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

Studies Development Plan

2022–2023

Environmental research proposed to begin in FY2022 to FY2023 for information needed to assess and manage impacts of offshore energy and marine mineral development on the human, marine, and coastal environments.

BOEM

Bureau of Ocean Energy Management

Table of Contents

List of Figures

List of Tables

List of Acronyms

AERMOD	American Meteorological Society/EPA Regulatory Model
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CESU	Coastal Ecosystem Studies Unit
CMI	Coastal Marine Institute
COP	Construction and Operations Plan
DOC	Department of Commerce
DOE	Department of Energy
DOI	Department of the Interior
DOT	Department of Transportation
DPP	Development & Production Plan
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	environmental impact statement
EMF	electromagnetic field
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
ESP-PAT	Environmental Studies Program Performance Assessment Tool
FPS	Frying Pan Shoals
FY	fiscal year
G&G	geological and geophysical
GCCESU	Gulf Coast Cooperative Ecosystem Studies Unit
GOM	Gulf of Mexico
GOMR	Gulf of Mexico Region
HAPC	Habitat Areas of Particular Concern
IWG	interagency working group
LiDAR	light detection and ranging
LME	large marine ecosystem
MBTA	Migratory Bird Treaty Act
MMP	Marine Minerals Program
MMPA	Marine Mammal Protection Act
MSFCMA	Magnuson-Stevens Fishery Conservation & Management Act
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOMEC	National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone
NOPP	National Oceanographic Partnership Program
NOSB	National Ocean Sciences Bowl
NREL	National Renewable Energy Laboratory

NSL	National Studies List
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEP	Office of Environmental Programs
ONR	U.S. Office of Naval Research
OREP	Office of Renewable Energy Programs
PICOC	Problem, Intervention, Comparison, Outcome, and Context
PSD	Prevention of Significant Deterioration
PSO	Protected Species Observers
SDP	Studies Development Plan
SME	subject matter expert
SSQ	Strategic Science Question
STRETCH	Strategy for Emerging Technology
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
USCRP	U.S. Coastal Research Program
USGS	U.S. Geological Survey

1 Overview

1.1 Introduction

1.1.1 Bureau of Ocean Energy Management Mission

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

1.1.2 Realizing Ocean Stewardship Through Science

Environmental stewardship is at the core of BOEM's mission. Diverse Federal laws task BOEM with protecting the marine, coastal, and human environments and, through its Environmental Studies Program (ESP), BOEM utilizes the best available science to support sound policy decisions and manage Outer Continental Shelf (OCS) resources. Since its inception in 1973, ESP's mission has been 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.* In undertaking its mission, ESP funds and oversees research on a wide range of topics, including physical oceanography, atmospheric sciences, biology, protected species, social sciences and economics, submerged cultural resources, and environmental fates and effects.

ESP has its roots in Section 20 of the Outer Continental Shelf Lands Act (OCSLA). BOEM's research mandate under OCSLA is, fundamentally, to assess and understand how the Bureau's decision-making impacts the environment (both physical and human), and how those impacts can be avoided or minimized. To do this, ESP conducts three types of research studies:

Baseline Studies: Provide information needed for the assessment and management of environmental impacts from offshore energy and mineral extraction activities on the human, marine, and coastal environments of Federal and state waters.

Impact Studies: Predict impacts on marine biota that may result from offshore energy development or marine mineral extraction.

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.

ESP is in the process of finalizing a decadal vision that outlines the drivers and challenges that BOEM will likely face over the next 10 years and that identifies specific information the Bureau's decisions makers will need to address those challenges. Issues that will drive BOEM's research needs over the next decade include the continuation of the offshore oil and gas industry, the expansion of offshore renewable energy development, an increased demand for offshore sand and gravel, and the potential mining of critical minerals. Specific challenges that will need to be addressed during this time frame include the

decommissioning of oil and gas infrastructure, science needs for offshore wind development, data and policy requirements for the mining of critical minerals, management of BOEM-funded data, and impacts stemming from a changing climate. The document also proposes a vision for ESP, that of *realizing ocean stewardship through science*. This vision both complements ESP's mission and aligns the program with the broader stewardship role DOI plays in managing the Nation's public lands.

Together with environmental assessment and regulation, ESP forms the foundation of BOEM's environmental program and ensures that environmental protection is a foremost concern and an indispensable requirement in BOEM's decision-making. Administratively, ESP is housed within BOEM's Office of Environmental Programs (OEP), though ESP's work cuts across all BOEM's regions and programs. OEP's overarching goal for ESP is to be "first in class"—the best research program there is in the context of BOEM's mission and constraints.

1.1.3 Funding

To date, ESP has provided over $1 billion for research on environmental impacts and monitoring associated with energy and mineral development. Average annual planned funding for ESP is currently $30 million, though the expenditure level has varied over the years. ESP funds are currently dispersed for defined projects through three vehicles: interagency agreements with Federal agencies; cooperative agreements with state, local, and nonprofit institutions, including Native American tribal communities; and competitive contracts. BOEM aims to use funds in a way that deliver the most needed and highest quality research at the best value to the government. **Figure 1** shows how ESP allocates funding by both vendor and discipline between fiscal years (FY) 2017 and 2021.

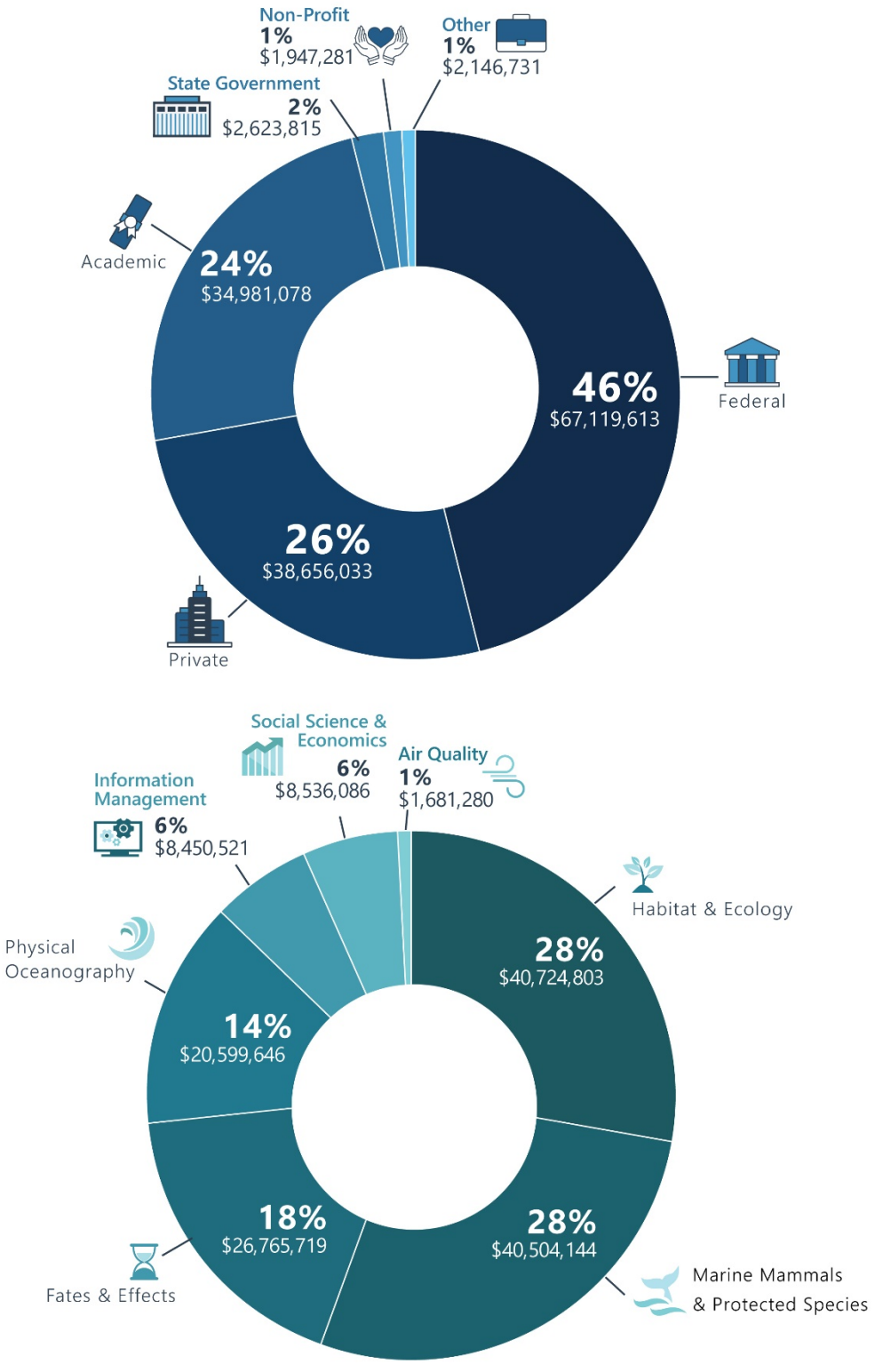


Figure 1. Cumulative ESP expenditures for FY 2017–2021 by vendor type (top) and discipline (bottom)

1.2 ESP Principles

ESP is guided by four main principles:

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

1.2.1 Use-Inspired Science

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

1.2.2 Scientific Integrity and Credibility

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.[1]

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

National attention has been directed toward ESP's performance measures and accountability. The ESP Performance Assessment Tool (ESP-PAT) helps ESP fulfills its mission of providing the best possible scientific information for making decisions concerning our offshore resources. The ESP-PAT is an

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

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.

1.2.3 Peer Review

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

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

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

1.2.4 Partnering and Leveraging

ESP regularly encourages inter- and intra-agency study collaborations with BOEM's Federal partners, and many of BOEM's important and award-winning research efforts were completed through the cooperation with agencies such as the National Aeronautics and Space Administration (NASA), U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and U.S. Navy's Office of Naval Research (ONR). BOEM has established partnerships with the States of Louisiana and Alaska through their respective Coastal Marine Institutes (CMIs), and the Bureau is also a member of eight Coastal Ecosystem Studies Unit (CESU) networks (Alaska, Californian, Chesapeake Watershed, Gulf Coast, Hawaii-Pacific Islands, North Atlantic Coast, Pacific Northwest, and Piedmont-South Atlantic Coast), enabling the Bureau to efficiently establish cooperative agreements with state-owned institutions.

BOEM coordinates its efforts with ocean research programs, such as the National Oceanographic Partnership Program (NOPP) and the U.S. Coastal Research Program (USCRP). NOPP is a collaboration of Federal agencies and provides leadership and coordination of national oceanographic research and education initiatives. NOPP adds significant integrative value to the individual oceanographic, ocean science, resource management, and ocean education missions of the Federal agencies and their partners, in common pursuit of the wise use of the oceans and the maintenance of their health. As a charter member of NOPP, BOEM continues to explore options to increase its participation, and its investments have grown dramatically in recent years. ESP has funded, through NOPP, research focused on chemosynthetic communities, oil spill impacts on shipwrecks and their biological communities, high-

frequency radar mapping of surface circulation in Alaska, improving cetacean electronic data loggers, and a variety of renewable energy projects. Several studies have received the NOPP Excellence in Partnering Award and DOI's Partners in Conservation Award. A collaboration of Federal agencies, academics, and stakeholders, USCRP aims to identify coastal research needs, foster research opportunities, enhance funding for academic programs, and promote science translation.

1.2.5 Information Management and Dissemination

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

Access to completed ESP studies is available through the ESP Information System (ESPIS).[2] 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 National Environmental Policy Act (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.[3]

BOEM presents the results of ESP-funded research both domestically and internationally to a variety of audiences, including professional and academic societies, industry forums, and governmental workshops. These events spread scientific information to wide audiences, and many projects have opportunities for educational components. BOEM also publishes its own magazine *Ocean Science*[4] and quarterly *Science Notes* newsletters.[5]

Information concerning ongoing research supported through ESP is available on the BOEM website.[6] The ongoing research is arranged by BOEM OCS Region and discipline. Information provided for each study includes a complete description, status report, cost, and expected date of its final report. Where applicable, BOEM also provides affiliated websites, presentation abstracts, and papers.

1.2.6 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. ESP undertakes several activities to encourage students in their academic training and provide young professionals with opportunities to succeed in their careers. These activities are in support of ESP's education goals of developing (1) an ocean-literate public, (2) a pipeline of marine scientists to meet ESP needs either through employment at BOEM or at universities, and (3) a science-literate marine workforce. Through cooperative

[2] http://www.boem.gov/espis/
[3] https://marinecadastre.gov/
[4] https://www.boem.gov/Ocean-Science/
[5] https://www.boem.gov/Science-Notes/
[6] https://www.boem.gov/environment/environmental-studies/ongoing-environmental-studies-region

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

1.3 About the Studies Development Plan

1.3.1 Studies Development Plan (SDP) Overview

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

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

An overview of BOEM's proposed national and regional research is provided in **Sections 2–6**. **Appendix A** includes tables summarizing new studies that are projected to begin in FY 2022 and FY 2023, and **Appendix B** provides the study profiles for each region.

1.3.2 What BOEM Needs to Know

BOEM's mission is to manage development of OCS energy and mineral resources in an environmentally and economically responsible way. The Bureau looks to ESP to provide the best available science to help it fulfill its mission and requires information on the following five topic areas.

1. **Effects of Impacting Activities:** Information on environmental impacts from activities authorized by BOEM, how to prevent or lessen adverse impacts, and how to provide information needed for legal compliance. Specific issues include
    - Oil and other chemical releases into the sea or onshore, including both large and low-level, chronic discharges
    - Air pollutant emissions

- Greenhouse gas emissions
- Sound in the sea
- Obstructions to migration or movement of biota
- Seabed disturbance
- Coastal lands disturbance
- Socioeconomic impacts of exploration and development and their interactions

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

    - Distribution and abundance of species, particularly those that are highly regulated or particularly vulnerable to adverse change in status; important for subsistence, commercial, or recreational use; or invasive
    - Biogeographic areas of ecological, cultural, or commercial importance or sensitivity
    - Marine environmental quality and productivity
    - Air quality
    - Diversity and productivity of platform biota
    - Presence and nature of shipwrecks and submerged cultural landscapes
    - Obstruction of access to marine sediments and the associated impact on coastal restoration projects
    - Subsistence use and resources relied on by Native American tribal communities for food and culture
    - Quality of life indicators for coastal Native American tribal communities and other peoples

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 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.

1.3.3 Criteria for Study Development and Approval

The following seven 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 SDP or NSL.

1. **Need for Information in BOEM Decision-Making:** All studies must contribute to BOEM's need to know as described above. This requirement is not meant to favor studies addressing specific impacts (e.g., the impact of seismic airguns on commercial and recreational fish stocks) as opposed to broader studies, whose insights are indirect but important to understanding the impacts of BOEM's activities (e.g., population distribution and abundance, or ecosystem dynamics). As noted above, ESP studies include both expenditures to address specific research

questions and expenditures for "infrastructure," such as maintenance of museum collections and ocean observing systems, which support an array of research projects addressing BOEM information needs. All study profiles must articulate the study's relevance and importance to BOEM decision-making, as well as the level of need that must be considered in setting priority. This criterion accounts for the urgency of information and is intended to provide for a reasonable level of support in each region and across BOEM's three programs: oil and gas, renewable energy, and marine minerals.

2. **Contribution to Existing Knowledge:** Studies must be designed to contribute substantially to existing knowledge, and profiles should describe how the proposed work addresses information needs or will improve, confirm, or challenge current understanding.
3. **Research Concept, Design, and Methodology:** All study profiles must provide a sound research concept (including questions asked), design, and methodology. This does not require a high level of detail such as would be provided in specific proposals to carry out the work, but the basic proposal concept, design, and methodology must be sound. The quality of the research design and methodological innovation are important considerations evaluated in this criterion. The archiving of data and the curation of collected specimens are also considered core components of this criterion.
4. **Cost-Effectiveness:** Studies must be cost-effective, and the expense of a study is relevant in comparing its value with other study opportunities. This does not mean that costly studies are disfavored if the expense is necessary for important knowledge or leveraged with other funders.
5. **Leveraging Funds:** Study proposals should explore opportunities for shared funding. These may involve the transfer of funds from or to BOEM, contributions to a shared account, or coordination of separately funded work toward common objectives.
6. **Partnerships:** Study proposals should support collaboration with Native American tribal communities whenever appropriate and feasible and should explore any opportunities for public outreach and engagement, such as "citizen science" or involvement of aquariums or other non-profits. Partnering is encouraged with other Federal agencies, academic organizations, non-profits, or commercial enterprises to achieve shared mission needs.
7. **Multi-Regional and Strategic Utility:** Studies may gain priority if they support multi-regional or strategic needs. Purely local studies will still be considered, but if everything else is equal, a study serving broader values is of higher priority for funding than one that does not. Collaboration is encouraged for identifying such needs.

1.3.4 Strategic Science Questions

In response to internal and external reviews of the ESP, BOEM developed a series of Strategic Science Questions (SSQs) to be addressed at the programmatic level. These questions are meant to provide consistency and guidance to the ESP research portfolio across regions as we move toward a more

comprehensive understanding of those topics over the coming decade. These research questions need to be addressed at a national level and have implications across all BOEM regions and programs.

At the highest level, 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, ESP needs to continue to develop science that addresses the following key questions:

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

1.3.5 SDP Development Process

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

ESP introduced an updated study profile format in 2018 to further improve a profile's scientific rigor and to enhance any potential statement of work. Under this format, authors frame their proposed studies by defining the following elements: Problem, Intervention, Comparison, Outcome, and Context (PICOC). Study profiles ultimately identify a set of specific research questions that link back to the SSQs to guide ESP's broader research portfolio over the next 5 to 10 years.

1.4 Overview of BOEM's Programs

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

BOEM's management of the OCS focuses on three main program areas: conventional energy (oil and gas), renewable energy, and marine minerals.

1.4.1 Conventional Energy

OCSLA (43 U.S.C. §1344) requires DOI to prepare a national OCS oil and gas leasing program consisting of a proposed lease sale schedule on the size, timing, and location of areas for Federal OCS oil and natural gas leasing. DOI has the role of ensuring that the U.S. Government receives fair market value for acreage made available for leasing and that any oil and gas activities conserve resources, operate safely, and take maximum steps to protect the environment. The current 2017–2022 National OCS Oil and Gas Leasing Program addresses OCS oil and gas exploration, development, and production in the Gulf of Mexico (GOM), Pacific, and Alaska Regions (BOEM 2016a). Executive Order 14008 directed DOI to pause new oil and natural gas leasing on public lands and offshore waters, concurrent with a comprehensive review of the Federal oil and gas program. However, the responsibility remains for BOEM to manage ongoing leases, review and approve exploration and development plans on those leases, and prepare for decommissioning, while still minimizing or avoiding potential environmental impacts. As of March 2021, approximately 12.4 million OCS acres are actively leased by BOEM for conventional energy development, and in FY 2020, OCS conventional energy development provided for 2% of the Nation's natural gas production and about 15% of domestic oil production.

1.4.2 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. The first two turbines on the OCS were installed off the coast of Virginia during the summer of 2020 and are now producing electricity. On May 10, 2021, the Record of Decision was signed to approve Vineyard Wind—the Nation's first commercial scale wind project—with construction planned to begin in 2022.

In March 2021, the White House released details of its plan to boost the offshore wind energy industry.[7] The Departments of Interior, Energy (DOE), Commerce (DOC), and Transportation (DOT) are coordinating their actions to better support rapid offshore wind deployment and job creation. DOI, DOE, and DOC announced a shared goal of deploying 30 gigawatts (GW) of offshore wind in the United States by 2030, while protecting biodiversity and promoting ocean co-use. At BOEM, efforts to support current and future renewable energy activities are well underway, and there are currently 16 active leases along the Atlantic Coast from Massachusetts to North Carolina. In addition to the Vineyard Wind project, 14 additional Construction and Operations Plans (COPs) are under review, and several more are expected within the next year, cumulatively representing more than 19 GW of new clean energy. BOEM also announced a new priority Wind Energy Area in the New York Bight (an area of shallow water between Long Island and the New Jersey coast) that will serve the largest metropolitan center in the country. BOEM will look to hold a lease sale for this area, along with one in the Carolinas, in late 2021 or early 2022.

1.4.3 Marine Minerals

OCSLA assigns DOI (delegated to BOEM) responsibility for authorizing exploration and development of non-energy minerals on the OCS, preventing the waste of natural resources, and ensuring related environmental protection. Section 8(k) of OCSLA sets forth specific requirements for the non-competitive use of sand, gravel, and other sediment and establishes the leasing framework for the competitive sale of any marine mineral.

Since 1995, BOEM has executed 61 negotiated agreements and conveyed rights to approximately 168.6 million cubic yards of sand and sediment for coastal restoration projects along the coastline of eight different Atlantic and GOM states (statistics updated through May 2021). These projects have protected billions of dollars of infrastructure, as well as important ecological habitats, along almost 420 miles of the Nation's coastline.

The Marine Minerals Program (MMP) is responsible for executing competitive lease agreements for other non-energy minerals, such as strategic mineral resources like copper, lead, zinc, and gold, as well as critical minerals (83 Federal Register 23295) such as cobalt, manganese, platinum, and rare earth minerals. Developers have periodically expressed interest in obtaining leases to develop these resources; however, no leases have been issued for these resources. Executive Order (EO) 13817 (A *Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*) has spurred renewed interest in marine minerals, such as rare earth elements, and provided an impetus to identify domestic sources of these minerals that include potential offshore sources. The MMP has authorized geological and geophysical (G&G) exploration activities for a wide range of marine minerals, including sand, heavy minerals, phosphorites, gold, and other deepwater minerals of interest.

[7] https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/

2 National Studies

2.1 Introduction

BOEM's OEP provides a national context for ESP and supports linkages among the Bureau's programs and regional offices. OEP conducts environmental reviews, including NEPA analyses, and produces compliance documents supporting decisions on the national OCS oil and gas leasing program, renewable energy development, and marine mineral exploration and leasing activities. While most of BOEM's regional offices focus on research and information needs for their respective geographic areas, studies initiated by OEP are predominantly national in scope, have program-wide applications, or utilize emerging or new technology. Any regional studies led by OEP typically focus on the Atlantic. OEP may also develop studies with Federal agencies, universities, or external partners in order to leverage resources and foster collaborative relationships. Efforts are made to incorporate and build upon the findings of previous studies.

To meet national assessment needs, OEP considered the areas of information that BOEM needs to know as posed in the ESP Strategic Framework (BOEM 2020). A comparison of these areas with the historical knowledge of national scientific needs identified through the development of the Programmatic Environmental Impact Statement (EIS) for the 2017–2022 National OCS Oil and Gas Leasing Program (BOEM 2016b), the Programmatic EIS currently on pause, other NEPA analyses, and associated consultations led to the development of this year's 10 study profiles. Furthermore, OEP considered study needs associated with the recently created BOEM Center for Marine Acoustics, which will focus on complex science and policy issues that require development of specialized expertise, models, and risk assessment frameworks related to marine sound and potential environmental effects. Along with advanced modeling, this center will drive the full range of tools BOEM uses to assess and manage risk, including scientific research, policy development, and methods for effectively communicating risk to decision-makers and stakeholders. Lastly, OEP launched an initiative to promote the use of emerging technology in ESP-funded studies in FY 2020. This Strategy for Emerging Technology (STRETCH) aims to establish BOEM as a leader among resource management agencies in adopting and using new and emerging technologies to answer key science questions concerning OCS energy and mineral resource development activities.

Appendix A includes the tables of proposed studies for FY 2022. **Appendix B** provides the profiles for the proposed studies.

2.2 Decision Context

Within the next 5 to 10 years, OEP will need to address potential impacts from decisions with program-level relevance, such as supporting the development of an upcoming national OCS oil and gas leasing program or related G&G permitting decisions, or internal policy that is Bureau-wide, including issues such as potential acoustic effects. As mentioned above, also of interest for OEP's near-term decisions are studies that span multiple BOEM programs or regions (for example, a study focusing on species found in multiple regions or issues that transcend a specific region or program); are demonstrative in

nature (for example, to determine whether new or improved technology may be acceptable for geophysical survey to identify resources); and/or fulfill a national stakeholder outreach or education need.

2.2.1 Upcoming Decisions

- Programmatic Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) consultations and streamlining initiatives, such as for decisions related to G&G permitting and pile driving for the construction of offshore wind energy facilities
- Future of the national OCS oil and gas leasing program, including identification of potential areas for activity exclusions or programmatic mitigation
- Revised Council of Environmental Quality and DOI NEPA regulations

2.2.2 Current/Relevant Issues

BOEM continues to address needs to support the ongoing national OCS oil and gas leasing program, which includes the Pacific Ocean, GOM, and offshore Alaska. With the responsibility to understand potential effects of ongoing oil and gas leasing, studies will be needed to fill data gaps and understand the direct and indirect impacts of these activities, especially if they occur in areas that have not been leased in many years. Additionally, the potential expansion of offshore renewable energy will also require a better understanding of the potential environmental and human health impacts. The Bureau 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.

In June 2020, BOEM published its Final Rule on *Air Quality Control, Reporting, and Compliance* (30 CFR Part 500), which will require more detailed air data, including emissions inventories (activity and emissions factors data), meteorological data, and photochemical and dispersion modeling. Another critical need for air quality is to replace the outdated Offshore & Coastal Dispersion modeling with U.S. Environmental Protection Agency's (EPA's) American Meteorological Society/EPA Regulatory Model (AERMOD), which will require installing platform downwash and coastal fumigation algorithms. BOEM is also considering further working with NASA to assess offshore pollutants using high-resolution satellite data for offshore air quality management in the GOM, Pacific, and Atlantic Regions.

BOEM was heavily involved in the creation of the *National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone* (NOMEC Strategy). The NOMEC Strategy was developed following the issuance of a November 2019 Presidential Memorandum that called on Federal agencies to "act boldly" in implementing its ambitious strategic goals. It includes the following five goals:

1. Coordinate interagency efforts and resources to map, explore, and characterize the United States EEZ
2. Federal agencies will coordinate mapping efforts to compile a complete map of deep water (> 40 m) by 2030 and nearshore waters by 2040
3. Explore and characterize priority areas of the United States EEZ

4. Develop and mature new and emerging science and technologies to map, explore, and characterize the United States EEZ
5. Build public and private partnerships beyond Federal agencies to map, explore, and characterize the United States EEZ

The National Ocean Mapping, Exploration, and Characterization (NOMEC) Council was established pursuant to the NOMEC Strategy in June 2020 to coordinate agency policy and actions needed to advance ocean mapping, exploration, and characterization, and support collaboration with non-government partners and stakeholders. The Council's mission is to serve as a senior-level point of interagency coordination for the Federal Government. Two interagency working groups (IWGs) report to the Council—the preexisting IWG on Ocean and Coastal Mapping and the newly created IWG on Ocean Exploration and Characterization. BOEM staff serve on the NOMEC Council and on each IWG (and co-chair the IWG-OEC). ESP will continue to consider ways to tie BOEM-needed mapping and exploration activities to the NOMEC Strategy, in coordination with the Council.

In addition to the mapping activities that might be conducted under the auspices of the NOMEC Strategy, the Bureau also needs to gather further information on the location and extent of critical minerals on the OCS and assess the potential impacts of their extraction on the environment. This information will build upon previous studies that analyzed the ecological structure and sensitivity of distinct deepwater habitats.

In January 2021, President Biden issued a series of Executive Orders that outline the priorities of the incoming administration. The pillars of the Biden administration have been named to include racial justice, climate change, the COVID-19 pandemic, and *Building Back Better*, which focuses on the rebuilding the economy through support of small businesses and investment in jobs of the future. The Bureau is committed to supporting studies that contribute to these priorities and to advancing our understanding of potential effects from renewable energy projects, especially to disadvantaged communities. One EO highlighted the goal of conserving at least 30 percent of our lands and oceans by 2030.[8] To support this effort, the Bureau needs to collate information on deepwater benthic habitats and submarine canyons to better inform decisions on exclusion areas for offshore energy development.

The focus of the Biden administration is shifting toward the use of renewable energy, and it remains the Bureau's responsibility to understand and mitigate or avoid potential environmental and human health effects from ongoing oil and gas activities, including decommissioning.

2.2.3 NEPA/Consultation Information Needs

OEP requires robust, current data to fully analyze and disclose the potential for impacts to biological, physical, chemical, and cultural resources from OCS activities at the programmatic and site-specific level. This analysis includes impacts from offshore oil and gas, as well as G&G activities. NEPA analyses for renewable energy and marine minerals activities are currently led by their respective programs. Often,

[8] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/

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, OEP's information needs include examining the effectiveness of current and proposed mitigation and minimization measures to lessen or eliminate impacts from offshore energy or G&G activities. Additional studies addressing these NEPA/Consultation needs will enable OEP to have a more robust analysis of potential impacts from OCS activities and to propose more successful mitigation and minimization measures.

For the FY 2022–2023 SDP, OEP NEPA and consultation needs focus on air quality, ecological concerns for marine mammals and fishes, socioeconomics, climate change, human health impacts from offshore activities, and tribal relations. This information will enable BOEM to conduct more comprehensive NEPA analyses and associated consultation.

2.3 Alignment With SSQs

In recent years, OEP has had a particular focus on studies that address cumulative effects of offshore energy development as well as those that promote the use of new and emerging technologies. 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 developing an OCS genomic sampling strategy for marine invertebrates. Use of new technology continues to be a priority this year, with 6 of the 10 proposed studies incorporating emerging technologies.

Two proposed studies focus on the human side of BOEM's research. The first of these seeks to work with BOEM's Native American tribal partners to better understand maritime environments on the Atlantic Coast, and the second is concerned with privacy issues regarding social science research.

BOEM is committed to providing all necessary information to make informed decisions regarding offshore energy, which includes the identification of sensitive habitats that may be considered as exclusion areas. BOEM has also worked to update regional air quality models and their inputs to better understand the potential impacts of OCS energy development on the human and marine environment and is now looking to design standard operating procedures to use satellite data for offshore air quality management. Similarly, at a national level, ESP has worked to proactively develop and fund updates to key economic analyses that support offshore energy programs.

A full list of the studies proposed by OEP and their alignment with the SSQs can be seen in **Table 1**. Study profiles can be viewed by clicking on the study titles.

