental Deoxyribonucleic Acid (eDNA): A Proof-of-Concept Study
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Katherine Segarra (katherine.segarra@boem.gov)
Procurement Type(s)	Interagency agreement with the U.S. Geological Survey (USGS)
Performance Period	FY 2020–2022
Date Revised	March 6, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	BOEM must perform biological monitoring and impact studies in sufficient quantities and at the appropriate scale to address current and planned Outer Continental Shelf (OCS) activities.
Intervention	eDNA may prove to be a powerful and cost-effective tool for BOEM's long-term monitoring efforts and future impact studies.
Comparison	Conventional survey techniques will be compared to eDNA profiles to determine the efficacy of eDNA in biological monitoring. Community assemblages at natural and artificial reefs from decommissioned platforms will be compared and analyzed as part of a long-term data set.
Outcome	This proof-of-concept study will inform future decisions regarding decommissioning and other activities and will inform best practices for BOEM's biological research efforts.
Context	Gulf of Mexico (GOM) predominantly, but could also be applied to future reefed platforms or installations across the OCS as well as aid in future monitoring efforts.

BOEM Information Need(s): This study will provide information related to affected resources, monitoring, cumulative impacts, and compliance. The information gathered through this study will inform BOEM's decision making regarding the fate of future decommissioned oil and gas platforms in all OCS regions as well as the Flower Garden Banks National Marine Sanctuary (FGBNMS) proposed expansion. It will also contribute to BOEM's understanding of artificial and natural reef ecology and temporal dynamics in community structure at these GOM sites. This is a proof-of-concept study using eDNA to assess marine fish and invertebrate community structure, which may prove an efficient tool for BOEM to conduct monitoring and impact studies to comply with the Outer Continental Shelf Lands Act (OCSLA), National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Essential Fish Habitat (EFH). This project will also contribute to BOEM's long-term monitoring efforts at the FGBNMS.

This study leverages funds from the USGS by taking advantage of an ongoing research partnership between the USGS, National Oceanic & Atmospheric Administration (NOAA), and the Texas Parks and Wildlife Department (TPWD). The ship time, survey efforts, and long-term data from this partnership will contribute to the success and cost-effectiveness of this effort. Although this study is focused on reefed platforms and natural reefs in the GOM, the results of this study can be applied to other OCS regions, especially the development of eDNA in biological monitoring efforts and decisions regarding decommissioning, both BOEM-wide priorities. The information gathered could also be applicable to renewable energy installations, which may also serve as artificial reefs. Future research applications include detection of invasive species, monitoring impacts from OCS and non-OCS activities on the affected environment, identifying habitat use of protected species, examining the impacts of new installations on the OCS, and examining the community response to disturbance.

Background: As of 2018, 532 decommissioned platforms have been reefed in the GOM under the Bureau of Safety & Environmental Enforcement's (BSEE's) Rigs-to-Reefs policy. The Texas Rigs-to-Reefs Program is administered through the TPWD in state and Federal waters. These reefs provide habitat for sessile invertebrates, a host of reef fish species, and larger predators such as sharks. These artificial reefs are frequented by recreational fishers and divers. The USGS has partnered with TPWD to monitor these artificial reefs as well as sites in the FGBNMS to understand the dynamics of these ecosystems. Their research has focused on long-term status and trends of environmental conditions and biological research. The biological monitoring on these natural and artificial reefs have traditionally been limited to visual surveys by scientific divers or remotely operated vehicles in order to determine the type and quantity of marine life living on the reef. However, biological monitoring of reef sites is an ever-evolving science and eDNA has been shown to improve the detection of cryptic species as compared to many traditional survey techniques.

The use of eDNA is emerging as a useful tool in ecological monitoring. DNA shed into the environment can be detected in trace amounts and decays relatively rapidly in the marine environment (Thomsen *et al.*, 2012), allowing it to be used as a proxy for species presence in oceanographic sampling. It has been used in aquatic and marine environments to successfully determine the presence of specific species (Dunker *et al.*, 2016; Lacoursière-Roussel *et al.*, 2018), including invasive species (Nevers *et al.*, 2018; Klymus *et al.*, 2017), to estimate relative abundance (Tillotson *et al.*, 2018), and to determine fish community composition (Andruszkiewicz *et al.*, 2017). Rather than using labor- and cost-intensive traditional survey methods, eDNA has the potential to be both a more sensitive and economical approach to biomonitoring.

This project will utilize eDNA as an emerging analytical technique to improve monitoring practices of sensitive habitats in the GOM. This proposed work is a collaboration with the USGS and will leverage an ongoing, successful partnership between the USGS, NOAA, and the TPWD. This study will improve the power of long-term ecological monitoring through a proof-of-concept of using eDNA to conduct biological surveys. The results of this effort will lay the groundwork and coordinate with ongoing efforts using eDNA to monitor ecosystems (including in the Pacific and Atlantic) and detect temporal changes in species composition. This project will be performed in coordination with other BOEM-funded eDNA efforts including the Sanctuaries and Santa Barbara Channel Marine Biodiversity Observation Network (MBON) as well as the Natural History National Museum and would, at a minimum, contribute to the development of a novel monitoring technology that partnerships like

MBON could employ. The data products of this study (assessment of biodiversity at artificial and natural reefs and a comparison of traditional and eDNA surveys) will serve as valuable baseline information on the GOM environment.

Objectives: BOEM will examine the eDNA of invertebrate and fish communities at natural and artificial reefs in the GOM. The major objectives are:

- Assess biodiversity (via species diversity and richness indices) at natural and artificial reefs using traditional survey methods.
- Consider temporal trends in fish and invertebrate communities at artificial and natural reefs in the GOM.
- Compare GOM fish and invertebrate communities at artificial and natural reefs using traditional and eDNA survey methods.
- Determine the suitability of using eDNA for BOEM's biological monitoring purposes.

Methods: This study will advance ecosystem monitoring and biodiversity estimation methods by evaluating an emerging analytical technique: eDNA. Taking advantage of ongoing traditional ecosystem surveys conducted on the FGBNMS and Texas Parks & Wildlife Department (TPWD) artificial reef sites, replicate water samples will be collected and preserved for eDNA analysis. The species assemblage of fish and invertebrate communities will be examined via eDNA analysis. These two communities were chosen because of their interest to BOEM as affected resources as well as their suitability for eDNA analysis; proven primers for these marine groups already exist. Specific species can also be targeted should such research questions be identified (*e.g.*, presence of invasive or imperiled species). The assemblages of the reefed platforms will be compared to those of the natural reef sites in the FGBNMS. Results will be compared to traditional surveys conducted concurrently with eDNA collection. Comparison of eDNA profiles at depth and at the surface will determine best practices for future efforts. Data interpretation will benefit from *in situ* chemical and physical data provided by the USGS. These results can be analyzed as part of a long-term data set created through the USGS and TWPD partnership to estimate changes in species composition. The estimated cost for this study will provide support for sample collection, laboratory processing, and statistical and data analysis. At this funding level, triplicate samples can be analyzed from two natural and two artificial reef sites at two depths (bottom and surface). Ship time and data from traditional surveys, chemical, and physical instrumentation will be provided as in-kind contributions.

Specific Research Question(s):

1. How do the fish and invertebrate communities at artificial reefs and natural reefs in the Western GOM differ?
2. How do the results from the eDNA and traditional survey methods compare? Can eDNA be reliably used to estimate community structure in long-term

biodiversity monitoring? Community metrics created by the two methods may be compared.

3. How do populations of species of interest (*e.g.*, lionfish, urchins) differ between the natural and artificial reef environments?

4. How do eDNA profiles at specific sites differ with depth?

5. Do the results of this study have implications on future decisions regarding the fate of decommissioned platforms?

References:

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Klymus KE, Marshall NT, Stepien CA (2017) Environmental DNA (eDNA) metabarcoding assays to detect invasive invertebrate species in the Great Lakes. PLoS ONE 12(5): e0177643. https://doi.org/10.1371/journal.pone.0177643

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Tillotson MD, Kelly RP, Duda JJ, Hoy M, Kralj J, Thomas QP (2018) Concentrations of environmental DNA (eDNA) reflect spawning salmon abundance at fine spatial and temporal scales. Biological Conservation 220: 1-11. doi:https://doi.org/10.1016/j.biocon.2018.01.030

Title	Data Gap: Shipwrecks in the Mesophotic Zone and Their Benthic Communities
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov), Mark Belter (mark.belter@boem.gov), Melanie Damour (melanie.damour@boem.gov), and Alicia Caporaso (alicia.caporaso@boem.gov)
Procurement Type(s)	Cooperative Agreement; Possible National Oceanographic Partnership Program (NOPP) Candidate
Performance Period	FY 2020–2024
Date Revised	February 22, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The mesophotic zone (40–150 m) represents one of the biggest data gaps in marine science at BOEM. The Bureau has a clear need to characterize shipwrecks and their ecological role to develop proper management and avoidance strategies based upon ranges of archaeological site preservation and ecological community structure in a high-energy environment.
Intervention	Four to six shipwreck and hardbottom sites will be selected for archaeological and biological characterization, documentation, and mapping using photogrammetry. This will allow for proper recordation of entire shipwreck sites as well as sessile benthic organisms inhabiting them. Where possible, motile species information will be captured.
Comparison	Different hull types (wood, steel, *etc.*) will be represented in the study sites to identify variability in shipwreck condition, material distribution, and site formation. Comparison of sessile benthic assemblages among shipwreck sites and on nearby natural reef habitats will be examined to identify factors contributing to community structure and habitat suitability.
Outcome	Study results will contribute to resolving a significant data gap for mitigating archaeological sites in high-energy environments. Also, characterization of biological assemblages inhabiting the *de facto* hardbottom habitat will improve our understanding of mesophotic community diversity and distribution on the Outer Continental Shelf (OCS). Study results will inform adaptive management strategies and mitigations that consider both the ecological role of shipwrecks and their archaeological importance.
Context	Shipwrecks and hardbottom in the Gulf of Mexico, between 40–150 meters.

BOEM Information Need(s): With limited data on sites in the mesophotic zone, including site patterning and essential defining characteristics, archaeologists are left with inadequate data to determine if avoidance measures intended to mitigate impacts to historic shipwrecks employed in these water depths are sufficient. Current archaeological mitigations and avoidance criteria only take into account archaeological remains, and not the potential impacts to the associated biological community. Impacts to the biological community may alter the environmental equilibrium of the archaeological site, significantly affecting its rate of degradation, stability, and eligibility to the National Register of Historic Places (NRHP).

The default shipwreck avoidance scheme of 300 meters was developed to protect sites that have had little to no documented debris fields in low-energy environments like the deep sea. The mesophotic zone, by contrast, is a high-energy environment both in terms of storm-induced wave activity and currents, but also from the relatively high rate of industry activity, high density of pipelines (and their movement), marine minerals activities, and frequent anchor deployments from operations under BOEM purview. Similarly, there is a data gap of benthic communities in the mesophotic zone, an area important to the information needs of BOEM. The program needs to prioritize multi-disciplinary scientific observations in the mesophotic zone to ensure the Agency's current mitigation strategies are appropriate. This information will directly inform pre-lease and programmatic National Environmental Policy Act (NEPA) analysis and post-lease mitigation applications and provide mission-critical site modeling that will directly inform Gulf of Mexico operations as well as forthcoming Atlantic management regimes.

Background: Few direct observations have been made of shipwreck sites and benthic habitats in the mesophotic zone of the Gulf of Mexico. To date, research on shipwrecks in the Gulf of Mexico has primarily focused on sites either in depths accessible by divers (<40 meters) or by remotely operated vehicles (ROVs) in depths > 200 meters, leaving a significant data gap.

Objectives:

- This study will document and map four to six potential shipwreck targets and hardbottom sites in the mesophotic zone in order to identify diagnostic features for archaeological analysis, variability in overall site condition, material distribution, and site formation.

- There are 175 potential sites in BOEM's databases identified with side scan sonar within the mesophotic zone. The protocols for the mapping task will allow for the characterization of sessile benthic communities, including spatial distribution relative to the available wreck substrate.

- Comparison of sessile benthic assemblages with those found on natural reef habitats in similar environments (region, water depth, *etc.*) will be examined to identify factors contributing to community structure and habitat suitability for observed species. Ideally, shipwreck site selection will include diverse vessel ages and types in a range of water depths for comparison.

- The final report will include management and avoidance recommendations based on these analyses.

Methods: The specific methodology to achieve the objectives of this research will be developed by the cooperative parties as an integral part of this research. The video transect methodologies developed for photogrammetry mapping in deepwater will be applied at this depth range with modification to account for sediment turbidity at and near the seafloor. Modeling will be performed by BOEM staff in-house. Three-dimensional (3-D) models of the sites and ortho-rectified mosaics will be generated for each of the sites utilizing ROV-acquired high-definition video. This has been successfully accomplished at deep-water sites like the Blake Ridge Shipwreck, 15377, and the Monterrey Shipwrecks. These models and maps will be made available to the public and scientific community via BOEM's website.