Table 1. Alignment of proposed FY 2022 National studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	BOEM-Tribal Collaboration: Understanding Marine Environments on the Atlantic Coast	-	✓	-	-	-	-	-	-	-	✓	-	-
2	Offshore Air Quality (AQ) from NASA's Satellites and Related Experiments	✓	✓	✓	✓	-	✓	-	✓	✓	-	✓	✓
3	Understanding Impacts of Habitat Modifications on Commercial Fisheries and Apex Predator Distribution	-	✓	✓	-	-	-	✓	✓	-	-	-	✓
4	Submarine Canyons of the US EEZ Atlas	✓	✓	✓	-	-	-	-	-	-	-	-	✓
5	Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery – Phase II	-	✓	-	-	-	-	-	-	-	-	✓	✓
6	Incorporating PAMGUARD into the Tethys Passive Acoustic Data Metadata System	✓	✓	✓	-	✓	-	✓	-	✓	-	✓	✓
7	Standardizing National Integrated Ecosystem-Based Assessment for Transparent Visualization of Scenario Trade-Offs	✓	✓	✓	✓	✓	-	✓	-	✓	-	-	✓
8	Developing Best Practices and Applying Environmental DNA (eDNA) Tools and in Support of Assessing and Managing Living Marine Species in an Ecosystem-based Context	✓	✓	✓	-	-	✓	✓	-	-	-	✓	✓
9	Evaluation of Plankton (Phytoplankton and Zooplankton) Communities in the Vicinity of Offshore Oil and Gas (O&G) Sites of the Outer Continental Shelf (OCS)	✓	✓	✓	-	-	✓	✓	✓	-	-	✓	✓

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
		Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
10	Balancing Privacy and Policy: Data Science Techniques to Better Inform Future Conventional Energy Leasing Decisions	✓	-	-	-	-	-	-	-	-	✓	✓	-

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

3 Alaska Studies

3.1 Introduction

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

Figure 2. Alaska OCS Region planning areas

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

study reports are posted on ESPIS.[9] An alternate location for browsing Alaska Region study reports by year is the Alaska Regional Office's website.[10]

When conducting research projects, the ESP in Alaska routinely coordinates with numerous Federal, state, and local agencies; tribal entities; non-governmental organizations; academic institutions; and active research and monitoring programs in Alaska supported by industry. The Alaska Regional Office also strives to enhance community engagement and incorporate into its decision-making processes the local and indigenous knowledge of Alaska Native tribes, Alaskan residents, and the permanent participants of the Arctic Council (Kendall et al. 2017; Brooks et al. 2019). ESP considers and integrates local and indigenous knowledge at all stages, beginning with the study development process and through the preparation of study products and interpretation of results.

The University of Alaska CMI, a cooperative arrangement created in 1993, allows ESP in Alaska to tap the scientific expertise of regional and local experts to collect and disseminate environmental information about coastal topics associated with the development of energy resources in the Alaska OCS. In nearly three decades, the Alaska CMI has funded 120 studies, including 11 student-led projects, and leveraged approximately $22 million of Bureau funds into $45 million of relevant marine-based research, with non-Federal matching funds from more than 50 different organizations.

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

Currently, the Alaska OCS Region has 33 active leases from previous lease sales; there are 14 in the Cook Inlet Planning Area and 19 in the Beaufort Sea Planning Area.

On January 29, 2021, BOEM received an application to conduct G&G and ancillary activities from Hilcorp Alaska LLC for a proposed shallow hazards survey and archaeological study in the Cook Inlet. The geohazard site clearance survey is required by BOEM to identify seafloor obstructions, shallow drilling hazards, and archaeological resources prior to consideration of any further exploration activities.

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

On April 13, 2018, BOEM approved a revision to the Exploration Plan submitted by Eni US Operating Company, Inc. to conduct drilling into leased OCS areas in the Beaufort Sea from their Spy Island drill site, an existing gravel island located in state waters. In April 2019, Eni completed drilling one well into Federal acreage. In 2020, the Bureau of Safety and Environmental Enforcement (BSEE) approved Eni's request for a Suspension of Operations effective until April 2022.

On October 17, 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 January 2021 is approximately 178 million barrels, with the Federal portion comprising more than 31.2 million barrels.

Appendix A includes the tables of proposed studies for FYs 2022 and 2023. **Appendix B** provides the profiles for the proposed studies.

3.2 Decision Context

3.2.1 Current/Relevant Issues

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

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

BOEM is evaluating expansion of its program in Alaska to include renewable energy and critical minerals. Relevant issues include renewable energy potential for the OCS off Alaska, the potential distribution of

marine mineral deposits in the region (including in deepwater areas offshore the Aleutian Islands), and environmental considerations associated with the development of these new and technology-dependent programs.

3.2.2 NEPA/Consultation Information Needs

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

In anticipation of potential exploration activities on existing leases within Cook Inlet, BOEM needs updated information about the physical and biological environment in Cook Inlet and Shelikof Strait to support NEPA analyses, especially for evaluation of changing baselines. There is an ongoing need for a better understanding of the causes and potential long-term effects of recent changes in forage fish populations and seabird die-offs and colony failures 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. Other particular interests for information in Cook Inlet include, but are not limited to the following: distribution, density, and community composition of fish and invertebrates; improved understanding of links between the pelagic and nearshore benthic ecosystem; presence, distribution, and habitat use by marine mammals; ecological responses to the presence of oil and gas platforms; baseline information about potential impacts from oil- and gas-related activities to community health in the Cook Inlet region; and updated observation and synthesis of the physical oceanography of this highly dynamic area.

Information about variability and long-term trends in oceanographic conditions and biological communities is also sought for the Arctic. There is a need to establish a long-term strategy for monitoring the abundance, distribution, and habitat use of cetaceans and other marine mammals. In addition, efforts to assess the impacts of vessel presence and sound on marine mammals and to synthesize physical oceanographic information are ongoing needs for the Arctic.

More broadly, information is needed about the potential frequency of pipeline gas release and related impacts. Finally, a synthesis of historical oil and gas activities on the Alaska OCS would inform future impact assessments.

3.3 SSQs Unique to the Alaska Region

In addition to the programmatic SSQs identified in **Section 1.3.4**, the Alaska Region must consider issues related to sea ice, including the following questions:

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

3.4 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 peoples and input from sources of indigenous knowledge.

The Alaska Region has considered the SSQs together with the specific information needs outlined above to develop our list of studies proposed for FYs 2022 and 2023. The studies proposed for the Alaska Region inform a broad repertoire of knowledge and address each of the SSQs to varying extents. **Tables 2 and 3** contain matrices indicating the strongest intersections between each study and the strategic questions.

BOEM is evaluating expansion of its program in Alaska to include renewable energy and critical minerals. Relevant issues include renewable energy potential for the OCS off Alaska and environmental considerations associated with the development of these new and technology-dependent programs. Although the list of proposed studies was developed in the context of BOEM's conventional energy program, several of the projects in Cook Inlet would also address information needs associated with renewable energy development in the area. Likewise, proposed studies in the Beaufort and Chukchi Seas could inform decisions regarding potential seafloor mining of marine minerals in the Arctic.

Table 2. Alignment of proposed FY 2022 Alaska studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									ALASKA REGION QUESTIONS		
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**	AK 1: **Ocean Currents and Sea Ice**	AK 2: **Reduced Sea Ice**	AK 3: **Sea Ice and Spilled Oil**
1	Lower Cook Inlet Fish and Invertebrate Community Composition, Distribution, and Density	✓	✓	-	✓	-	-	✓	-	✓	-	-	✓	-	-	-
2	Using Multiple Tools to Assess Marine Mammal Distribution, Numbers, and Habitat Use in Cook Inlet	✓	-	-	✓	-	-	✓	-	-	-	✓	✓	-	-	-
3	Pipeline Gas Release Frequency, Scenarios, and Impacts	✓	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-
4	Alaska Coastal Marine Institute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Baseline Health Summary for the Cook Inlet Region	✓	-	-	✓	-	-	-	-	-	✓	-	-	-	-	-
6	Alaska Assessment for Cetaceans and Other Marine Mammals (ACOMM)	✓	-	✓	✓	✓	-	-	-	-	-	✓	✓	-	✓	-
7	Collaborative Synthesis to Understand the Impacts of Vessel Presence and Sound on the Marine Environment and Subsistence Activities in the Pacific Arctic	✓	✓	-	✓	-	-	-	-	-	✓	✓	✓	-	-	-
8	Cook Inlet Physical Oceanography: Synthesis and Observation	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	✓	-	-

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									ALASKA REGION QUESTIONS		
		Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**	AK 1: **Ocean Currents and Sea Ice**	AK 2: **Reduced Sea Ice**	AK 3: **Sea Ice and Spilled Oil**
9	Renewable Energy Potential for the Alaska Outer Continental Shelf	-	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
10	Using Predator Diets to Monitor Trends in Forage Fish Composition in Lower Cook Inlet	✓	-	-	✓	-	-	✓	-	✓	-	✓	✓	-	-	-
11	Seabird and Forage Fish Distribution, Trends, and Community Structure in Lower Cook Inlet	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	-	-	-
12	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities	✓	-	-	✓	-	-	✓	-	-	-	-	-	-	-	-
13	Partnering to Improve Oil Spill Modeling in Ice	✓	-	-	✓	-	-	-	-	✓	-	✓	-	✓	-	✓
14	Linking Pelagic and Nearshore Benthic Ecosystems in Lower Cook Inlet and Kachemak Bay Through Meroplankton: Collaborating with the Gulf Watch Alaska Monitoring Program in Cook Inlet	✓	-	-	✓	-	-	✓	-	-	-	✓	✓	-	-	-

ESP STRATEGIC SCIENCE QUESTIONS

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

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

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

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

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

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

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

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

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

ALASKA REGION QUESTIONS

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

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

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

Table 3. Alignment of proposed FY 2023 Alaska studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									ALASKA REGION QUESTIONS		
Priority Rank	Study Title	Conven-tional Energy	Renew-able Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**	AK 1: **Ocean Currents and Sea Ice**	AK 2: **Reduced Sea Ice**	AK 3: **Sea Ice and Spilled Oil**
TBD	Collaboration with North Pacific Research Board (NPRB): Arctic Marine Synthesis	✓	-	-	✓	-	-	✓	-	-	-	-	✓	-	✓	-
TBD	Comprehensive Synthesis of the Physical Oceanography of the U.S. Arctic 2005–2021	✓	-	-	✓	-	-	-	-	✓	-	-	-	✓	✓	-
TBD	Ecological Response to the Presence of Oil and Gas Production Platforms in Cook Inlet, Alaska	✓	-	-	✓	-	-	✓	-	-	-	-	✓	-	-	-
TBD	Using Emerging Technologies to Update Lower Cook Inlet Seabird Colony Counts	✓	-	-	✓	-	-	-	-	-	-	✓	✓	-	-	-

ESP STRATEGIC SCIENCE QUESTIONS

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

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

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

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

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

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

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

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

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

ALASKA REGION QUESTIONS

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

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

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

4 Gulf of Mexico Studies

4.1 Introduction

Ongoing activities in the Gulf of Mexico Region (GOMR) consist of conventional oil and gas development and non-energy marine mineral leasing of sediment resources to support coastal restoration projects. GOMR is now also moving ahead in establishing a framework for future offshore renewable energy leasing and development in the GOM through the creation of a wind energy taskforce.

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

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

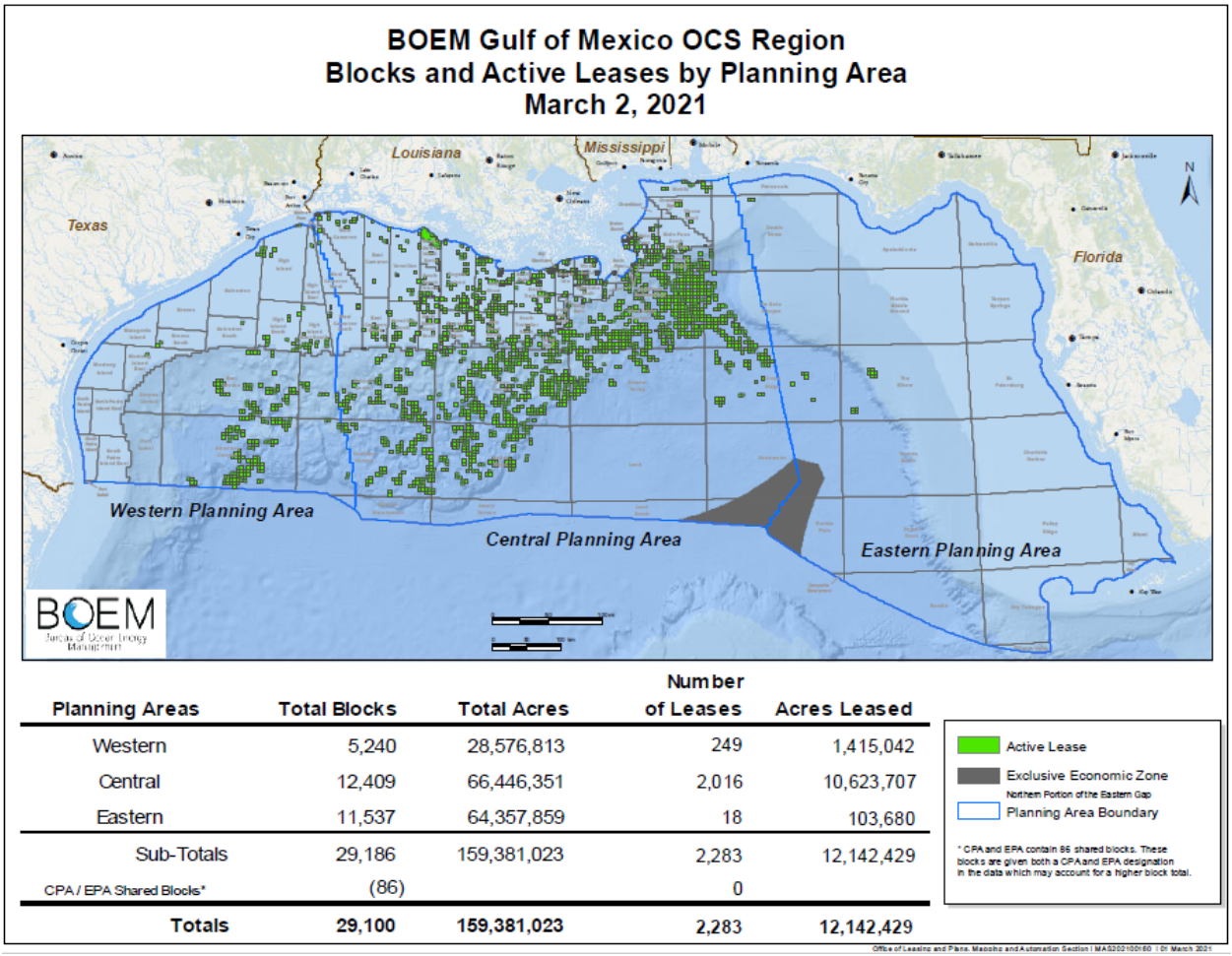
In 2010, BOEM joined the Gulf Coast Cooperative Ecosystem Studies Unit (GCCESU) as a Federal partner. Membership in the GCCESU creates additional opportunities for interdisciplinary and multi-agency research, technical assistance, and education through collaborations within a network of member Federal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

Appendix A includes the tables of proposed studies for FYs 2022 and 2023. **Appendix B** provides the profiles for the proposed studies.

4.1.1 Conventional Energy

As of March 2, 2021, there are nearly 2,300 active oil and gas leases on the GOM OCS (**Figure 3**). Within active leases, there are nearly 1,800 platforms making substantial contributions to the Nation's energy supply. GOMR currently provides approximately 25% of U.S. domestic oil production and 11% of U.S. domestic gas production. Energy exploration and production activities include leasing, exploration, development, removal of platforms, and installation of pipelines. Two lease sales were proposed for 2021 in the 2017–2022 National OCS Oil and Gas Leasing Program (BOEM 2016a); both lease sales are currently on hold. For more information on GOMR, please visit the region's web page. [11]

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



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	249	1,415,042
Central	12,409	66,446,351	2,016	10,623,707
Eastern	11,537	64,357,859	18	103,680
Sub-Totals	29,186	159,381,023	2,283	12,142,429
CPA / EPA Shared Blocks*	(86)		0	
Totals	**29,100**	**159,381,023**	**2,283**	**12,142,429**

Figure 3. GOM OCS Region planning areas and active oil and gas leases (March 2, 2021)

4.1.2 Marine Mineral Activities

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

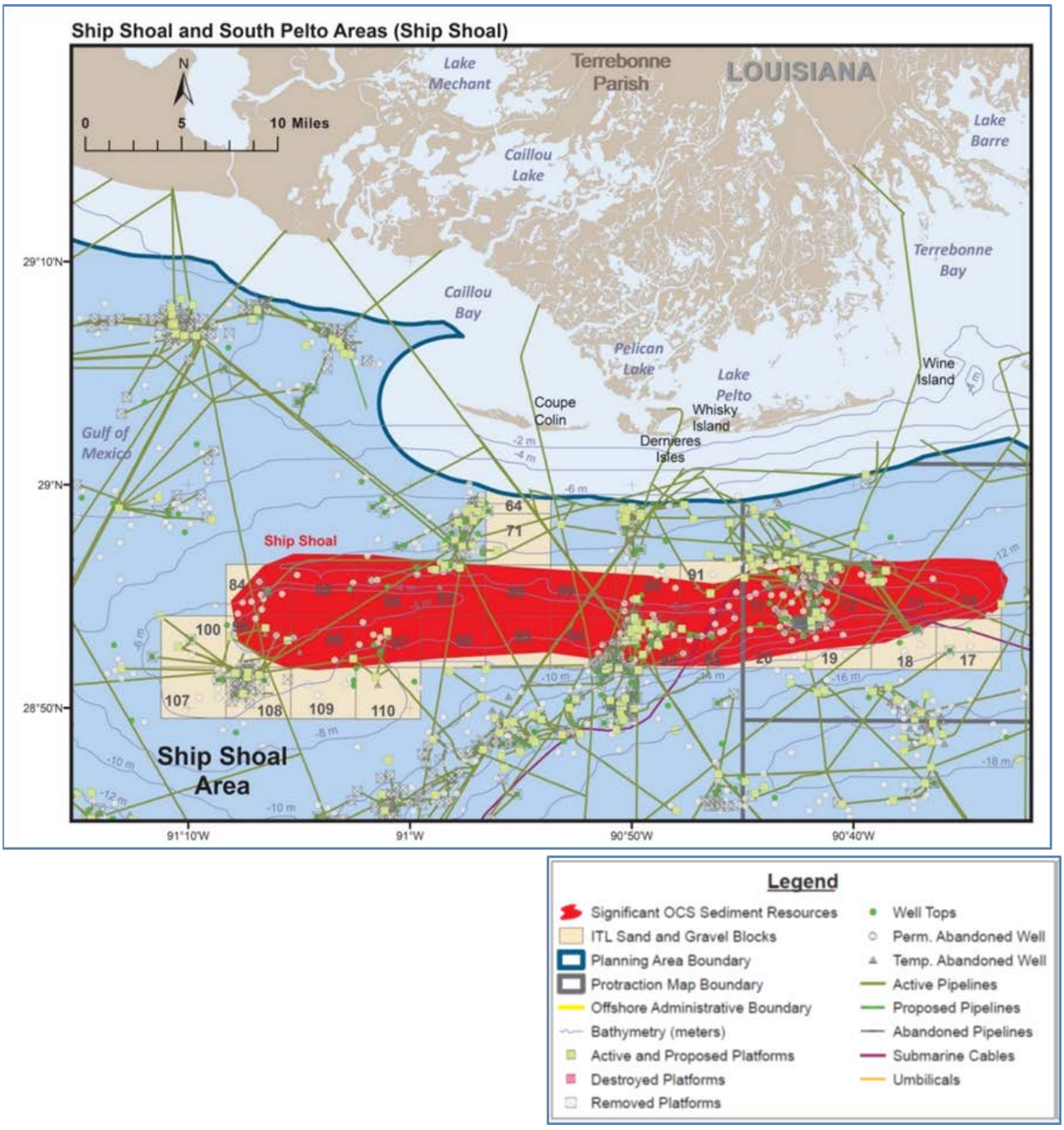


Figure 4. Complex, competing-use challenges in the GOM

4.1.3 Renewable Energy Activities

BOEM published two studies conducted by the NREL in FY 2020. The first report is a survey and assessment of renewable energy technology types in the GOM OCS (Musial et al. 2019). The second report focuses on offshore wind and incorporates regional economic modeling and site-specific analyses (Musial et al. 2020).

In August 2020, the Governor of Louisiana, John Bel Edwards, signed Executive Order JBE2020-18 to establish a Climate Initiatives Task Force and set greenhouse gas emission reduction goals for the State of Louisiana. On October 21, 2020, the State of Louisiana sent a request to BOEM for the establishment of a State Task Force. BOEM has begun the initial steps in developing a Regional Task Force to include Louisiana, Texas, Mississippi, and Alabama. The first GOM Intergovernmental Task Force Meeting has been scheduled for June 15, 2021.

4.2 Decision Context

4.2.1 Current/Relevant Issues

BOEM continues to need a better understanding of the impacts from conventional energy development and related infrastructure and to better identify potential resources that could be affected by BOEM decision-making. One information need is to reevaluate existing survey guidelines for identifying potential submerged pre-contact archaeological sites and preserved paleo landforms. Existing survey guidelines in GOMR have long been inadequate to effectively identify potentially preserved sites in order to prescribe appropriate avoidance distances. Based on advances in geophysical survey technology and the recent discovery and investigation of a preserved 8,000-year-old burial site with human remains in state waters off the western coast of Florida, new information is needed to inform revisions to BOEM's survey guidelines as well as better inform tribal consultations for all of BOEM's activities in the GOM.

4.2.2 NEPA/Consultation Information Needs

BOEM needs new data to better understand and disclose the potential for impacts to biological and cultural resources, sensitive ecosystems, and air and water quality from sources such as drilling-related activities, oil and gas well abandonment, and plastic pollution from abandoned umbilicals. Other studies will forecast avian interactions with potential offshore wind energy infrastructure and examine the chemical products used in conventional energy development. These studies will provide the information needed to better understand the effects of BOEM's programs on the human, coastal, and marine environments per OCSLA, as well as other laws, including NEPA and the National Historic Preservation Act (NHPA). Information provided by these studies will enable BOEM to conduct more comprehensive and informed environmental impact assessments, associated NEPA analyses, and tribal consultations.

4.3 Alignment With SSQs

With a robust conventional energy program spanning several decades, GOMR continues to identify information needs related to actual and potential impacts from conventional energy-related activities. The information gathered will inform cumulative impacts and other NEPA analyses, as well as environmental and tribal consultations, and will contribute to the assessment the effectiveness of existing mitigations and survey guidelines. 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. Lastly, in support of environmentally

responsible offshore renewable energy development activities, studies related to renewable energy will inform BOEM's decision-making process regarding future renewable energy planning, leasing, and development efforts on the GOM OCS.

4.3.1 Conventional Energy

GOMR is proposing 10 study profiles for the FY 2022 NSL and 3 profiles for FY 2023 and beyond. All profiles address at least one national SSQ, while several of the profiles address two or more questions (**Tables 4 and 5**). All studies will inform the conventional energy program; several studies will additionally inform the MMP and/or Renewable Energy Program.

Several profiles propose to assess anthropogenic and other impacts on sensitive resources, ecosystems, and air and water quality; forecast migratory bird movement to inform potential offshore wind development; and address air emissions factors. Other profiles propose to explore the use of innovative machine learning methods and technologies to gather and provide the environmental information needed for decision-making. Finally, other profiles address the effectiveness of current mitigations developed for resource protection and continue long-term monitoring of the Flower Garden Banks National Marine Sanctuary. Study results would inform future site-specific environmental reviews and environmental analyses, such as cumulative impacts.

4.3.2 Marine Minerals Activities

MMP has one new study profile proposed in the GOM for FY 2022 (**Table 9**). This proposal addresses two SSQs and focuses on evaluating the efficacy of use and cost of thermal detection technologies for nighttime Protected Species Observers (PSO) monitoring procedures (SSQ #9) during marine mineral related activities, such as G&G surveys, dredging, trawling animal capture, and relocation operations. There has been no formal integration and assessment of thermal detection technology (SSQ #8) into current mitigation practices, and there is potential for these tools to enhance existing PSO protocols while likely reducing survey and mitigation costs. Incorporating thermal detection technologies to PSO monitoring would supplement nighttime mitigations by providing continuous (day and night) mammal and sea turtle surveillance. Also, a quantitative evaluation would provide a baseline recommendation on future use of this technology. We anticipate that the study results will be broadly applicable across MMP activities as well as across all BOEM program areas in different geographic regions.

4.3.3 Renewable Energy Activities

Emerging Programs in GOMR is proposing one study for the FY 2022 NSL. The profile addresses two SSQs and focuses on assessing bird migration in offshore areas with high wind energy development potential. During spring and fall migration, globally significant numbers of birds migrate offshore at night in the GOM and Atlantic Regions, and these diverse populations may lethally interact with wind facilities (SSQ #4). To better understand bird migration patterns in offshore areas, this study will focus on modifying migratory bird forecasting models developed to track terrestrial bird migratory movements and apply them to offshore forecasting. Offshore near-real-time forecasts of migratory bird populations (SSQ #9) would help inform offshore wind energy planning and permitting the GOM and Atlantic Regions.

Table 4. Alignment of proposed FY 2022 GOM studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
TBD	A Programmatic Study of Chemical Products Used in Gulf of Mexico Oil and Gas Operations: Inventory, Disposal, and Risks	✓	✓	✓	✓	-	✓	-	-	-	-	-	✓
TBD	Benthic Community Characterization at BOEM "No Activity Zones"	✓	-	-	✓	-	-	-	-	-	-	-	✓
TBD	Documenting Deep and Shallow Drill Splay: Improving Resource Guidance	✓	-	-	✓	-	✓	✓	-	✓	-	✓	✓
TBD	Documenting Historic Deep and Shallow Drill Splay: Improving Resource Guidance	✓	-	-	✓	-	✓	✓	-	✓	-	✓	✓
TBD	Efficacy of Unmanned Aircraft Systems (UAS) to Improve Mitigation Measures Required for Seismic Surveying and Site Construction and Removals	✓	✓	✓	-	-	-	-	-	-	-	✓	-
TBD	Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico (GOM)	✓	-	-	✓	-	✓	-	✓	✓	-	-	✓
TBD	Live Forecasts of Migratory Bird Movements Offshore to Monitor Potential Avian Interactions with Wind Development	-	✓	-	-	-	-	✓	-	-	-	-	-
TBD	Reevaluating BOEM's Guidelines for Identifying Submerged Pre-Contact Archaeological Sites in the Gulf of Mexico	✓	✓	✓	-	-	-	✓	-	-	✓	✓	-

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
		Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
TBD	Scoping Study on Offshore Oil and Gas Air Emissions Factors	✓	-	-	✓	-	-	-	✓	-	-	-	-
TBD	Study of Plastic Pollution from Abandoned Umbilicals in the Gulf of Mexico (GOM)	✓	-	-	✓	-	✓	-	-	-	-	-	-

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

Table 5. Alignment of proposed FY 2023 GOM studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
TBD	A Demographic Analysis Update to "*Air Quality Modeling in the Gulf of Mexico Region*"	✓	-	-	-	-	-	-	✓	-	✓	-	-
TBD	Developing a Machine Learning Tool for Identifying Shipwrecks and Anthropogenic Features in Multibeam Echosounder (MBES) Datasets	✓	✓	✓	-	-	-	-	-	-	-	✓	-
TBD	Long-Term Coral Reef Monitoring at Flower Garden Banks (FGB), Gulf of Mexico: 2022–2025	✓	-	-	✓	-	-	-	-	✓	-	-	✓

ESP STRATEGIC SCIENCE QUESTIONS

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

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

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

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

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

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

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

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

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

5 Pacific Studies

5.1 Introduction

BOEM's Pacific Region includes the OCS areas offshore California, Oregon, Washington, and Hawaii (**Figure 5**). The region's current responsibilities encompass three BOEM programs: ongoing conventional energy operations, renewable energy development, and potential leasing of marine mineral resources. ESP started in the Pacific Region in 1973. Over its 48-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 2022–2023 SDP, the Pacific Region participated in outreach to many stakeholders for input. The Pacific Region received and considered 96 study ideas from stakeholders, including Federal, state, and local agencies, a tribal organization, universities, nonprofit organizations, stakeholder alliances, and private companies. Additionally, eight Pacific Region staff proposed 12 study ideas. Regional managers and staff considered all relevant and mission-oriented study ideas; those found to be directly relevant and timely were prioritized by regional managers and staff and are proposed in this SDP.

Appendix A includes the tables of proposed studies for FY 2022. **Appendix B** provides the profiles for the proposed studies.

5.1.1 Conventional Energy Activities

The current 2017–2022 National OCS Oil and Gas Leasing Program (BOEM 2016a) does not include new oil and gas lease sales for the Pacific Region. Currently, there are 32 active oil and gas leases in the region, all of which are in the Southern California Planning Area (**Figure 6**). Oil and gas were first produced from Pacific OCS leases in 1968; annual production peaked in the mid-late 1990s and has been steadily declining. As of December 31, 2020, cumulative production was 1.4 billion barrels of oil and 1.9 trillion cubic feet of gas; annual production was 4.5 million barrels of oil and 2.7 billion cubic feet of gas (C. Baver, personal communication). The substantial decline in production since 2015 is due to a number of factors, including (1) the shut-in of six platforms (including Hidalgo, Harvest, and Hermosa, west of Point Conception) following the May 2015 break of an onshore pipeline that transported oil from the platforms; (2) the 2018 bankruptcy of the operator of Platforms Gail and Grace (in the eastern Santa Barbara Channel) and the shut-in of those platforms; (3) the temporary shut-in of Platform Irene (west of Point Arguello) in early 2019; and (4) the shut-in of Platforms Hogan and Houchin (in the eastern Santa Barbara Channel) in October 2019.

The expectation of future decommissioning of platforms in Federal waters has been discussed for years. Planning for the decommissioning of Platforms Gail, Grace, Hidalgo, Harvest, Hermosa, Hogan, and Houchin is now underway. BOEM will maintain close coordination with BSEE and other Federal, state, and local permitting agencies throughout the decommissioning process.