Specific Research Question(s):

1. What is the variability of observable shipwreck debris scatter within varieties of site types, conditions, and depths in the mesophotic zone?

2. Is the shipwreck eligible for listing in the NRHP?

3. What benthic species inhabit shipwreck sites in the mesophotic zone? What is the relative abundance and distribution of constituent species?

4. How do community structures found on shipwrecks compare and contrast with those observed on nearby natural hardbottom habitats?

References:

Title	Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, & Archaeology Project II (GOM-SCHEMA II)
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Melanie Damour (melanie.damour@boem.gov), Jimmy Moore (james.moore@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, and Cooperative Agreement (3-part study)
Performance Period	FY 2020–2024
Date Revised	February 28, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Need to better understand he cumulative impacts of the 2010 *Deepwater Horizon* (*DWH*) oil spill on deepwater historic shipwrecks and their microbiomes across multiple scales (micro-, meso-, and macro). The hypotheses are that: 1) spill-impacted sites from the first GOM-SCHEMA study will continue to exhibit evidence of impact, and 2) ecosystem recovery at the microbial community level has begun to occur at impacted sites.
Intervention	Assess extent and duration of documented effects at impacted sites at multiple scales as compared to unimpacted sites, and evaluate ecosystem recovery.
Comparison	Sampling and experiments at up to seven shipwrecks (wooden-hulled and metal-hulled) from within three areas of spill impact (heavy, moderate, and unimpacted) will be comparatively analyzed to determine if wood degradation, metal corrosion, site preservation, and microbiomes continue to be affected by oil, dispersant, and/or dispersed oil exposure ten years after the spill, compared to measurements of the same sites from the first GOM-SCHEMA study.
Outcome	Better understanding of a major oil spill's actual long-term impacts on shipwrecks and their microbiomes.
Context	Gulf of Mexico (GOM) OCS in water depths ranging from 150 m to 2,000 m (Western, Central, and Eastern). Study results will apply Gulf-wide and to other BOEM regions.

BOEM Information Need(s): The study will inform BOEM about the cumulative impacts of a major oil spill on submerged cultural resources in the GOM; results will be incorporated into Cumulative Impacts analysis and Catastrophic Spill Event Analysis sections of BOEM's National Environmental Policy Act (NEPA) documents. Study results will also allow BOEM to make informed decisions in its efforts to "take into account" (per Section 106 of the National Historic Preservation Act of 1966) the actual impacts of an oil spill on historic properties prior to leasing and permitting. The resulting time series datasets will directly inform long-term monitoring of ecosystem recovery after a major oil spill in the deepwater GOM. Metal corrosion studies will inform BOEM and the Bureau of Safety & Environmental Enforcement (BSEE) about risk management, engineering, and safety considerations for steel structures (oil and gas platforms, pipelines, *etc.*) exposed to anthropogenic inputs of oil in the GOM. The study primarily addresses three of BOEM's Strategic Science Questions: #3 (acute and chronic effects of hydrocarbons on ecosystems), #4 (effects of BOEM-regulated activities on cultural resources), and #9 (best affected resources for long-term monitoring).

Background: The first GOM-SCHEMA study collected sediment, water, and biological samples; high-resolution photo and video; and three-dimensional (3-D) laser and 3-D sonar data between 2013 and 2015 to document the impacts of the 2010 *DWH* oil spill on historic shipwrecks and their microbiomes. The study identified multiple lines of evidence that sites within the spill-impacted areas were impacted by oil and/or dispersant exposure but it is not known how long those impacts persisted (Hamdan *et al.*, 2018; Salerno *et al.*, 2018; Mugge *et al.*, 2019). A follow-up, multi-partner, interdisciplinary GOM-SCHEMA II study will determine how long these impacts persist, and if ecosystem recovery has begun at spill-impacted sites ten years after the spill. Vessel support will be provided through interagency partnering. In addition to interagency and cooperative agreements with other study partners, a contractor will participate in overall project design and management, collect 3-D acoustic/optical scans of shipwrecks, analyze archaeological data and compare with previously collected datasets, and document observable site changes over time.

Objectives:

- Document the study shipwrecks' current state of preservation;
- Assess and quantify any observable transgressive changes at the sites since the first GOM-SCHEMA study and prior to the *DWH* spill;
- Determine if spill-related impacts to shipwreck microbiomes persist and how they have affected shipwreck preservation; and
- Profile whole microbial communities, assess their current condition, compare with their post-spill condition in 2014–2015, and compare with communities from unimpacted sites.

Methods: Repeat data collection, sampling, experiments, and analyses at shipwrecks from the first GOM-SCHEMA study (sediment, water, biological, 3-D scanning, archaeological data, *etc.*) to assess their archaeological and ecological condition ten years after the spill.

Specific Research Question(s):

1. What are the current ecological and archaeological conditions of study sites a decade after the *DWH* spill as compared to prior to and four years after the spill?
2. How long after the spill did impacts persist at affected sites and do the sites show evidence that ecosystem recovery is occurring at the microbial community level?

3. What are the long-term impacts of an oil spill and spill response on deepwater shipwreck microbiomes and site preservation at the micro-, meso-, and macroscales as compared to unimpacted sites?

References:

Hamdan, L.J., J.L. Salerno, A. Reed, S.B. Joye, and M. Damour, 2018. The impact of the Deepwater Horizon blowout on historic shipwreck-associated sediment microbiomes in the northern GOM. *Scientific Reports* 8:9057. doi:10.1038/s41598-018-27350-z. https://www.nature.com/articles/s41598-018-27350-z.pdf

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Title	Host and Serve the Bureau of Ocean Energy Management's (BOEM's) Meteorological Data on the Gulf of Mexico Coastal Ocean Observing System (GCOOS) Website
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Cooperative agreement
Performance Period	FY 2020–2024
Date Revised	February 21, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Operators need to use official meteorological data in air dispersion modeling of air quality impacts to an onshore area from proposed activities, but BOEM has limited capabilities to disseminate these data through the internet.
Intervention	Host and serve the meteorological database on GCOOS website to facilitate access to stakeholders.
Comparison	Providing internet access *versus* delivering this database through land mail services.
Outcome	Stakeholders and other interested parties would have direct access to the meteorological data for air dispersion modeling.
Context	Western, Central, and Eastern Gulf of Mexico

BOEM Information Need(s): The Outer Continental Shelf Lands Act (OCSLA) under Section 5(a)(8) requires compliance with the National Ambient Air Quality Standards (NAAQS) pursuant to the Clean Air Act (42 U.S.C. 7401 *et seq.*). BOEM requires operators to perform air dispersion modeling using BOEM's 5 year meteorological dataset to determine whether there could be significant air quality impacts to an onshore area from proposed activities in a plan. BOEM needs a way to facilitate access to their 5 year meteorological dataset.

Background: Under 30 Code of Federal Regulations (CFR) 550.303(d) an operator is required to perform air dispersion modeling when exemption amounts are exceeded. Air dispersion modeling requires meteorological inputs. Currently, to obtain the meteorological data BOEM requires to use in the air dispersion modeling, the operator must mail a hard drive to BOEM, which is time consuming and may come at a cost to the stakeholder or interested party. Meteorological data can be hosted on a website, using modern internet data access protocols. This will help to streamline plans that require air dispersion modeling, because operators would have ready access to required meteorological inputs. The air dispersion modeling results are used to determine whether there could be significant air quality impacts to an onshore area from proposed activities in a plan. This study disseminates large meteorological data files provided by air quality studies. New meteorological data is being provided by the BOEM Gulf of Mexico OCS Region Modeling Study; however, BOEM does not currently have an effective tool to disseminate these data on a website or through other means. Available data transfer services, such as MessageWay®, are not capable of handling large meteorological files. GCOOS already hosts products from BOEM. GCOOS is one of the 11 regions under the Integrated Ocean Observing System (IOOS), which is supported by the National Oceanic & Atmospheric Administration (NOAA). Currently, BOEM is working with GCOOS to host some meteorological data for a cost of $30,000 for 3 years. As a precedent, BOEM's Alaska OCS Region is now providing some of its meteorological data through the NOAA IOOS Alaska Ocean Observing System (AOOS) website (BOEM, 2013). The U.S. Environmental Protection Agency and state government agencies may also be interested in having access to this data.

Objectives: Address distribution of large data files (up to ~5 TB) provided by BOEM air quality studies.

Methods: BOEM will provide the meteorological fields, which can be used for air dispersion modeling, to GCOOS for hosting, including the Weather Forecasting & Research Model datasets. The meteorological files would be hosted on the GCOOS website and freely accessible to external users. At a minimum, a Web Accessible Folder (WAF) should be established to allow external users with internet to access the files.

Specific Research Question(s): N/A

References:

BOEM, 2013. Arctic Air Quality Impact Assessment Modeling Study 2009–2013, http://portal.aoos.org/alaska-statewide.php#module-metadata/864fa9ea-8686-11e6-9dd4-00265529168c/0b069f5d-15d7-4fc9--a639-088f5433bd4d.

https://ioos.noaa.gov/about/

Title	Impacts of Drilling on Biological and Archaeological Resources: Revisiting Resource Avoidance Guidance for Well Site Surface Locations
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Katherine Segarra (katherine.segarra@boem.gov) Mark Belter (mark.belter@boem.gov)
Procurement Type(s)	Interagency agreement or Cooperative Agreement
Performance Period	FY 2020–2024
Date Revised	March 6, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
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	Avoidance measures and other mitigation strategies may be improved to minimize a variety of impacts from drilling activities.
Comparison	Using a Before-After-Control-Impact (BACI) study design, the potential impacts of drilling will be assessed at depths relevant to anticipated development scenarios through pre- and post-drilling measurements and comparisons to control sites.
Outcome	The results of this study will be used to evaluate 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 in shallow (<200 m) and deepwater (2000–3000 m) depth ranges applicable to future forecasted Gulf of Mexico and Atlantic OCS Region drilling and inform all BOEM efforts nationally.

BOEM Information Need(s): Understanding the impacts of OCS activity on benthic resources is paramount to 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 relies 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. This interdisciplinary study will examine multiple impact-producing factors (*e.g.*, noise, drilling muds and cuttings, seabed disturbance) and their potential impact on ecological and cultural 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 activity. BOEM's partners (Bureau of Safety & Environmental Enforcement, National Oceanic & Atmospheric Administration, and Gulf of Mexico Fisheries Management Council) may utilize this research to improve their management and enforcement practices.

Background: Bottom-disturbing operations can cause damage to any resources that reside on or near the seabed, particularly biological and archaeological resources. Biologically sensitive communities may be smothered or exposed to toxins and persistent noise and archaeological resources may be permanently destroyed. BOEM provides guidance to operators for the avoidance and protection of biologically sensitive features and submerged cultural resources. A stipulation to avoid and protect such habitats has been made a part of appropriate OCS oil and gas leases since 1973. BOEM's experience with offshore development, supplemented by independent studies such as CSA (2006), Austin *et al.*, (2004), and DeBlois *et al.*, (2014), serve as a basis for current benthic impact mitigations as described in Notices to Lessees & Operators 2005-G07, 2009-G39, and 2009-G40. However, the efficacy of BOEM's mitigations regarding bottom impacts has not been rigorously evaluated since 2006 (CSA 2006) which examined physical, chemical, and biological impacts from drilling in medium water depths. Furthermore, although recent findings indicate low-frequency anthropogenic noise may affect marine fish and invertebrates (Solan *et al.*, 2016; Nedelec *et al.*, 2016), the intensity and impacts of drilling noise should be further examined.

As BOEM expands OCS activities into deeper waters and more planning areas, 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 and better anticipate the recovery of ecologically sensitive benthic environments.

Objectives: The objectives of this study are to:

- Assess the impact distance of drilling on benthic habitats and communities as determined by sediment/drilling mud accumulation, water quality, sound intensity, chemical changes in the surface sediments, changes in epibenthic and infaunal community density and composition, and changes in seabed characteristics.

- Compare the impact distance of drilling at sites of differing water depth and other geophysical features (*e.g.*, current regimes). This includes 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: The methods will be similar to the BACI study design of CSA (2006) to allow comparison of results and thus save on costs.

Through the drilling permit process, study sites will be identified that are targeted for imminent drilling and have adjacent (~1500 feet) hardbottom habitat (at a minimum) or, ideally, established benthic communities. Sites with known adjacent shipwrecks will be prioritized. CSA (2006) sampled drilling sites at 1000 to 1125 m. This study will target triplicate sites in more shallow, shelf water (< 200 m) and deeper (2000–3000 m) water. One control site per depth range will also be selected. The depth gradient from this study combined with sites from CSA (2006) will allow us to determine how water depth influences the extent of benthic impacts.

At each site, a sampling transect will be established between the drill site and the hardbottom/benthic community in a direction 'downstream' from the drill site based on prevailing current directions. Suggested sampling locations along the transect are 1000, 1500, 2000, and 3000 feet from the drilling site. Prior to drilling, baseline data on water quality (*e.g.*, pH, dissolved oxygen, temperature, salinity, turbidity, total suspended solids), bathymetry (via high-resolution surveys), sediment characteristics (via grab samples to measure grain size, porosity, % organic carbon, infauna community composition, polycyclic aromatic hydrocarbons, heavy metal, and barite concentrations), acoustic conditions (sound pressure level and frequency spectra), and epibenthic community surveys (via underwater video and photography) will be collected along each transect. Sediment traps and steel coupons will be deployed along the transects to measure accumulation and chemical composition of sediment/drilling muds and potential impacts on metal corrosion rates. Current meters and acoustic monitors (*e.g.*, hydrophones) will be deployed. Post-drilling, all measurements will be repeated and sediment traps, metal coupons, hydrophones, and current meters will be recovered. Depending on the information collected by operators, additional high-resolution surveys may not be needed. Drilling timing, acoustic Doppler current profiler data, and drilling discharges will be collected from operators. Depending on the direction of the current(s) during drilling, the transects may or may not lie within the path of the most heavy deposition of the cuttings plume. Therefore, in addition to transect sampling, the entire drilling areas will be surveyed before and after activity to determine the direction and extent of the plume.

Biological impacts on the epifauna and infauna will be determined by comparisons of species diversity and composition. Cultural impacts will be determined by both corrosion rates (via metal coupons) and any visible changes to shipwrecks present. Physical impacts will be determined via comparison of imagery via high-resolution surveys. Changes in acoustic conditions will be measured from the hydrophone recordings, focusing on the change in sound pressure level and acoustic spectra during the course of the drilling process and with distance from the drill site.

Specific Research Question(s):

1. How do impacts to biological and cultural resources vary with distance from drill site and water depth? These impacts could include physical (*e.g.*, accumulation

rates, decibel level), biological (*e.g.*, smothering, loss of diversity), and chemical (*e.g.*, changes to water chemistry) changes.

2. How does impact distance vary with water depth?

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

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Title	Integrated Analysis of Submarine Mudslides in the Mississippi Delta Front and the Potential Impacts to Historic Shipwrecks
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Douglas Jones (douglas.jones@boem.gov) Melanie Damour (melanie.damour@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2020–2025
Date Revised	February 19, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Mudslides are known to displace large shipwrecks hundreds of meters over short (sub-decadal) time periods, potentially impacting the archaeological interpretation of these wrecks and endangering nearby oil and gas infrastructure. The environmental conditions and mechanisms driving this mudslide activity are currently poorly understood.
Intervention	Use new and existing data sets to characterize surface and subsurface sediments and physical oceanographic processes at known shipwrecks; conduct baseline archaeological analysis at these sites; and establish acoustic sensors to monitor potential future wreck displacement due to mudslide activity.
Comparison	Use existing and new survey data as time series markers for shipwreck movement to evaluate the spatial extent, frequency, and magnitude of previous mudslide events at these shipwrecks, relative to regional and site-specific analysis from previous studies within the Mississippi River Delta Front.
Outcome	An understanding of environmental factors that have influenced previous mudslide activity at shipwrecks and the associated hazards to oil and gas leasing and infrastructure regulated by BOEM/Bureau of Safety & Environmental Enforcement, and a management tool to predict the frequency and magnitude of potential future impacts.
Context	Outer continental shelf (OCS) areas offshore the Mississippi Delta Front susceptible to mudslide events, and known to contain potentially vulnerable oil and gas infrastructure and historic shipwrecks.

BOEM Information Need(s): An area on the OCS offshore of the Mississippi River Delta Front (MRDF) is subject to a highly dynamic environment affecting sediment deposition, stability, mass wasting, and other transport processes. In addition to being actively leased for oil and gas development, this area contains a combination of at least 21 known shipwrecks of potential historical significance and sonar targets that are strongly indicative of shipwrecks. Recent industry surveys and BOEM studies have exhibited evidence that these shipwrecks are being displaced hundreds of meters by mudslide events of unknown frequency and scale. As part of its responsibilities under the National Historic Preservation Act (NHPA), BOEM requires avoidance of these shipwrecks during permitted activities; however, there is often a delay of years or even decades between when industry surveys locate these sites and when permitted activities take place. During this interval, sediment transport processes may displace these sites beyond the boundaries of the initial avoidance requirement, placing nearby industry infrastructure at risk from collision and potentially impacting the archaeological integrity of the shipwrecks themselves. This study proposes a multi-disciplinary investigation of selected known and potential shipwreck sites to identify previous and predicted future impacts from mudslides, and to examine the localized environmental factors influencing the magnitude and frequency of these events. Because these shipwrecks could provide temporally well-constrained markers of short- and long-term mudflow dynamics, they are invaluable tools for evaluating the geologic conditions actively driving MRDF mudflows. This information is needed to better understand mudslide occurrences, to develop appropriate mitigation strategies for industry avoidance of shipwrecks, and to better understand archaeological site formation processes in the MRDF. This information in turn will inform BOEM's NHPA and National Environmental Policy Act (NEPA) analyses of potentially significant historic properties on the OCS.

Background: Since the late 1970s, BOEM and industry have sponsored numerous studies that examined sediment transport in the MRDF and identified areas of instabilities and mudslide activity that pose a considerable risk to oil- and gas-related infrastructure. (Coleman *et al.,* 1980; Nodine *et al.*, 2007; Bentley *et al.,* 2018). Many of these studies have identified impacts to oil and gas infrastructure following hurricanes or major storm events; however, more recent studies suggest that mudslides 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 seafloor displacement of hundreds of meters for 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 (as of 2017), and mudslides have moved it more than 500 m since it was discovered in 2001. Uncertainty about the effects of sediment transport processes on shipwrecks calls into question the effectiveness of avoidance mitigation strategies in the MRDF. When a large, steel-hulled vessel and its surrounding sediments can transit hundreds of meters during a single storm event (as did *Virginia*), then BOEM's typical avoidance requirement for historic shipwrecks of 300 m may be insufficient, and the wrecks could pose a hazard to nearby pipelines or other oil and gas infrastructure.

Objectives:

- Identify sediment characteristics and other environmental conditions at selected shipwreck sites that have been impacted by previous mudslides and/or are at risk to future mudslide events;

- Quantify the frequency and scale of previous mudslide events in these areas and the resulting archaeological impacts;

- Conduct site assessments and National Register eligibility evaluations of selected shipwrecks;
- Identify potential hazards to oil and gas infrastructure from shipwreck movement; and
- Recommend mitigation and monitoring strategies for potentially significant shipwrecks in this area.

Methods:

1. Examine existing data from industry surveys and BOEM-funded studies to select known and potential shipwreck sites for additional investigation;
2. Where necessary, collect new geotechnical and geophysical data at these locations, to include sediment cores of varying depths and types, ultra-high resolution multibeam bathymetry (<2 m resolution), side scan sonar, and compressed high-intensity radar pulse (CHIRP) seismic profiles;
3. Comparison of this data to existing site-specific studies conducted at non-shipwreck sites within the MRDF;
4. ROV investigation of confirmed wrecks and their surrounding seabed to inform archaeological analysis and seabed characterization;
5. Evaluate the potential for development and deployment of techniques to track wreck movement using acoustic or other means.

The U.S. Geological Survey (USGS) has been a partner on previous BOEM studies in the MRDF and they maintain an active research interest in this area. USGS staff time for field and lab work, and possibly additional USGS funds, are anticipated to be available for this study.

Specific Research Question(s):

1. What are the site-specific geological and environmental conditions at areas known to have been impacted by mudslides?
2. What is the frequency and scale of past mudslide events?
3. What impact have these events had on known archaeological sites?
4. Can these sites be used to track and study future mudslide events?

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Title	Investigation of an Ancient Bald Cypress Forest in the Northern Gulf of Mexico: Phase 2
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Alicia Caporaso (alicia.caporaso@boem.gov)
Procurement Type(s)	Cooperative Agreement with Louisiana State University (LSU)
Performance Period	FY 2020–2022
Date Revised	February 21, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	The BOEM-funded 2015–2018 pilot study provided significant baseline data on the submerged Cypress Forest; however, some of the analyses, including geophysical rectification of buried features, specimen dating, and pollen profiles, proved imprecise or inconclusive due to methodology and equipment tested and applied.
Intervention	Incorporate three-dimensional (3-D) sub-bottom survey to the complement of geophysical survey techniques and collect 10 m vibracores at the site to obtain a deeper, continuous sedimentary record of lithic, peat, pollen, and foraminifera samples.
Comparison	This study will produce geophysical rectification of buried features, specimen dating, and pollen profiles, not fully achieved in previous analyses.
Outcome	Geophysical resolution of buried features including tree stumps, accurate dating of buried foraminifera and other botanical and faunal remains, and a more refined pollen profile—all of which will allow scientists to create a more accurate model of successive paleoclimate regimes and associated ecological systems
Context	The Submerged Cypress Forest is a preserved, partially buried Pleistocene landform with intact tree remains still in growth position located ~13 miles off the coast of Alabama on the Gulf of Mexico (GOM) continental shelf.

BOEM Information Need(s): BOEM devotes considerable resources to carrying out its mission to identify and preserve the Nation's natural and cultural resources as per the National Historic Preservation Act (NHPA) of 1966 and the National Environmental Policy Act (NEPA) of 1969. However, there is a gap in understanding how the presence of preserved landforms such as submerged forests and marshlands, which contain valuable information of past ecosystems, climate, and physical geology/geography, fits within this realm and how the geological and geophysical characteristics of these submerged terrestrial habitats interplay with BOEM's Outer Continental Shelf (OCS) management needs and objectives. The information developed by this study may subsequently be used by BOEM to: (1) develop more effective survey methods for detecting and characterizing such seabed features, many of which are associated with intact, valuable sand resource deposits, and (2) determine if environmental analyses are necessary for such sites when relevant to proposed oil, gas, and dredging activities.

Background: In late 2004, local divers found a location on the OCS in ~60 ft. of water with abundant fish ~13 mi. south of Orange Beach, Alabama after Hurricane Ivan made landfall nearby on September 16 of that year. Diver surveys in 2013 found the depression contained layers of clay sediments with well-preserved woody remnants and several tree stumps exposed or partially exposed. Radiocarbon dating of the wood and woody remnants and remnants and optically stimulated luminescence (OSL) dating of the sediment cores collected from the site suggests the forest age and burial occurred ~42–70 ka.

From 2015–2018, in partnership with the Coastal Marine Institute program at LSU, BOEM funded a study to achieve the objectives listed below. This study successfully produced excellent data and information to achieve these goals (*e.g.* Gonzales *et al.*, 2017 and Reese *et al.*, 2018); however, some of the analyses, including geophysical rectification of buried features, specimen and site dating, and pollen profiles, proved imprecise or inconclusive due to methodologies used and equipment tested.

Objectives: The objective is to refine the characterization of a submerged Pleistocene landform in the northern GOM that contains well-preserved ancient bald Cypress stumps to improve the precision of previously developed information on the geological, geophysical, ecological, and paleoenvironmental characteristics of this site type. By establishing the place of the submerged Cypress forest site within the sedimentological context of the GOM, this research will:

- develop a model to predict other submerged paleoforest sites within the GOM by
- determining the preservation characteristics of the site; and
- improving understanding of the site's depositional and geomorphic characteristics.