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

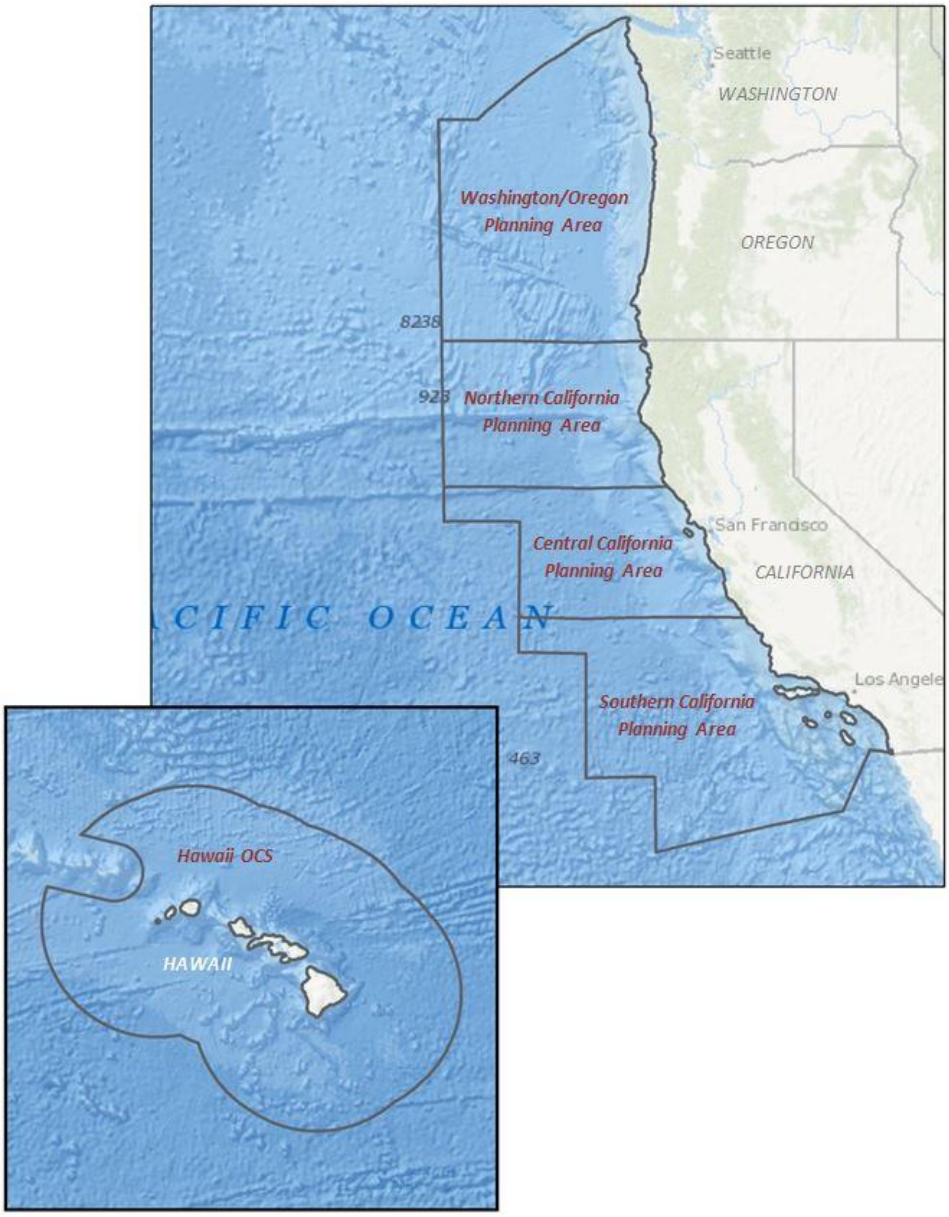


Figure 5. Pacific Region OCS planning areas

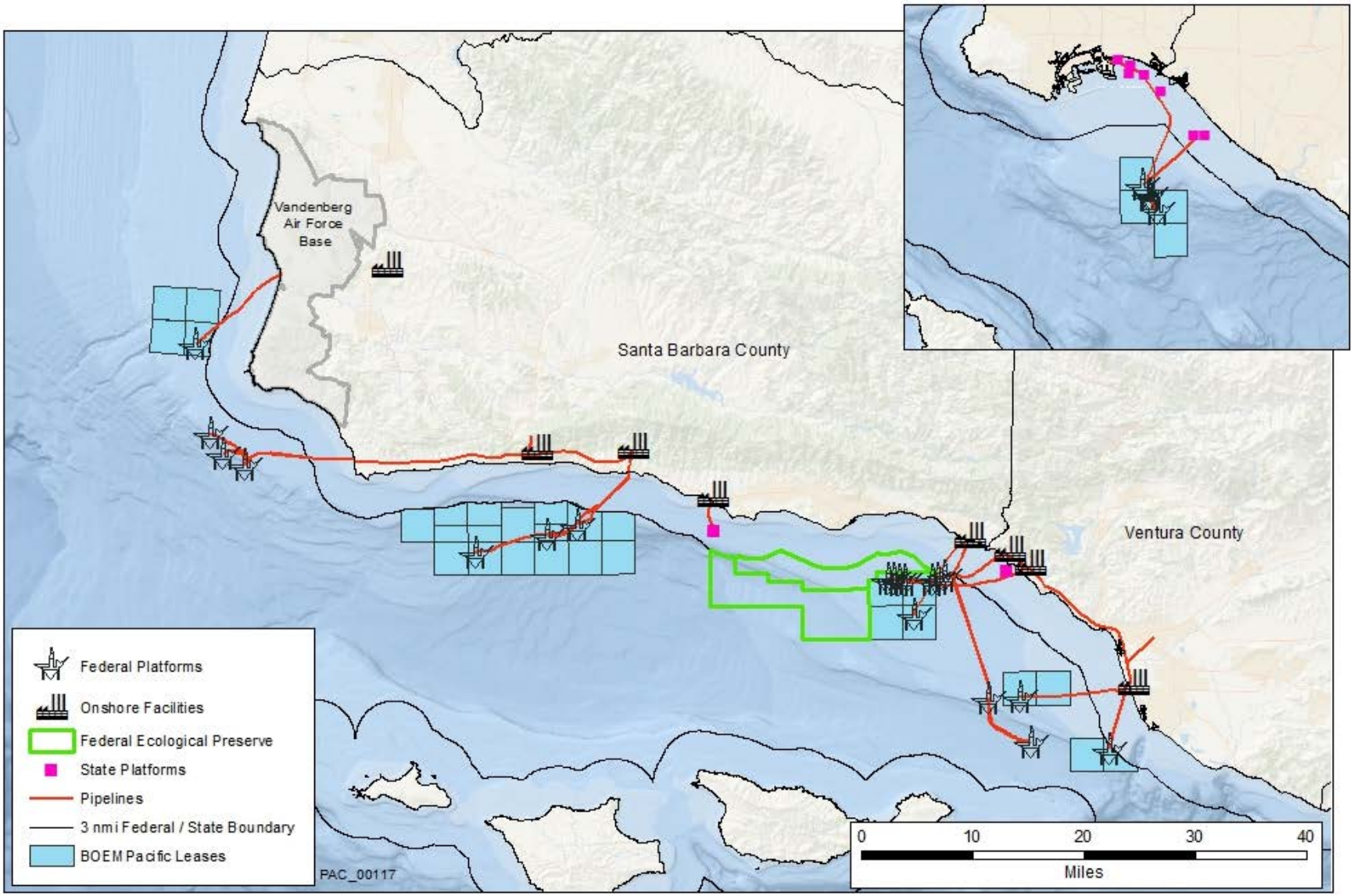


Figure 6. Oil and gas leases and facilities in the Pacific Region

5.1.2 Renewable Energy Activities

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

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

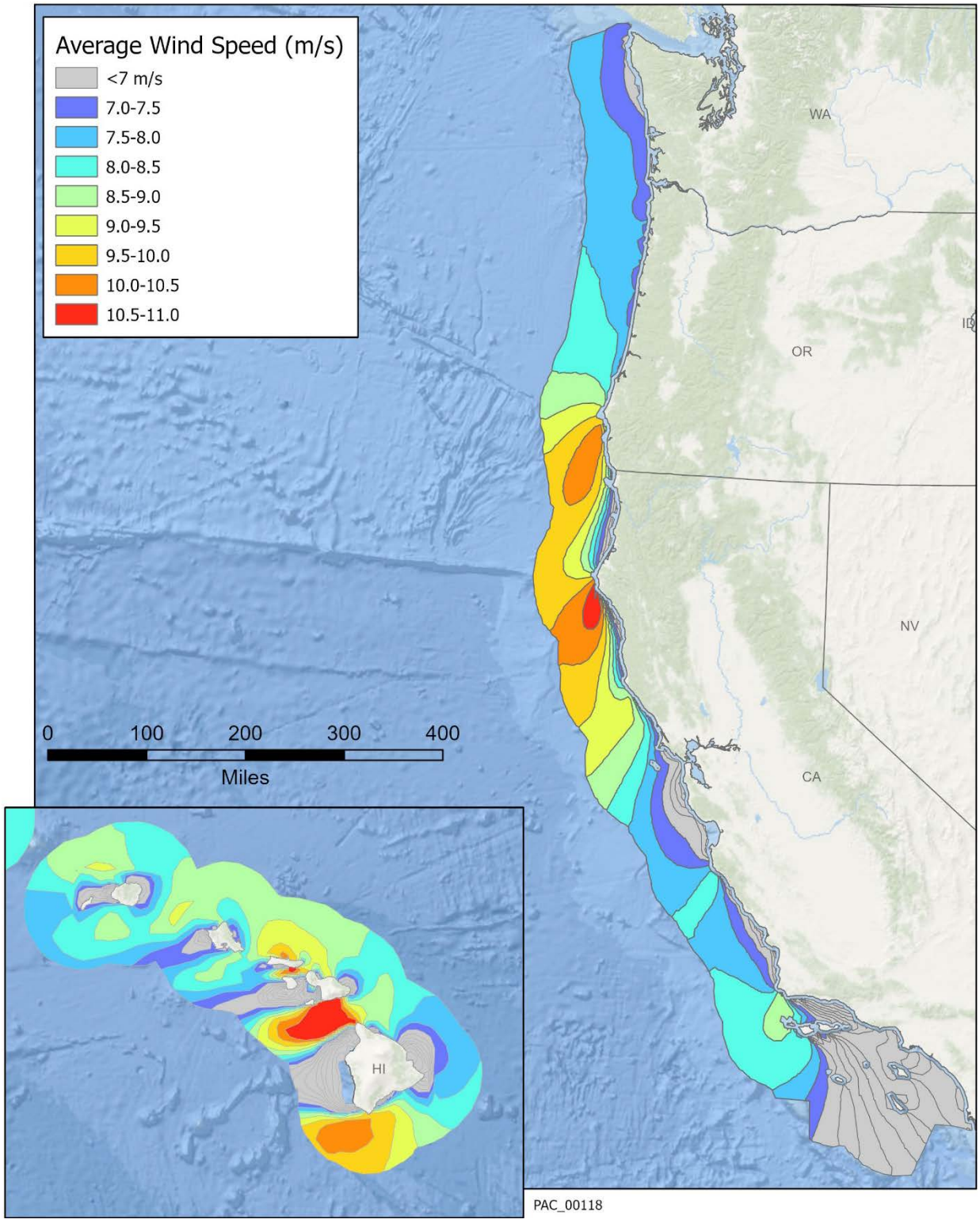


Figure 7. Annual average wind speed offshore the U.S. West Coast and Hawaii

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

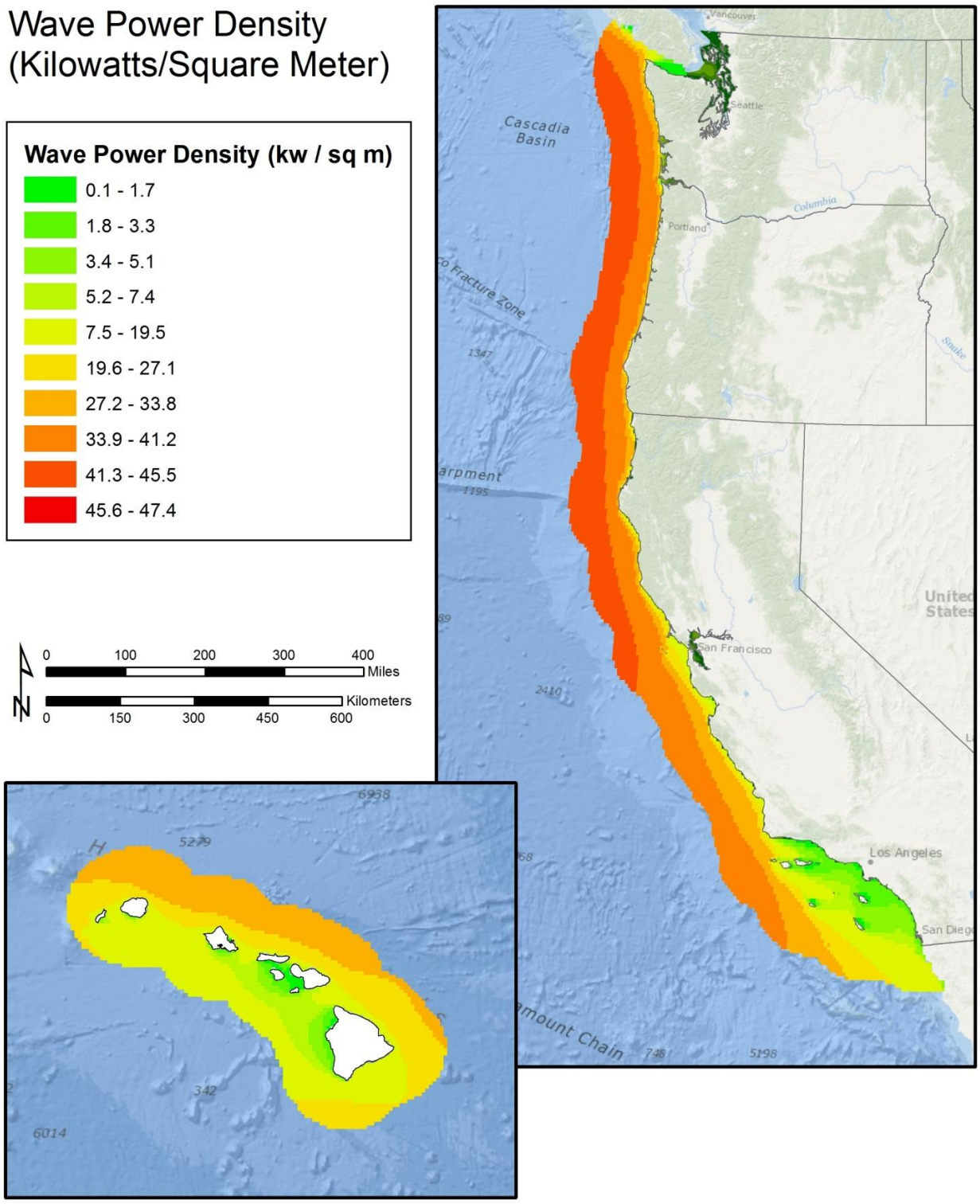


Figure 8. Annual average wave power density offshore the U.S. West Coast and Hawaii

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

Figure 9. Areas of interest for renewable energy in the Pacific OCS, including Call Areas for wind energy offshore California and Hawaii, and a wave energy research lease offshore Oregon

5.1.3 Marine Minerals Activities

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

5.2 Decision Context

5.2.1 Conventional Energy Science Strategy and Decision Context

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

- *Information needs*:
  - Status and trends of environmental conditions 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., acquiring information needed to evaluate foreseeable industry applications, including decommissioning, Rigs-to-Reefs, and alternate-use proposals)
  - 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 2022, the strategy to support the Pacific Region's renewable energy program is centered on (1) refining information about environmental conditions and biological communities in areas of potential renewable energy development offshore California, Oregon, and

Hawaii and (2) obtaining baseline information about cultural resources and human uses adjacent to areas of potential wind energy development offshore Oregon and Hawaii. As such, proposed studies informing renewable energy address these key information needs and applied uses for informed decision-making by BOEM:

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

- *Applied uses for informed decision-making:*
  - Decisions and actions related to issuance of research and commercial leases for renewable energy offshore California, Oregon, and Hawaii (e.g., offshore planning, providing information to renewable energy task forces and 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

5.3 Alignment With SSQs

Current and forecasted activities in the Pacific Region (see **Section 5.1**), and BOEM's decision-making related to those activities, are the basis for BOEM's information needs and science strategies. Among the portfolio of Pacific Region studies proposed for FY 2022, the proposed studies inform conventional energy (four), renewable energy (eight), and marine minerals (three). Of the nine proposed studies in the portfolio, five have potential applicability to more than one program (**Table 6**).

As shown in **Table 6**, each proposed study addresses more than one of BOEM's SSQs (themes), including the following areas:

- Assessing cumulative effects (9 studies)
- Determining effects of sound (1 study)
- Determining effects of exposure to hydrocarbons or other chemicals (1 study)
- Determining effects of habitat or landscape alteration (9 studies)
- Determining how future ocean conditions and dynamics may mask effects of OCS activities (3 studies)
- Using social science research in impact assessment (5 studies)
- Using existing or emerging technology to improve research results (5 studies)
- Determining which resources, measures, and systems are best used for long-term monitoring (7 studies)

Table 6. Alignment of proposed FY 2022 Pacific studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	O`ahu's Traditional Cultural Landscapes	-	✓	-	✓	-	-	✓	-	-	✓	-	✓
2	Seafloor Condition OCS Monitoring: BIGHT'23	✓	-	-	✓	-	✓	✓	-	-	-	-	✓
3	Tag You're It! Habitat Use of Large Whales of the Santa Barbara Channel and Hawai'i	✓	✓	-	✓	-	-	✓	-	-	-	✓	✓
4	Birds, Bats, and Beyond: Networked Wildlife Tracking in the Southern California Bight	✓	✓	-	✓	-	-	✓	-	-	-	✓	✓
5	Ancient Landscapes off the Washington Coast	-	✓	✓	✓	-	-	✓	-	-	✓	✓	✓
6	The California Current Marine Biodiversity Observing Network for Offshore Energy	✓	✓	✓	✓	✓	-	✓	-	✓	-	✓	✓
7	Social Values, Perceptions, and Likelihood of Social Action in Potential Wind Energy Areas in the Pacific Outer Continental Shelf Region	-	✓	-	✓	-	-	✓	-	-	✓	-	-
8	Maritime Heritage of the U.S. Pacific Islands	-	✓	✓	✓	-	-	✓	-	✓	✓	✓	✓
9	Multi-Criteria Decision Analysis (MCDA) Tool for Informing Spatial Planning of Offshore Wind Energy Development	-	✓	-	✓	-	-	✓	-	✓	✓	-	-

ESP STRATEGIC SCIENCE QUESTIONS

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

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

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

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

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

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

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

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

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

6 Atlantic Studies

6.1 Introduction

The Atlantic OCS extends from Maine to Florida and is divided into four planning areas (**Figure 10**). The OCS planning areas extend from the Federal and state boundary at 3 nautical miles out to the outer boundary of the EEZ at approximately 200 nautical miles. Although not by design, these planning areas roughly coincide with the LMEs along the Atlantic as defined by NOAA.[12] On the Atlantic OCS, the renewable energy program and MMP are actively managing leases. No oil and gas exploratory drilling or development activities are currently taking place as part of the conventional energy program.

Appendix A includes the tables of proposed studies for FYs 2022 and 2023. **Appendix B** provides the profiles for the proposed studies.

6.1.1 Conventional Energy Program

With the change of Administration in January 2021 and shift in priorities for offshore conventional energy, BOEM does not currently anticipate that new information will be needed in FY 2022 to support and inform a conventional energy program in the Atlantic OCS Region. As such, no new study profiles focusing on conventional energy in the Atlantic Region are being considered for funding in FY 2022 at this time.

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

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

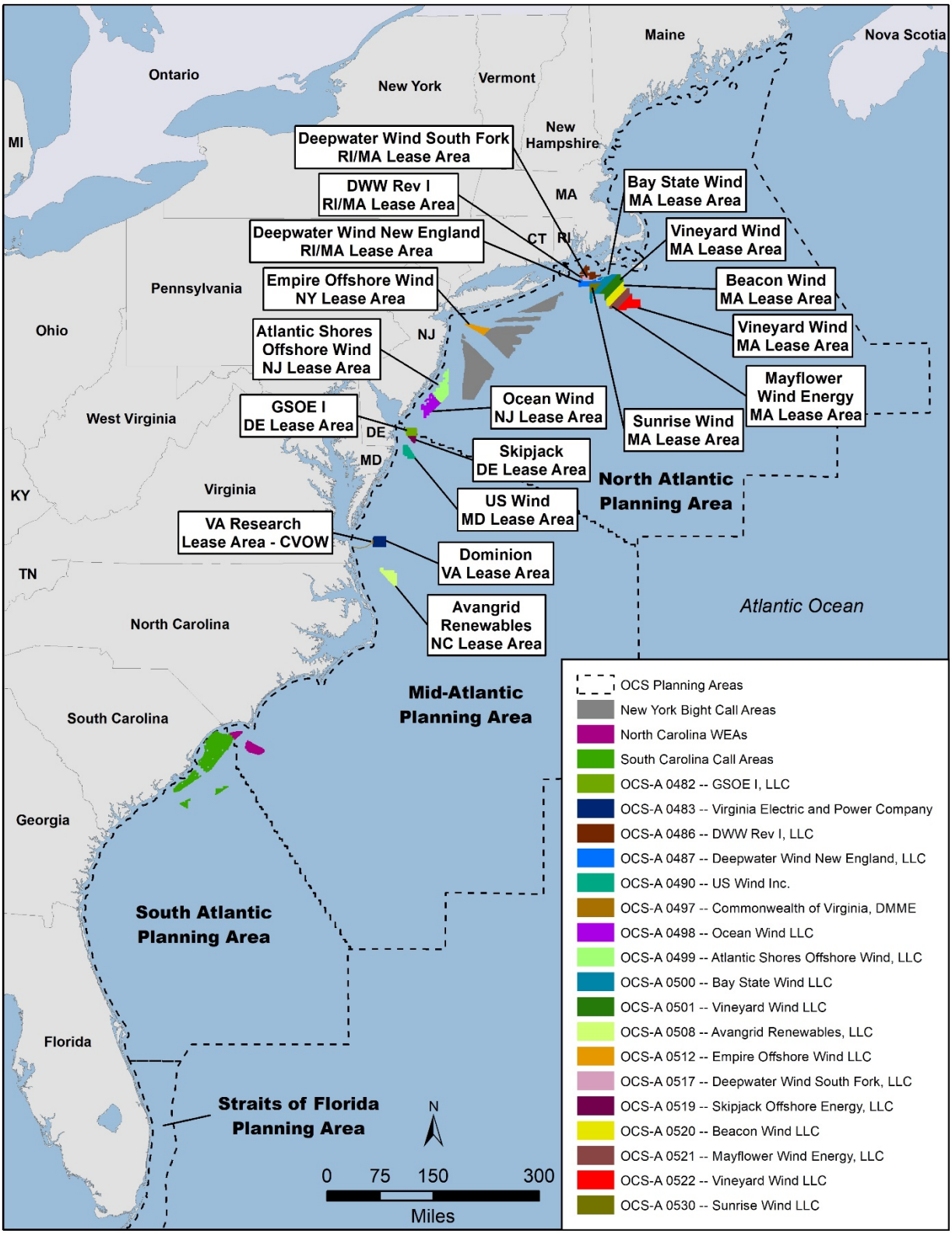


Figure 10. Atlantic Region OCS planning areas for renewable energy and Renewable Energy Areas

6.1.2 Renewable Energy Program

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

OREP now has 16 active leases along the Atlantic Coast extending from Massachusetts to North Carolina. Additional leasing is anticipated off New York and the Carolinas within the year. Site assessments conducted by developers are underway in many of the areas, including geophysical and biological surveys and wind resource measurements using LiDAR (light detection and ranging) buoys. The next phase of development is the submittal of COPs by industry for these lease areas. BOEM approved the first COP for the Vineyard Wind project in spring 2021. BOEM is reviewing an additional 14 COPs and anticipates receiving several more in the next year. The areas for development include Massachusetts, Rhode Island, New Jersey, New York, Delaware, Maryland, and Virginia. The first two turbines on the OCS were installed off Virginia in May 2020 on a research lease owned by the Commonwealth of Virginia. BOEM is actively engaged in research at this location; research includes monitoring the sound from operating turbines and development of biological communities on the turbine and surrounding scour protection. BOEM held the first regional task force meeting for the Gulf of Maine to initiate the process of leasing. With leasing several years out, now is the time to initiate baseline studies, such as a comprehensive assessment of existing data, conducting wildlife surveys, and understanding tourism and recreation.

6.1.3 Marine Minerals Activities

The MMP continues to evaluate and authorize G&G exploration offshore North Carolina and Florida and lease OCS sand for use in beach nourishment and coastal restoration New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Florida. OCS sand has been used to protect valuable Federal and state assets and infrastructure, such as national seashores along Assateague Island (MD) and the Outer Banks (NC), and NASA's Wallops Island Flight Facility along Virginia's Eastern Shore (**Figure 11**). BOEM's resource evaluation research is focused in resource-constrained areas offshore south and mid-Atlantic states, where demand is the greatest, and long-term planning efforts for improved coastal resilience are increasing. Some project proponents are evaluating the potential to use OCS sand offshore Long Island, New York, and New England states in the next decade. There is also growing interest in critical minerals in the Atlantic OCS, such as heavy minerals found in inner shelf sand shoals and sheets, or potential manganese nodules in deepwater environments such as the Blake Plateau. In 2020, President Trump withdrew many of the most prospective areas in the Atlantic from commercial marine mineral leasing through 2032.

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

6.2 Decision Context

6.2.1 Current/Relevant Issues

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

6.2.2 NEPA/Consultation Information Needs

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

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

6.3 Alignment With SSQs

6.3.1 Renewable Energy Program

Tables 7 and 8 show how the Atlantic OCS Region studies focused on renewable energy address the SSQs. With the goal to approve 16 COPs by the end of 2024, the focus is on information needed to evaluate these plans and to begin post-construction monitoring. Key issues of concern raised by the public include the visual impacts to coastal communities, impacts to commercial fishing, and protection of alterations to the environment because of the presence of the turbines.

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.[13] The potential for future leasing in the Gulf of Maine will require establishing baseline information of wildlife. Two key areas of concern are bird and bat strikes, where individuals are killed by collision with the turbines, and displacement by the presence of the structures.

Marine Fish & Fisheries

The effects of renewable energy development on fish and shellfish range from physical modification of the seafloor habitat to physical and behavior modification due to noise. Impacts also extend to the fisheries that depend on those resources. Fundamental to protecting fish species is an understanding of the physical habitat and how fish use these habitats for important life-history events. It is important to understand this information not only at the project level but also at the regional level. BOEM has invested resources in understanding high priority fish or fisheries (Atlantic sturgeon, lobster, black sea bass), locations (leased areas), and impact-producing factors (seafloor disturbance, sound, electromagnetic field [EMF]). These priorities are informed through intergovernmental task forces, public meetings, formal information solicitations, and recommendations made in BOEM-funded studies. The New England[14] and Mid-Atlantic Fishery[15] Management Councils have also identified their information needs that crosscut offshore wind energy. These fisheries management agencies have identified the following priorities: monkfish distribution, habitat characterization, future state habitat models, offshore wind effects on scallop production, noise effects to fish, fishing displacement due to offshore wind, effects on fisheries independent surveys, how offshore wind impacts specific fishery management measures, and differential impact to commercial and recreational fisheries.

In the Atlantic renewable energy program, BOEM has placed endangered and threatened fish species and commercially important fish species as high priorities. Within these groups, BOEM then evaluates the vulnerability of the species to BOEM-permitted activities. These species 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). Current projects include acoustic impacts to commercially important longfin squid and black sea bass, hydrodynamic modeling of scallop and other fish larvae through wind facilities, and regional habitat and fish characterization. With development expected in the next few years, emphasis is now on better mitigation measures, such as the use of inclusive designs for scour protection and coverings to protect

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

cables. With a New York lease sale by the end of this year, understanding the important clam fishery and its spatial needs will inform development.

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

6.3.2 Marine Minerals Program

Table 9 shows MMP studies proposed for this SDP; two studies focus on the Atlantic OCS Region (the third focuses on the GOM). The first study focuses on characterizing Atlantic sturgeon distribution and behavior around known Atlantic sand resources. Atlantic sturgeon is listed under the ESA and relies on the habitat associated with OCS sand resources. The study will assess temporal and spatial dimensions of sturgeon occurrence and behavior and dredging activities to determine the likelihood of dredge or trawl encounter (SSQ #4). Potential direct impacts to sub-adult and adult sturgeon from dredging and associated activities, especially relocation trawling, are neither well documented nor well understood (SSQ #4). This study proposes to implement a field study in an area where sturgeon occur during dredging and relocation trawling can be used to observe interactions and characterize the behaviors and duration of recovery. Improving understanding and assessment of impacts to Atlantic sturgeon may influence mitigations measures and borrow area design.

The other study focuses on gathering baseline data related to physical, biological, chemical, and human-coupled natural systems to analyze and compare potential dredging impacts to Frying Pan Shoals (FPS), North Carolina. FPS, a large cape-associated shoal complex, is designated as Essential Fish Habitat (EFH) and a Habitat Area of Particular Concern (HAPC). Project proponents and coastal engineers have identified FPS as a potential long-term resource to support future coastal resiliency planning efforts in the sand-starved Southeast North Carolina region. Physical and biological ecosystem drivers of this highly productive and dynamic system are understudied and could be adversely affected by potential dredging activities (SSQ #6). This study will address potential impacts to benthic and fish habitats (SSQ #4) through the collection of baseline information, evaluation of dredging scenarios, and quantitative consideration of ecosystem trade-offs.

Both studies propose field work that would focus on developing and employing best available resources, measurements, and systems that could be used for future long-term monitoring efforts (SSQ #9).

Table 7. Alignment of proposed FY 2022 OREP studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Offshore Wind Impacts on Oceanographic Processes: North Carolina to New Jersey	-	✓	-	✓	-	-	✓	-	-	-	-	-
2	Offshore Wind Turbine Visibility Study	-	✓	-	✓	-	-	✓	-	-	✓	-	✓
3	Seasonal Residency and Movement of Highly Migratory Sea Turtles in Atlantic Offshore Wind Areas	-	✓	-	✓	-	-	✓	-	-	-	-	-
4	Evaluating Effectiveness of Nature Inclusive Design Materials	-	✓	-	✓	-	-	✓	-	-	-	-	-
5	Comparative Study of Aerial Survey Techniques	✓	✓	✓	✓	-	-	✓	-	-	-	✓	✓
6	Tracking Movements of Common Terns Staging on Muskeget Island	-	✓	-	-	-	-	✓	-	-	-	-	-
7	Clam Industry Spatial Needs Analysis – NY Bight	-	✓	✓	-	-	-	-	-	-	✓	-	-
8	Exploring the Connectivity Among Offshore Wind Turbines	-	✓	-	✓	-	-	✓	-	-	-	-	-
9	Sediment-borne Wave Disturbances and Propagation and Potential Effects on Benthic Fauna	-	✓	-	-	✓	-	-	-	-	-	✓	-

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
		Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
10	Coastal Landscape/Seascape Character Classification and Assessment Methodology Development	-	✓	-	✓	-	-	✓	-	-	✓	-	✓
11	Baseline Tourism and Recreation Along the Gulf of Maine	-	✓	-	✓	-	-	✓	-	-	✓	-	-
12	Ecological Baseline Study of the U.S. Outer Continental Shelf Off Maine	-	✓	-	✓	-	-	✓	-	-	-	-	✓
13	Investigating Persistent Super Aggregations of Right Whales and Their Prey in Lease Areas OCS-A 0521 and OCS-A 0522 in the North Atlantic	-	✓	-	-	-	-	✓	-	-	-	✓	✓

ESP STRATEGIC SCIENCE QUESTIONS

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

Table 8. Alignment of proposed FY 2023 OREP studies with BOEM programs and SSQs

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Using Acoustic Monitoring to Evaluate Ecosystem Changes from Offshore Wind Development	✓	✓	✓	-	✓	-	✓	-	-	-	-	✓
2	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic	✓	✓	✓	✓	-	-	✓	-	-	-	-	-
3	Estimating Bird and Bat Flight Heights from Wildlife Strike Data	-	✓	-	-	-	-	✓	-	-	-	✓	-
4	A Comprehensive Assessment of Existing Gulf of Maine Ecosystem Data and Identification of Data Gaps to Inform Future Research	-	✓	-	-	-	-	✓	-	✓	-	-	-
5	Post-Construction Wildlife Surveys Outside of the MA WEA	-	✓	-	-	-	-	✓	-	-	-	-	✓
6	Offshore Landscape, Seascape, and Visual Impact Mitigation Study	-	✓	-	-	-	-	-	-	-	✓	-	-

ESP STRATEGIC SCIENCE QUESTIONS

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

Table 9. Alignment of proposed FY 2022 MMP studies with BOEM programs and SSQs

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
		Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Efficacy of Thermal Detection Technology for Nighttime Protected Species Observer Surveys	-	-	✓	-	-	-	-	-	-	-	✓	✓
2	Sturgeon Response to Dredge Activities and Recovery After Trawl Capture Near Outer Continental Shelf (OCS) Sand Resources	-	-	✓	-	-	-	✓	-	-	-	-	✓
3	Fish Fry: Frying Pan Shoals Ecosystem Dynamics	-	-	✓	-	-	-	✓	-	✓	-	-	✓

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

7 References

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

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

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

Brooks JJ, Crowley HA, Coon CC, Kendall JJ. 2019. Traditional knowledge & ocean research. The Journal of Ocean Technology. 14(1) 49–58.