Methods: The following methods and tasks are planned for this study:

1. Use high-resolution 3-D compressed high-intensity radar pulse (CHIRP) sub-bottom profiler and tight line spacing to resolve the shape and position of tree stumps and other unusual features at the main site identified by Phase 1 study
2. Ground-truth geophysical survey targets using divers
3. Collect 10 m vibracores at several locations throughout the main site to obtain a deeper, continuous sedimentary record of sedimentary, peat, and pollen samples than was previously obtained
4. Expand geophysical survey area to other (~1–2) known buried tree sites in the northern central GOM
5. Use established dating methods (radiocarbon, OSL, floating tree ring) to compare the age of sediments and the subsequent sedimentation rates to calculate the ages of the *in situ* tree stumps

6. Examine microfossils in the sediments for shifts from terrestrial-freshwater conditions and marine species, particularly for the new 10 m cores

7. Refine the paleoenvironmental setting of the forest through pollen and tree-ring analysis

8. Refine the model to predict other buried forest sites in the northern GOM

Specific Research Question(s):

1. What are the geophysical characteristics of wood buried in sediments in an offshore setting?

2. What types of geomorphology and related ecosystems allow for preservation of wood on 10,000-year time scales?

3. How important are coastal processes and/or climatic shifts to the preservation of wood on these timescales?

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Title	Islands in the Deep—A Biological Review of Shipwreck Investigations
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Alicia Caporaso (alicia.caporaso@boem.gov) Scott Sorset (scott.sorset@boem.gov)
Procurement Type(s)	Cooperative Agreement; Interagency Agreement
Performance Period	FY 2020–2023
Date Revised	February 19, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Historic shipwrecks frequently host benthic communities, yet little is known about their biological associations. To accommodate Outer Continental Shelf (OCS) energy development in an environmentally responsible manner, BOEM needs information on the coupled relationship of shipwrecks and associated biological communities.
Intervention	Analyze existing high-resolution video data, still images, two-dimensional (2-D) ortho-rectified mosaics, and three-dimensional (3-D) photogrammetric mosaics to understand the conditions that influence the distribution and density of constituent species associated with shipwrecks in deepwater habitats.
Comparison	Subject shipwrecks are located in deep-water environments at variable depths and at variable distances from active oil and gas industry activity. Each site is composed of a unique assemblage and overall size/amount of anthropogenic material.
Outcome	Improved protection and mitigative intervention of deepwater shipwrecks and their associated biological communities as coupled resources.
Context	Ultra-deep water shipwrecks for which high-resolution remotely operated vehicle (ROV)-based imagery was systematically collected on both the Gulf of Mexico and Atlantic OCS.

BOEM Information Need(s): Few studies (*e.g.*, Brooks *et al.*, 2016 - Lophelia Coral) have formally characterized faunal assemblages associated with historic shipwrecks in the deep waters of the Gulf of Mexico and Atlantic OCS. BOEM requires information about the ecological role of historic shipwrecks that function as hard bottom habitat for complex benthic communities in order to understand the coupled ecological and physical processes that actively function at shipwreck sites. In some deep-water areas of the OCS, shipwrecks may form the primary source of hardbottom habitat for benthic organisms. Current archaeological mitigations and avoidance criteria only take into account archaeological remains, and not the potential impacts to the associated biological community. Impacts to the biological community may significantly alter an archaeological site, affecting its rate of degradation, stability, and eligibility to the National Register of Historic Places (NRHP). This study will improve our understanding of the coevolution of the material culture, biology, and ecology of the Gulf of Mexico and Atlantic OCS. This information will directly inform pre-lease and programmatic National Environmental Policy Act analysis and post-lease mitigation applications.

Background: Over the past six years, BOEM has partnered with the National Oceanic & Atmospheric Administration's exploration vessel (E/V) *Okeanos Explorer* program and the Ocean Exploration Trust to conduct ROV reconnaissance and Phase II mapping surveys of multiple NRHP-eligible shipwreck sites in the ultra-deep waters (>500 m) of the Gulf of Mexico and Atlantic OCS, including early 19th-century wooden sailing vessels. Purposefully designed visual documentation survey using high-resolution video and still capture technology, coupled with centimeter accuracy positioning control and the use of a calibrated laser scale, has allowed for accurate 3-D mapping, spatial measurement, and identification of archaeological artifacts and features and biological organisms.

Objectives: Analyze the existing high-resolution video data, still images, 2-D ortho-rectified mosaics, and 3-D photogrammetric mosaics in order to describe the biological assemblage of organisms living on and around the structure of the shipwrecks and to understand the conditions that influence the distribution (spatial heterogeneity, patterns, trends, associations, *etc.*) and density of these organisms. The ultimate goal is to develop a paradigm to explain the intersection between 19th-century shipwreck site equilibrium, the specific material culture present at the sites, and succession of site-specific biological communities.

The primary objectives and specific research questions are derived from the research proposal and subsequent work carried out in 2013 and 2014 on the Monterrey A shipwreck, and may be considered an expansion of this research.

Specific objectives include:

- Create a spatial inventory of species observed on a shipwreck and species observed during ROV decent and assent, using ROV video feed of four early 19th-century shipwreck sites.

- Describe any observed patterns in the distribution, orientation, or assemblage of species over the shipwreck sites.

- Identify traces and taphonomic signatures of organisms in and around the shipwrecks.

- Document physical conditions to help describe the environmental factors that are influencing the biological assemblages and influencing the shipwrecks themselves.

- Identify key material culture and environmental controls that may explain variation identified among shipwreck sites. For example, what components of shipwreck sites determine patterns of biological colonization and succession?

- Develop a paradigm to explain the intersection between 19th-century shipwreck site equilibrium, the specific material culture assemblage present at the sites, and site-specific community succession.

Methods: Shipwreck sites to be analyzed for this study include the sites known as: Monterrey B, Monterrey C, 15577, and Blake Ridge (n=4). Specific methodology to achieve the objectives of this research will be developed by the cooperative parties as an integral part of this research.

Specific Research Question(s):

1. What organisms have colonized the cultural resources and are using shipwrecks as benthic habitat and what are the generalized species/habitat associations at shipwrecks sites in these deep marine environments?

2. How is the biology influenced by the shipwrecks and by changes in the shipwrecks over time?

3. How do biological and physical processes influence the preservation of the shipwrecks and artifacts over time?

4. What are the mechanisms of destruction, alteration, and consumption of wood/iron and other materials found at the sites?

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Title	Meeting the Challenge: Developing Socioeconomic Baseline Data Collection and Rapid Response Research Plans
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Victoria Phaneuf (victoria.phaneuf@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	February 6, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
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 OCS 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 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.

Although 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 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:

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Title	National Register Eligibility Potential of Oil and Gas-Related Archaeological Sites in the Gulf of Mexico
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Douglas Jones (douglas.jones@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	February 24, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Submerged oil and gas-related archaeological sites that are over 50 years old are becoming potentially eligible for nomination to the National Register of Historic Places (NRHP), but BOEM lacks a full understanding of the historic significance of these sites.
Intervention	A document that places oil and gas-related sites, as a group, in their proper historic context and provides an analytical framework for interpreting the NRHP eligibility of known and future shipwreck discoveries.
Comparison	Oil and gas-related property types on the Outer Continental Shelf (OCS) that could potentially meet NRHP eligibility criteria *vs.* those that will not, and what characteristics define each.
Outcome	An improved National Historic Preservation Act (NHPA) and National Environmental Policy Act (NEPA) analysis that takes into account historically significant archaeological sites of recent vintage.
Context	The Gulf of Mexico OCS with a history of oil and gas exploration more than 50 years old.

BOEM Information Need(s): A targeted desktop analysis of the types of submerged archaeological sites likely to be encountered on the OCS and that are associated with the history of the Gulf of Mexico oil and gas industry. This analysis should include both a historical and technological overview of the development of oil and gas-related vessels and offshore platforms, and an interpretive framework for determining which of these properties, either individually or categorically, are currently potentially eligible for the NRHP. This framework will enable BOEM archaeologists, when conducting NHPA and NEPA reviews of agency permitted activities, to better distinguish relatively recent 20th Century submerged archaeological sites that are potentially NRHP eligible from those that likely are not, thereby improving BOEM's confidence in fulfilling its mandate towards appropriate site mitigation under NHPA.

Background: BOEM is required under Section 106 of the NHPA to consider the effects of agency actions on archaeological sites eligible or potentially eligible for the NRHP. To be determined NRHP eligible, an archaeological site (or any other type of historic property) generally must be at least 50 years old and meet one or more of the following criteria (along with retaining significant elements of its historic integrity):

- Be associated with events that have made a significant contribution to the broad patterns of our history
- Be associated with the lives of significant persons in our past
- Embody distinctive characteristics of a type, period, or method of construction, or that represent a significant and distinguishable entity whose components may lack individual distinction
- Be likely to yield information important in history or prehistory (National Park Service 1990)

Sites that are not individually eligible under the above criteria may be otherwise eligible as contributing properties to a National Register District or to a Multiple Properties eligibility determination.

The Gulf of Mexico's offshore oil and gas exploration industry is now over 70 years old, and over that history has had an unquestionable economic, political, and sociocultural impact regionally, nationally, and internationally (Criteria A, above). There are also an unknown number of industry-related vessel and platform sinkings that have occurred beyond the 50-year eligibility minimum, some of which BOEM is aware of through industry surveys. In particular, the early decades of the industry were defined by a rapid technological evolution from surplused and repurposed World War II-era military craft to purpose-built drilling rigs of increasing capability and engineering sophistication. Some of these were completely unique, one-of-a-kind vessels, while others represent evolutionary stages of hull construction and drilling technologies still in use today (Criteria B and D). Likewise, other industry support (*i.e.*, non-drilling) vessels may have undergone a similarly significant technological development throughout the Gulf of Mexico's OCS history.

Mid- to late-20th Century shipwrecks are routinely discovered during industry surveys. Whether they are associated with oil and gas operations or other commercial activities, such wrecks are frequently considered "modern" by the surveying archaeologists and, therefore, interpreted as being ineligible for NRHP inclusion. This interpretation, however, rarely, if ever, takes into consideration the long, encompassing, and significant history of OCS oil and gas exploration and development. This study will analyze whether that approach is appropriate or, alternately, provide recommendations on which types of archaeological sites may warrant a more robust analysis.

Objectives: To provide a reference tool for both BOEM and industry archaeologists to determine the appropriate analytical criteria for identifying oil and gas industry-related archaeological sites that may be NRHP eligible.

Methods:

1. A desktop synopsis, compiled from primary and secondary sources, of the technological history of oil and gas-related vessel and platform types, and their relative contribution in the context of the industry's regional and national

significance. Types of offshore vessels and infrastructure studied should include, but not be limited to, Mobile Offshore Drilling Units (MODUs), offshore production vessels, supply vessels, crane barges, pipe-laying vessels, diving support vessels, anchor handling vessels, tenders, fuel barges, other offshore service vessels, and production platforms;

2. A review of similar sources as well as available shipwreck databases to identify known and potential shipwrecks and platforms of the types identified under the first task, that are submerged on the Gulf OCS; and

3. A recommended framework for determining which of these sites may be potentially eligible for the NRHP.

4. Preparation of NRHP nominations for any properties determined potentially eligible and for which sufficient information exists to complete the nomination forms.

Specific Research Question(s):

1. Are any oil and gas-related archaeological sites in the Gulf of Mexico, either individually or in categorical classifications, potentially eligible for the NRHP?

2. How can BOEM appropriately determine those that are eligible from those that are not?

References:

National Park Service, 1990. *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation*. U.S. Department of the Interior, National Park Service, National Register, History, and Education.

Title	Shallow Water Pipeline Long-term Stability Assessment
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Mark Belter (mark.belter@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	FY 2020–2023
Date Revised	February 20, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Benthic habitats, cultural resources, oil and gas infrastructure, access to sand resources, and navigation may be adversely impacted by displaced pipelines.
Intervention	Baseline mapping and as-built verification of shallow water (<200' depth) pipelines representative of Outer Continental Shelf (OCS) infrastructure (*e.g.*, diameters and orientation) in the Western and Central GOM Planning Areas. Installation accuracy will be assessed and verified pipeline locations will provide a basis for assessing long-term stability.
Comparison	Displacement over time will be compared with existing guidelines to evaluate the adequacy of current distancing requirements.
Outcome	The new information may inform updated avoidance guidelines and removal policy.
Context	BOEM analyses assumed abandonment in place was the exception. In practice, abandonment is the default action and there is insufficient information to assess the potential impacts.

BOEM Information Need(s): In accordance with the Outer Continental Shelf Lands Act, National Environmental Policy Act, Magnuson-Stevens Fishery Conservation and Management Act, and National Historic Preservation Act; BOEM is required to assess a variety of potential impacts occurring as a result of oil- and gas-related activities on the OCS. The extent of pipeline abandonment-in-place activities (*i.e.*, number of pipeline segments and total linear miles) is greater than previously understood and more information is needed for BOEM to adequately assess potential impacts to OCS resources. Exposed and displaced shallow water pipelines may represent an increased risk to OCS infrastructure, navigation, sand resource access, Essential Fish Habitat, and cultural resources.

Background: A records review indicates the Bureau of Safety & Environmental Enforcement (BSEE) approved decommissioning of 3,709 pipelines in the past 10 years. Of these, 90.7% of the pipelines were abandoned in place, representing 98.2% of the total linear miles decommissioned during this period (9,075 miles). Pipelines installed or abandoned in water depths less than 200 ft. are known to be susceptible to displacement if located in the path of a tropical storm event. Less information is available regarding risks associated with unburial due to subsidence, human interaction, or other factors. Although active pipelines are supposed to be monitored and incidents reported to BSEE, there is no such requirement for abandoned pipelines. As a result, BOEM needs additional information on decommissioned pipeline incidents to fully assess the frequency, magnitude, or potential impacts of pipeline displacement. A review of reports regarding displacement of active pipelines suggests the potential is significant:

1. Large and small diameter pipelines are regularly displaced by bottom currents and sediment transport associated with tropical cyclone events.

2. Buried pipelines can become unburied by storm pressure on the seafloor and have been documented at depths greater than 200 ft. (Gearhart *et al.*, 2011) and, potentially, to a depth of 400 ft. (Hooper and Suhayad, 2005).

3. Lateral movements greater than 5,000 ft. have been reported for pipeline segments several miles in length (MMS, 2007; Tian *et al.*, 2015).

4. Analyses following hurricanes Andrew (1992), Lili (2002), Ivan (2004), Katrina (2005), and Rita (2005) identified 164 pipeline segments displaced by hurricane-related bottom currents (SES, Inc., 2005; DNV, 2006; Nodine *et al.*, 2006; DNV, 2007; MMS, 2007).

5. Minerals Management Service-funded studies found large variations in operator reporting practices and degrees of detail reported by operators. Due to discrepancies, statistical analyses of hurricane-related damage were considered to underestimate impacts and be relatively unreliable (DNV, 2007).

6. Analysis of pipeline damage and storm paths hurricanes suggest some sensitive habitat areas may be subject to repeated incidents (DNV, 2007; Tian *et al.*, 2015).

Objectives: The purpose of this study is to collect sufficient long-term pipeline stability data to assess the potential impacts to OCS resources, infrastructure, and users posed by existing and future abandoned pipelines.

Methods: BSEE records and reports will be used to estimate the extent of past pipeline displacement. The National Oceanic & Atmospheric Administration's Charts Division survey data will be used to supplement BSEE reports. A selection (~20) of new/active pipelines and abandoned pipelines in the vicinity of biological, historic, and mineral resources will be identified for monitoring. Initial gradiometer surveys will be used to assess pipeline locations with respect to as-built plats and to establish a baseline for the study. Monitoring surveys will be conducted every two years. Side scan surveys will be performed on a small, randomly selected subset of segments and displaced segments to determine presence and relief of potential obstructions.

Specific Research Question(s):

1. What is the frequency (%) of pipeline displacement (lateral and unburial)?

2. When lateral displacement occurs, what is the expected range (ft.)?

3. In what regions is there an increased probability of pipeline displacement? What are the contributing factors (*e.g.*, subsidence and seafloor instability)?

References:

Det Norske Veritas. 2006. *Pipeline Damage Assessment from Hurricane Ivan in the Gulf of Mexico*. Minerals Management Service Technology Assessment Program, Project 553. 68 pp.

Det Norske Veritas. 2007. *Pipeline Damage Assessment from Hurricanes Katrina and Rita in the Gulf of Mexico*. Minerals Management Service Technology Assessment Program, Project 581. 104 pp.

Gearhart, II, R., D. Jones, A. Borgens, S. Laurence, T. DeMunda, and J. Shipp. 2011. *Impacts of recent hurricane activity on historic shipwrecks in the Gulf of Mexico Outer Continental Shelf*. 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 2011-003. 202 pp.

Hooper, J.R., and J.N. Suhayda. 2005. *Hurricane Ivan as a Geologic Force: Mississippi Delta Front Seafloor Failures*. Offshore Technology Conference, Houston, TX. 2 - 5 May, 2005. OTC 17737.

Minerals Management Service. 2007. *Offshore Pipeline Stability During Major Storm Events*. Presentation by Manny Gagliano to the Government / Industry Pipeline Research and Development Forum, New Orleans, LA.

Nodine, M.C., S.G. Wright, and R.B. Gilbert. 2006. *Mudslides during Hurricane Ivan and an Assessment of the Potential for Future Mudslides in the Gulf of Mexico*. Minerals Management Service Technology Assessment Program, Project 552. 44 pp.

Stress Engineering Services, Inc. 2005. *Evaluation and Comparison of Hurricane Induced Damage to Offshore GOM Pipelines from Hurricane Lili*. Minerals Management Service Technology Assessment Program, Project 503. 81 pp.

Tian, Y., B. Youssef, and M.J. Cassidy. 2015. *Assessment of Pipeline Stability in the Gulf of Mexico During Hurricanes Using Dynamic Analysis*. Theoretical and Applied Mechanics Letters 5 (2015) 74-79.

Title	Outer Continental Shelf (OCS)-Related Transportation Infrastructure in Louisiana and Texas
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Sindey Chaky (sindey.chaky@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2021–2023
Date Revised	February 15, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	BOEM does not have current information regarding onshore intermodal transportation associated with Outer Continental Shelf (OCS) activities, particularly roads, railroads, and waterways connected to ports and terminals.
Intervention	This study will document and analyze onshore intermodal transportation associated with onshore activities.
Comparison	This study will expand BOEM's knowledge of onshore OCS-related infrastructure to include intermodal transportation.
Outcome	BOEM will acquire analyses of key OCS-related onshore transportation routes, usage estimates, and maps.
Context	BOEM-defined Economic Impact Areas (EIA) in Louisiana and Texas.

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 the Outer Continental Shelf Lands Act, National Environmental Policy Act, and Coastal Zone Management Act, particularly with regard to cumulative effects analyses. 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 and cumulative effects 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 pipeyards, 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. Although BOEM's efforts include transportation systems that link 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, often due just to the scale of the demand and the fact that transportation infrastructure may have its types of socioeconomic problems, some of which may become more pressing as deepwater developments continue to concentrate support-related activities into fewer ports. For example, in Louisiana, Highway (Hwy) 1 was identified as critical for energy activities based out of Port Fourchon, which is the main port utilized by Gulf of Mexico deepwater operators. Any disruption to transportation on Hwy 1 would negatively affect those operators, the service industries that support them, OCS production capabilities, and ultimately, the Nation's energy supply.

Objectives: This study seeks to understand the shore-side part of this intermodal transportation system 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 the industry sectors associated with each of the three transportation types in terms of organization, size, employment, industry trends, 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):

1. How does the shore-side part of the OCS-related intermodal transportation system function, specifically looking at: transportation by truck, transportation by water, and transportation by rail?

2. For each of these commercial elements what are the economic sectors and industries involved?

3. What is their geography, and what are the flows of traffic?

4. Where are there choke points where transportation needs are close to or exceed the infrastructure?

References:

Title	Distribution and Abundance of Biodiversity Associated with U.S. Exclusive Economic Zone (EEZ) Critical Minerals Within the Pacific Ocean
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov) Mark Leung (mark.leung@boem.gov) Lisa Gilbane (lisa.gilbane@boem.gov)
Procurement Type(s)	Intra-agency Agreement with the U.S. Geological Survey (USGS)
Performance Period	FY 2020–2024
Date Revised	April 4, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Critical minerals are vital to the U.S. economy but their availability is limited. Offshore domestic sources of critical minerals may present an outstanding opportunity for development, but areas low in biodiversity must first be identified for potential leasing.
Intervention	Describe the distribution and abundance of biodiversity associated with critical minerals within the U.S. EEZ, Pacific OCS Region, by developing and ground-truthing models that predict areas of potential economic importance and low in biodiversity.
Comparison	The distribution and abundance of biodiversity associated with critical minerals in different areas.
Outcome	Identification of areas that could be leased for exploration and development; implementation of directives outlined in EO 13817 and S.O. 3559.
Context	All Planning Areas of the Pacific OCS Region, emphasizing Washington/Oregon and Northern California. Additional areas that may be surveyed include the Hawaiian Outer Continental Shelf (OCS) and Federal submerged lands of the U.S. Pacific Territories outside National Marine Sanctuaries and Monuments.

BOEM Information Need(s): As land-based mineral resources become increasingly difficult and expensive to acquire, the potential for mining resources from the deep sea has become economically feasible. Despite the increasing interest from industry in critical minerals, the quantity and characteristics of the resources are uncertain, and many stakeholders worry about risks to vulnerable deep-sea ecosystems. Therefore, there is an urgent need to identify submerged lands that have high economic potential but low biodiversity, making them suitable for further exploration and leasing. This study implements directives outlined in EO 13817 *A Federal Strategy To Ensure Secure and Reliable Supplies of Critical Minerals*, and S.O. 3559 *Critical Mineral Independence and Security*.

Background: Discovery of new uses for an increasing number of minerals has enabled rapid advancement in a variety of sectors: energy production, national defense systems, information technology, health care, and telecommunications (Schulz *et al.*, 2017). The importance of these critical minerals to modern society has generated concern about their limited supply, and the U.S. would benefit from identifying and developing domestic sources. Deep-sea minerals are an option that can help fill this need.

Seafloor massive sulfides (SMS) are deposits of metal-bearing minerals that form in association with hydrothermal vent systems (Hannington *et al.*, 2011), particularly within seafloor spreading systems and island back-arc basins. Within the Pacific OCS Region, the Gorda Ridge-Escanaba Trough contains SMS, and there has been commercial interest in this area since the 1980s. The priorities for this study are to describe the biodiversity associated with inactive vent systems or "dead bodies", determine the relationship between ecological value and the potential extent and character of the mineral resources, and to compare measures of biodiversity among dormant and active systems. The aim is to identify low-biodiversity lease areas for mineral development. Additionally, information may be collected regarding the potential for "renewable minerals", where human-created hydrothermal vents may be used to continuously precipitate and harvest minerals in a controlled system (Nozaki, *et al.*, 2016; Kodama, 2016), and thereby circumventing traditional and often destructive mining practices altogether. If time and funding allow, other areas may be surveyed for biodiversity associated with cobalt crusts, manganese nodules, and rare earth-yttrium (REY) muds (Hein *et al.*, 2009; Schultz *et al.*, 2017).

Objectives: The purpose of this study is to investigate the distribution and abundance of biodiversity in relation to the concentration of critical minerals on the Pacific OCS and nearby habitats.

Methods: Mineral resource investigation methods for SMS may use several remote sensing technologies, including an autonomous underwater vehicle (AUV) with an electromagnetic sensor (to detect metal-bearing minerals), multibeam bathymetry, and side scan sonar. A remotely operated vehicle (ROV) will ground-truth remote sensing data and provide imagery regarding associated biotic communities. Water samples will be collected and used for elemental analysis as well as for deoxyribonucleic acid (DNA) metabarcoding, the latter being an independent and cost-effective way to initially describe biodiversity (Ji *et al.*, 2013). Depending upon logistical and funding constraints, other methods (*e.g.*, acoustic recordings, box cores, *etc.*) may also be employed to describe the ecological baseline of an area.

Specific Research Question(s):

1. What is the distribution and concentration of critical minerals (*e.g.*, SMS) within three area types: (i) active vent systems, (ii) inactive vent systems, and (iii) nearby, non-SMS habitats?

2. What is the distribution, abundance, and overlap of species associated within three area types: (i) active vent systems, (ii) inactive vent systems, and (iii) nearby, non-SMS habitats?

3. Using spatial interpolation models and trade-off matrices, what areas have the highest economic potential for minerals but the lowest biodiversity value and sensitivity to disturbance?

References:

Hannington, M., Jamieson, J., Monecke, T., Petersen, S. and Beaulieu, S., 2011. *The abundance of seafloor massive sulfide deposits*. Geology 39:1155–1158.

Hein, J.R., Conrad, T.A., and Dunham, R.E., 2009. *Seamount characteristics and mine-site model applied to exploration-and mining-lease-block selection for cobalt-rich ferromanganese crusts*. Marine Georesources and Geotechnology 27:160–176.

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Nozaki, T., Ishibashi, J.I., Shimada, K., Nagase, T., Takaya, Y., Kato, Y., Kawagucci, S., Watsuji, T., Shibuya, T., Yamada, R., and Saruhashi, T., 2016. *Rapid growth of mineral deposits at artificial seafloor hydrothermal vents*. Scientific Reports 6:.22163.

Schulz, K.J., DeYoung, J.H., Jr., Seal, R.R., II, and Bradley, D.C., eds., 2017. *Critical mineral resources of the United States—Economic and environmental geology and prospects for future supply*: U.S. Geological Survey Professional Paper 1802, 797 p., https://doi.org/10.3133/pp1802.

Title	The Environmental Status of Artificial Structures Offshore California
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov) David Ball (david.ball@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2020–2022
Date Revised	April 4, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Decision makers need information about how offshore projects that contribute significant amounts of hard substrate into the marine environment may be evaluated, managed, and potentially incorporated into an artificial reef program.
Intervention	Field surveys of natural and artificial habitats and subsequent analyses of survey data.
Comparison	Comparisons among natural and artificial habitat types according to depth and biogeographic zone.
Outcome	Evaluation criteria that can be used to inform decommissioning decisions by the State of California, BOEM, and Bureau of Safety & Environmental Enforcement (BSEE); information about potential artificial reef consequences of offshore wind in the California Current System.
Context	Southern California Planning Area

BOEM Information Need(s): Offshore energy development changes the distribution and abundance of local marine habitats and species via the introduction of artificial substrate (Schroeder and Love, 2004; Boehlert and Gill 2010). This “artificial reef” effect potentially modifies a variety of local and regional processes, including those that drive the ecological dynamics of managed, sensitive, or non-native species. Artificial reefs may also enhance certain human activities such as fishing or diving. Decision makers must therefore understand how offshore projects that contribute significant amounts of hard substrate into the marine environment may be evaluated, managed, and potentially incorporated into an artificial reef program. In the Pacific OCS Region, habitat issues are of particular importance due to (1) the imminent decommissioning of oil and gas platforms, which may remove potentially important habitat for managed fish species, and (2) the introduction of new artificial habitat from floating offshore platforms. Information produced from this study will be used in NEPA and consultation documents when reviewing offshore projects that add marine infrastructure into the environment.