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

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

Kendall JJ, Brooks JJ, Campbell C, Wedemeyer KL, Coon CC, Warren SE, Auad G, Thurston DK, Cluck RE, Mann FE, et al. 2017. Use of traditional knowledge by the United States Bureau of Ocean Energy Management to support resource management. Czech Polar Reports. 7(2): 151–163.

Musial W, Tegen S, Driscoll R, Spitsen P, Roberts O, Kilcher L, Scott G, and Beiter P (National Renewable Energy Laboratory and the Alliance for Sustainable Energy, LLC, Golden, CO). 2019. Survey and assessment of the ocean renewable resources in the US Gulf of Mexico. New Orleans (LA): Bureau of Ocean Energy Management. Report No.: OCS Study BOEM 2020-017. 82 p.

Musial W, Beiter P, Stefek J, Scott G, Heimiller D, Stehly T, Tegen S, Roberts O, Greco T, Keyser D (National Renewable Energy Laboratory and the Alliance for Sustainable Energy, LLC, Golden, CO). 2020. Offshore wind in the US Gulf of Mexico: regional economic modeling and site-specific analyses. New Orleans (LA): Bureau of Ocean Energy Management. Report No.: OCS Study BOEM 2020-018. 94 p.

APPENDIX A: Tables of Proposed Studies for FYs 2022 and 2023

Table A-1. National studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
65	HE	Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery – Phase II
68	IM	Balancing Privacy and Policy: Data Science Techniques that May Better Inform Future Conventional Energy Leasing Decisions
72	SE	BOEM-Tribal Collaboration: Understanding Maritime Environments on the Atlantic Coast
76	HE	Developing Best Practices and Applying Environmental DNA (eDNA) Tools and in Support of Assessing and Managing Living Marine Species in an Ecosystem-Based Context
80	HE	Evaluation of Plankton (Phytoplankton and Zooplankton) Communities in the Vicinity of Offshore Oil and Gas (O&G) Sites of the Outer Continental Shelf (OCS)
84	IM	Incorporating PAMGUARD into the Tethys Passive Acoustic Data Metadata System
88	AQ	Offshore Air Quality (AQ) from NASA's Satellites and Related Experiments
92	IM	Standardizing National Integrated Ecosystem-Based Assessment for Transparent Visualization of Scenario Trade-Offs
96	PO	Submarine Canyons of the US EEZ Atlas
99	HE	Understanding Impact of Habitat Modifications on Commercial Fisheries and Apex Predator Distribution

Discipline Codes

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

Table A-2. Alaska studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
103	MM	Alaska Assessment for Cetaceans and Other Marine Mammals (ACOMM)
105	IM	Alaska Coastal Marine Institute
107	SE	Baseline Health Summary for the Cook Inlet Region
110	MM	Collaborative Synthesis to Understand the Impacts of Vessel Presence and Sound on the Marine Environment and Subsistence Activities in the Pacific Arctic
113	PO	Cook Inlet Physical Oceanography: Synthesis and Observation
116	HE	Linking Pelagic and Nearshore Benthic Ecosystems in Lower Cook Inlet and Kachemak Bay Through Meroplankton: Collaborating with the Gulf Watch Alaska Monitoring Program in Cook Inlet
118	HE	Lower Cook Inlet Fish and Invertebrate Community Composition, Distribution, and Density
121	FE	Partnering to Improve Oil Spill Modeling in Ice
123	FE	Pipeline Gas Release Frequency, Scenarios, and Impacts
126	IM	Renewable Energy Potential for the Alaska Outer Continental Shelf
129	IM	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities
131	HE	Seabird and Forage Fish Distribution, Trends, and Community Structure in Lower Cook Inlet
134	MM	Using Multiple Tools to Assess Marine Mammal Distribution, Numbers, and Habitat Use in Cook Inlet
136	HE	Using Predator Diets to Monitor Trends in Forage Fish Populations in Lower Cook Inlet

Discipline Codes

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

Table A-3. Alaska studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
139	IM	Collaboration with North Pacific Research Board (NPRB): Arctic Marine Synthesis
142	PO	Comprehensive Synthesis of the Physical Oceanography of the U.S. Arctic 2005–2020
145	MM	Ecological Response to the Presence of Oil and Gas Production Platforms in Cook Inlet, Alaska
148	HE	Using Emerging Technologies to Update Lower Cook Inlet Seabird Colony Counts

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

Table A-4. GOM studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
151	FE	A Programmatic Study of Chemical Products Used in Gulf of Mexico Oil and Gas Operations: Inventory, Disposal, and Risks
154	HE	Benthic Community Characterization at BOEM "No Activities Zones"
157	HE	Documenting Deep and Shallow Drill Splay: Improving Resource Guidance
160	HE	Documenting Historic Deep and Shallow Drill Splay: Improving Resource Guidance
163	MM	Efficacy of Unmanned Aircraft Systems (UAS) to Improve Mitigation Measures Required for Seismic Surveying and Site Construction and Removals
166	FE	Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico (GOM)
169	HE	Live Forecasts of Migratory Bird Movements Offshore to Monitor Potential Avian Interactions with Wind Development
172	SE	Reevaluating BOEM's Guidelines for Identifying Submerged Pre-Contact Archaeological Sites in the Gulf of Mexico
175	AQ	Scoping Study on Offshore Oil and Gas Air Emissions Factors
177	FE	Study of Plastic Pollution from Abandoned Umbilicals in the Gulf of Mexico (GOM)
Discipline Codes		
AQ = Air Quality FE = Fates & Effects HE = Habitat & Ecology IM = Information Management		MM = Marine Mammals & Protected Species PO = Physical Oceanography SE = Socioeconomics

Table A-5. GOM studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
179	SE	A Demographic Analysis Update to "*Air Quality Modeling in the Gulf of Mexico Region*"
182	SE	Developing a Machine Learning Tool for Identifying Shipwrecks and Anthropogenic Features in Multibeam Echosounder (MBES) Datasets
186	HE	Long-Term Coral Reef Monitoring at Flower Garden Banks (FGB), Gulf of Mexico: 2022–2025
Discipline Codes		
AQ = Air Quality FE = Fates & Effects HE = Habitat & Ecology IM = Information Management		MM = Marine Mammals & Protected Species PO = Physical Oceanography SE = Socioeconomics

Table A-6. Pacific studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
189	SE	Ancient Landscapes off the Washington Coast
192	HE	Birds, Bats, and Beyond: Networked Wildlife Tracking in the Southern California Bight
196	SE	Maritime Heritage of the U.S. Pacific Islands
199	IM	Multi-Criteria Decision Analysis (MCDA) Tool for Informing Spatial Planning of Offshore Wind Energy Development
202	SE	O`ahu's Traditional Cultural Landscapes
204	HE	Seafloor Condition OCS Monitoring: BIGHT'23
207	SE	Social Values, Perceptions, and Likelihood of Social Action in Potential Wind Energy Areas in the Pacific Outer Continental Shelf Region
210	MM	Tag You're It! Habitat Use of Large Whales of the Santa Barbara Channel and Hawai'i
213	HE	The California Current Marine Biodiversity Observing Network for Offshore Energy

Discipline Codes

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

Table A-7. OREP studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
217	SE	Baseline Tourism and Recreation Along the Gulf of Maine
220	SE	Clam Industry Spatial Needs Analysis – NY Bight
222	SE	Coastal Landscape/Seascape Character Classification and Assessment Methodology Development
225	MM	Comparative Study of Aerial Survey Technique
227	HE	Ecological Baseline Study of the U.S. Outer Continental Shelf Off Maine
229	HE	Evaluating Effectiveness of Nature Inclusive Design Materials
231	FE	Exploring the Connectivity Among Offshore Wind Turbines
233	HE	Investigating Persistent Super Aggregations of Right Whales and Their Prey in Lease Areas OCS-A 0521 and OCS-A 0522 in the North Atlantic
235	PO	Offshore Wind Impacts on Oceanographic Processes: North Carolina to New Jersey
238	SE	Offshore Wind Turbine Visibility Study
241	MM	Seasonal Residency and Movement of Highly Migratory Sea Turtles in Atlantic Offshore Wind Areas
244	FE	Sediment-borne Wave Disturbances and Propagation and Potential Effects on Benthic Fauna
249	HE	Tracking Movements of Common Terns Staging on Muskeget Island

Discipline Codes

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

Table A-8. OREP studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
252	HE	A Comprehensive Assessment of Existing Gulf of Maine Ecosystem Data and Identification of Data Gaps to Inform Future Research
255	HE	Estimating Bird and Bat Flight Heights from Wildlife Strike Data
257	HE	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic
260	SE	Offshore Landscape, Seascape, and Visual Impact Mitigation Study
263	HE	Post-Construction Wildlife Surveys Outside of the MA WEA
265	HE	Using Acoustic Monitoring to Evaluate Ecosystem Changes from Offshore Wind Development

Discipline Codes

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

Table A-9. MMP studies proposed for FY 2022, alphabetized by title

Profile Page #	Discipline	Study Title
267	MM	Efficacy of Thermal Detection Technology for Nighttime Protected Species Observer Surveys
270	HE	Fish Fry: Frying Pan Shoals Ecosystem Dynamics
273	HE	Sturgeon Response to Dredge Activities and Recovery After Trawl Capture Near Outer Continental Shelf (OCS) Sand Resources

Discipline Codes

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

APPENDIX B: FY 2022–2023 Study Profiles Organized by Region

Title	Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery – Phase II
Administered by	Headquarters
Procurement Type(s)	TBD
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Performance Period	FY 2022–2024
Date Revised	April 16, 2021
PICOC Summary	
Problem	A significant challenge for integrating remote sensing methods for population surveys is the tremendous volume of data collected during image-based surveys and the lack of suitable tools for automated detection, classification, and counting of wildlife targets collected on at-sea transects. The current methodology requires experts to manually identify all species on an image-by-image basis, a strategy that will soon be untenable due to the magnitude of necessary datasets to process by a limited number of expert teams.
Intervention	Phase I of this project accomplished automating detection using convolutional neural networks (Ke et al. 2021). In Phase II – we will develop the classification and counting architecture of the algorithm.
Comparison	This method will use marine wildlife images collected on BOEM-funded studies to train the algorithm and compare classification efficiency across species and dynamic survey conditions.
Outcome	This project will produce a transferrable computer vision algorithm to identify and count marine wildlife in imagery collected on aerial survey operations.
Context	This project applies to all BOEM regions if the imagery is available.

BOEM Information Need(s): High-resolution camera systems are now deployed on nearly all aerial surveys to capture transect-level imagery of seabirds, sea turtles, and marine mammals. This project will develop and evaluate strategies for efficiently automating wildlife counts in aerial photographs and will reduce the costs of long-term monitoring programs through rapid data processing. This approach will also improve species identification, particularly species challenging to identify by observers on aerial surveys. Automating detection and classification with deep learning workflows will improve NEPA and similar analyses by expediting information to the manger. BOEM and multiple other agencies are collecting large volumes of aerial survey data that require years to process by hand. High-resolution imagery coupled with precise classification algorithms, as proposed by this study, will lead to more precise population estimates and species identification than visual surveys methods, while increasing safety of the scientists in the aircraft.

Background: Federal, State, and Provincial wildlife management agencies in North America have a long history of using aircraft to monitor the population abundance of marine wildlife at sea. Improved sensor, computing, and image processing technologies offer promise in enhancing marine animal population surveys' safety while improving the quality of data derived and creating a permanent, georeferenced

record of observations. Automation of marine animal detections and classification is critical if remote sensing solutions are to be cost-efficient (Groom et al. 2013, Chabot et al. 2016).

In phase one of this project, we developed automated convolutional neural networks to filter out empty water imagery from large volumes of data and to accurately detect wildlife objects within the filtered results (Ke et al. 2021). In phase two, we propose to continue algorithm development to classify and count seabirds, turtles, and marine mammals in imagery automatically.

This project will partner with study AT-20-02 (AMAPPS III - Photogrammetric Aerial Surveys to Improve Detection and Classification of Seabirds, Cetaceans, and Sea Turtles). FWS (Mark Koneff) developed a high-resolution multi-array camera system to collect marine wildlife imagery at quantified multi-species hotspots (created by T. White) to improve our imagery catalog. We will also use imagery acquired by study NT-21-02 (Imagery Acquisition to Support and Enhance BOEM's Deep Learning Projects) to improve the algorithms.

Objectives: The goal of this project is to continue the development of automating detection and classification algorithms of marine wildlife (e.g., cetaceans, seabirds, and sea turtles) in digital aerial imagery. In phase 2, we will focus heavily on classification and counts. Specific objectives include the following:

1. Populate the annotated digital aerial imagery library with a higher diversity of species and environmental backgrounds that will strengthen the algorithms.
2. Develop classification and counting algorithms with a broader suite of imagery captured on AMAPPS III, NYSERDA aerial surveys and other projects that we are in the process of identifying.
3. Provide recommendations and guidance on image and environmental characteristics that maximize detection and classification accuracy.
4. Test detection and classification algorithms with a BOEM funded in-flight processing system currently in development by FWS (Mark Koneff) for AMAPPS III. When fully realized, inflight processing will use the algorithms developed by this project to detect and classify object in real time while on transect.

Methods:

- Acquire currently accessible digital aerial imagery from BOEM funded studies, and partners (e.g., FWS).
- Continue development of training algorithms using extant imagery.
- Develop and apply computer vision and machine learning algorithms to classify target wildlife species across a range of conditions affecting difficulty in classification.

Specific Research Question(s):

Can an efficient and reliable algorithm be developed to accurately detect, classify, and count a wide variety marine species in digital imagery collected by offshore aerial surveys?

Affiliated WWW Sites: Deep Learning for Automated Detection and Classification of Waterfowl, Seabirds, and other Wildlife from Digital Aerial Imagery

References:

Chabot D, Francis CM. 2016. Computer-automated bird detection and counts in high-resolution aerial images: a review. Journal of Field Ornithology.

Groom G, Stjernholm M, Nielsen RD, Fleetwood A, Petersen IB. 2013. Remote sensing image data and automated analysis to describe marine bird distributions and abundances. Ecological Informatics 14:2-8.

Ke TW, Yu ST, Koneff MD, Froncska DL, Fara L., Harrison TJ, Landolt KL, Hlavacek EJ, Lubinski BR, White TP. 2021. Deep learning workflow to support in-flight processing of digital aerial imagery for wildlife population surveys. (In review)

Title	Balancing Privacy and Policy: Data Science Techniques to Better Inform Future Conventional Energy Leasing Decisions
Administered by	Headquarters
BOEM Contact(s)	Jonathan Blythe (jonathan.blythe@boem.gov), Jeff Brooks (jeffrey.brooks@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2023
Date Revised	February 11, 2020
PICOC Summary	
Problem	Vulnerable communities have the right to participate in OCS development decisions that may impact their lives and livelihoods. A statutory requirement under the Evidence Act of 2018 states that agencies shall perform evidence-building to inform agency policy. Quantitative socio-economic data can be shared with the public so agencies can better understand the circumstances affecting vulnerable communities and fully engage in a dialog with the public. However, privacy restrictions limit what agencies can do. This needs to be addressed in a way that still engages the public interests and is fully transparent.
Intervention	BOEM will use statistical information to characterize the wellbeing of resident communities and their vulnerability to impacts from BOEM's conventional energy development. This analysis will be designed to use rigorous statistical methodology, be completely reproducible, and protect the privacy of survey participants and the data sovereignty and security of affected communities.
Comparison	Technological solutions may facilitate dissemination of quantitative information in BOEM policy and ensure public access to reproducible, analytical results.
Outcome	Open and accessible BOEM socio-economic data, better informed decision analysis for NEPA, and protection of individual privacy and scientific integrity
Context	Vulnerable communities near OCS conventional energy development and associated infrastructure in the North Slope of Alaska

BOEM Information Need(s): BOEM needs statistical information about conventional energy lease sales to characterize and manage the impacts to vulnerable communities. This study will be a pilot project for a new tool, that can facilitate the use of statistical information to support evidence-based policymaking and Privacy Act compliance (Privacy Act, 1974). This is partially in response to Biden administration priorities expressed in the January 27, 2021 executive order: "Restoring trust in government through scientific integrity and evidence-based policymaking."

Background: The Alaska Arctic is an area with small communities that are vulnerable to federal activities in the Alaska OCS region. Livelihoods and critical infrastructure may be affected by BOEM's leasing decisions, because oil and gas development is a major employer and source of revenue to municipal governments. Employment produced by OCS activity may come at a tradeoff to traditional cultural practices of indigenous communities, such as annual subsistence hunting and fishing activities (Stephen

R. Braund & Associates, 2017). BOEM is aware of these tradeoffs and strives to consult with local communities as part of its lease sales in the region.

Communities whose lives and livelihoods center around the Gulf of Mexico may also be vulnerable to conventional energy development. For example, the oil and gas sector is a large employer in Louisiana, which is a plus for many communities living there, but more research is needed to understand the impacts to subsistence activities (Hemmerling and Colten, 2017). BOEM has difficulty incorporating this trade-off into its oil and gas planning activities, partially because the impact to vulnerable communities is not well understood.

A remedy for ensuring a more equitable representation of vulnerable communities in BOEM's conventional energy OCS leasing plans is to employ evidence-building supported by rigorous statistical analysis of quantitative scientific information. Social and natural processes are critically interdependent, and characterizing these dynamics as part of an integrated socio-ecological system is particularly important for understanding system vulnerabilities (Auad, Blythe, Coffman et al. 2018). BOEM could use objective and reproducible statistical analyses to study the socio-ecological system, and rigorously test hypotheses about the impacts of OCS activities to vulnerable communities. These quantitative techniques can help BOEM compare current circumstances to previous periods and project future scenarios. Physical sciences contribute to evidence-building when they present a scenario with important consequences for local communities, such as a local environmental change associated with regional or global climate change. Without an objective analysis of OCS development under reasonable scenarios, many of the decisions that BOEM makes may not appropriately anticipate predictable system vulnerabilities.

The Evidence Act of 2018 requires that agencies conduct evidence-building activities to improve policymaking. A novel technique will be explored in this study, called differential privacy, that addresses the important privacy considerations in accessing and disseminating quantitative social science information (Evans et al. 2021). Also, title two of the Evidence Act, the OPEN Government Data Act, institutes reforms that enables the public, industry, and NGOs to scrutinize data that have been influential to government policy.

Objectives:

- Disseminate BOEM collected human subjects survey information for BOEM policymaking, while protecting the privacy of communities and participants that make up the BOEM survey.
- Determine the limited use and appropriate interpretation of BOEM survey information.
- Enable independent analysis that is scientifically defensible and statistically valid.

Methods: Differential privacy requires a governance mechanism where the government, scientists, and stakeholders decide the limited and appropriate use of quantitative data. This should include at least representatives from the surveyed communities, including tribal liaisons, an intertribal institutional review board (IRB) expert (Kelley et al. 2013), the BOEM privacy official, BOEM social scientists, and experts in the application of differential privacy to semi-quantitative and categorical longitudinal survey data. The governance framework is especially suited to deliberate on the dissemination of a particular survey dataset, and any other contextual circumstances of this study deemed relevant by the government.

This pilot study will be designed to address an agency information need in Alaskan North Slope communities or a scientific process question, using BOEM's Arctic communities longitudinal survey

(Stephen R. Braund & Associates, 2017). For example, this study could produce a power analysis of the baseline survey's sample size to inform the survey design and quality of possible continued longitudinal surveying. BOEM's primary role, other than funding the study, is to provide context to the governance body on pressing policy questions of the agency, for example concerns about an upcoming leasing decision. BOEM Governance Board members can also pre-identify excepted topics of research, for example exempting science questions that may bring undue attention to sensitive matters, such as any matter that is the subject of ongoing litigation that could be used against the agency in ongoing court proceedings. The BOEM privacy official and the intertribal IRB expert will remain neutral on information needs but advise the board on the rules and regulations for human subjects research. The differential privacy expert will advise on quantitative analysis methodology, and what research questions may be feasible to address given the existing survey data and available publications/ reports on the baseline survey. Other governance members will also contribute context and knowledge to give the communities that they represent equal footing in the governance deliberations. Scientists that are not part of the governance framework submit requests to use survey information for analyses that they propose. The study then proceeds to fund and facilitate the selected analysis and encourages appropriate sharing and publishing of results.

This study will produce a data deliverable that BOEM will release to the public to meet statutory compliance with the Open Government Data Act. The contributing scientists may receive an early copy of the analytical results and will be afforded exclusive access for a moratorium period of between 90 days to two years so they can publish their analytical products. After this period of moratorium, BOEM will make public the results of analyses and associated data, with the intention of improving the uptake of this information and improving the evidence basis for BOEM policy. The survey data themselves are never released, so there is a calculated risk for compromising any survey participant's privacy.

Specific Research Question(s):

1. How will BOEM use information it has collected about vulnerable communities living near the OCS conventional energy development and associated infrastructure, and how can this be used most effectively in BOEM evidence-based policymaking?
2. Can evidence building activities proceed in a manner that takes various considerations into account and produces an analytical output that is acceptable to all parties, because the public was engaged in the proposal of suitable scientific analyses, oversight of the scientific process in executing the scientific analysis, and the governance of the limited use of a community's sensitive data?
3. Will the analysis that results stand up to scrutiny and legal challenges from the public, industry and NGOs once it has been made publicly available under statutory requirements for open data?

References:

Auad G, Blythe J, Coffman K, Fath BD. 2018. A dynamic management framework for socio-ecological system stewardship: A case study for the United States Bureau of Ocean Energy Management. Journal of Environmental Management. 225(November 2018): 32-45. DOI: 10.1016/j.jenvman.2018.07.078

Evans G, King G, Smith AD, Thakurta A. 2021. Differentially private survey research. (Accessed Online: May 19, 2021) URL: http://garyking.org/DPsurvey

Foundations of Evidence-Based Policymaking Act of 2018 (P.L. 115-435), and associated implementation guidance provided by the Office of Management and Budget and/or the General Services Administration.

Hemmerling SA, Colten CE. 2017. Environmental Justice: A Comparative Study in Louisiana. 197 p. OCS Study BOEM 2017-068. Obligation No.: M03PD00005. URL: https://espis.boem.gov/final%20reports/5650.pdf

Kelley A, Belcourt-Dittloff A, Belcourt C, Belcourt G. 2013. Research Ethics and Indigenous Communities. American Journal of Public Health. 103(12):2146-2152. URL: http://doi.org/10.2105/AJPH.2013.301522

Open, Public, Electronic, and Necessary (OPEN) Government Data Act (P.L. 115-435 Title II)

Privacy Act, as amended 5 U.S.C. 552a. 1974.

Stephen R. Braund & Associates. 2017. Social indicators in coastal Alaska: Arctic communities. 538 p. OCS Study BOEM 2017-035. Obligation No.: M11PC00032. URL: https://espis.boem.gov/final%20reports/5604.pdf

Title	BOEM-Tribal Collaboration: Understanding Marine Environments on the Atlantic Coast
Administered by	Headquarters and OREP
BOEM Contact(s)	John Primo (john.primo@boem.gov), Justin Bedard (justin.bedard@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022–2026
Date Revised	May 12, 2021
PICOC Summary	
Problem	BOEM needs an improved understanding of the relationships Tribes have with the marine and coastal environments to better assess the potential effects of OCS Wind Energy. To do so, BOEM must overcome a legacy of poor relations between Tribes and the US government.
Intervention	This study implements a collaborative research effort that addresses BOEM's information needs and enriches relations between BOEM and various Tribes of the Northeastern US (NE Tribes). BOEM aims to do this via adhering to the principles of collaborative research and co-production of knowledge in which these entities identify research objectives, methods, etc. *jointly*.
Comparison	The use of comparison is to be determined, as this study is purposefully designed to be jointly determined by BOEM and the NE Tribes. Comparisons may be supported by the study's baseline characterizations of the marine environment.
Outcome	Information objectives include documentation of tribal understandings of the marine and coastal environments and the identification of best practices for Tribal consultation. The major outcome is to inform NEPA and OCSLA work associated with the pending Wind Energy Development boom on the Atlantic Coast. The collaborative study process itself is part objective and outcome as it results in the joint development of this research effort, mutually identified objectives (e.g., information needs, practical deliverables/outcomes) of value to Tribes and BOEM, and enriched relationships between the Tribes and BOEM.
Context	Tribes and associated areas in the NE US; associated with Massachusetts, Rhode Island, New York, Connecticut, and several other states in the region.

BOEM Information Need(s): The Atlantic Coast is experiencing a 'boom' in offshore wind energy activity. The latest mandates from the Biden Administration (e.g., '30x30') have energized the national effort to expand the nation's renewable energy supply (Whitehouse.gov). At present there are no less than 15 developments in the Atlantic's offshore wind pipeline. BOEM has a significant information gap that needs to be addressed soundly and innovatively. BOEM requires baseline information to document Tribal understandings and utilization of the marine environment and associated key resources to inform environmental assessments and ultimately OCS decision-making (NEPA, OCSLA, EPAct). As part of BOEM's mandate it must engage in a government to government relationship with Federally recognized Tribes (NHPA, EO 13175). This study aims to meet these needs by using a collaborative research approach that aims to understand the marine environment through Tribal perspectives, and by

identifying best practices for government to government consultations associated with OCS Wind Energy development activities.

Background: For BOEM to meet its responsibilities to Federally recognized Native American Tribes, BOEM must further understand Tribal interests associated with the OCS and the marine environment. BOEM has done this over the years by studying traditional ecological knowledge, subsistence practices, and various cultural aspects (TCPs, landscapes, etc.). The Alaska Region has led this type of research, and there have been studies in the Pacific and elsewhere (Ball, et. al., 2015; Galginaitis, 2014; Kofinas, et. al., 2016). These studies have increasingly demonstrated a high degree of collaboration between the Bureau, scientists, and Native peoples. This effort aims to expand on this burgeoning direction of work to improve our understanding of Tribal interests in the Northeastern Atlantic Region. Just as importantly, this study aims to take a further step on that continuum of collaboration toward an equal partnership in co-producing knowledge in further clarifying Tribal interests.

Objectives: The Environmental Studies Program aims to meet both traditional program information objectives and non-traditional objectives, namely:

Traditional objectives:

- An enhanced understanding of the marine environment in the Northeastern US, as understood through the Tribes' perspectives.
    - An understanding of *Tribes history, current state*, demographics, languages, ties to other Tribes, governance structure, and their general views on offshore wind development
    - An understanding of the significance of the *relevant marine and terrestrial environment* to Tribes
    - An understanding of current *socioeconomic* conditions – Tribal businesses, community economic strategies or goals, current or potential training or education programs
    - Identification and documentation of *socio-cultural resources* of significance in the coastal and marine environment – these could be ideological (beliefs/values 'aka' intangible), TCPs, sites, remains, etc.
    - Identification of Tribal concerns with OCS Wind Energy Development as appropriate in relation to each of the preceding domains – historical, current state, environment, socioeconomic, sociocultural
    - A better understanding of the culturally and/or historically significance to Tribes of places and resources on the OCS to better inform federal decision making related to avoiding, minimizing, and/or mitigating impacts.
- Insights on or best practices for government-to-government consultations/engagement on the development of offshore wind energy
    - Appropriate protocols for communication – representation, frequency, location/means, routine exchanges, etc.
    - Enhance/Assist information sharing – what is useful for Tribes, develop practices or protocols for gov and Tribes to use to exchange information on OCS Wind Energy
    - Identify avenues for increased participation of Tribes in the Wind Energy Industry – identify businesses or skill sets that are in place

Non-traditional, relational objectives:

- Enhanced relations between BOEM and the Involved Tribes – as evidenced through the trust and cooperation needed for a successful collaborative research effort
- Capacity enhancement for Tribes – TBD (e.g., training, tool creation, outreach efforts)

Methods: The bedrock of this study is a collaborative research approach with the intent of BOEM being partners or co-producers in knowledge production with a self-identified group of NE Tribes. This approach has been broadly engaged over the last two decades in various fields such as international development, conservation and development, and Indigenous knowledge studies. There are various degrees of collaboration and measures of success noted in the literature (Isaac 2015; Koster, Baccar and Lemelin 2012; Kothari, Camil and Brown 2013). There are several key hallmarks with this type of research, namely, collaborative creation of the research objective(s) and design. The intent is that all parties are equal partners and have a legitimate influence in the research design, agree with the general direction of the study and have something of value to gain by the completion of objectives.

With this study BOEM aims to further an ongoing dialogue with NE Tribes by presenting the general concept of this study to them in seeking their partnership. BOEM would capitalize on the flexibility of its procurement process ('nimble') and use a collaborative research approach to engage Tribes as meaningful partners in the study design process and in the award/selection process. The literature asserts that this is essential for there to be a successful collaborative study (Isaac 2015; Koster, Baccar and Lemelin 2012; Kothari, Camil and Brown 2013).

Specific methods for the study, beyond its collaborative approach, are TBD. However, BOEM's information objectives necessitate some type of sociocultural approach. Potential research approaches include, but are not limited to the following, a cultural landscape approach, ethnography, and/or cultural modelling. Likely methods include, semi-structured discussions, focus groups, participant observation, unstructured discussions, literature/archival review, etc. One overarching epistemological objective would be to garner information about the marine and coastal environments through the perspectives (i.e., how they perceive or interpret the environment, understand, and know it) of the various NE Tribes. This is the only way to understand what is significant to these Tribes and what might be affected by OCS Wind energy development.

Specific Research Question(s): Overarching Queries: How do NE Tribes view and relate to the marine environment (coastal and related lands, and ocean areas)? What are their concerns/understandings of OCS Wind Energy Development (e.g., effects – positive, negative, uncertain)? How can Tribes and BOEM best work together to address the challenges inherent to OCS Wind Energy planning and development?

- Are there social, cultural, historical and economic features or aspects of the environment that hold significance? What are they? What is their significance?
- Are there specialized or unique Tribal ways of understanding the environment that are of import to Tribes and are not easily translated or understood by non-Tribal members?
- What are Tribes concerned with regarding the development of OCS Wind?
- What lessons can be learned about collaborative research from this effort? Are there best practices or useful insights that support successful collaboration?

References:

Ball D, Clayburn R, Cordero R, Edwards B, Grussing V, Ledform J, McConnell R, Monette R, Steelquist R, Thorsgard E, Townsend J. 2015. A Guidance Document for Characterizing Tribal Cultural Landscapes. US Department of Interior, Bureau of Ocean Energy Management.