Background: The National Fishing Enhancement Act of 1984 (NFEA; 33 U.S.C. 2101) was enacted to promote and facilitate efforts to establish artificial reefs in U.S. waters. The NFEA calls for the use of the best scientific information available to site, construct, and subsequently monitor and manage artificial reefs in a manner which will enhance fishery resources to the maximum extent practicable, minimize environmental risks, and avoid conflicts with other stakeholders. To accomplish these goals the NFEA directed the formation of a National Artificial Reef Plan (NARP).

On the Outer Continental Shelf (OCS), a departure from complete platform removal during decommissioning may be granted to a lessee if the remaining structure is incorporated into a state artificial reef program that complies with the NARP and satisfies the U.S. Coast Guard navigational requirements. In southern California, it remains undetermined to what extent platform habitat (including shell mounds) and other similar man-made structures (such as pipelines, cables, and metal-hulled shipwrecks) contribute to regional scale ecological dynamics compared to natural substrates. This is due in part to the lack of a comprehensive understanding of the extent of man-made habitat available and variation in the quality of these habitats across and nearby the Southern California Bight (SCB). Because of the necessity of the State of California's acceptance of a reefed platform into their artificial reef program, current information needs include understanding the status of the current network of artificial habitats in California and determining how these artificial habitats are functioning in reference to nearby natural areas.

Objectives: The overall objective of this study is to evaluate the current status of artificial reef habitat in and nearby the SCB to inform future National Environmental Policy Act (NEPA) analyses regarding the ongoing and proposed changes to marine habitats from offshore energy activities, and to provide guidance to assess and manage future artificial reef proposals and projects at a regional scale, especially Rigs-to-Reefs projects.

Methods: Using available information on the distribution of artificial structures offshore southern California (*e.g.*, Lewis and McKee, 1989; MarineCadastre.gov), the physical characteristics of artificial structures will be determined using site-appropriate methods and may include multibeam or side scan sonar. Biological characteristics will be assessed using visual surveys via SCUBA divers, remotely operated vehicles, or submersibles. Sociological status (human use) will be assessed by summarizing recreational fishing data, direct observation, and by collecting new data via guided discussions with stakeholders. Similar data on selected nearby natural habitats will also be collected to provide a basis for comparison. The data collected will be analyzed using multivariate statistical methods (*e.g.*, boosted regression trees) to identify characteristics of natural and artificial reefs associated with high productivity and resilience. Ecosystem services will also be analyzed.

Specific Research Question(s):

1. What is the physical, biological, and sociological status of artificial structures within the Southern California Planning Area?

2. Which physical, biological, or geographical features are important in determining the ecological status and productivity of these reefs?

3. What criteria should be used to evaluate future artificial reef proposals to determine environmental benefits and ecosystem services?

References:

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Title	Fostering a Cohesive Interagency Offshore Mapping and Hard Bottom Habitat Characterization Program
Administered by	Pacific OCS Region
BOEM Contact(s)	Jeremy Potter (jeremy.potter@boem.gov), Lisa Gilbane (lisa.gilbane@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2022
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	There is limited information about the location and community composition of 'sensitive' seafloor habitats (*e.g.*, hard bottom, seeps) that may be affected by leasing activities along the Pacific Outer Continental Shelf (OCS).
Intervention	Interdisciplinary research to improve knowledge of sensitive seafloor habitats for responsible planning of Pacific OCS energy development.
Comparison	N/A
Outcome	Improved understanding of diversity and distribution of hard bottom habitats and associated biological communities in the vicinity of ongoing and proposed BOEM activities.
Context	The potential domain includes northern and south-central California, and Oregon. If BOEM activities expand to other Pacific OCS Region geographies, we would consider including them in out years.

BOEM Information Need(s): The BOEM Pacific OCS Region needs authoritative baseline information to inform decision making across program areas (*e.g.*, conventional energy, renewable energy, marine minerals). Proactively collecting the information on identification, biodiversity, ecology, and food-web dynamics of deepwater benthic communities—including commercially important fish—is prudent to inform National Environmental Policy Act (NEPA) documents and potential mitigations.

Background: Pacific OCS Region has a dramatically increasing need for deepwater benthic information to inform potential management decisions associated with conventional energy, renewable energy, and marine minerals. This study seeks to adapt the past successes of prior deepwater BOEM - National Oceanic & Atmospheric Administration (NOAA) - U.S. Geological Survey (USGS) interagency efforts in the Gulf of Mexico and Atlantic to the Pacific. Due to complementary ongoing field efforts and new budget initiatives at NOAA and USGS, BOEM has a 'low-cost' opportunity to initiate a more cohesive and nimble interagency effort in partnership to address regional needs. Fieldwork funded by this study will expand upon and complement previous work under Cal DIG (*California Deepwater Investigations and Groundtruthing*) I (PC-17-02) and II (PC-19-06).

Objectives: The interagency effort will improve understanding of the functional characteristics of benthic habitats within the wider California Current ecosystem and inform near-term and future management decisions for multiple agencies. This adaptive effort will allow BOEM to quickly leverage opportunities with interagency partners within the overall area of interest. Objectives associated with BOEM funding include:

- Identify and map major geologic features and seafloor.
- Identify the distribution and abundance of benthic communities and selected commercially important fish and invertebrate species.
- Validate recently developed fisheries based analyses and deep-water coral and sponge habitat suitability models.
- Assess relative sensitivity of selected areas by comparing food-web ecology, coral age-structure, and genetic diversity across depths and environmental gradients.

Methods: A broad range of interdisciplinary methods will be employed to map, sample, and characterize hard bottom habitats, including deep coral and chemosynthetic communities. High-resolution, ship-based mapping technologies will delineate substrate types and document the distribution of hard bottom areas. Unmanned systems will provide additional seafloor imagery and enable collection of seafloor samples and environmental parameters. Collected data will be analyzed using appropriate laboratory materials/protocols and software systems in order to describe community composition, complexity, and sensitivity to impacts. Subset of field activities will include remotely operated vehicle (ROV) operations for the collection of limited coral and sponge samples for taxonomic, genetic identification, isotopic testing, and submission to the Smithsonian Institution under an existing BOEM Agreement. To complement traditional taxonomic and genetic approaches, environmental deoxyribonucleic acid (eDNA) sampling will be incorporated to continue assessing its use a biodiversity tool. Data management best practices and annotation consistent with the Coastal and Marine Ecological Classification Standard will be followed to ensure information accessibility, with coral and sponge locations submitted in a format consistent with the NOAA Deep Sea Coral Research and Technology Program (DSCRTP) national geodatabase. Study results will be made available via peer-reviewed literature, a final report, and as datasets in usable formats such as geographic information system (GIS) layers.

Specific Research Question(s):

1. Where are there sensitive hard bottom benthic habitats in the vicinity of potential conventional and renewable leasing areas of the Pacific OCS?

2. What is the community composition of these sensitive habitats? How are these species ecologically and genetically connected?

References:

Title	A Marine Biodiversity Observation Network (MBON) for the California Current System (CCS)
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov) Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2020–2024
Date Revised	April 4, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Ongoing and prospective energy and mineral activities in the CCS may disrupt ecosystem function and services, and a cost-effective system is needed to determine the magnitude of these impacts.
Intervention	Long-term studies that monitor marine ecosystems are necessary to distinguish between changes caused by natural processes and those caused by human activities. By leveraging existing datasets and building upon previous work, select indicator species and essential biodiversity variables (EBVs) will be assessed at scales appropriate for impact analyses.
Comparison	Potential effects will be evaluated via long-term data that allow an assessment of impacts from development against the backdrop of known natural variability. The range and patterns of natural variability, and relationships to environmental drivers, can only be discerned from long-term data collection. Technologically advanced tools like environmental deoxyribonucleic acid (eDNA), satellite-tracked animal tags, and satellite remote sensing, will enable cost-efficient observation at an ecosystem scale.
Outcome	Study products will assist BOEM in performing National Environmental Policy Act (NEPA) impact analyses and consultations, and address stakeholders' concern about potential ecosystem consequences from offshore energy and mineral development.
Context	Potentially all four Planning Areas within the CCS: Washington/Oregon, Northern, Central, and Southern California.

BOEM Information Need(s): BOEM needs a comprehensive yet rigorous monitoring system for the OCS to help discern and understand patterns and changes in composition and function, and to distinguish impacts due to human activities from environmental change. Results from this project will inform NEPA impact analyses, consultations, and decision making related to ongoing and prospective energy and mineral activities in the CCS.

Background: Biological and physical measurements that characterize ecosystem status and trends inform decision making regarding energy production, mineral extraction, and climate change. Long-term observations of the ecosystem, preferably over decades, and ideally across trophic levels from microbes to marine mammals, are needed to improve understanding of ecosystem dynamics and better assess possible anthropogenic effects against a naturally variable system. A strong focus on biodiversity, including taxonomic, genetic, and functional diversity is recommended (Duffy *et al.*, 2013). Diversity can be a gauge of system resilience and functional complexity because high levels of biodiversity promote ocean health and secure the multiple functions and services the oceans provide (Palumbi *et al.*, 2009). Thus, managing resources in ways that conserve existing marine biodiversity will support appropriate ocean energy management (Geijzendorffer *et al.*, 2016). This strategy also aligns with broader national and international goals of determining comprehensive, long-term biodiversity measures (*e.g.*, U.N. Convention on Biological Diversity; Anderson *et al.*, 2017). The work proposed here builds on the demonstration MBON in the Santa Barbara Channel (SBC-MBON, ending in 2020), which is part of a national Marine Biodiversity Observing Network. SBC-MBON also links to the California Cooperative Oceanic Fisheries Investigations, Integrated Ocean Observing System (IOOS), Animal Telemetry Network (ATN), Multi-Agency Rocky Intertidal Network (MARINe), the National Science Foundation's Long-term Ecological Research, the National Aeronautics & Space Administration's Group on Earth Observations Biodiversity Observation Network (GeoBON) and the Southern California Coastal Water Research Project Authority, among others. This observing network concept is tested and ready to expand to other areas within the CCS where OCS energy or mineral development is foreseeable.

Objectives:

- Build on the initial SBC-MBON efforts to extend biodiversity observing to areas important to ongoing or prospective energy or mineral activities in the CCS.
- Refine machine-learning techniques to analyze and synthesize biodiversity data from imagery, especially from seafloor mapping activities.
- Describe spatial patterns of marine biodiversity (whales to microbes) in frontier areas using autonomous underwater vehicles (AUVs) and eDNA and deoxyribonucleic acid (DNA) metabarcoding techniques.
- Simultaneously compare habitat model predictions, acoustic detection, and environmental DNA monitoring techniques for marine mammals and fishes to refine abundance estimates within BOEM areas of interest, and determine the most efficient survey methodology.
- Continue to optimize data management and synthesis through collaboration with the National Oceanographic Partnership Program, ATN, IOOS, MARINe, and other relevant programs.

Methods: The project will build upon methodology developed and described in study PC-15-05, *Demonstrating an Effective Marine Biodiversity Observation Network in the Santa Barbara Channel*, including acoustic and optical imaging, genomics/eDNA, and essential biodiversity variables.

Specific Research Question(s):

2. What are the strengths and weaknesses of various survey methods to monitor essential biodiversity variables or species of interest?

1. What are the regional patterns of biodiversity in areas of interest to ongoing or prospective energy and mineral activities within the CCS?

References:

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

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

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

U.N. Council on Biological Diversity. *Strategic Plan for Biodiversity 2011–2020*. https://www.cbd.int/decision/cop/?id=12268 (accessed 2/20/2019).

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 (also, possible Interagency Agreement)
Performance Period	FY 2020–2023
Date Revised	April 3, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
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[1]. BOEM needs to gather baseline information on archaeological and cultural 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 2012), Gulf of Mexico OCS (Pearson *et al.*, 2003), Hawaii (NOAA 2017; Watson *et al.*, 2017; Van Tilburg *et al.*, 2017), and Pacific OCS (ICF

[1] 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.

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:

- 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 georeferenced database;

- collect data from archival and secondary sources to develop a georeferenced database of terrestrial properties listed and potentially eligible for listing on the NRHP;

- compile and summarize ethnographic information from indigenous communities regarding traditional use and traditional cultural properties that could be impacted by offshore development;

- 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; and

- 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. with appendices.

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.

Pearson, C.E., James, S.R., Jr., 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.

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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.

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.

Title	Over Water Migration Movements of Black Brant
Administered by	Pacific OCS Region
BOEM Contact(s)	David Pereksta (david.pereksta@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2020–2024
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Migrating waterfowl may be impacted by offshore wind turbines including possible turbine avoidance, thus, a reduction in habitat, as well as risk of collision. Black Brant have been identified as a species that could be impacted during their oversea migration along the Pacific Coast.
Intervention	Attach tracking devices to 150 Black Brant over three years on their breeding grounds in Alaska prior to their southbound migration. Collect time series data for up to five years including latitude, longitude, and altitude of the birds as they migrate.
Comparison	Identify oversea Black Brant migratory routes from Alaska to the U.S. Pacific Coast to understand pathways, timing, and flight altitude.
Outcome	Use the data collected to characterize potential risk to the species from offshore wind energy development and incorporate into offshore wind turbine micrositing decisions.
Context	Pacific Coast of North America (Alaska to California)

BOEM Information Need(s): BOEM needs to address potential bird interactions with offshore wind energy infrastructure off the U.S. West Coast. Stakeholder input regarding offshore wind development offshore California has identified that impacts to migratory birds are a concern. In particular, several stakeholders have specific concerns about potential impacts to the Black Brant; a migratory species of goose that breeds in the Arctic and winters along the Pacific Coast of the U.S. and Mexico. Black Brant have an oversea migration and fly over the Gulf of Alaska (GOA) *en masse* during fall migration. The entire migrating population have been known to simultaneously depart Izembek Lagoon National Wildlife Refuge, located at the tip of the Alaska Peninsula for long overwater flight to wintering areas on the Pacific Coast. Several critical wintering areas for Black Brant along the coast of California are close to BOEM's Wind Energy Call Areas (Humboldt Bay and Morro Bay). The information collected by this study will be used by BOEM to analyze the effects to Black Brant and other waterfowl from offshore wind energy projects off the Pacific Coast of the U.S. and influence the micrositing of turbines if appropriate.

Background: Numerous bird species fly over open ocean throughout their annual cycle. Some species utilize open ocean habitats on a daily basis while other species use the open ocean biannually for long-distance migrations. For the latter group, minimal observational information is available about threat avoidance. There are inadequate data available on these birds for informing avian risk assessments at offshore development sites. It is known that waterfowl leave southwest Alaska and fly over the GOA to make landfall between the Alaska panhandle and the southern tip of Baja California, but exact spatial data of these migrations is unknown. Where they make landfall depends on prevailing winds. The migratory movements of several species of Arctic-nesting geese are being tracked from the Arctic. Recent data collected on Greater White-fronted Geese and Snow Geese show that they migrate north in the spring through the interior and along the Pacific Coast to breeding areas in Alaska. However, during the fall migration to wintering areas , all surviving tagged geese flew directly from southwest Alaska over open ocean to the northern California Coast, passing near the proposed offshore wind development areas.

Swans and geese are sensitive to disturbance from offshore wind energy infrastructure (Desholm 2009). In a recent vulnerability assessment for marine birds of the California Current System, Black Brant were found to have a “medium” population collision vulnerability and a “high” population displacement vulnerability (Adams *et al.*, 2016). Current tracking data has shown that studies like the one proposed can provide information to assess the potential effects of offshore wind development on migrating waterfowl, including Black Brant. The larger body size of Black Brant allows them to carry larger and more accurate detailed tracking devices (Global System for Mobile Communications [GSM] collars). Identifying the oversea migratory routes of Black Brant from Alaska to the Pacific Coast will allow BOEM to assess the potential collision and displacement risks to the species from offshore wind energy development and cite projects in a way that minimize effects to the species.. In addition, if tracking of Black Brant continued during the development and operation of wind energy installations, the data collected during this proposed study would facilitate measuring the actual effects of the projects to the species.

Objectives: Collect data on over water migration routes for Black Brant along the Pacific Coast of North America to facilitate assessing potential collision and displacement impacts to the species from offshore wind energy development.

Methods: Fifty (50) Black Brant per year for three years would be outfitted with Global Positioning System (GPS)/GSM collars prior to their southbound migration. These devices provide minute-by-minute data for up to five years including latitude, longitude, and altitude of the birds as they migrate. Black Brant tagging can be incorporated into one or more of several ongoing projects in Alaska (Izembek National Wildlife Refuge or Yukon Delta National Wildlife Refuge).

Specific Research Question(s):

1. What are the migratory routes of Black Brant from the Arctic to the Pacific Coast of the U.S. including their spatial location, timing, and flight altitudes?

2. What is the overlap of these migratory routes with proposed call areas for wind energy development off the Pacific Coast of the U.S.?

3. What is the risk to migrating Black Brant and other waterfowl from offshore wind energy development?

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.

Desholm, M., 2009. *Avian sensitivity to mortality—Prioritizing migratory bird species for assessment at proposed wind farms*: Journal of Environmental Management. v. 90, no. 8. p. 1,672–1,679.

Title	A Three-Dimensional (3-D) Assessment of West Coast Continental Shelf Seabird Density: Species Composition at Different Heights Above the Sea Surface
Administered by	Pacific OCS Region
BOEM Contact(s)	David Pereksta (david.pereksta@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2020–2022
Date Revised	March 7, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Marine birds may be impacted by offshore wind turbines including possible turbine avoidance, thus, a reduction in habitat, as well as risk of collision. To date, assessments of potential impacts to marine birds have focused on quantification of spatial use of Outer Continental Shelf (OCS) waters.
Intervention	Combine at-sea seabird data sets, data and analyses indicating seabird flight characteristics as a function of wind strength, and models of the windscape in West Coast coastal and offshore areas. From these data, devise a 3-D model of seabird use of OCS waters and how it would be affected by winds.
Comparison	Show identified seabird hotspots not just in terms of species composition but also in vertical space use of seabirds in strong wind conditions. In that regard, the seabird species composition would differ at different heights above the sea surface as a function of seabird flight behavior as affected by wind strength.
Outcome	Species composition and densities of seabirds in coastal waters of the Pacific at several height strata above the ocean surface (*e.g.*, 10, 30, 50 m) as a function of the "windscape" as affected by wind speed at various rates: <20, 20–30 and >30 kts. Data will be binned into 5'×5' cells.
Context	Pacific (West Coast of U.S. and Hawaii).

BOEM Information Need(s): BOEM needs to address potential seabird interactions with ocean energy infrastructure off the U.S. West Coast and Hawaii, where the availability of at-sea seabird data are the most complete and intensive in U.S. waters. We have a need to combine at-sea seabird data sets, data and analyses indicating seabird flight characteristics as a function of wind strength, and models of the windscape in West Coast coastal and offshore areas to show seabird hotspots not just in terms of species composition but also in vertical space use of seabirds in strong wind conditions. Such an analysis would guide the layout and the appropriateness of the siting of wind turbines or other ocean energy infrastructure in the Pacific OCS Region.

Background: To date, most of the research on seabird spatial use of potential offshore wind project areas has been conducted in Europe, where the seabird species composition is quite different from that of the U.S. West Coast and where the conditions under which data were gathered were in 'moderate' winds (*e.g.*, Cook *et al.*, 2012; Johnston *et al.*, 2013). In the European studies, the coastal species mix includes mostly ducks, loons, grebes, shags, gulls, terns, and alcids. All of these species typically use 'flapping' flight in most wind conditions, and have the most control over their flight trajectories compared to flight behavior that includes relatively extensive periods of gliding. Moreover, flappers typically fly just above the sea surface to exploit lower wind strengths found there, and easily avoid large objects, such as buoys, wind turbines, and ships. Such research, while instructive does not provide information on the wind conditions that most offshore seabirds experience, at least episodically (*e.g.*, in storms or even in persistently strong winds), nor with respect to the species mix that is typical of the West Coast. In West Coast waters there is a much higher prevalence of gliding and flap-gliding species, whose behavior and height above the sea surface changes with wind strength (Ainley *et al.*, 2015). Winds off the U.S. West Coast during the upwelling season typically reach 30–35 kts daily, greatly exceeding the wind conditions investigated off European shores. Although such a wind regime is ideal for energy generation, it offers challenges to avoiding impacts to wildlife.

Objectives: Predict the risk of seabirds within different flight style guilds to collision with offshore wind turbines in the Pacific in three dimensions.

Methods: Combine seabird densities and behavior, as a function of wind, with remotely sensed wind products derived from satellite scatterometers. From this information, make predictions about the risks involved among West Coast seabirds to wind turbines, developing a spatially explicit data layer that accounts for the frequency of strong wind events. This will enhance our ability to address the sensitivity of particular vulnerable species (*e.g.*, soaring seabirds) and inform selection of ocean habitat for wind farm development. For the entire U.S. West Coast westward to the continental shelf break, derive a geospatial index that incorporates the frequency of strong wind events (days per month and by wind direction; Miller *et al.*, 2014), providing a 3-D picture of seabird occurrence as a function of wind.

Specific Research Question(s):

1. What are the risks among West Coast seabirds to collision with wind turbines?
2. Can we predict these risks by developing a spatially explicit data layer that accounts for the frequency of strong wind events?

References:

Ainley, D.G., Porzig, E., Zajanc, D., and Spear, L.B., 2015. *Seabird flight behavior and height in response to altered wind strength and direction*. Marine Ornithology 43:25–36.

Cook, A.S.C.P., Johnston, A., Wright, L.J., and Burton, N.H.K., 2012. *A Review of Flight Heights and Avoidance Rates of Birds in Relation to Offshore Wind Farms*. Strategic Ornithological Support Services, Project SOSS-02. Norfolk, UK: British Trust for Ornithology.

Johnston, A., Cook, A.S.C.P., Wright, L.J., Humphreys, E.M., and Burton, N.H.K., 2013. *Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines*. Journal of Applied Ecology 51(1):31–41.

Kinlan, B., Winship, A., Rankin, R., Miller, P., and Christensen, J., 2015. *Applications of a model-based U.S. Atlantic coast-wide synthesis of at-sea marine bird distributions to ocean energy spatial planning*. Abstract, Pacific Seabird Group, San Jose, California.

Title	Understanding the Seasonal Distribution of Cetacean Species in the Northern and Central California Call Areas Using Archival Passive Acoustic Monitoring (PAM)
Administered by	Pacific OCS Region
BOEM Contact(s)	Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2020–2022
Date Revised	April 3, 2019
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	More information is needed on the ambient soundscape and seasonal cetacean habitat use within and around the Northern and Central California Call Areas which restrict BOEM's ability to accurately assess the potential impacts on these protected species under the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) from offshore renewable energy development.
Intervention	Collect and analyze passive acoustic data in the Northern and/or Central California Call Areas to gain spatial and comprehensive temporal insight on the occurrence and distribution of protected cetacean species. Simultaneously, collect ambient soundscape data.
Comparison	This data would provide the baseline for any effects analysis of future operational monitoring data and can be compared to data collected by the National Oceanic & Atmospheric Administration's (NOAA's) Ocean Noise Reference stations in the Olympic Coast and Channel Islands National Marine Sanctuaries.
Outcome	Description of the spatial and temporal occurrence of cetacean species and ambient soundscapes in the Northern and/or Central California Call Areas.
Context	Northern and/or Central California

BOEM Information Need(s): BOEM needs to understand the occurrence and distribution of protected cetacean (whale, dolphin, and porpoise) species within and around the Northern and Central California Call Areas, and when these species occur in these areas. In addition, BOEM needs to understand the ambient soundscapes in these areas to adequately assess the overall acoustic contribution of BOEM-related activities. This information is needed to properly assess potential impacts to these species from offshore energy-related activities in line with our regulatory responsibilities under the MMPA, ESA, and National Environmental Policy Act. This information would also inform the identification of wind energy areas and the types of mitigation strategies required to minimize potential impacts to these marine mammals from offshore energy-related activities.

Background: Cetacean distribution and abundance data are traditionally collected by large vessels and aircraft conducting surveys in offshore areas. These surveys (*e.g.*, Pacific Marine Assessment Program for Protected Species [PacMAPPS] California, PC-

17-04b) provide important data; but due to the expense and difficulty in collecting data during bad weather or during times of low visibility, the surveys are generally conducted intermittently during the summer and fall seasons. As such, these data suffer from spatial and temporal (*e.g.*, seasonal) gaps.