Galginaitis M. 2014. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). U.S. Dept. of the Interior, Bureau of Ocean Energy Management.

Isaac D. 2015. Values and Co-production: Examining the Interface of Indigenous Peoples' Understandings and Scientific Understandings. University of Waterloo.

Kofinas G, BurnSilver S, Magdanz J, Stotts R, Okada M., 2016. Subsistence Sharing Networks and Cooperation: Kaktovik, Wainwright, and Venetie, Alaska. U.S. Dept. of the Interior, Bureau of Ocean Energy Management.

Koster R, Beccar K, Lemelin H. 2012. Moving form research ON, to research With and FOR Indigenous communities: A critical reflection on community-based participatory research. The Canadian Geographer. Kothari, A., Camill, P., and Brown, J., 2013. Conservation as if People Also Mattered: Policy and Practice of Community-based Conservation. Conservation & Society.

White House 2021. FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs. Released March 29, 2021. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/

Environmental Studies Program: Studies Development Plan | FY 2022–2023

Title	Developing Best Practices and Applying Environmental DNA (eDNA) Tools and in Support of Assessing and Managing Living Marine Species in an Ecosystem-based Context
Administered by	Headquarters
BOEM Contact(s)	Timothy White
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2023
Date Revised	January 13, 2021
PICOC Summary	
Problem	The number of taxa that eDNA is capable of monitoring is still growing, as new markers are being developed. However, managers remain skeptical about eDNA's reliability as a tool for accurately resolving localized community structure of managed species from invertebrates (e.g., clams) to fish, turtles, whales, and seabirds.
Intervention	Groundtruth known (i.e., quantified) seasonal community hotspots of managed species with eDNA to evaluate strengths and weakness of the eDNA net within ecosystem-based studies.
Comparison	Community-level persistent hotspots of managed taxa (e.g., clams, fish, turtles, whales, and seabirds) recently quantified and integrated by T. White provide target areas on the Atlantic to sample and test for congruence between known community structure and eDNA.
Outcome	eDNA best practices methodology; identification of taxa easily resolved by eDNA and those that are not; buildout of genetic database and recommendations for improvement.
Context	Atlantic (applicable to all regions)

BOEM Information Need(s): 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. It fixes deoxyribonucleic acid (DNA) that degrades over a few hours to a few days, offering a contemporaneous snapshot of species occurrence in the study area (Ficetola et al., 2008; Lafferty et al., 2018). BOEM's eDNA strategy encouraged the Bureau to consider developing eDNA as a tool for ecological sampling to improve environmental monitoring. Since then, Stoeckle et al. (2020) investigated the ground-truthing of fish distribution and abundance by sampling for fish in the water column with net tows vs. collecting water samples for eDNA. They confirmed the reliability of eDNA as a new kind of sampling net for fish taxa. As BOEM continues ecosystem monitoring from surf clams to seabirds, it should evaluate how well eDNA performs at resolving the spectrum of known local marine communities and networks. In other words, is eDNA nowadays only reliable to detect fish taxa in the local surroundings but not other managed species like clams, turtles, whales, and seabirds? If BOEM cannot determine which federally managed taxa eDNA can reliably detect, the technology will fail to support NEPA evaluations and permitting processes effectively.

Background: The number of taxa eDNA is capable of monitoring is still growing as new markers are developed, but already, existing applications demonstrate eDNA metabarcoding capable of identifying more species than other standard sampling methods (Pitz et al., 2017; Cordier et al., 2019), including identifying species not known to occur in the study area (Foote et al., 2012). This study will evaluate and develop eDNA sampling tools to augment BOEM's monitoring surveys intended to improve the detection of managed and invasive taxa in BOEM planning areas. BOEM and the Northeast Fisheries Science Center will assess the eDNA "net" for accuracy in resolving community structure in space and through time by comparing taxa identified in water samples with quantified multi-species hotspots (developed by T. White) derived from fisheries and observer-based monitoring programs (e.g., AMAPPS). This potential study's results will get us closer to understanding how well the current state of eDNA technology can resolve managed species identification and community structure. It will also tell us which taxa BOEM and NMFS need to focus on to improve the technology's robustness. In addition, this study will enhance genetic reference libraries necessary for detection (Watts and Miksis-Olds, 2018; Liu et al., 2019). Overall, eDNA works and is ready to be deployed at sea for a range of research interests (Hansen et al., 2018; Stoeckle et al., 2018).

This project will coordinate with the following institutions and projects:

- Smithsonian Institution to improve reference databases
- Ongoing BOEM studies NT-19-04 Automated Detection and classification of Wildlife Targets in Digital Aerial Imagery and AT-20-02 (AMAPPS III - Photogrammetric Aerial Surveys to Improve Detection and Classification of Seabirds, Cetaceans, and Sea Turtles).: here we will collect imagery concurrently with eDNA sampling locations to image conspicuous marine wildlife; Imagery will train deep learning algorithms in production by study NT-19-04;
- NOAA's EcoMon surveys, which has been underway collecting water at locations on the EEZ

Objectives: BOEM and the Northeast Fisheries Science Center will evaluate the eDNA "net" for accuracy in resolving community structure in space and through time by comparing taxa identified in water samples with quantified multi-species hotspots (T. White) derived from fisheries and observer-based sampling programs (e.g., AMAPPS). This project proposes identifying which species and guilds eDNA resolves well and those it misidentifies with an ecosystem-based context. For example, seabirds and invertebrates (e.g., clams) have been overlooked in most eDNA studies, even though these communities are essential in BOEM assessments and by other federal agencies. We will evaluate how well eDNA metabarcoding resolves marine communities using retrospective analyses (persistent communities) and simultaneous observations (observers; net tows; aerial cameras). The main objectives are to identify strengths and weaknesses in methodology; address weaknesses by populating genetic databases where feasible, and guide future BOEM projects across the regions.

Methods:

Temporal and Spatial coverage:

- Temporal: two seasons, one in each year (either spring/fall, spring/spring, or fall/fall comparisons)
- Diel: Day versus night collections in both areas
- Spatial: at community level hot and cold spots on the Atlantic EEZ in the vicinity of proposed wind energy development

- Cross shelf: Generally to operate < 50 m, maybe out to 100m on the LTER transect
- Vertical: Replicates at multiple vertical stations (surface, Chlmax, thermocline, bottom, etc.)

eDNA:

- Multi-marker approach to sample vertebrates and invertebrates;
- DNA extraction and preliminary QA/QC will be done at NOAA's Milford (CT) facility;
- Next Gen Sequencing will be outsourced (currently Cold Spring Harbor (NY));
- Bioinformatics and related analyses and reporting will be by Dr. Liu;
- Reference collections are actively being improved in collaboration with the Smithsonian Institution.
- Build reference collections in publicly accessible databases such as GenBank, consistent with the goals of a multi-genomic-marker approach

Specific Research Question(s):

1) Can eDNA reliably detect managed taxa and community structure (e.g., from clams to seabirds) to support NEPA evaluations and BOEM's permitting processes?
2) Can eDNA predict and confirm multi-species hotspots derived from decades worth of observations and in-situ sampling?
3) Ultimately, can we advance best practices and are reference libraries good enough to detect community-level interactions?

Affiliated WWW Sites: https://www.fisheries.noaa.gov/feature-story/tracking-marine-life-invisible-clues-edna-enhances-ecosystem-monitoring

References:

Cordier T, Frontalini F, Cermakova K, Apothéloz-Perret-Gentil L, Treglia M, Scantamburlo E, Bonamin V, Pawlowsk J. 2019. Multi-marker eDNA metabarcoding survey to assess the environmental impact of three offshore gas platforms in the North Adriatic Sea (Italy). *Marine environmental research*, *146*, pp.24-34.

Ficetola GF, Miaud C, Pompanon F, Taberlet P. 2008. Species detection using environmental DNA from water samples. *Biology letters*, *4*(4), pp.423-425.

Hansen BK, Bekkevold D, Clausen LW, Nielsen EE, 2018. The sceptical optimist: challenges and perspectives for the application of environmental DNA in marine fisheries. *Fish and Fisheries*, *19*(5), pp.751-768.

Lafferty KD, Benesh KC, Mahon AR, Jerde CL, Lowe CG. 2018. Detecting southern California's white sharks with environmental DNA. *Frontiers in Marine Science*, *5*, p.355.

Liu Y, Wikfors GH, Rose JM, McBride RS, Milke LM, Mercaldo-Allen R. 2019. Application of environmental DNA metabarcoding to spatiotemporal finfish community assessment in a temperate embayment. *Frontiers in Marine Science*, *6*, p.674.

Pitz K, Closek C, Djurhuus A, Michisaki R, Walz K, Boehm A, Breitbart M, Kelly R, Chavez F. 2017. Rewards and challenges of eDNA sequencing with multiple genetic markers for marine observation programs. Biodiversity Information Science and Standards 1. e20548.

Stoeckle MY, Adolf J, Charlop-Powers Z, Dunton KJ, Hinks G, VanMorter SM. 2020. Trawl and eDNA assessment of marine fish diversity, seasonality,and relative abundance in coastal New Jersey, USA. Journal of Marine Science, doi:10.1093/icesjms/fsaa225.

Watts AW, Miksis-Olds JL. 2018. The ocean as a living sensor: environmental DNA and acoustics for detecting marine life. In Proceedings of the National Conference on Marine Environmental DNA 2018.

Title	Evaluation of Plankton (Phytoplankton and Zooplankton) Communities in the Vicinity of Offshore Oil and Gas (O&G) Sites of the Outer Continental Shelf (OCS)
Administered by	Headquarters
BOEM Contact(s)	Stephanie Sharuga (stephanie.sharuga@boem.gov), Courtney Elliton (courtney.elliton@boem.gov)
Procurement Type(s)	Contract, Inter-agency Agreement, Cooperative Agreement
Performance Period	FY 2022–2025
Date Revised	March 30, 2021
PICOC Summary	
Problem	There are no recent studies that explore the potential effects on plankton from offshore energy activities, especially for ongoing O&G in the OCS (excluding oil spills). It is also not well understood how to best evaluate potential effects of offshore energy activities on plankton. Plankton are important because they support marine ecosystems in diverse and critical ways, including for many ESA- and MMPA-listed species.
Intervention	This study will use different traditional and new approaches for sampling and evaluating plankton (phytoplankton and zooplankton) communities in areas of OCS O&G activities. It will compare the utility of these approaches to resolve plankton community characteristics and explore possible reasons for variation.
Comparison	Satellite imagery, water samples, and eDNA will be used to sample and evaluate plankton community characteristics from areas of O&G sites and comparable reference sites. Historical data will also be considered when interpreting results.
Outcome	This study will explore how the presence of O&G infrastructure and related ongoing activities may influence plankton community characteristics. It will also determine the advantages and limitations of different approaches to sampling and evaluating plankton, including exploring whether the use of eDNA may identify differences in plankton community characteristics with better resolution than traditional methods alone.
Context	This study will take place in the Gulf of Mexico and Pacific Regions, but the results will have national relevance.

BOEM Information Need(s): BOEM is responsible for analyzing all aspects of the marine environment when carrying out its mission, which includes evaluating marine productivity and associated microscopic organisms such as plankton. Plankton are important to study because of their ubiquitous nature and diverse roles including for population connectivity, as an important food source for all species (including ESA- and MMPA-listed species), as key indicator species of climate change and pollution, roles in "dead zones" and associated fish kills, and as a potential human health impact from harmful algal blooms. Additionally, plankton include larvae of ESA-listed species (e.g., species of grouper, sawfish, corals) and others protected under Magnuson Stevens Act. There is minimal information on the interactions between planktonic organisms and ongoing O&G activities along the OCS. Further, there is a need to test the viability of different methods for sampling and evaluating plankton and subsequently develop standard operating procedures (SOPs) and best practices. These can be incorporated into the broader

Environmental Studies Program (ESP), including for O&G, renewable energy, and marine minerals. Information from this study will be used nationally and regionally by BOEM for a wide variety of applications, including for National Environment Policy Act (NEPA) documents, environmental analyses, National Program development, and more. This study directly ties in with several OEP goals, including First in Class (e.g., no one else has studied plankton in this context), National Program Environmental Review (e.g., current data gap and need to know effects on plankton from ongoing O&G activities), Emerging Technologies in Science (e.g., satellite imagery, eDNA), and Modernize Environmental Science and Analysis Communication.

Background: Previous plankton studies have typically focused on investigating potential impacts from oil spills but have not emphasized investigating effects of "typical" activities associated with offshore O&G (e.g., extraction, maintenance, decommissioning) on those communities (Daly et al., 2021; Ozhan et al., 2014; Tang et al., 2019; Buskey et al., 2016). O&G activities may have a variety of potential effects on plankton communities. For example, pollution and vessel activities related to O&G may have negative impacts by potentially reducing abundances, diversity, and fitness (D'Costa et al., 2016). O&G platforms may also have potentially positive effects on plankton communities. Studies have suggested oil and gas platforms can serve as biodiversity hotspots, facilitate population connectivity, and boost ecosystems and the corresponding ecosystem services provided (van Elden et al., 2019; Friedlander et al., 2014). The specific types of potential impacts and degree of effects on plankton populations needs to be explored further.

Satellite imagery with chlorophyll *a* measurements can be used to estimate phytoplankton abundances, while plankton nets and water sampling are commonly used for zooplankton. A newer, environmental DNA (eDNA)-based approach, however, may have advantages for biodiversity surveys of these fauna compared with traditional sampling and identification approaches because it has high throughput, high efficiency, and generally low costs (Yang & Zhang, 2020). Even if an organism is not physically present during sampling, eDNA can be collected from the environment in many forms (e.g. feces, mucous, carcasses) (USGS, 2013). eDNA offers a snapshot of the species abundance and diversity present in the area. The capabilities of eDNA allow classification of multiple plankton indices, which have, for example, been shown to be highly correlated with water pollution (Yang & Zhang, 2020). The use of eDNA in environmental monitoring is already being explored with increasing frequency. The majority of eDNA studies in relation to O&G activities, however, have been done internationally and focus on pelagic species and benthic invertebrates (Cordier et al., 2019; Mauffrey et al., 2020; Laroche, 2018; Laroche et al., 2018; Antich et al., 2020). Further, there is a need to establish protocols to explore and standardize its use for environmental assessments related to management of the OCS and develop a clearer understanding of its advantages and limitations for such uses.

Objectives:

- Characterize the plankton (phytoplankton and zooplankton) communities around offshore oil and gas sites (<2 km from platform) in the Gulf of Mexico and Pacific Regions
- Determine whether plankton communities are different in the vicinity of oil and gas activities compared to reference sites and explore trends in community characteristics
- Evaluate and compare different approaches, including inexpensive and/or minimally invasive "new" methods, for sampling and characterizing plankton communities
- Develop SOPs and best practices for plankton studies and for broader ESP, marine minerals, and renewables

Methods: This study will focus on phytoplankton and zooplankton, using both traditional and "newer" approaches for sampling and evaluating community characteristics. All phytoplankton size groups will be considered. Zooplankton sampling will focus on those in the macroplankton (20-200 mm) to mesoplankton (0.2-20 mm) size ranges or smaller. These size ranges were chosen because they incorporate the majority of planktonic organisms occupying the lowest trophic levels while also including larval life cycle stages of important larger fauna. Phytoplankton will be sampled using traditional approaches such as chlorophyll *a* measurements from satellite imagery and from physical water samples, as well as through the newer approach of using eDNA. Tim White (DES) has offered to assist in the analysis of the satellite imagery in-house with an algorithm he developed. Zooplankton will be sampled using the traditional approaches of plankton nets (for larger size classes) and physical water samples, as well as eDNA and a plankton recorder (if available). Water samples will be collected to accompany the plankton samples. These samples will be used for water quality measurements such as temperature, turbidity, salinity, pH, dissolved oxygen, chlorophyll *a*, total organic carbon (TOC), and other nutrients (e.g., nitrogen, phosphorous, iron). Additionally, select contaminants will also be measured, including PAHs and certain heavy metals.

Sampling will occur at sites in close proximity to O&G activities in the Gulf of Mexico and Pacific Regions, as well as at reference sites further away. In order to maximize opportunities for sampling while also minimizing costs, an emphasis will be placed on opportunistic sampling by working cooperatively with other studies and their associated research cruises. This will include coordinating with Federal and state agencies and academic and other research stations to identify sampling opportunities, depending on location. All plankton sampling will be done at consistent times of the day for the companion reference and O&G sites.

Community characteristics that will be evaluated include distribution, abundance, biomass, species composition, and overall diversity. The ability to evaluate certain plankton community characteristics may vary by sampling approach, which will be important for determining applicability of different approaches for future studies. Community characteristics will be compared between sites in proximity to O&G activities and reference sites, with historical data factored in as well (where applicable). Water quality measurements will be incorporated into these analyses to evaluate potential trends between those measurements and community characteristics. Further, this study will develop SOPs and best practices for plankton studies and the broader ESP. The composition of plankton communities is dynamic, which can make it challenging to identify trends in species diversity and abundance. The development of these SOPs and best practices will help identify the appropriate methods for studying plankton at this scale.

Specific Research Question(s):

- How can different approaches be used for characterizing plankton communities, specifically for environmental analysis?
- Do plankton communities differ (e.g., abundances, diversity) in the vicinity of offshore O&G sites compared to reference sites? Are there observable trends?
- Is eDNA a viable approach for evaluating plankton communities? What are the implications for broader use in fauna studies under the ESP?

References:

Antich A, Palachin C, Cebrian E, Golo R, Wangensteen OS, Turon X. 2020. Marine biomonitoring with eDNA: Can metabarcoding of water samples cut it as a tool for surveying benthic communities? Molecular Ecology. 00:1-14.

Buskey E, White H, Esbaugh A. 2016. Impact of oil spills on marine life in the Gulf of Mexico: effects on plankton, nekton, and deep-sea benthos. Oceanography. 29(3):174-181.

Cordier T, Frontalini F, Cermakova K, Apotheloz-Perret-Gentil L, Treglia M, Scantamburlo E, Bonamin V, Pawlowski J. 2019. Multi-marker eDNA metabarcoding survey to assess the environmental impact of three offshore gas platforms in the North Adriatic Sea (Italy). Marine Environmental Research. 146:24-34.

D'Costa PM, D'Silva MS, Naik RK. 2016. Impact of pollution on phytoplankton and implications for marine econiches. Marine Pollution and Microbial Remediation.205-222.

Daly KL, Remsen A, Outram DM, Broadbent H, Kramer K, Dubickas K. 2021. Resilience of the zooplankton community in the northeast Gulf of Mexico during and after the Deepwater Horizon oil spill. Marine Pollution Bulletin. 163:111882.

Friedlander AM, Ballesteros E, Fay M, Sala E. 2014. Marine communities on oil platforms in Gabon, West Africa: high biodiversity oases in a low biodiversity environment. PLoS One. 9(8):e103709.

Laroche O. 2018. Investigating eDNA/eRNA metabarcoding methods for assessing impacts of offshore oil and gas activities on benthic ecosystems. [Auckland, NZ]: The University of Auckland.

Laroche O, Wood SA, Tremblay LA, Ellis JL, Lear G, Pochon X. 2018. A cross-taxa study using environmental DNA/RNA metabarcoding to measure biological impacts of offshore oil and gas drilling and production operations. Marine Pollution Bulletin. 127:97-107.

Mauffrey F, Cordier T, Apotheloz-Perret-Gentil L, Cermakova K, Merzi T, Delefosse M, Blanc P, Pawlowski J. 2020. Benthic monitoring of oil and gas offshore platforms in the North Sea using environmental DNA metabarcoding. Molecular Ecology. 00:1-16.

Ozhan K, Parsons ML, Bargu S. 2014. How were phytoplankton affected by the Deepwater Horizon oil spill? BioScience. 64(9):829-836.

Tang D, Sun J, Zhou L, Wang S, Singh RP, Pan G. 2019. Ecological response of phytoplankton to the oil spills in the oceans. Geomatics, Natural Hazards and Risk. 10(1):853-872.

USGS. 2013. Application of environmental DNA for inventory and monitoring of aquatic species. Fact Sheet 2012–3146. 4 p.

van Elden S, Meeuwig JJ, Hobbs RJ, Hemmi JM. 2019. Offshore oil and gas platforms as novel ecosystems: a global perspective. Frontiers in Marine Science. 6.

Yang J, Zhang X. 2020. eDNA metabarcoding in zooplankton improves the ecological status assessment of aquatic ecosystems. Environ Int. 134:105230.

Title	Incorporating PAMGUARD into the Tethys Passive Acoustic Data Metadata System
Administered by	Headquarters
BOEM Contact(s)	James Price (james.price@boem.gov), Jonathan Blythe (jonathan.blythe@boem.gov), TJ Broussard (t.j.broussard@bsee.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2025
Date Revised	April 05, 2021
PICOC Summary	
Problem	Metadata documentation of passive acoustic data acquired from moving platforms at the level that will best facilitate its secondary use is often done as an afterthought to the data collection effort, separated in time long enough for important details to be forgotten or time consuming to resurrect. Also, further development of the Tethys metadata system to accommodate future user needs would require an expensive overhaul of the core program.
Intervention	Merging the popular PAMGUARD data acquisition system with the Tethys metadata documentation system allows for metadata documentation to be done currently with the data acquisition from mobile platforms while the details of the data collection effort are fresh in the minds of the data collectors. That, combined with additional software provided by the intended archive, the National Centers for Environmental Information (NCEI) for formatting the data-metadata package into the NCEI archival format, enables the data collectors to walk off the boat with an archive-ready data set with no further work needed. Additionally, this study will create a user's programmable interface inside the integrated package, with which users can add functionality to Tethys without needing a major overhaul of core of the Tethys software. This is a low-cost alternative to the more typical way of upgrading software.
Comparison	Commonly, metadata are constructed after the data collection effort when details may have been forgotten or are time consuming to reconstruct. Also, adding functionality to software is usually done by a major overhaul of the core of the software. This is a time-consuming and expensive effort.
Outcome	This study will produce a well-integrated package for easy and practical metadata documentation concurrently with data collection from mobile platforms. It will also add a user's programming interface to easily add additional functionality as needed by the user community. Finally, it will enable post-processing of archived data to do analyses informed by documented, referenced ancillary data.
Context	Passive acoustic monitoring is ubiquitous in marine research and environmental protection conducted in many geographic locations of interest to BOEM for impact assessment and mitigation. Also, it is in common use by geophysical surveyors working under BOEM-permitted exploratory activities.

BOEM Information Need(s): Passive acoustical monitoring (PAM) has been an important part of many BOEM-funded studies to determine the occurrence, density, distribution, and migratory behavior of

marine mammals and some species of fish. This information is fundamental in impact assessments and, possibly, in formulating mitigation strategies. In addition, BOEM must be able to distinguish between natural variability and changes caused by offshore energy development and mineral extraction. This is particularly important at this time of apparent rapid climate change. In order to observe change over many years and decades, it is a practical necessity to compare observations collected from many different data-gathering activities. Other kinds of research investigating long-term, wide spatial scale phenomena need to draw from data from many earlier, smaller-scope research. Also, questions like cumulative effects can be addressed by "secondary use" of archived ("historical") data, thereby enhancing BOEM's ability to assess impacts. Necessarily, data must be well documented and preserved in a way that is practical for subsequent investigations to access.

A biological opinion on the federally regulated oil and gas program activities in the Gulf of Mexico (GOM) (USDOC, NOAA, 2020a and 2020b), as well as recently issued regulations under the Marine Mammal Protection Act to authorize take of marine mammals incidental to conducting geophysical surveys during oil and gas program activities in the GOM (*Federal Register*, 2021), require all raw observational data of protected species (including acoustic observations from PAM) be made available to BOEM, BSEE, and National Marine Fisheries Service (NMFS). In addition, the biological opinion requires BOEM and BSEE to report and present "a summary of all PAM efforts" to NMFS during their Annual Activity Review. Consequently, a PAM data management system is needed to assist BOEM and BSEE in meeting their Endangered Species Act (ESA) reporting requirements. The Tethys metadata system will be that PAM data management system.

Background: Tethys is a passive acoustic monitoring metadata database system designed to organize and store acoustic metadata (http://tethys.sdsu.edu; see also Tethys (2013), Roch, et al. (2013), and Roch, et al. (2016)) . Tethys has been developed over many years through joint BOEM-Navy funding. The data schema (rules that govern how data is organized) were designed to permit representations of acoustic metadata that are comparable across long time frames by providing a consistent format. A set of schemata have been developed for describing instrumentation, effort, detections and localizations. In addition to the standard reporting fields, the schema permits the addition of user-defined information, thus letting PAM practitioners define their own information such as referencing physical oceanographic and meteorological data to help in the analysis and interpretation of the acoustical observations.

The Tethys metadata system has been adopted as the community standard by NOAA's National Center for Environmental Information (NCEI), now serving as the permanent archive of raw marine acoustical observations. This study, in conjunction with an ongoing, companion project funded by the Navy's Living Marine Resources (LMR) Program, is the final increment in Tethys' development, bringing Tethys to maturity to give NCEI a reliable, user-friendly metadata tool that also meets the needs of the scientists and natural resource managers wanting to make secondary user of the archived data.

PAMGUARD, the software package that this study seeks to incorporate into Tethys, is a semiautomated, open source software for real-time acoustic detection and localization of cetaceans and other species from mobile platforms. It can also be used as a stand-alone tool for analysis of previously collected acoustical observations. With the recent efforts at standardizing and optimizing the methods of acoustical measurements from moving platforms (e. g. LMR, 2018, and Barkaski and Thode, 2021), PAMGUARD has become a preferred tool in the collection and analysis of marine acoustical data and is the most common software used for BOEM permitted geological and geophysical surveys with PAM requirements in the GOM. Tethys integrated with PAMGUARD affords metadata documentation concurrently with data collection rather than at a post-processing stage when important details can be

forgotten or misrepresented. In addition, this study includes creating a programmer's interface for the integrated package that will allow adding future functionality to Tethys without requiring a major overhaul of the core program.

Objectives:

1. Integrate PAMGUARD into the Tethys metadata system with a user-friendly interface for the combined packages enabling metadata documentation concurrently with data collection.
2. Add improved functionality for batch processing of large offline datasets (data previously collected from ship-based surveys, drifters, fixed archival recorders, gliders, etc.).
3. Develop an interface to other programming languages so that detection, classification and localization (DCL) algorithms written in the Matlab or Python programming languages can be called from within PAMGUARD. This will enable the integrated package to acquire additional functionality without needing a major overhaul of the core of the integrated package.

Method: Experts with each software package will learn the minutiae of the other software and jointly make the necessary modifications and code verification to achieve the objectives. PAMGUARD expert Douglas Gillespie, Senior Research Fellow at the University of St Andrews, Scotland, U. K. and Tethys creator Marie Roch, Professor of Computer Science at San Diego State University, formally proposed this project to the LMR program, BOEM's partner in the development of Tethys. LMR ended up funding other developmental objectives that BOEM did not fund, and, with this study, BOEM will fund the proposed Tethys-PAMGUARD integration.

Specific Research Question(s): This study does not address a specific research question. It enhances the community-accepted metadata standard for the preservation and secondary use of passive acoustical data, including those collected from moving platforms. There is a wealth of data now from BOEM-permitted seismic surveying operations, and these data, suitably documented and archived, can inform may research questions concerning impacts to living marine resources and practical questions like what kinds of mitigation strategies are possible and practical. Also, when enough data accumulates covering long periods of time and wide geographic areas, research questions concerning climate change can be addressed.

Affiliated WWW Sites: https://tethys.sdsu.edu/

References:

Barkaski M J, Thode A. 2021. BOEM report pending from BOEM environmental study: https://www.boem.gov/sites/default/files/documents/environment/environmental-studies/Optimization%20of%20Towed%20Passive%20Acoustic%20Monitoring%20%28PAM%29%20Array%20Design%20and%20Performance.pdf

Federal Register. 2021. Taking and importing marine mammals; taking marine mammals incidental to geophysical surveys related to oil and gas activities in the Gulf of Mexico; final rule. 86 FR 5322, pp. 5322-5450. January 19, 2021.

LMR, U.S. Navy's Living Marine Resources Program Report 2018, specifically: https://navysustainability.dodlive.mil/files/2017/05/LMRFactSheet_Project28.pdf contained within the full report: https://www.navfac.navy.mil/content/dam/navfac/Specialty%20Centers/Engineering%20and%20Expeditionary%20Warfare%20Center/Environmental/lmr/LMRAnnualReport2018v2.pdf

Roch MA, Baumann-Pickering S, Batchelor H, Hwang D, Sirovic A, Hildebrand JA, Berchok CL, Cholewiak, D, Munger LM, Oleson EM. et al. 2013. Tethys: a workbench and database for passive acoustic metadata. Oceans 2013, 5 pp.

Roch MA, Batchelor H, Baumann-Pickering S, Berchock CL, Cholewiak D, Fujioka E, Garland EC, Herbert S, Hildebrand JA, Oleson EM. et al. 2016. Management of acoustic metadata for bioacoustics. Ecological Informatics 31, 122-136, doi:http://dx.doi.org/10.1016/j.ecoinf.2015.12.002.

U.S. Dept. of Commerce. National Oceanic and Atmospheric Administration. 2020a. Biological opinion on the federally regulated oil and gas program activities in the Gulf of Mexico. Internet website: https://www.fisheries.noaa.gov/resource/document/biological-opinion-federally-regulated-oil-and-gas-program-activities-gulf-mexico. Accessed April 2, 2021.

U.S. Dept. of Commerce. National Oceanic and Atmospheric Administration. 2020b. Appendices to the biological opinion on the federally regulated oil and gas program in the Gulf of Mexico. Internet website: https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico. Accessed April 2, 2021.

Title	Offshore Air Quality (AQ) from NASA's Satellites and Related Experiments
Administered by	Headquarters
BOEM Contact(s)	Holli Wecht (holli.ensz@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2026
Date Revised	March 14, 2021
PICOC Summary	
Problem	No air quality (AQ) monitors exist in the offshore areas of the Gulf of Mexico (GOM), Atlantic, or Pacific Regions to aid BOEM in the management of AQ impacts as required under the Outer Continental Shelf Lands Act (OCSLA) and/or the National Environmental Policy Act (NEPA).
Intervention	NASA's measurements from SCOAPE-I & TROPOMI with TRACER-AQ Experiment data will support TEMPO satellite algorithm development. NASA will also provide nitrogen dioxide (NO_2) pollutant validation post-launch. These estimates will allow BOEM to potentially monitor and track offshore pollutants using the TEMPO satellite leading to better management of impacts in the future.
Comparison	NASA will compare NO_2 data in GOM during TRACER-AQ with TROPOMI & SCOAPE-I, followed by TEMPO validation to ensure accuracy of TEMPO data.
Outcome	NASA will provide BOEM a Standard Operating Procedure for use of TROPOMI and TEMPO data in their management of air quality pollutants.
Context	Development measurements are provided by SCOAPE-I and TRACER-AQ measurements using OMI and TROPOMI with prototype over the GOM. All satellite data will also be available in the Pacific and Atlantic Regions.