Passive acoustic monitoring (PAM) techniques are well established in the scientific community (Sousa-Lima *et al.*, 2013; Booth *et al.*, 2017) as a data collection technique that complements past and current visual survey efforts. Archival systems allow for the detection of vocalizing species as continuous or duty-cycled recordings for a year or more providing long-term, seasonally representative data. Additionally, ambient soundscape data is collected simultaneously. Baseline soundscape data specific to the Northern and Central California Call Areas is not currently available, although data collected from one recorder offshore Central California (Diablo Canyon) will be considered when it becomes available.

Objectives:

- Deploy archival acoustic recorders in and around the Northern and Central California Call Areas.
- Collect biological acoustic data, ensuring recorder frequencies cover specific species of interest (*e.g.*, beaked, humpback, fin, killer, and minke whales).
- Analyze recorded data to quantify patterns in ambient soundscapes in the Northern and Central California Call Areas.

Methods: Archival passive acoustic recorders are readily available to accomplish the above objectives, for example from bottom-mounted and/or Slocum gliders and/or Drifting Acoustic Spar Buoy Recorders [DASBRs], *etc.*). Various researchers and organizations make use of different types of archival passive acoustic monitoring (PAM) recorders. The selected recorders will be able to tolerate depths of >500 m. The types and number of the units and the design of the array will be determined after consulting with BOEM's acoustics experts. Automatic acoustic detectors will be parameterized to identify and quantify the vocalizations of the key marine mammal species (and the methods for this process will be captured using the Tethys metadata system). For soundscape-level analyses, the data will be processed using the Atlantic Deepwater Ecosystem Observatory Network (ADEON) data standards in order to ensure that the information is comparable to similar data collected in other areas (*e.g.*, the Atlantic). In order to inform the design of the array(s), a basic propagation model will be run inputting species parameters of certain species (*e.g.*, fin whales) to get a sense about the characteristics of the whale calls and what will be detected and at what distances.

Specific Research Question(s):

1. Which marine mammal species frequent the Call Area(s)?
2. What is the seasonal occurrence/distribution of marine mammal species in the Call Area(s)?

3. If localization is possible, what can be said about the abundance of the various marine mammal species?

4. What is the ambient noise level in the Call Area(s)?

    a. What are the major contributors to the soundscape?

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APPENDIX III. ABBREVIATIONS AND ACRONYMS

2-D	two-dimensional
3-D	three-dimensional
3S	Sea mammals, Sonar, Safety
a priori	(English: "from what is before")
ABWC	Alaska Beluga Whale Committee
ACT	Alliance for Coastal Technologies
ACT	Atlantic Cooperative Telemetry
ad hoc	(English: "to this")
ADCP	acoustic Doppler current profiler
ADEON	Atlantic Deepwater Ecosystem Observatory Network
AEP	auditory evoked potential
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AIS	automatic identification system
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMBON	Arctic Marine Biodiversity Observing Network
AMBON	Atlantic Marine Biodiversity Observation Network
ANCSA	Alaska Native Claims Settlement Act
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
AOOS	Alaska Ocean Observing System
ARGOS	Advanced Research & Global Observation Satellite
ARIS	Adaptive Resolution Imaging Sonar
ASGARD	Arctic Shelf Growth, Advection, Respiration and Deposition Rate Experiments
ASPIRE	Atlantic Seafloor Partnership for Integrated Research and Exploration
ATN	Animal Telemetry Network
AUTEC	Atlantic Undersea Test and Evaluation Center
AUV	autonomous underwater vehicle
AWS	automated weather system
BACI	Before-After-Control-Impact
BACIPS	Before-After-Control-Impact Paired-Series
bbls	barrels
BIWF	Block Island Wind Farm
BOEM	Bureau of Ocean Energy Management
BP	Blake Plateau
BRAHSS	Behavioural Response of Australian Humpback Whales to Seismic Surveys
BRS	Behavioral Response Study

BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
Cal DIG	California Deepwater Investigations and Groundtruthing
CALDIG	California Deepwater Investigations and Groundtruthing
CALPUFF	California Puff
CAMx	Comprehensive Air quality Model with extensions
CARICOOS	Caribbean Regional Association for Coastal Ocean Observing
CART	Classification and Regression Tree
CCS	California Current System
CE	small cyclonic eddy
CeNCOOS	Central & Northern California Ocean Observing System
CEQ	Council on Environmental Quality
cf	cubic feet
CFR	Code of Federal Regulations
CHIRP	compressed high-intensity radar pulse
CIB	Cook Inlet belugas
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CMAQ	Community Multi-scale Air Quality model
CMI	Coastal Marine Institute
CMS	Convention on Migratory Species
CNMI	Commonwealth of the Northern Mariana Islands
CO	carbon monoxide
Co	cobalt
COARE	Coupled Ocean Atmosphere Response Experiment
COP	construction and operation plan
C-POD	cetacean and porpoise detector
CR	Conservation Recommendation
CSLI	CubeSat launch initiative
Cu	copper
D.C.	District of Columbia
DAC	Data Assembly Center
de facto	(English: "in fact")
DEEP SEARCH	Deep Sea Exploration and Research of Coral/Canyon/Cold seep Habitats
Dept.	Department
DES	Division of Environmental Sciences
DIDSON	Dual-frequency Identification Sonar
DNA	deoxyribonucleic acid
DOI	Department of the Interior
DPP	Development and Production Plan

DPP	Draft Proposed Program
DR2	Disaster Research Response
DSCRTP	Deep Sea Coral Research and Technology Program
DSLR	digital single-lens reflex
DWH	*Deepwater Horizon*
DWM	Department of Wildlife Management
e.g.	*exempli gratia* (English: "for example")
EO	Executive Order
E/V	exploration vessel
EA	Environmental Assessment
EBV	essential biodiversity variable
ed.	editor
eDNA	environmental deoxyribonucleic acid
EET	Emissions Exemption Threshold
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIA	Economic Impact Areas
EIS	Environmental Impact Statement
EMF	electromagnetic field
en masse	(English: "in a mass")
EO	Executive Order
EP	Exploration Plan
EPA	Environmental Protection Agency
EPAct	Energy Policy Act
ESA	Endangered Species Act
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
ESP-PAT	Environmental Studies Program Performance Assessment Tool
ET	Escanaba Trough
et al.	*et alia* (English: "and others")
et seq.	*et sequens* (English: "and the following")
etc.	*et cetera* (English: "and so forth")
FACT	Florida Atlantic Coast Telemetry
Fe-Mn	ferromanganese
FGBNMS	Flower Garden Banks National Marine Sanctuary
FLIR	forward-looking infrared
FPSO	floating production, storage, and offloading
FR	Federal Register
ft.	foot
FWS	Fish & Wildlife Service
FY	fiscal year

G&G	geological and geophysical
GCCESU	Gulf Coast Cooperative Ecosystem Studies Unit
GCM	General Circulation Model
GCOOS	Gulf of Mexico Coastal Ocean Observing System
GeoBON	Group on Earth Observations Biodiversity Observation Network
GGBN	Global Genome Biodiversity Network
GIS	geographic information system
GOA	Gulf of Alaska
GOM	Gulf of Mexico
GoMAPPS	Gulf of Mexico Marine Assessment Program for Protected Species
GOMR	Gulf of Mexico Outer Continental Shelf Region
GOM-SCHEMA	Gulf of Mexico Shipwreck Corrosion, Hydrocarbon Exposure, Microbiology, and Archaeology
GPS	Global Positioning System
GSD	ground sample distance
GSM	Global System for Mobile Communications
H.R.	House Resolution
HF	high-frequency
HFR	high-frequency radar
HMS	highly migratory species
Hwy	Highway
HYCOM	Hybrid Coordinate Ocean Model
Hz	hertz
i.e.	*id est* (English: "that is")
IA	interagency agreement
IARPC	Interagency Arctic Research Policy Committee
IDIQ	Indefinite Delivery/Indefinite Quantity
IFREMER	*Institut français de recherche pour l'exploitation de la mer* (English: "French Research Institute for Exploitation of the Sea")
in situ	(English: "on site")
Inc.	Incorporated
IOOC	Interagency Ocean Observation Committee
IOOS	Integrated Ocean Observing System
IUCN	International Union for the Conservation of Nature
IWAQM	Interagency Workgroup on Air Quality Modeling
Jr.	junior
ka	kilo-annum
km	kilometer

KPB	Kenai Peninsula Borough
kts	knots
LC	loop current
LCE	loop current eddy
LCI	Lower Cook Inlet
LEO	Local Environmental Observer
LiDAR	light detection and ranging
LLC	limited liability company
LME	large marine ecosystem
LSU	Louisiana State University
LTK	local traditional knowledge
m	meter
MARACOOS	Mid-Atlantic Regional Association for Coastal Ocean Observing System
MARINe	Multi-Agency Rocky Intertidal Network
MassCEC	Massachusetts Clean Energy Center
MBON	Marine Biodiversity Observation Network
MBTA	Migratory Bird Treaty Act
MHz	megahertz
mi.	miles
MIA	missing in action
MMP	Marine Minerals Program
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
Mn	manganese
mNNS	marine non-native species
MODU	mobile offshore drilling unit
MRDF	Mississippi River Delta Front
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MW	megawatt
n.d.	no date
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NANOOS	Northwest Association of Networked Ocean Observing Systems
NARP	National Artificial Reef Plan
NAS	National Academies of Sciences, Engineering, and Medicine
NASA	National Aeronautics & Space Administration
NASEM	National Academies of Sciences, Engineering, and Medicine
NCEI	National Centers for Environmental Information
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act

NFEA	National Fishing Enhancement Act
NGO	non-governmental organization
NHC	Natural Hazards Center
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NM	nautical miles
nm	nautical miles
NMFS	National Marine Fisheries Service
NMFSC	National Marine Fisheries Science Centers
NMNH-IZ	National Museum of Natural History, Department of Invertebrate Zoology
no.	number
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NOSB	National Ocean Sciences Bowl
NO_x	oxides of nitrogen
NPAL	National Pacific Acoustic Laboratory
NPS	National Park Service
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
NSL	National Studies List
NWASC	Northwest Atlantic Seabird Catalog
NYB	New York Bight
O_3	ozone
OBIS	Ocean Biogeographic Information System
OCD	Offshore & Coastal Dispersion
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEP	Office of Environmental Programs
ONR	Office of Naval Research
OREP	Office of Renewable Energy Programs
OSL	optically stimulated luminescence
OSOE	Oil-spill Occurrence Estimator
OSRA	oil spill risk analysis
p.	page
P.L.	Public Law
PacIOOS	Pacific Islands Ocean Observing System

PacMAPPS	Pacific Marine Assessment Program for Protected Species
PAM	passive acoustic monitoring
PARR	Public Access to Research Results
Pb	lead
PCAD	population consequences of acoustical disturbances
PCoD	population consequences of disturbances
PEE	pseudo-experimental exposure
PERF	Petroleum Environmental Research Forum
pH	potential of hydrogen
PI	principal investigator
PICOC	Problem, Intervention, Comparison, Outcome, and Context
PM	particulate matter
PM_{10}	particulate matter 2.5 to 10 micrometers in diameter
$PM_{2.5}$	particulate matter 2.5 micrometers or less in diameter
POW	Prisoner of War
POWER	Pacific Ocean Whale and Ecosystem Research
pp.	pages
PSD	Prevention of Significant Deterioration
PTT	platform transmitter terminal
QA	quality assurance
QC	quality control
RESTORE	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States
RGB	red-green-blue
RODEO	Real-time Opportunity for Development Environmental Observations
ROV	Remotely Operated Vehicle
S.	Senate bill
S.O.	Secretarial Order
S.S.	steamship
Sb	antimony
SBC	Santa Barbara Channel
Sc	scandium
SCB	Southern California Bight
SCCOOS	Southern California Coastal Ocean Observing System
SDP	Studies Development Plan
SECOORA	Southeast Coastal Ocean Observing Regional Association
SMCA	Sunken Military Craft Act
SME	subject matter expert
SMS	seafloor massive sulfides
SO_2	sulfur dioxide

SOCAL	Southern California
SPAM	Spatial and Acoustic Ecology of Marine Megafauna
SSMI	Special Sensor Microwave Imager
SSQ	Strategic Science Question
T.B.D.	to be determined
TB	terabyte
Te	tellurium
TEMPO	Tropospheric Emissions: Monitoring of Pollution
TOPP	Tagging of Pacific Predators
TPWD	Texas Parks and Wildlife Department
U.N.	United Nations
U.S.	United States
U.S.C.	United States Code
UAS	Unmanned Aircraft Systems
UCI	Upper Cook Inlet
UHD	ultra-high definition
UK	United Kingdom
USACE	United States Army Corps of Engineers
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
v.	volume
ver.	version
viz.	*videlicet* (English: "namely")
VOC	volatile organic compound
vs.	*versus* (English: "in contrast to")
VTOL	vertical take-off and landing
WAF	Web Accessible Folder
WebFIRE	Website for Factor Information Retrieval
WRF	Weather Research & Forecasting