BOEM Information Need(s): BOEM has no air quality (AQ) monitors over the waters in the Gulf of Mexico (GOM), Atlantic, and Pacific Regions, making it difficult to measure and track pollutants, which may impact the air quality of states. Two of BOEM's responsibilities under the Outer Continental Shelf Lands Act (OCSLA 1334(a)(8)) is to ensure activities authorized do not significantly impact the state's air quality compliance with the National Ambient Air Quality Standards (NAAQS) in the GOM and to draft National Environmental Policy Act (NEPA) documents in the Atlantic and Pacific Regions assessing impacts from our authorized activities. Using NASA's 2021 TRACER-AQ field measurements and the upcoming TEMPO (Tropospheric Emissions: Monitoring of Pollution) satellite mission's hourly, high resolution pollutant data offshore, will allow BOEM to better manage air quality from energy resources, including oil and gas, renewables, and sand/gravel projects. This study would build on the previous NASA's Satellite Coastal Oceanic and Atmospheric Pollution Experiment (SCOAPE) in 2019 in the GOM (Thompson 2020).

Background: A 3-year Interagency Agreement between BOEM and NASA's Goddard Space Flight Center successfully addressed two questions:

1. Can satellite data be used to inform BOEM about AQ over the OCS (Outer Continental Shelf)? Yes, NASA provided examples of pollutants over GOM, including TROPOMI satellite NO_2.

2. How accurate are the NO_2 satellite data over the GOM and Atlantic Regions? TROPOMI Total Column (TC) NO_2 satellite data agreed with both coastal and shipboard Pandora spectrometers that provided independent ground-truth. Under clean air conditions, satellite-Pandora agreement was 2-3%; for more polluted conditions, agreement was 15-20%.

Objectives:

1. The NO_2 impact of ONG emissions will be studied in TRACER-AQ with GCAS.
2. Prepare for TEMPO by developing a Standard Operating Procedure (SOP) for BOEM air subject matter experts to use for air management using OMI/TROPOMI satellite TROPC NO_2 routinely over GOM OCS (publicly available data), then extending to Atlantic and Pacific coasts.
3. Optional: Post-TEMPO launch. Conduct a SCOAPE-II in central GOM, revisiting SCOAPE-I region with a dedicated oceanographic cruise during NASA aircraft operations to be conducted, as TRACER-AQ with GV and GCAS, possibly other platforms, e.g. NASA's P-3B aircraft?
4. Optional: Add TEMPO sampling SOP for BOEM to TROPOMI SOP to monitor future air quality impacts of ONG.

Methods:

1. The NO_2 impact of ONG emissions will be studied in TRACER-AQ. Because the current GV aircraft sampling does not extend to the central GOM, NASA will augment the 2021 TRACER-AQ field measurements with 1-3 flights that (a) transect western and central GOM; (b) sample central GOM NO_2 with "racecar track" sampling over the SCOAPE-I region (blue line in Figure 1). Figure 1 also shows the annual average TROPOMI TROPC NO_2 and platforms with greater than 250tpy of NO_x emissions (Wilson 2019). The measurements also includes two permanently placed Pandoras to measure TC NO_2 in the coastal GOM.

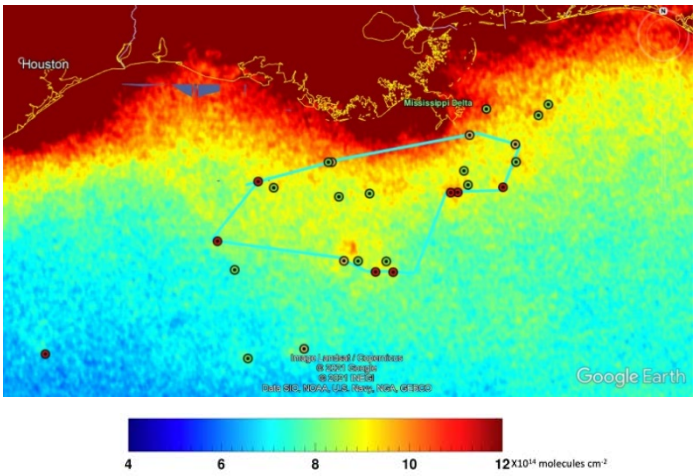


Figure 1: Using the Annual Average TROPOMI TROPC column NO_2 to determine the Draft G-V Flight Path

2. To prepare a SOP, a nominal sampling protocol will range from weekly to rolling 2-3-week averages. Assume Pandora spectrometers are aligned on GOM coast (have been deployed in

Houston for several years); Pandoras are currently operating along mid-Atlantic coast from Long Island-NJ-MD-VA-NC.

Specific Research Question(s):

1. Although SCOAPE-I gave a snapshot of OCS AQ in May 2019, what is the distribution of TC NO_2 and tropospheric column (TROPC) NO_2 over the GOM year-round? NASA will develop a climatology for BOEM that discriminates land and ONG sources using TROPOMI satellite data.
2. How do TROPOMI and Pandora TC NO_2 measurements during NASA's 2021 TRACER-AQ aircraft and ground campaign in the Houston area and western GOM compare to SCOAPE-I measurements? BOEM will derive the answer from NASA's Gulfstream V (GV) aircraft operating a TROPC NO_2 instrument "GCAS" (GEOstationary Coastal and Air Pollution Events (GEO-CAPE) Airborne Simulator) during TRACER-AQ over ONG platforms near Houston and Galveston. GCAS will also evaluate TROPOMI and fly over a Pandora and *in-situ* NO_2 analyzer network operating in TRACER-AQ. A second remote sensor on the GV, the UV-Differential Absorption Lidar (UV-DIAL) will provide vertical profiles of ozone and aerosols to track plumes that are transported downwind from emissions sources.
3. How can SCOAPE-I and TRACER-AQ be linked when they are not in the same part of GOM? BOEM will support collection of NASAs GCAS TROPC NO_2 and UV-DIAL data over the central GOM (off Louisiana) by augmenting GV flights, re-sampling the SCOAPE-I region, thus connecting SCOAPE-I measurements to TRACER-AQ. This requires Pandora(s) along the Louisiana coast to further connect TRACER-AQ and SCOAPE-I and to prepare for the hourly air quality measurements from TEMPO.

Affiliated WWW Sites:

TRACER-AQ Mission Page: https://www-air.larc.nasa.gov/missions/tracer-aq/index.html

SCOAPE Mission Page: https://www-air.larc.nasa.gov/missions/scoape/index.html

NASA SCOAPE Technical Report: https://ntrs.nasa.gov/citations/20205008618

BOEM OCS Study 2019-072: https://espis.boem.gov/final%20reports/BOEM_2019-072.pdf

References:

Demetillo MA, Navarro A, Knowles KK, Fields KP, Geddes JA, et al. 2020. Observing Nitrogen Dioxide Air Pollution Inequality Using High-Spatial-Resolution Remote Sensing Measurements in Houston, Texas. *Environmental Science & Technology*, 54 (16), 9882-9895, doi: 10.1021/acs.est.0c01864.

Duncan BN. 2020. NASA resources to monitor offshore and coastal air quality. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2020-046. 32 p.

Judd LM, Al-Saadi JA, Janz SJ, Kowalewski MG, Pierce RB, Szykman JJ, Valin LC, et al. 2019. Evaluating the impact of spatial resolution on tropospheric NO_2 column comparisons within urban areas using high-resolution airborne data, *Atmos. Meas. Tech*., 12, 6091–6111, https://doi.org/10.5194/amt-12-6091-2019 .

Thompson AM. 2020. Evaluation of NASA's remote-sensing capabilities in coastal environments. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2020-047. 33 p.

Thompson AM, Stauffer RM, Boyle TP, Kollonige DE, Miyazak K, Tzortziou M, Herman JR, Jordan CN, Lamb BT. 2019. Comparison of near-surface NO2 pollution with Pandora total column NO2 during the Korea-United States Ocean Color (KORUS OC) campaign*, J. Geophys. Res*., 124, doi: 10.1029/2019JD030765.

Thompson AM, Kollonige DE, Stauffer RM, Abuhassan N, Kotsakis AE, Swap RJ, Wecht HE. 2020. Satellite and shipboard views of air quality along the Louisiana coast: The 2019 SCOAPE (Satellite Coastal and Oceanic Atmospheric Pollution Experiment) cruise. *Environmental Manager [EM]* http://pubs.awma.org/flip/EM-Oct-2020/thompson.pdf.

Wilson D, Billings R, Chang R, Do B, Enoch S, Perex H, Sellers J. 2019. Year 2017 emissions inventory study. New Orleans (LA): US Department of Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-072. 231 p.

Title	Standardizing National Integrated Ecosystem-Based Assessment for Transparent Visualization of Scenario Trade-Offs
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Stephanie Sharuga (stephanie.sharuga@boem.gov), Ian Slayton (Ian.Slayton@boem.gov) Idrissa Boube (idrissa.boube@boem.gov), Lisa Gilbane (lisa.gilbane@boem.gov), Deena Hansen (deena.hansen@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022 (with optional years in FYs 2023–2024)
Date Revised	May 4, 2021
PICOC Summary	
Problem	The lack of an integrative approach to environmental assessments leads to varying approaches across regions and programs. This results in an inability to integrate non-linear impacts, or address trade-offs, as well as repetitive work by BOEM staff with limited time and increasing demands. A regional, project-specific approach does not allow decision makers to clearly envision alternative options at various spatial scales and over time. This limited, project-specific approach does not allow BOEM to visualize comprehensively how decisions may impact Environmental Justice communities, Tribes, and other stakeholders, or account for ecosystem dynamics associated with a changing climate.
Intervention	Develop a consistent national framework by adapting existing dynamic modeling frameworks to advance integrated environmental assessments at multiple spatial and temporal scales, and account for diverse objectives, drivers, and stakeholders' priorities. Outputs can be publicly accessible, promote community participation and buy-in, and collectively support transparent, science-based decisions and strategic planning in OCS assessment that reduce conflict, reveal new opportunities, and streamline BOEM processes.
Comparison	Without this study, increasing demands on limited staff can delay thorough assessments, increasing the potential for litigation and hindering public services, and BOEM is less likely to achieve OEP's strategic goal of modernized analysis and communication. Opportunities for meaningful stakeholder participation will also remain limited, as well as for addressing non-linear, cumulative, and climate effects—concerns consistently raised in comments during the studies development, EIS, and COSA processes that, left unaddressed, can reduce stakeholder buy-in and trust, as well as the knowledge base from which BOEM operates.
Outcome	Increased efficiency and flexibility, including ready accommodation of new information. Improved stakeholder engagement and visualizations that clearly demonstrate impacts and uncertainty, revealing opportunities for BOEM, its partners, and stakeholders
Context	Multiple scales from the Status of the OCS to site specific assessments

BOEM Information Need: BOEM currently lacks an integrated, ecosystem-based approach for synthesizing diverse data sources and visualizing trade-offs across multiple uses and jurisdictions. Static, environmental assessment methods are inadequate due to increasing amounts and complexity of data, intricate ecosystem and human interactions, diverse community impacts, and a dynamic changing climate. Advancing BOEM's environmental assessment processes can promote efficient use of limited resources and stakeholder engagement while simultaneously illustrating a range of decision outcomes. This study will create tools for improved, more integrated assessments, which BOEM can employ across mission areas, such as for the identification of minimal-conflict wind energy call areas in the Pacific or Gulf Regions and the exclusion nomination process of the National Program (Musial et al 2019 and BOEM study MM-17-05 currently in progress). As a result, BOEM will be able to better envision opportunities and reduce conflicts. It will also advance much-needed improvements in evaluating uncertainty, cumulative impacts, and knock-on effects of activities occurring along the OCS.

Background: The Office of Environmental Program's long-term strategic goals include leveraging innovative emerging technology and modernizing communications and analysis while ensuring transparent, science-informed decisions. Further, federal mandates, such as in the National Environmental Policy Act, and regional ocean planning boards affirm the need to consider a range of costs and benefits – and potential tradeoffs between them – when making environmental planning and management decisions. BOEM's ability to meet these aims remains limited. Current assessment approaches do not fully capture the interconnected reality of people and natural resources in space and time, especially when factoring in multiple OCS regions and uses. This hampers the identification of conflict and non-linear effects, increasing uncertainty about future outcomes. Additionally, public outreach and engagement is not often maximized as part of advancing new analytical methods. Relying on only conventional approaches limits new and meaningful avenues for involvement and can restrict BOEM's understanding of the needs and values held by a diversity of stakeholders.

Leveraging emerging technologies can address these concerns and modernize approaches but has yet to be operationalized in OCS assessment. Powerful ecosystem models exist for a variety of environments and are in use for spatial planning and decision-making (Altman et al., 2014; Boumans et al., 2015; Fulton et al., 2015; Watters et al., 2013), including for BOEM (BOEM). Such tools pull together available data resources and expert knowledge – i.e., everything known about a system – to develop computer models of both the natural ecosystem and reliant human communities, resulting in simulation environments for testing possible courses of action. These environments operate much as a flight simulator helps a pilot train – but in this case, scientists, decision makers, and other stakeholders can provide feedback and explore the range of outcomes for different management decisions such as in a changing climate. In sharp contrast to conventional static assessments offering specific and often narrow advice, these approaches are explicitly built for understanding knock-on effects, cumulative outcomes, and tradeoffs among costs and benefits under changing conditions and over different periods of time. Because of their usefulness, they are increasingly used in science-based decision support (Link et al., 2012).

Objectives:

- Phase 1: Develop a national framework for integrated assessments by adapting existing structure to connect existing resources and engagement processes with modeling tools and forward integrated assessments across NEPA, MSA, ESA, Tribal Consultation, and others of OCS resources across programs.

- Phase 2: Create accessible, web-based tools on an existing data portal to demonstrate potential outcomes of alternative management decisions across different resources, sectors, and communities to support science-based decision-making.
- Phase 3: Forward additional, site-specific use of the framework and tools related to planning for select renewable energy or marine mineral extraction sites to account for changing distributions as a result of climate change.

Methods: This study will use existing modeling approaches and expertise to first create a basic, generalized model and scenario environment structure, and then define a plan for customizing this for more specific models and environments. This avoids the need for constructing new models and promotes a cost-effective, achievable process. Critically, the basic model's flexibility will also accommodate diverse information resources, including expert and traditional knowledge from across communities. This encourages BOEM's assessments to center diverse stakeholders and employ an iterative process of engagement. This iterative process allows feedback to improve the model, promotes community buy-in and trust (Fulton et al., 2015), and ensures the inclusion of a wider array of human needs and values. Incorporating a range of data sources also reduces the inherent uncertainty of narrower approaches that focus on only part of the system. In addition, the basic model structure will include ways of clearly documenting remaining uncertainty and testing its impacts on results, providing further insight to BOEM on knowledge gaps and future research needs. Finally, the process will include accessible ways to share outcomes with staff, stakeholders, and the public, including an online portal to explore the data used, different management options, and outcomes and tradeoffs (Kaufman et al., 2015).

The process of customizing the basic model leverages the ability to "plug and play" elements from existing models that have been sourced and involves updating the basic structure with site-specific information and data. Therefore, the stage will start with an inventory of all existing OCS environmental and socioeconomic data resources for the EIS, as well as related cross-agency and stakeholder relationships and outreach endeavors and assessment approaches already in use. This inventory will result in a comprehensive library of processes, resources, impacts, and human values and needs, which will be included in online portals accessible to BOEM staff and, when appropriate, stakeholders and the public. This information will then advance the basic structure into a systems model and simulation environment for exploration of the EIS, and outcomes of that exploration will be compared with those from a conventional static approach. Collectively, then, this will test both the process as well as its value for a specific BOEM need. Results will be shared with partners and stakeholders for feedback. An optional additional stage would employ a systems model perspective to address renewable energy and marine mineral extraction planning, demonstrating project repeatability and value to a range of BOEM responsibilities from EIS to OCS assessment more broadly.

Specific Research Question(s): How can we best account for changing ecosystems and reducing conflict in spatial planning?

References:

Assessing Biological and Oceanographic Processes that Drive Fisheries Productivity on New England Sand Shoals and the Potential for Dredging Related Disruption. https://www.boem.gov/sites/default/files/documents/environment/environmental-studies/MM-17-05.pdf

Altman I, Boumans R, Roman J, Gopal S, Kaufman L. 2014. An ecosystem accounting framework for marine ecosystem-based management *in* M Fogarty & JJ McCarthy, eds. *The Sea: Marine Ecosystem-Based Management*. Harvard University Press, Cambridge, MA.

Boumans R, Roman J, Altman I, Kaufman L. 2015. The Multiscale Integrated Model of Ecosystem Services (MIMES): Simulating the interactions of coupled human and natural systems. *Ecosystem Services* 12:30–41.

Fulton EA, Boschetti F, Sporcic M, Jones T, Little RL, Dambacher JM, Gray R, Scott R, Gorton R. 2015. A multi-model approach to engaging stakeholders and modellers in complex environmental problems. *Environmental Science & Policy* 48:44-56.

Watters GM, Hill SL, Hinke JT, Matthews J, Reid K. 2013. Decision-making for ecosystem-based management: evaluating options for a krill fishery with an ecosystem dynamics model. *Ecological Applications* 23(4): 710-725.

Link JS, Ihde TF, Harvey CJ, Gaichas SK, Field JC, Brodziak JKT, Townsend HM, Peterman RM. 2012. Dealing with uncertainty in ecosystem models: The paradox of use for living marine resource management. *Progress in Oceanography* 102:1-2-114.

Musial W, Beiter P, Nunemaker J, Heimiller D, Ahmann J, Busch J. 2019. Oregon Offshore Wind Site Feasibility and Cost Study. NREL/TP-5000-74597. nrel.gov/docs/fy20osti/74597.pdf.

Gopal S, Kaufman L, Pasquarella V, Ribera M, Holden C, Shank B, Joshua P. 2015. Modeling Coastal and Marine Environmental Risks in Belize: the Marine Integrated Decision Analysis System (MIDAS). *Coastal Management* 43:217–237.

https://tethys.pnnl.gov/sites/default/files/publications/Lester-et-al-2013.pdf

https://www.pnas.org/content/109/12/4696

https://www.researchgate.net/publication/228342331_ARIES_ARtificial_Intelligence_for_Ecosystem_Services_A_new_tool_for_ecosystem_services_assessment_planning_and_valuation

Title	Submarine Canyons of the US EEZ Atlas
Administered by	Headquarters
BOEM Contact(s)	Robert Martinson (robert.martinson@boem.gov), Paul Knorr (paul.knorr@boem.gov), Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2023
Date Revised	January 11, 2021
PICOC Summary	
Problem	Submarine canyons and submarine canyons systems are prime candidates for conservation efforts owing to their associated biotic diversity and abundance (e.g., corals, marine mammals, and fish), physical oceanography (currents), and ecological value (nutrient conduits). BOEM has easily accessible information on a subset of the largest OCS canyons, but to conduct more timely and complete environmental assessments, it requires more information for the remainder of the large canyons, including those located outside the OCS but within the EEZ.
Intervention	Gather existing information into a geodatabase and (electronic) atlas of all larger submarine canyons of the OCS and EEZ
Comparison	Information about large submarine canyon ecology can be better contrasted with non-canyon areas.
Outcome	The outcome will be a product that can be referenced or incorporated into environmental assessments by all Program areas and Regions.
Context	This study covers all BOEM regions and EEZ areas located in territorial waters that could potentially become subject to BOEM jurisdiction in the future.

BOEM Information Need(s): The purpose of this requirement is to complete BOEM's collection of maps and scientific information on submarine canyons of the Outer Continental Shelf (OCS). BOEM has existing information on the largest OCS submarine canyons, completed in late 2019, but details of medium to large canyons, including those located outside of the OCS but within the Exclusive Economic Zone (EEZ), are lacking. BOEM needs this baseline information about these additional canyons to inform national and regional scale Environmental Impact Statements (EISs), Environmental Assessments (EAs), ecological investigations, and leasing decisions. The deliverables resulting from this study, particularly the storymaps and authoritative boundary demarcations, will also be used for the Status of the OCS (SOCS) initiative and will inform leasing decisions and the new Federal "30 by 30" initiative, which aims to set aside 30% of Federal lands and oceans by 2030. Furthermore, the results of this study may contribute to the fulfillment of the National Ocean Mapping, Exploration, and Characterization Council's (NOMEC) National Strategy for Mapping, Exploring, and Characterizing the U.S. EEZ (2020), particularly the subgoals focused on the exploration and characterization of priority areas and making such data usable and available.

Background: The Department of the Interior, Bureau of Ocean Energy Management (BOEM), Office of Environmental Programs (OEP) supports all BOEM programs, including renewable energy, marine

minerals, and the Five-Year Oil and Gas Program (Program) on the OCS. OEP coordinates and prepares an associated Programmatic Environmental Impact Statement (Programmatic EIS) for the Program with input from Federal, state, local government agencies, tribes, interest groups, and the general public. Several of these entities suggested exclusion of some submarine canyons from the Program. BOEM found (from public feedback and its own review) that the mapping and information on submarine canyons were scattered throughout disparate websites and publications.

Consequently, BOEM funded study NT-18-X03, Large Submarine Canyons of the United States Outer Continental Shelf Atlas ("OCS Atlas"). The initial review identified approximately 700 submarine canyons over 10 km long, of which approximately 130 were categorized as "large," which included those canyons that were at least 75 km long and 1 km wide, and were incised at least 100 m. Due to limited funding, a panel of BOEM and external subject matter experts then selected a subset of 71 canyons, based on size, location, and availability of information for detailed mapping and literature review. The study then delivered a detailed review of these 71 canyons, including copies of over 200 references, packaged as a printed atlas in PDF form and archived within a GIS database.

Objectives: Creation of a geodatabase inventory and digital atlas with maps, metadata, and a geodatabase with descriptions of size summarized for all larger EEZ and OCS submarine canyons; this includes 59 canyons that were identified but not mapped in the previous study and as-yet unidentified canyons on the non-OCS EEZ (i.e., Hawaii and the territories). The geodatabase will ultimately be housed by BOEM OEP and shared with other BOEM programs and the public. Information therein can then be posted to the BOEM website and used directly or incorporated by reference into marine minerals and renewable energy projects, the Program document and Programmatic EIS, and the SOCS platform.

Methods: The contractor will conduct the following activities:

- Employ an objective methodology to inventory the locations and names of the ~59 large submarine canyons on the United States OCS in the Atlantic, Pacific, Arctic Oceans, and the Gulf of Mexico, which were not included in the 2019 OCS Atlas. Additionally, the scope specifically includes the EEZ of U.S. territories, which were not included in the previous OCS-focused compilation. The inventoried canyons would use bathymetric data to generate values for the average and maximum width, length, and depth range. An initial size criterion may include submarine canyons that are at least 10 km long, 1 km wide at widest point, and 120 m deep; the exact specifications will be discussed and collaboratively determined.
- Map the submarine canyons on the OCS using existing bathymetric data following similar overall methodology used in the previous study. The spatial extent of the inventoried canyons will be depicted with shapefiles, along with metadata. The methodology may need to be adjusted to compensate for differences in basemap resolution.
- Conduct a literature survey and provide copies of references mentioning history, geography, size, geology, biology, water quality, currents, and any official designation (e.g., part of a National Marine Sanctuary) at each canyon. Flag references that are noteworthy. Synopsis or descriptions are not required, merely a list of citations for each canyon. Additionally, provide a Coastal and Marine Ecological Classification Standard (CMECS) description for each canyon, including those described in the Large Submarine Canyons of the United States Outer Continental Shelf Atlas (2019).
- Assemble the inventory, maps, and descriptions to produce a preliminary draft atlas of 50–60 pages, including regional overviews of the Atlantic, Gulf of Mexico, Caribbean, Pacific, and Arctic

OCS. Develop a geodatabase containing spatial (feature class of submarine canyons and their attributes) and non-spatial (geodatabase table containing associated literature) data that are linked via a relationship class. The outlines and locations of the large submarine canyons that were previously identified will included in the Atlas regional overview pages, and if appropriate, on detailed views. The page layout should be in 11”x17” format.

- Available references on the newly described canyons discussing the geography, history, geology, biology, water quality, and oceanographic conditions will be associated with each canyon and copies of the references provided for BOEM’s reference. Full summaries (e.g., a literature review) are not required, but particularly noteworthy references will be tagged appropriately.
- Combine the new information and the old information into two ArcGIS storymaps. A comprehensive storymap, designed to maximize analytical utility, will be housed on the BOEM IT infrastructure for internal users only. A second storymap, designed primarily for outreach, will be published on the ArcGIS Online portal. The comprehensive storymap will also serve as an initial venue and template for the new SOCS initiative. Links/pages will also be provided on GeoESPIS.

Specific Research Question(s):

1. Where are the large submarine canyons, and what is their extent? This follow-on effort will provide a more complete answer to that question.
2. On which submarine canyons should BOEM focus the most study attention concerning effects when implementing marine minerals, renewable energy, or oil and gas projects?
3. Are there OCS submarine canyons near which leasing should potentially be restricted (e.g., withdrawn areas) and for what reasons?
4. Are there parts of the OCS with high densities of submarine canyons systems that could be more efficiently managed as exclusion areas or withdrawals from leasing?

References:

CSA Ocean Sciences Inc., De Leo FC, Ross SW. 2019 Large submarine canyons of the United States outer continental shelf atlas. Sterling (VA). US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-066. 51p.

Federal Geographic Data Committee. 2012. FGDC-ST-2012, Coastal and Marine Ecological Classification Standard. Washington, D.C. 353p. (https://coast.noaa.gov/data/digitalcoast/pdf/cmecs.pdf)

National Ocean Mapping, Exploration, and Characterization Council. 2020. National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone. Washington, D.C. Ocean Policy Committee, Ocean Science and Technology Subcommittee. 25p. (https://iocm.noaa.gov/about/documents/strategic-plans/20200611-FINAL-STRATEGY-NOMEC-Sec.-2.pdf)

Title	Understanding Impacts of Habitat Modifications on Commercial Fisheries and Apex Predator Distribution
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Mary Cody (mary.cody@boem.gov), Deena Hansen (deena.hansen@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022–2025
Date Revised	April 22, 2021
PICOC Summary	
Problem	BOEM needs to understand the effects of wind turbines and mineral extraction on large predator movement to manage OCS resources in an environmentally responsible manner. As an indicator species, the behavior and abundance of gray seals (*Halichoerus grypus atlantica*) are not well understood due to their rapidly changing distribution as their populations recover, particularly in the southern portion of the range. We also know very little about the predator-prey relationships between sand-dependent forage species, such as the sand lance, and their legally protected predators. such as seals and whales. The current approach to avoiding environmental and direct human impacts of energy development and mining on the continental shelf is sophisticated but still static. BOEM needs to take into account how ecosystems change over time, particularly predator-prey relationships, to better manage the resources while permitting renewable energy infrastructure and mineral extraction. The most important changes arise from the interactions among the things of concern: peoples' varied marine-dependent livelihoods and life requirements, endangered species, threatened habitats. Current approaches fail to adequately consider these interactions, or overall system dynamics, and this can lead to incorrect impressions, bad decisions, and failure to anticipate system behaviors that can have a big effect on outcomes.
Intervention	Integrate predator movements into ecosystem-based models. Gather distribution and behavioral data to integrate opportunistic observational, fisheries independent and dependent data featuring these species movements to a) create improved distribution maps of target species now and in the future under climate change scenarios and b) incorporate protected species and pelagic fishery sectors into model outputs.
Comparison	This study will compare data on species movement, fishery interactions, and ecological models which incorporate dynamics of climate change against currently used single species assessments which do not account for the chaos within natural systems.
Outcome	An improved model for use in environmental impact assessments to better understand how mineral mining and offshore wind development could affect species behavior and distribution, as well as predator-prey relationships
Context	Southern Cape Cod to Delaware OCS

BOEM Information Need(s): Understanding of the impacts of habitat modifications resulting from BOEM permitted activities on protected species in the Northeast and Mid-Atlantic are lacking across both the marine mineral and renewable energy programs. Information regarding the distribution, behavior and ecological impacts of a rebounding gray seal population will allow BOEM to effectively evaluate the potential for impacts from offshore wind farms and mineral extraction. Additionally, BOEM's FY17 study investigating the productivity and ecology of sand shoals has developed an ecosystem level model that reveals tradeoffs between various management scenarios for sand mining based on disruption to foraging species benthic habitat. During the model scoping process, it was noted that there are information needs which, if addressed, can dramatically impact the model utility. This could benefit ecosystem modeling for marine mineral and distribution modeling for renewable energy programs. Notably missing and valuable to these assessments is information on the changing movements of protected species, such as seals, and high-value migratory species (HMS) that depend upon the same forage species, as well as precipitating economic and social impacts across diverse stakeholder groups. This profile seeks to leverage investments being made into related research by the National Marine Fisheries Service (NMFS), the U.S. Navy, and the Northwest Atlantic Seal Research Consortium and other non-government organization who share the common goal with BOEM of understanding the changing distribution and abundance of these species from a whole-system perspective. Matching funding and in-kind vessel support has been committed by several partners, pending final approval of this profile.

Background: The number of gray seals in the Northeast has risen dramatically in recent decades. Few were observed in the early 1990s, and this has increased to at least 24,000 counted in Southeast MA in 2015 (Pace et al., 2019). With a range from New Jersey north to Labrador; tagging studies and NMFS bycatch estimates indicate they breed, pup, and forage in areas that overlap with BOEM sand borrow areas and wind energy areas (WEAs)(Puryear et al., 2016; Hayes et al. 2019). This study focuses on gathering and incorporating spatial movement data into decision scenario modeling to answer questions on the distribution and the role of productivity fluctuations, and on potential consequences for target fishery species within Northeast and Mid-Atlantic WEAs and sand borrow areas to inform environmental impact assessment.

Critical to illuminating the relationship between sand borrow areas and both commercially valuable HMS and protected species is understanding how modification of sand habitats impact the abundance and spatial movement patterns associated with forage base. This is composed of several key forage species in the Northeast and Mid-Atlantic, including sand lance (*Ammodytes spp*), key species that occur over potential sand shoal borrow areas from Southern Cape Cod through North Carolina. For example, sand lance can comprise over 50% of biomass of gray seal diet in seals foraging off Cape Cod (Ampela, 2009). Offshore energy structures (e.g. a wind turbine foundation) can create foraging habitat, and acoustic tagging of fish around these structures suggests they may increase foraging success (Russell et al., 2014). Changes in the available forage species, as well as increases in foraging habitat and its use, distribution, or abundance of animals around these foundations, can increase the potential for human interactions (e.g., construction) and fisheries (e.g., entanglement) in WEAs. These interactions may have population level impacts for gray seals. Gray seals have the highest bycatch mortality of all protected species. Fisheries interactions have increased, with fewer than 10 grey seal interactions in 1993, to more than 1,000 annually in four out of the last 5 years - the highest bycatch of any US marine mammal species (NEFSC, 2020). To better understand the population, ecological, and anthropogenic effects of and to rebounding gray seals, there is a pressing need to obtain basic ecological information of this increasing seal population in Atlantic Outer Continental Shelf (OCS) waters prior to development of offshore wind facilities or sand mining activities. This study would additionally identify ecological

linkages between fluctuating productivity, climate change dynamics and select HMS, which would demonstrate the utility of the trade-off tool beyond previously initial identified fishery sectors.

Movement data is needed to address increasing ocean use overlap, specifically the effects of sand mining, and understanding dynamics of the expanding population of rebounding marine mammal species. Movement data are also limited to determine differences in age class, sex and ocean basin use areas and assumptions on consumption and foraging habitat needs in U.S. waters. Studies conducted on seals tagged on Sable Island, Canada indicate that gray seals utilize different areas of nearshore and offshore areas depending on age, sex, season and life history stage (Austen et al., 2004; Beck et al., 2007).

This study aligns with several goals across the ESP Strategic Framework and OEP long term strategic goals. Gathering baseline movement and behavior data, as well as modeling various decision scenarios, allows us to understand the effect of habitat alteration resulting from BOEM regulated activities. The ability to leverage machine learning to produce dynamic ecosystem models supports both the DES strategic framework and the OEP long term goal #5. This affords the ability to look beyond the 'this happens here' black or white approach to assessment, and create dynamic models affording insight into potential impacts to stakeholders, such as different fishery sectors, which supports goal #6 of improved communications of risk and modernizing analysis. BOEM's use of emerging technology will also be present in the first ever data collection using open-source CTD tags currently in development. Open-source tags allow for a dramatic cost reduction as well as leveraging marine animals as mobile oceanographic sensors contributing to characterizing the OCS.

Objectives: a) Collect pre-construction and pre-sand mining information on the distribution, abundance, and movements of gray seals and associated apex predators; b) Leverage existing, fisheries, oceanographic data and model frameworks to project the environmental impacts by integrating apex predator movement ecology; c) Participate in partnerships to advance tag design in the area of habitat mapping.

Methods: Methods employed will consist of aggregating existing movement data, as well as deploying behavior logging tags on HMS/apex predator species which should utilize existing methodology for quantifying prey density through visual and acoustic survey. Additionally, combining data synthesized as part of BOEM's FY17 study on Productivity and Ecology of Sand Shoals with telemetry data associated with HMS species into a dynamic modeling framework to visualize potential impacts as a result of varying development scenarios.

Specific Research Question(s):

1. How does habitat modification influence apex predators in an ecosystem?
2. What are the important ecological areas for upper trophic predators such as gray seals?

References:

Ampela, K., M. DeAngelis, R. DiGiovanni, Jr., and G. Lockhart. 2018. Seal Tagging and Tracking in Virginia, 2017-2018. Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-15-8006, Task Order 17F4058, issued to HDR, Inc., Virginia Beach, Virginia. March 2019.

Ampela, Kristen. *The diet and foraging ecology of gray seals (Halichoerusgrypus) in United States waters*. City University of New York, 2009.

Austin, D., Bowen, W.D. and McMillan, J.I., 2004. Intraspecific variation in movement patterns: modeling individual behaviour in a large marine predator. *Oikos*, *105*(1), pp.15-30.

Beck, C.A., Iverson, S.J., Bowen, W.D. and Blanchard, W., 2007. Sex differences in grey seal diet reflect seasonal variation in foraging behaviour and reproductive expenditure: evidence from quantitative fatty acid signature analysis. *Journal of Animal Ecology*, *76*(3), pp.490-502.

Flanders KR, Olson ZH, Ono KA., 2020. Utilizing next-generation sequencing to identify prey DNA in western North Atlantic grey seal *Halichoerus grypus* diet. Marine Ecological Progress Series 655, pp. 227-240.

Hayes, S.A., Josephson, E., Maze-Foley, K. and Rosel, P.E., 2019. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments–2018. *NOAA Technical Memorandum NMFS-NE*, *258*.

Hernandez, K.M., Bogomolni, A.L., Moxley, J.H., Waring, G.T., DiGiovanni Jr, R.A., Hammill, M.O., Johnston, D.W., Sette, L. and Polito, M.J., 2019. Seasonal variability and individual consistency in gray seal (Halichoerus grypus) isotopic niches. *Canadian Journal of Zoology*, *97*(11), pp.1071-1077.

Pace, R.M., Josephson, E., Wood, S.A., Murray, K. and Waring, G., 2019. Trends and patterns of seal abundance at haul-out sites in a gray seal recolonization zone.

Payne, P.M. and Selzer, L.A., 1989. The distribution, abundance and selected prey of the harbor seal, Phoca vitulina concolor, in southern New England. *Marine Mammal Science*, *5*(2), pp.173-192.

Moxley, J.H., Bogomolni, A., Hammill, M.O., Moore, K.M., Polito, M.J., Sette, L., Sharp, W.B., Waring, G.T., Gilbert, J.R., Halpin, P.N. and Johnston, D.W., 2017. Google haul out: Earth observation imagery and digital aerial surveys in coastal wildlife management and abundance estimation. *BioScience*, *67*(8), pp.760-768.

Northeast Fisheries Science Center (U.S.) (Ed.). (2020). *State of the Ecosystem 2020: Mid-Atlantic* (noaa:23889). https://repository.library.noaa.gov/view/noaa/23889

Roman, Joe, and James J. McCarthy. "The whale pump: marine mammals enhance primary productivity in a coastal basin." *PloS one* 5.10 (2010): e13255.

Russell, D., S. Brasseur, D. Thompson, G. Hastie, V. Janik, B. McClintock, J. Matthiopoulos, S. Moss, and B. McConnell. 2014. Marine mammals trace anthropogenic structures at sea. Current Biology 24(14):638-639.

Wood SA, Murray KT, Josephson E, Gilbert J. 2020. Rates of increase in gray seal (*Halichoerus grypus atlantica*) pupping at recolonized sites in the United States, 1988-2019. Journal of Mammalogy 101(1):121-128.

Title	Alaska Assessment for Cetaceans and Other Marine Mammals (ACOMM)
Administered by	Alaska Regional Office
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2026
Date Revised	April 30, 2021
PICOC Summary	
Problem	Marine ecosystems surrounding Alaska support a high diversity of cetacean species, several of which are listed as endangered under the Endangered Species Act (ESA). Additional data on species abundance and trends, seasonal distribution and movements, and habitat use is needed in this region to more fully assess the potential effects on cetaceans and other marine mammals of current and future oil and gas activities associated with the Outer Continental Shelf.
Intervention	Rotational, large-scale, visual and acoustic, ship-board or aerial surveys and acoustic moorings are proposed across the Alaska OCS to obtain data on the presence, distribution, and abundance of marine mammals, with particular focus on subsistence-harvested species such as bowhead and beluga whales; endangered species such as North Pacific right and fin whales; and species that may be vulnerable to noise from seismic air guns and other loud sound sources, such as beaked whales.
Comparison	These surveys will provide baseline information and facilitate future comparisons to examine the potential effects of natural and anthropogenic disturbances. The resulting habitat density models for key cetacean species will be compared to areas of interest for potential future oil and gas activities.
Outcome	This program will provide data on the abundance, trends, and distribution of cetaceans in the Alaska OCS, including Cook Inlet and the Beaufort Sea, to facilitate the development of habitat-based density models to better understand how natural and anthropogenic disturbances may affect marine mammal species.
Context	All Alaska OCS Areas

BOEM Information Need(s): Information on abundance and distribution of cetaceans and other marine mammals is needed to assess overlap between species' habitat and potential oil and gas activities in the coastal and offshore regions of Alaska. The ACOMM program would provide BOEM and collaborating Federal agencies with cetacean information needed to meet their regulatory requirements under the ESA, Marine Mammal Protection Act (MMPA), and National Environmental Policy Act (NEPA).

Background: Federal agencies are responsible for assessing and managing protected species within the waters of the U.S. EEZ. Data on cetacean abundance, distribution and habitat use are critical for assessing potential natural and anthropogenic impacts. This need for cetacean information has led to the development of three very successful large-scale, multi-agency, cetacean assessment programs jointly established and funded by BOEM, NOAA, and the U.S. Navy: 1) Atlantic Marine Assessment Program for Protected Species (AMAPPS), 2) Gulf of Mexico Marine Assessment Program for Protected

Species (GoMMAPPS), and 3) Pacific Marine Assessment Program for Protected Species (PacMAPPS). The missing sector in this national effort is the Arctic, and an Arctic Marine Assessment Program for Protected Species (ArMAPPS) is in the planning stages. Establishing the ArMAPPS program will fill the remaining regional gap to provide basic cetacean assessments across U.S. territorial waters.

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

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

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

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

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

Specific Research Question(s):

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

Title	Alaska Coastal Marine Institute
Administered by	Alaska Regional Office
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2024
Date Revised	April 30, 2021
PICOC Summary	
Problem	The BOEM Environmental Studies Program needs applied scientific studies to provide information for making responsible decisions for managing energy and marine mineral resources on the U.S. Outer Continental Shelf (OCS).
Intervention	Scientific information collected for leasing, exploration, and development decisions tends to be more readily accepted by the local and regional populace if the studies are conducted by well-known and scientifically respected local experts and institutions.
Comparison	Through the CMI, BOEM will obtain high quality scientific research to meet the shared goals of BOEM and the State of Alaska at substantial savings due to the one-to-one cost match requirement.
Outcome	The CMI program will use highly qualified, scientific expertise at local levels to collect and disseminate environmental information needed for OCS oil and gas and renewable energy decisions; address local and regional OCS-related environmental and resource issues of mutual interest; and strengthen the BOEM-State partnership in addressing OCS oil and gas information needs.
Context	All Alaska OCS Planning Areas

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

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

BOEM contribution of up to $1,000,000 per year. Typically, five to seven new projects are funded each year.

Objectives: The Framework Issues which guide the CMI are as follows:

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

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

The structure of the CMI not only promotes extensive input from BOEM's academic partners in Alaska, it also allows for a great deal of flexibility to rapidly address priority information needs as they arise. Furthermore, the requirement for matching funds at a one-to-one level facilitates extensive leveraging and partnership arrangements for the projects.

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

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

Title	Baseline Health Summary for the Cook Inlet Region
Administered by	Alaska Regional Office
BOEM Contact(s)	Jeffrey Brooks (jeffrey.brooks@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2024
Date Revised	April 30, 2021
PICOC Summary	
Problem	Energy development activities and related accidents could affect human health in nearby communities. Information on health conditions and key social determinants of health for the Cook Inlet region need updating to inform environmental impact analyses and tribal consultations.
Intervention	The study would provide the BOEM, State of Alaska, borough governments, tribes, and Native corporations with an assessment that summarizes baseline health conditions and determinants in potentially affected communities.
Comparison	BOEM would compare results with existing assessments in the state and other regions.
Outcome	BOEM would use the data to describe the affected environment, develop alternatives, analyze potential effects, develop mitigation measures, and conduct consultations.
Context	Coastal communities, local governments, and tribes in the Cook Inlet Planning Area

BOEM Information Need(s): An assessment of baseline health conditions and social determinants of health would describe the affected environment required in the environmental analysis process. This study would establish the baseline to facilitate analyses of potential adverse impacts to community health from energy and minerals development activities and help determine appropriate mitigation measures when needed. This assessment would help BOEM understand and effectively meet its obligations under Executive Order 12898, Environmental Justice in Minority and Low-Income Populations.

Background: Community health is holistic and consists of multiple interrelated determinants, including living conditions, genetics, diet and nutrition, food security, income and education, access to healthcare, and integrity of cultural identity (Bouchard-Bastien et al. 2014; Curtis et al. 2005; HHIC 2014, 2015; Loring and Gerlach 2009; McAninch 2012). A baseline health summary creates a point of reference for the health status of a community prior to development of a proposed project and describes an overall health profile for an area. The baseline health summary would inform decision-makers about health vulnerabilities and strengths of coastal communities and help them better understand the potential health implications of proposals and better inform deliberations (DHSS 2018).

Objectives:

- Describe baseline health conditions in communities potentially affected by energy and minerals development activities in the region
- Describe key social determinants of community and public health in the region

Methods: Researchers would visit communities to engage partners and other stakeholders through conversations about public health concerns related to energy and minerals development activities. Community outreach meetings would be conducted with local and tribal governments, representatives of Alaska Native corporations, and possibly public health professionals. Participants would share information, scope issues, ask for pertinent sources of information, and provide context for the baseline summary. Researchers would collect, organize, and review all baseline information related to health from within potentially affected coastal communities, including available sociocultural, subsistence use, food security, and disease data. Sources of baseline information would include state and Federal agency reports, national and borough census data, local and aggregated health records, and academic and professional publications. A final report would be produced to summarize and document the compilation of findings.

Specific Research Questions:

1. What is the overall health profile in the Cook Inlet Planning Area?
2. What is the context and scope of a health impact assessment for the region?
3. What is the health status, including vulnerabilities and strengths, of potentially affected communities?
4. What social determinants of health could be potentially affected by energy and minerals development activities?

References:

Bouchard-Bastien E, Gagné D, Brisson G. 2014. Social Impact Assessment in the Environmental Sector: Health Networks Support Guide. Abbreviated Version. Publication No. 1800. Gouvernment du Quebéc, Institut National de Santé Publique, pp. 33.

Curtis T, Kvernmo S, Bjerregaard P. 2005. Changing Living Conditions, Lifestyle and Health. International Journal of Circumpolar Health. 64(5):442-450.

DHSS (Alaska Department of Health and Social Services). 2018. Baseline Health Summary: Liberty Project. Anchorage, AK: Alaska Department of Health and Social Services, Environmental Public Health Program, pp. 31.

HHIC (Habitat Health Impact Consulting). 2014. Health Indicators in the North Slope Borough: Monitoring Effects of Resource Development Projects. Barrow, AK: North Slope Borough, Department of Health and Social Services, pp. 56.

HHIC. 2015. Health Impact Assessment in the North Slope Borough: A Guide for Stakeholders, Decision-Makers and Project Proponents. North Slope Borough, Department of Health and Social Services, pp. 34.

Loring PA, Gerlach SC. 2009. Food, Culture, and Human Health in Alaska: An Integrative Health Approach to Food Security. Environmental Science and Policy. 12:466-478.

McAninch J. 2012. Baseline Community Health Analysis Report. (Iłuaġniaġnikkun Qaisaksrat: A Report on Health and Wellbeing). Barrow, AK: North Slope Borough, Department of Health and Social Services, pp. 339.

Title	Collaborative Synthesis to Understand the Impacts of Vessel Presence and Sound on the Marine Environment and Subsistence Activities in the Pacific Arctic
Administered by	Alaska Regional Office
BOEM Contact(s)	Catherine Coon (catherine.coon@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2024
Date Revised	April 30, 2021
PICOC Summary	
Problem	Increased vessel traffic associated with reduced sea ice could lead to a range of effects in the Arctic. Marine mammals and other protected species may be exposed to higher noise levels, increased possibility of collision, and potential impacts from vessel discharges and other pollutants, including an increased chance of oil spills in a region with limited response capacity. These same factors could also impact subsistence communities.
Intervention	This study will synthesize spatial and temporal trends in vessel presence and quantify marine mammal vulnerability to related impacts. Indigenous knowledge holders, conventional scientists, and other partners will be invited to discuss and prioritize community concerns, and to co-design and interpret research that measures effects of vessel traffic and sound data.
Comparison	This study will estimate the increase in vulnerability for marine mammals, and the communities that rely on them for food security and cultural identity, due to increased vessel traffic in the Arctic.
Outcome	This study will provide spatial and temporal information on vessel activities, related vulnerabilities to marine mammals, and impacts on subsistence activities, including noise footprints of the vessels.
Context	Bering Strait, Chukchi Sea, and Beaufort Sea

BOEM Information Need(s): BOEM considers information about effects on marine mammals and subsistence activities from vessel traffic in its NEPA documents. To support these analyses, better information is needed about spatial and temporal trends in vessel traffic in the Arctic and effects associated with their presence (e.g., increased noise, discharges). This study will estimate effects on species protected under the Marine Mammal Protection Act and Endangered Species Act (ESA), from the Bering Strait and into the Chukchi and Beaufort OCS areas, to support NEPA and ESA Section 7 consultations. This research also will assess future vessel activity to inform development of mitigation measures.

Background: Increased vessel traffic in the Pacific Arctic triggers questions of potential effects and growing focus toward mitigating the impacts. The accelerated loss of sea ice has restructured physical and ecological patterns in the 'Pacific Arctic Gateway' and is leading to expanded anthropogenic activities in the region (Moore and Stabeno 2015, Duffy-Anderson et al. 2019, Wood et al. 2015). Vessel transits of the Bering Strait have notably increased in recent years, presenting environmental and

cultural threats in the Arctic (Huntington et al. 2015, Raymond-Yakoubian 2018, Raymond-Yakoubian and Daniel 2018). Arctic marine mammals are particularly vulnerable to effects from vessels (Reeves et al. 2014), including potential increases in underwater noise; marine mammal strikes; disturbance to Indigenous hunters; vessel discharges; and other pollutants, groundings, and oil spills (Hauser et al. 2018, Halliday et al. 2017, McWhinnie et al. 2018).

Objectives:

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

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

Researchers will compile and analyze coastal and offshore vessel tracking data to document vessel presence and vessel speeds on monthly or seasonal scales, categorized by vessel type. They will develop geospatial products (as heatmaps or routes) to overlap vessel presence information with existing information on important habitat areas for feeding, migrations, and subsistence use. These products will be used to develop estimates of population-specific marine mammal exposure to vessels in areas and during periods of concern identified by local users. Researchers will develop methods to quantify and analyze 'exposure' and 'sensitivity' for potentially affected populations. Methods may include artificial intelligence techniques for automatic identification system (AIS) data coupled with the exposure of species building from previously published estimates and incorporating factors such as relative species sensitivity to strikes, disturbance, noise exposure, and oil spill potential. Researchers and the Expert Steering Committee will address how best to look toward the future of both increased vessel traffic and changes in the environment relating to climate.

Specific Research Question(s):

1. How can vessel mitigation measures balance Indigenous community concerns, industry or research activities, and protected species conservation?
2. What trends have been observed in vessel presence, type, speed, and cumulative sound in the Pacific Arctic?
3. Where, when, and how has marine mammal vulnerability to vessels changed in recent years?

4. How do population-specific vulnerabilities to vessels vary for different routing scenarios?
5. What has been the number and distribution of different types of vessels relative to traditional harvesting areas and/or seasons?
6. Where, when, and how have there been potential vessel-based conflicts with subsistence species or harvest areas?

References:

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

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

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

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

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

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

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

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

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

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

Title	Cook Inlet Physical Oceanography: Synthesis and Observation
Administered by	Alaska Regional Office
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2026
Date Revised	April 30, 2021
PICOC Summary	
Problem	Physical oceanographic information for Cook Inlet is not synthesized into a regional framework and is difficult to access. This dispersion of data, particularly for the most recent period, adds complexity to evaluating a changing baseline or when using in general circulation model (GCM) verification and validation.
Intervention	Collate physical oceanographic data since 2000 in Cook Inlet and Shelikof Strait; synthesize data into a regional framework; identify information needs for sampling; and conduct coordinated deployment of high-resolution ocean observing to improve the accuracy of GCMs used to model oil spill trajectories in the Inlet and Shelikof Strait
Comparison	This study will compare areas to determine where low-resolution, little, or dated sampling exists. It will inform the collection of physical oceanographic measurements to improve general circulation models and observe trends in a changing climate.
Outcome	A comprehensive and understandable reference of Cook Inlet oceanography, including updated datasets, that is readily available for environmental analyses and GCM verification and validation
Context	Cook Inlet Planning Area

BOEM Information Need(s): BOEM uses baseline physical oceanographic information, including seasonal variation and baseline trends, to inform National Environmental Policy Act analyses in Cook Inlet. Teasing apart impacts to the environment from multiple stressors, including a warming Gulf of Alaska, requires historical and up-to-date physical oceanographic measurements. These measurements are also necessary to verify and validate GCM output to assure quality products for use in oil spill trajectory analyses.

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

Accurate information on surface wind fields, ocean currents, and sea ice is important for oil spill trajectory simulations and the potential impacts on Cook Inlet physical, biological, or social resources

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

Objectives:

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

Methods: Researchers will identify and gather existing, relevant, and readily available physical oceanographic datasets for the Cook Inlet and Shelikof Strait. The datasets will be organized into a common framework for review and identification of specific information needs to guide development of field plans. Researchers will conduct a field campaign to collect oceanographic measurements needed to provide stratification, freshwater forcing, and higher resolution surface and subsurface current data to enhance the ability to model 3-D currents. Data collection may include a combination of vessel surveys, moorings, and possibly high frequency (HF) radar installations. Information will be synthesized to describe and discuss the physical oceanography of Cook Inlet and Shelikof Strait within a regional framework. Data products and associated metadata will be disseminated through the Alaska Ocean Observing System (AOOS) web portal.

Specific Research Question(s):

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

References:

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

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

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

Litzow, MA, Hunsicker ME, Ward J, Anderson SC, Gao J, Zador SG, Batten S et al. 2020. Evaluating ecosystem change as Gulf of Alaska temperature exceeds the limits of preindustrial variability. Progress in Oceanography 186 (2020): 102393.

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

Title	Linking Pelagic and Nearshore Benthic Ecosystems in Lower Cook Inlet and Kachemak Bay Through Meroplankton: Collaborating with the Gulf Watch Alaska Monitoring Program in Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2025
Date Revised	April 30, 2021
PICOC Summary	
Problem	The current Gulf Watch Alaska (GWA) program considers top-down effects (predation from sea stars, otters, and shore birds) on rocky intertidal community composition, but the influence of larval recruitment (supply-side) has not been investigated. Especially in times of prominent environmental drivers (e.g., heatwaves and resulting ecological responses), the repopulation and genetic mixing provided by larval recruitment is likely to play a vital role in nearshore community recovery and resilience.
Intervention	This study will provide molecular species-level identifications of meroplankton collections to identify patterns in meroplankton abundance and key intertidal species at high taxonomic resolution.
Comparison	The GWA program has monitored the oceanography, phytoplankton, and zooplankton in Kachemak Bay (monthly) and lower Cook Inlet (seasonally), allowing for analysis of spatial and temporal patterns. Nearshore community composition in Kachemak Bay has been monitored systematically since 2012; these data and those from other ongoing studies provide a rich database as a framework for spatial and temporal comparisons. This study will also assess the extent to which Kachemak Bay is a representative system for lower Cook Inlet.
Outcome	Using existing meroplankton data, augmented with new meroplankton collections, this study will provide information on how interannual and seasonal changes in the timing and abundance of meroplankton larval supply affects recruitment of key rocky intertidal species.
Context	Kachemak Bay and lower Cook Inlet. In addition to GWA, this study links to other ongoing efforts in Kachemak Bay.

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

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

Objectives:

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

Methods: Existing data since 2012 on seasonal meroplankton composition from the GWA Environmental Drivers work will be analyzed in the context of simultaneously collected physical oceanographic data (temperature, salinity). This information will guide new collections of meroplankton during the proposed study for DNA-metabarcoding so that species-level information can be obtained for taxa that cannot be identified at sufficient level using morphological criteria (esp. bivalves and echinoderms). Metabarcoding will target several key taxa as well as composite samples (eDNA) using gene primers for invertebrates (CO1 and16S) followed by high-throughput sequencing. Bioinformatics using the National Center for Biotechnology Information (NCBI) nucleotide and Barcode of Life Data (BOLD) databases will be used to match these meroplankton sequences to known species sequences. Then, meroplankton information can be linked to nearshore community composition, including appropriate lag times (months, year). Variability in patterns will then be evaluated in the context of environmental conditions using multivariate statistics.

Specific Research Question(s):

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

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

Title	Lower Cook Inlet Fish and Invertebrate Community Composition, Distribution, and Density
Administered by	Alaska Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Inter-agency Agreement, Cooperative Agreement
Performance Period	FY 2022–2027
Date Revised	April 30, 2021
PICOC Summary	
Problem	Recent observations document large-scale changes to some components of the lower Cook Inlet marine ecosystem. Evidence indicates a warming climate as a driving variable of these changes. Data on the fish and invertebrates of Cook Inlet is limited, and much of it is dated, which limits our understanding of the current community structure and our ability to assess if any large-scale shifts have occurred. This information is necessary to analyze what effects resource development activities might have on these communities.
Intervention	This study will conduct systematic and comprehensive research to collect benchmark data on the fish and invertebrate community composition, distribution, relative abundance, diet, and energy density, as well as physical variables in the lower Cook Inlet region.
Comparison	This data will provide context for understanding the driving forces influencing changes to the current ecosystem.
Outcome	Products will include a current description of the fish and invertebrate community structure and distribution in lower Cook Inlet integrated with existing fish and mammal databases. A future monitoring plan will provide the tools and resolution needed to track future changes to these resources.
Context	Cook Inlet Region

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

Background: To differentiate environmental changes and anthropogenic effects on marine populations, we must have a good understanding of the current marine ecosystem, how trophic levels interact, and how physical factors and oceanography influence biota. In the 1970s, the coastal ecosystem of the Gulf of Alaska and lower Cook Inlet shifted from a community dominated largely by crustaceans to one dominated by fish (Anderson, 2000; Anderson and Piatt, 1999; Ware, 1995). It is difficult to predict what the fish and invertebrate communities will look like in the future, but changes in the lower trophic community due to regime shifts are likely to echo throughout the food web (Hare and Mantua, 2000). In Cook Inlet, sea bird die-offs have been linked to depressions in forage fish communities (Piatt et al. 2020; AK-20-10). These forage fish provide food for other fish, and those community interactions

haven't been studied in depth. Potential changes in groundfish community structure will have echoing effects on commercial, subsistence, and recreational fishing in the area. Documenting these changes will help BOEM to adequately analyze effects of potential resource development activities for NEPA analyses and EFH consultations. By examining the fish and invertebrate communities of Cook Inlet, we will grow our understanding of the region and increase the accuracy of our regulatory analyses.

Objectives:

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

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

Establish New Benchmark Descriptions for Fish and Invertebrates: A systematic survey design with a sampling grid covering lower Cook Inlet will be developed. The design will include the sampling approaches necessary to describe the benthic and pelagic fish and invertebrate communities. Sampling will occur interannually and cover a temporal scale consisting of spring, summer/fall, and winter. For all fish and invertebrates captured, researchers will record the species composition, distribution, and relative abundance. The diet and energy density will also be determined for all fish species captured. Some invertebrates, such as shrimp, squid, and krill, may also be analyzed for energy density and histology. At all sampling stations CTD casts and plankton sampling will occur.

Identify Indicators/Drivers of Community of Shift: The project will develop a statistical approach to assess seasonal and interannual changes to the fish, invertebrate, and zooplankton communities by compiling existing relevant biological, physical and, oceanographic datasets. Data collected from this study will then be compared to past datasets to assess community changes as well as the physical and oceanographic factors correlated with those changes. Particular attention will be focused on describing community changes between warm and cold-water years.

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

Specific Research Question(s):

1. What is the current fish and invertebrate community structure of lower Cook Inlet?
2. How can we better assess environmental variation on the fish and invertebrate communities of lower Cook Inlet?
3. How can we better understand ecosystem change resulting from a regime shift?

4. How can we better predict future changes to the lower Cook Inlet ecosystem using oceanographic and biological monitoring data?

References:

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

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

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

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

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

Title	Partnering to Improve Oil Spill Modeling in Ice
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Contract, Inter-agency Agreement, Cooperative Agreement
Performance Period	FY 2022–2024
Date Revised	April 30, 2021
PICOC Summary	
Problem	The Arctic Maritime Spill Response Modeling (AMSM) Workshop and Work Groups identified key unresolved issues to improve oil spill modeling in ice.
Intervention	BOEM will enhance existing working relationships with NOAA ORR, BSEE, USCG District 17, USCG Pac Area, USCG MER, UAA Arctic Domain Awareness Center, Alaska DEC, Alaska Clean Seas, industry, and others by establishing financial cooperation, data sharing agreements, and logistical support agreements.
Comparison	BOEM and others (NOAA, BSEE, and/or USCG) will partner on collaborative research, leveraging expertise across several organizations to address oil in ice modeling needs for the Alaska North Slope or Cook Inlet region.
Outcome	This project will support mutually identified information needs to improve oil in ice algorithms used in general ice-ocean or trajectory models.
Context	Beaufort Sea, Chukchi Sea, Cook Inlet

BOEM Information Need(s): BOEM conducts oil spill trajectory analysis modeling in Arctic and Subarctic areas where sea ice forms during the winter. Improved oil in ice algorithms would refine OSRA model estimates used in NEPA assessments.

Background: Oil spill trajectory modeling is critical in providing insight and answering questions on oil spill risk and/or oil spill response. Models can calculate the risk to habitats or species from oil exposure or contamination and the extent to which habitats or species may be contacted, or protected, through response mitigation. Oil interactions with mobile sea ice or immobile landfast ice involve several processes that affect oil transport and fate (French-McCay et al. 2017). These interactions include spreading in broken ice; movement on, under, and through ice; and adsorption to snow. Many of these interactions and processes are at a finer scale than can be captured in oil spill models using inputs that are currently available from large-scale meteorological, hydrodynamic, and coupled ice–ocean models (ADAC and CSE 2019). Recent investigations have shown that improvements to the ice algorithms translated to improvement in oil spill trajectory performance.

Objectives: The Arctic Maritime Spill Response Modeling (AMSM) Workshop and Work Groups identified numerous research topic recommendations and synthesized them in a Final Report (ADAC and CSE Forthcoming). The goal of this project is to select two to three key research topic recommendations that can be readily implemented to improve oil in ice modeling algorithms for pack or landfast ice.

Methods: BOEM and other agencies (NOAA, BSEE, and/or USCG) will collaborate to advance oil in ice algorithms in coupled ice-ocean and/or trajectory models and advance collaborative studies that could help enhance informed decision-making on the oil spill trajectory modeling. The partnering agencies will identify mutual information needs and leverage resources to support research and development of algorithms and updated models.

Specific Research Question(s):

1. How can oil in ice algorithms used in general ice ocean or oil spill trajectory models be improved?
2. What key research topic recommendations resulting from the AMSM Workshop can be readily implemented to accomplish this?

References:

Arctic Domain Awareness Center (ADAC) and Center for Spills and Environmental Hazards (CSE). 2019. Arctic Maritime Spill Response Modeling (AMSM) Workshop Report December 3-5, 2019. 450 pp.

Arctic Domain Awareness Center (ADAC) and Center for Spills and Environmental Hazards (CSE). Forthcoming. Arctic Maritime Spill Response Modeling (AMSM) Final Report 2021.

French-McCay DP, Tajalli-Bakhsh T, Jayko K, Spaulding ML, Li Z. 2017. Validation of oil spill transport and fate modeling in Arctic ice. Arctic Science. 4(1): 71-97. https://doi.org/10.1139/as-2017-0027.

Title	Pipeline Gas Release Frequency, Scenarios, and Impacts
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2024
Date Revised	April 30, 2021
PICOC Summary	
Problem	Information about pipeline gas release frequency, release scenarios, and impacts is dispersed throughout peer reviewed and gray literature, and modeled scenarios specific to the Alaska OCS are unavailable. Impacts of natural gas to the environment are difficult to document or locate.
Intervention	This study will collate and synthesize existing technical information on U.S. onshore and offshore OCS pipeline gas releases and their impacts to the environment. This study would also model pipeline gas release scenarios relevant to the Alaska OCS using readily available software.
Comparison	The results will support gas release scenarios used in NEPA assessments by modeling gas release, ignition, and explosion frequencies; spatial footprint of hazards using Alaska OCS relevant data; and impacts to resources.
Outcome	The project will produce a synthesis report on historical offshore and onshore gas pipeline releases, including documentation of impacts to the environment. This synthesis will include quantitative scenario elements specific to the Alaska OCS, such as release frequencies or explosion footprints derived from modeling.
Context	All Alaska OCS areas

BOEM Information Need(s): Modeled gas pipeline release scenarios specific to the Alaska OCS are unavailable, and impacts of natural gas are not well documented and consequently are difficult to locate in the literature. BOEM uses information about the general impacts of natural gas and natural gas release scenarios to estimate impacts in NEPA documents. Better information on natural gas impacts to the environment and quantitative scenario factors from gas pipeline release models will facilitate informed and refined NEPA analyses. Frequency estimates are not available regularly in the literature. This study will use specific modeled pipeline gas releases relevant to the Alaska OCS to provide information on the frequency of U.S. onshore or offshore OCS pipeline gas releases caused by small or large-scale punctures, ruptures, ignition and/or explosions. Finally, this study will synthesize documented impacts to resources from natural gas releases for use in impact analyses.

Background: Natural gas pipelines are associated with potential hazards and risks that can lead to a natural gas pipeline failure. Major causal factors for pipeline failure, such as third-party digging, may differ substantially for the Alaska North Slope, where population density is unusually sparse. Estimates used for quantitative scenario elements, such as the hazard area, are difficult to generate without modeling. Serious impacts can occur from the release, dispersion, fire, and/or explosion of natural gas. Fire and ignition of a gas release can increase the impact area, as compared to dispersion. Depending

upon the circumstances and conditions, the type of open fire may vary. For example, ignited releases can produce jet fires, vapor cloud fires, or fireballs (Shan et al. 2020). Models can be used with confidence to estimate the hazard distance or hazard area from a natural gas pipeline release.

The impacts of natural gas releases to the environment are not widely reported and are often located in incident reports produced by the regulatory agency. However, some information on the impacts of natural gas to resources is dispersed throughout the body of scientific and gray literature.

Objectives:

- Synthesize technical information on the frequency, spatial and temporal footprint, modeling, and consequences of historical natural gas pipeline releases
- Estimate the frequency of occurrence of U.S. onshore and offshore OCS natural gas pipeline releases or ruptures using relevant historical information from the Department of Transportation, Pipeline and Hazardous Materials Safety Administration, and the Bureau of Safety and Environmental Enforcement
- Estimate the frequency of occurrence of onshore and offshore pipeline gas releases resulting in ignition, fire, and explosion for the Alaska North Slope and Cook Inlet region; discuss causal factors that are similar to or different from the continental U.S.
- Utilize specific pipeline release scenarios and a software system to model the behavior, dispersion, and ignition, fire, and explosion of natural gas in order to quantify the spatial and temporal footprint of the hazard

Methods: Researchers will collect existing U.S. onshore and offshore OCS pipeline natural gas release and impact information found in journal publications and gray literature reports produced by government, private sector, non-governmental, and academic entities, as well as information produced from regulatory agencies. Effort will focus on historical U.S. onshore and offshore OCS pipeline gas releases, ignition, or explosion frequency, and spatial and temporal footprints. Researchers will identify the best readily available model(s) to test specific parameters of an U.S. onshore or offshore OCS pipeline natural gas release or rupture and subsequent fire and or explosion. Using 3–6 pipeline scenarios provided by BOEM, the researchers would model specific input parameters. Products will include a technical summary reference for the frequency of onshore or offshore pipeline gas releases caused by small or large-scale punctures, ruptures, ignition and/or explosions, document scenarios, and quantitative parameters such as hazard area. Finally, this study will synthesize documented impacts to environmental, social, or economic resources from natural gas releases for use in impact analyses.

Specific Research Question(s):

1. What is the frequency of a natural gas pipeline release, and/or subsequent fire, and/or explosion?
2. Are there differences in frequencies between U.S. onshore and offshore OCS natural gas pipeline releases?
3. What are the best quantitative scenario elements to use for a natural gas release or rupture, ignition, and/or explosion from an onshore or offshore pipeline in a NEPA analysis?
4. What are the documented impacts of natural gas releases or subsequent fire or explosion to resources?

References:

Shan K, Shuai J, Yang G, Meng W, Wang C, Zhou J, Wu X, Shi L. 2020. Numerical study on the impact distance of a jet fire following the rupture of a natural gas pipeline. International Journal of Pressure Vessels and Piping. 187: 104159. https://doi.org/10.1016/j.ijpvp.2020.104159.

Title	Renewable Energy Potential for the Alaska Outer Continental Shelf
Administered by	Alaska Regional Office
BOEM Contact(s)	Jeffrey Brooks (jeffrey.brooks@boem.gov)
Procurement Type(s)	Interagency agreement or contract
Performance Period	FY 2022–2024
Date Revised	April 22, 2021
PICOC Summary	
Problem	The Energy Policy Act of 2005 authorized BOEM to issue leases, easements, and rights of way to allow for renewable energy development on the Outer Continental Shelf (OCS), but the current BOEM program does not actively consider renewable energy in Alaska. Information about renewable energy resources on the OCS is needed to inform decisions and understand potential environmental impacts.
Intervention	This study would conduct a literature synthesis and focus group discussions to compile descriptive and spatial information about renewable energy potential on the Alaska OCS and recommend environmental research needed to support development. The study would also address economic feasibility.
Comparison	The study would assess potential for wind, ocean thermal, ocean wave, tidal, and ocean current energy for Alaska compared to other regions.
Outcome	This study would enable more informed decisions about whether to develop a renewables program on the Alaska OCS. Future renewable energy projects, if economically feasible, have the potential to make substantial contributions to the state's and nation's energy portfolios.
Context	All renewable energy potential for the Alaska OCS would be considered.

BOEM Information Needs: The development of a renewable energy program in Alaska would support current priorities identified in the recent Executive Order on *Tackling the Climate Crisis at Home and Abroad* by advancing innovation, exploration, and development of renewable energy resources. There are likely many areas in the Alaska OCS appropriate for potential renewable energy development. The need to compile and document information to guide and support renewable energy development is a high priority for the BOEM. This study would provide information for development of a program in Alaska and recommendations for research to support future National Environmental Policy Act (NEPA) analyses required to develop renewable energy, including effects from habitat and landscape alteration; social, cultural, and economic impacts; and cumulative effects.

Background: A recent report recognized that the coastline and extensive EEZ of the United States contain vast untapped renewable energy sources in the forms of wave, tidal, wind, and thermal energy to help power the Nation (NSTC 2018). 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 renewable energy sources is a research priority

identified in the report for the next decade. This study would move BOEM toward achieving this goal in the Alaska OCS.

Geospatial analyses are needed to better prioritize where studies of key resources should be conducted. These analyses would help to identify the most likely areas of OCS renewable energy development in the near term and where more detailed environmental studies are needed for the longer term (Michel et al. 2007). The U.S. Department of Energy recently assessed offshore wind energy potential for Alaska; however, the study did not address economic feasibility or environmental impacts (Doubrawa et al. 2017). A number of management strategies are being used to address siting, permitting, monitoring, and mitigating the effects of renewables development to help facilitate permitting while protecting marine resources (Copping et al. 2020).

Objectives:

- Understand the potential for offshore renewable energy in the Alaska OCS
- Identify areas and sources of high potential for developing renewable energy
- Assess the economic feasibility of renewable energy development
- Identify management strategies to consider if BOEM's Renewable Energy Program is expanded to the Alaska OCS
- Identify preliminary research priorities and environmental data needs for potential NEPA analyses

Methods: Researchers would conduct a literature review and synthesis, compiling all available information about offshore renewable energy potential on the Alaska OCS. Researchers would focus on identifying areas most attractive for leasing. Products would include a georeferenced database and maps to depict spatial information, including suitable areas for renewables development and environmental characteristics that make these areas suitable. Energy potential would be defined to include what is producible with current technologies or those that may be realistically developed within fifteen years. Researchers would conduct and document focus group discussions with industry experts, utilities, and state and local governments to assess economic feasibility. Researchers would consider feasibility under different scenarios, including annual changes in high potential sources; changing climatic conditions; varying levels of infrastructure and port capacity; transport of materials and equipment to remote sites; and reasonably foreseeable technological advancements in energy capture, storage, and transport.

Specific Research Questions:

1. What is the offshore, renewable energy potential on the Alaska OCS, and which types are most feasible and practicable?
2. What are the primary environmental considerations related to renewable energy?
3. Which areas are most attractive for leasing, and what makes these areas suitable?
4. Is it economically feasible to recover this energy with current or anticipated future technologies?
5. How does the potential in Alaska compare with the Atlantic and Pacific OCS?
6. What strategies should BOEM consider to effectively design environmental studies to provide baseline data needed for a potential future leasing program?

7. If a renewable energy program is not practicable at this time, under what conditions could it be more viable, and what indicators may demonstrate a need to consider a renewables program in the future?

References:

Copping, A.E., Hemery, L.G., Overhus, D.M., Garavelli, L., Freeman, M.C., Whiting, J.M., Gorton, A.M., Farr, H.K., Rose, D.J., and Tugade, L.G. 2020. Potential Environmental Effects of Marine Renewable Energy Development—The State of the Science. Journal of Marine Science and Engineering, 8(11): 879. https://doi.org/10.3390/jmse8110879.

Doubrawa, P., Scott, G., Musial, W., Kilcher, L., Draxl, C., and Lantz, E. 2017. Offshore Wind Energy Resource Assessment for Alaska. NREL/TP-5000-70553. Golden, CO: U.S. Department of Energy, National Renewable Energy Laboratory, 29 pp. https://www.nrel.gov/docs/fy18osti/70553.pdf.

Michel, J., Dunagan, H., Boring, C., Healy, E., Evans, W., Dean, J.M., McGillis, A. and Hain, J. 2007. Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf. MMS OCS Report 2007-038. Herndon, VA: U.S. Department of the Interior, Minerals Management Service, 254 pp.

NSTC (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, 55 pp.

Title	Retrospective Synthesis of Historical Alaska OCS Oil and Gas Activities
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2024
Date Revised	April 30, 2021
PICOC Summary	
Problem	Quantitative information about historical Alaska Outer Continental Shelf (OCS) oil and gas exploration, development, and production activities (historical Alaska OCS activities) is not readily available for SMEs to validate lease sale exploration and development (E&D) scenarios or for geospatial and temporal evaluation of impact producing factors in National Environmental Policy Act (NEPA) analyses.
Intervention	This study will collate, quantify, and synthesize information about individual historical Alaska OCS activities, including various related parameters, and their geospatial and temporal footprints.
Comparison	The synthesis will enable prompt access to information, understanding of how historical Alaska OCS activities relate to the current activities in Alaska, and validation for E&D scenario levels of activities.
Outcome	A synthesis of historical Alaska OCS activity information will improve access, supply context, and support integrated geospatial and temporal assessments of potential future impacts.
Context	All Alaska OCS Areas

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

Background: BOEM uses information regarding historical Alaska OCS activities and their associated impact producing factors to evaluate potential impacts that may be associated with Alaska OCS oil and gas exploration, development, and production activities. In BOEM's NEPA assessments, impact producing factors are correlated with a range of parameters, such as the number, timing, location, water depth, well cellar depth, and results of wells drilled; discharges; facility types; and aircraft/vessels/vehicles utilized, including transportation routes used and the number and frequency of trips. Much of the historical information is contained within Environmental Studies Program monitoring reports (e.g., Burden et al. 1985, Kevin Waring and Associates 1985; Northern Resource Management 1980) and operator reports submitted to BOEM or its predecessors. BOEM's Alaska Resource Evaluation section has collated information on the 107 Alaska OCS wells drilled. However, it is difficult to find and synthesize activity information in a timely manner to answer questions related to historical Alaska OCS activities.

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

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

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

Specific Research Question(s):

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

References:

Burden PL, Feldman ML, Barloon KL. 1985. Monitoring OCS Activity in The Bering Sea. OCS Study MMS 85-0027/Technical Report 114. Prepared by Patrick Burden & Associates and Dames & Moore for USDOI, MMS, Alaska OCS Office. 193 pp. + Appendices. https://espis.boem.gov/final%20reports/1570.pdf

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

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

Title	Seabird and Forage Fish Distribution, Trends, and Community Structure in Lower Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Intra-agency Agreement
Performance Period	FY 2022–2025
Date Revised	April 30, 2021
PICOC Summary	
Problem	Recent perturbations to the Gulf of Alaska marine ecosystem have resulted in massive seabird die-offs, reduced breeding success, historically low at-sea densities of fish-eating seabirds, and a large-scale forage fish community collapse. Continued assessments of seabirds and forage fish will provide information on the recovery of ecosystem resources in the region.
Intervention	This study will quantify spatial and temporal variation in seabird and forage fish communities in lower Cook Inlet to inform the status of ecological resources in areas of oil and gas development.
Comparison	Results will be evaluated in the context of extensive historical data to quantify changes in seabird and forage fish populations in Cook Inlet.
Outcome	Continued assessments of seabird and forage fish communities will provide managers with information needed to assess resiliency of ecological resources to impacts from oil and gas-related activities in Cook Inlet.
Context	Cook Inlet Planning Area

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

Background: The USGS-led seabird and forage fish studies in lower Cook Inlet during the 1990s assessed factors regulating seabird populations, in the context of seabird population recovery following the 1989 M/V *Exxon Valdez* oil spill. The original project was designed to measure the population response of seabirds to fluctuating forage fish densities around seabird colonies in the region. Beginning in 2016, the USGS has supported research that repeated these historical studies of the 1990s to document the effects of a large-scale seabird die-off in the North Pacific. This ongoing work demonstrates that an

unprecedented multi-year marine heatwave caused a major disruption to the Gulf of Alaska trophic system, with major consequences for seabird and forage fish populations in Cook Inlet. In 2015–2016, about 1 million common murres died from starvation, and seabirds failed to produce offspring at multiple colonies in the Gulf of Alaska, including several colonies in Cook Inlet (Piatt et al. 2020). The large and conspicuous seabird die-off was accompanied by reduced quality and a synchronous collapse of key forage fish populations, including capelin, herring, and sand lance. Impacts to ecological resources were observed across trophic levels, and populations did not return to a normal state in the years that followed the heatwave. For example, at-sea densities of several fish-eating seabird species, including common murre, pigeon guillemot, marbled murrelets, and Kittlitz's murrelets, were the lowest ever documented during 2018. Additionally, horned and tufted puffin densities were consistently lower in 2016–2019 compared to baseline data from the late-1990s (Piatt et al. 2020). These observations make clear the need to continue assessments of seabird and forage fish communities to better understand the relationship between natural ecosystem change and potential impacts from oil and gas activities on ecological communities.

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

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

Methods: Protocols for monitoring forage fish and seabirds in lower Cook Inlet were developed during the colony work done for BOEM in 1995–2001, and details can be found in the final report on that project (Piatt 2002). At-sea work will be conducted along fixed transects within 50 km of two colonies, Gull Island in Kachemak Bay and Chisik Island on the west side of lower Cook Inlet. Forage fish abundance and community composition will be assessed using mid-water trawls and acoustic surveys. At-sea densities of seabird communities will also be measured on acoustic transects. To provide an index of forage fish food availability and habitat, zooplankton biomass and a suite of physical conditions will be measured in conjunction with each trawl. At colonies, we will census kittiwakes and murres on established monitoring plots and conduct full island censuses, obtain an index of reproductive success of adult birds, and collect data on diet composition of adults and chicks.

Specific Research Question(s):

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

References:

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

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

Title	Using Multiple Tools to Assess Marine Mammal Distribution, Numbers, and Habitat Use in Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	Christina Bonsell (christina.bonsell@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2025
Date Revised	April 30, 2021
PICOC Summary	
Problem	Updated information is needed on the temporal occurrence, distribution, and habitat use of cetaceans in Cook Inlet to evaluate potential effects from future OCS activities. Federal agencies need reliable information on the abundance and distribution on various ESA-listed large whale species (e.g., humpback, fin) and endangered Cook Inlet beluga whales to accurately evaluate potential impacts to these species and inform mitigation.
Intervention	A combination of aerial surveys and acoustic monitoring, paired with eDNA sampling, will provide seasonal information on abundance and distribution and year-round documentation of occurrence and quantification of the potential for disturbance.
Comparison	The implementation of a directed study will provide this information for a variety of uses by multiple agencies, including agency analyses, incidental harassment authorization requests, and future comparisons of anthropogenic impacts on cetacean distribution in this important area.
Outcome	This study will provide up-to-date information on the abundance, distribution, and habitat use of endangered large whales, Cook Inlet beluga, and other cetacean species in a key area of interest for oil and gas operations.
Context	Cook Inlet

BOEM Information Need(s): Information gained from this study is needed to establish abundance and distribution of several species of marine mammals, including two endangered large whale species (i.e., humpback, fin) and Cook Inlet beluga whales in lower Cook Inlet. Increased understanding of the seasonal density and distribution of the relevant species will assist BOEM and NMFS in pre- and post-lease NEPA assessment, design of temporal and spatial mitigation, and monitoring effects of activities. Results will support future Section 7 ESA consultations and preparation of future BOEM Biological Assessments/Evaluations and NMFS Biological Opinions.

Background: There are numerous species of marine mammals that occur within Lower Cook Inlet (LCI). Endangered fin whales are known to be present and to feed in this and adjacent areas in large numbers year-round, and feed intensively within and downstream of this area seasonally. Up to three populations of humpback whales (including one threatened and one endangered) occur in this area; assessment of the extent of use by these three populations is currently based on dated information. Aerial surveys, satellite-tag data, and passive acoustics show that belugas inhabit LCI waters; however, knowledge of

their distribution and use of the lower Inlet is scarce due to limited survey effort. Detection of the critically endangered North Pacific right whale in the bays of eastern Kodiak Island and historical sightings along the southern entrance to Shelikof Strait and near the Barren Islands demonstrate the potential presence of this ESA-listed species near Cook Inlet. Several other marine mammal species are present in or near these areas, including blue, sei, gray, killer, and minke whales, as well as harbor and Dall's porpoise, but their year-round seasonal distribution is not well documented, and seasonal estimates of density from dedicated surveys are unavailable.

Objectives:

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

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

Specific Research Question(s):

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

Title	Using Predator Diets to Monitor Trends in Forage Fish Composition in Lower Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2024
Date Revised	April 30, 2021
PICOC Summary	
Problem	Research in the Cook Inlet region indicates that ecosystem changes associated with warming conditions and marine heatwaves have caused declines in fish and seabird populations. Information on forage species variability is needed to link the lower trophic patterns to changes in fish, marine bird, and marine mammal populations.
Intervention	This study will focus on using fish (salmon and groundfish) and seabird diet data gathered by port sampling and citizen science to develop an index of seasonal and interannual changes in forage species composition over time. It will also develop a mobile phone application to facilitate long term data collection by researchers and fishermen.
Comparison	Study results will be evaluated in the context of ecosystem monitoring data, as well as other time series data on fish, seabird, and marine mammal populations.
Outcome	This study will provide a cost-effective tool to track temporal variability of forage fish composition in Cook Inlet. Products may include a new mobile phone application to facilitate collection of predator fish diet data.
Context	Cook Inlet Region, linking with the ongoing Gulf Watch Alaska program

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

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

Objectives:

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

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

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

To develop a time series of seabird diets on forage fish, this study will establish protocols to sample food loads delivered by adult Black-legged kittiwakes to their chicks at the deep-water dock in Homer and other harbor nesting sites, if applicable. Kittiwakes are a popular study species, having a circumpolar distribution and being widespread and easy to work with. The proposed location in Homer is unique in terms of accessibility because several hundred kittiwakes nest on harbor infrastructure that is easily accessible from the road system. Given the easy access, seabird diet sampling at the Homer dock could be done in a morning by 2–3 people.

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

Specific Research Question(s):

1. How does the relative community composition of forage fish species change seasonally and between years in lower Cook Inlet?
2. How are changes in community composition of forage fish related to changes in environmental conditions and plankton in lower Cook Inlet, and to changes in fish, seabird, and marine mammal populations?

3. How does the forage fish community here compare to other sites (e.g., Middleton Island)?

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

Title	Collaboration with North Pacific Research Board (NPRB): Arctic Marine Synthesis
Administered by	Alaska Regional Office
BOEM Contact(s)	Catherine Coon (catherine.coon@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2023–2025
Date Revised	April 30, 2021
PICOC Summary	
Problem	The BOEM Environmental Studies Program needs applied scientific studies to provide information for making responsible decisions for managing energy and marine mineral resources on the U.S. Outer Continental Shelf (OCS). BOEM, NPRB, and other organizations have a long history of supporting field data collection projects. Further efforts are needed to synthesize the results and identify ongoing information needs to develop recommendations for future projects.
Intervention	BOEM will partner with NPRB to build upon recent and ongoing Arctic research through financial cooperation, coordinated Request for Proposals (RFPs), and data sharing agreements. Approaches will draw on data collected by multiple field programs funded by BOEM and other organizations in recent decades and will support new statistical analyses and new collaborations.
Comparison	This partnership will examine areas where collaborative studies could help enhance informed decision-making on the sustainable use of resources
Outcome	Results will address mutual information needs through new synthesis projects.
Context	Beaufort Sea, Chukchi Sea

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

Background: The Alaska Regional Office has a long history of supporting multidisciplinary research, beginning with the "Outer Continental Shelf Environmental Assessment Program" (OCSEAP) surveys conducted between the 1970s and early 1990s and the "Beaufort Sea Monitoring Program" (BSMP) in the 1980s. The "Arctic Nearshore Impact Monitoring in Development Area" (ANIMIDA) program (and its continuation [cANIMIDA]) started in 1999 to provide baseline data and monitoring results for chemical contamination, turbidity, and subsistence whaling in the vicinity of the Northstar and Liberty development sites. This work was continued through the "ANIMIDA III: Boulder Patch and Other Kelp Communities in the Development Area" and "ANIMIDA III: Contaminants, Sources, and Bioaccumulation" studies, which were expanded to include Camden Bay. In 2007, the Alaska Regional Office developed a new suite of studies in the Chukchi Sea, conducting interim baseline research and monitoring in all the following fields of interest: meteorology, ice dynamics and basic oceanography, benthic fauna and sedimentation, marine mammals (including whales, walrus, seals, and polar bear),

fish, birds, and social systems. Most of the projects exhibited complex, multilateral collaborations, with explicit inter-disciplinary linkages between the physical and biological sciences, with careful attention to inter-annual variability and ecosystem processes. Many of them also provided a role for active participation by Alaska Native residents and input from sources of traditional knowledge.

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

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

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

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

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

References:

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

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

Environmental Studies Program: Studies Development Plan | FY 2022–2023

Title	Comprehensive Synthesis of the Physical Oceanography of the U.S. Arctic 2005–2021
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	FY 2023–2025
Date Revised	April 30, 2021
PICOC Summary	
Problem	In the last decade, a substantial volume of physical oceanography observational data was collected and analyzed across several large oceanographic programs in the northern Bering, Chukchi, and U.S. and Canadian Beaufort seas. This site- or region-specific information has not been comprehensively synthesized across the broad Arctic region adjacent to the U.S. to provide context for use in NEPA analyses or for developing information needs in a rapidly changing Arctic.
Intervention	This study will synthesize relevant oceanographic peer-reviewed journal articles and reports to develop a synthesis document that is readily accessible to BOEM analysts and the public.
Comparison	The synthesis will provide an enhanced understanding of the physical oceanography, note trends, and provide recommendations for addressing physical oceanographic information needs most relevant for the U.S. Arctic.
Outcome	A synthesis and description of physical oceanography in the U.S. Arctic with topical recommendations for further study identifying information needs to ensure that first-order ocean physics are understood and to provide data to validate future model results.
Context	Beaufort Sea, Chukchi Sea, Northern Bering Sea

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

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

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

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

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

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

Specific Research Question(s):

1. What additional insights can be gained through synthesis and integration of available U.S. Arctic oceanographic data and information?
2. What physical processes need further elucidation to better understand first order oceanic physics in a changing Arctic?
3. What is the current range of observing or idealized modeling approaches, and how can new technologies further address identified information needs?
4. What additional observational datasets would enhance the verification and validation of model results?

References:

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

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

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

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

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

Title	Ecological Response to the Presence of Oil and Gas Production Platforms in Cook Inlet, Alaska
Administered by	Alaska Regional Office
BOEM Contact(s)	Christina Bonsell (christina.bonsell@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	FY 2023–2025
Date Revised	April 30, 2021
PICOC Summary	
Problem	Current NEPA and ESA consultations require analyses of impacts to marine mammal, avian, and fish species from the installation and operation of offshore oil and gas platforms. In recent years, studies have been conducted in the Gulf of Mexico and along the west coast of the United States, investigating such impacts. However, this type of information is limited for cold water areas such as Alaska.
Intervention	This study will survey existing production platforms, facilities, and surrounding areas located in state waters within Cook Inlet, Alaska, for trends in species diversity, richness, and distribution.
Comparison	This study will compare data on plant, invertebrate, fish, avian, and mammalian species diversity, species richness, and localized distribution on and near existing production platforms in Cook Inlet with similar data from control areas to identify trends and patterns that may be attributed to the presence of the platforms.
Outcome	This study will provide insight into the ecological effects of offshore oil and gas platforms in state waters of Cook Inlet, Alaska, to inform assessment of potential changes related to future platforms in OCS waters.
Context	Cook Inlet Planning Area and Gulf of Alaska

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

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

Objectives:

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

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

Specific Research Question(s):

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

References:

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

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

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

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

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

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

Stanley DR, Wilson CA. 1996. Seasonal and spatial variation in density and size distribution of fishes associated with a petroleum platform in the northern Gulf of Mexico. Presented at: Fourteenth Annual Gulf of Mexico Information Transfer Meeting, November 1994; November 15-17, 1994; New Orleans, LA. https://www.boem.gov/environment/environmental-studies/proceedings-information-transfer-meetings

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

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

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

Title	Using Emerging Technologies to Update Lower Cook Inlet Seabird Colony Counts
Administered by	Alaska Regional Office
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Intra-agency Agreement
Performance Period	FY 2023–2026
Date Revised	April 30, 2021
PICOC Summary	
Problem	Colony surveys provide important information needed to mitigate disturbance and other potential effects on seabird populations from oil and gas activities, vessel traffic, oil spills. Traditionally, breeding seabird populations are estimated from colony-based censuses, though seabirds from these colonies forage offshore (up to 200 km), and diverse survey methods are needed to minimize undercounting these populations. Furthermore, large fluctuations in seabird breeding distribution and abundance are occurring at multiple colonies, likely due to significant environmental perturbations in the Gulf of Alaska (GOA) in recent decades (Piatt et al. 2020). A comprehensive review of all seabird colonies in the region is necessary to understand the extent of these fluctuations, and such a survey has not been conducted in decades.
Intervention	Updated information on seabird colony locations, species, and abundance will be collected to guide prudent oil and gas development activities for Lower Cook Inlet (LCI). Census efforts will prioritize colony size and species of concern within the outflow of LCI, including Shelikof Strait, the Kodiak Archipelago, and the Kenai Peninsula.
Comparison	Traditional boat-based census counts, population estimates using emerging technology, photographic counts with machine learning software, and indices derived from marine-band radar will be used to compare and quantify numbers of breeding seabirds at colonies in the LCI region. Results will be evaluated with historic colony estimates to document changes in seabird abundance and breeding distribution.
Outcome	This study will produce robust estimates of breeding bird populations in the Cook Inlet Planning Area. The improved knowledge and accessible database will facilitate siting decisions and analysis of potential effects.
Context	Cook Inlet

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

analyses, and other documentation for lease sales, exploration plans, and development and production plans.

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

Objectives:

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

Methods: Diverse techniques are required to accurately assess breeding numbers of different seabird species, depending on behavior (i.e., ledges vs burrow/crevice nesting), and colony accessibility. Alaska poses unique challenges due to the number of remote colonies. The USFWS and U.S. Geological Survey (USGS) continue to develop and refine methods to improve estimates of seabird abundance at colonies and minimize possible undercounting. New and current technologies, such as marine-band radar and photographic surveys from fixed-wing aircraft and helicopters, will be used to collect relative abundance of species and densities of seabird colonies. Researchers at USFWS will collaborate with the USGS Alaska Science Center to develop emerging technology protocols for determining abundance estimates of ledge nesting breeding seabirds (e.g., murres, kittiwakes). Working with partners at the Alaska Maritime National Wildlife Refuge and the Alaska Biological Research, Inc., researchers will develop indices of burrow nesting seabirds (e.g., tufted and horned puffins). Methods used to update census information at the 325 colonies will complement current work being conducted by USGS to expand understanding of all seabird species breeding in the LCI region.

Specific Research Question(s):

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

References:

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

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

Title	A Programmatic Study of Chemical Products Used in Gulf of Mexico Oil and Gas Operations: Inventory, Disposal, and Risks
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Ross Del Rio (ross.delrio@boem.gov), Trevis Olivier (trevis.olivier@boem.gov), Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Interagency Agreement, Contract
Performance Period	FY 2022–2025
Date Revised	February 4, 2021
PICOC Summary	
Problem	BOEM lacks a current inventory of chemical products used by the offshore oil and gas industry. BOEM routinely receives comments and requests for this information on Lease Sale NEPA documents from the USEPA, NGOs, and the general public, often citing concerns regarding potential pollutants in produced waters.
Intervention	Literature synthesis and coordination with offshore oil and gas operators to develop an updated inventory of the chemicals used in offshore oil and gas operations and their disposal methods, as well as evaluating the risks of a spill of such chemicals
Comparison	Comparing updated inventory data to the Boehm (2001) inventory data; including a comparison of inventory data between deep and shallow water depths and with other existing inventory data from onshore and State waters
Outcome	This study will result in an updated chemical product inventory and understanding of the chemicals used in offshore oil and gas operations; including disposal methods, fates, and risks of a spill of such chemicals.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): BOEM needs an updated, descriptive inventory of the chemicals used by the offshore oil and gas industry in the Gulf of Mexico (GOM). These oil and gas activities are authorized under the Outer Continental Shelf Lands Act (OCSLA). According to OCSLA (42 U.S.C. § 1346), BOEM must conduct assessments of environmental impacts related to oil and gas development. Furthermore, this information is needed to better evaluate the waters and sediments of the GOM, as well as the associated biota, in BOEM's leasing National Environmental Policy Act (NEPA) documents. Chemical products used in the GOM remains a controversial topic to the public and of high importance to BOEM's NEPA analyses. A centralized, vetted, and citable study such as this will aid greatly in responding to the questions and concerns that continually arise during the NEPA and consultation processes.

Background: This project is an update of the dated, but highly valuable, Mineral Management Service study by Boehm et al. (2001).Though Boehm et al. (2001) was labelled as a literature review, it had, in practice, a broader scope as it involved important participation from oil and gas operators, chemical suppliers, and government agencies. The study also developed models for offshore exploration and production operations to estimate the volume of chemicals transported, stored, and expected to be used at any one time in the GOM and to assess the ecological risks of chemical spills. In addition, a study

like the one proposed here was completed for chemicals associated with offshore wind power generation facilities (Bejarano et. al., 2013). Bejarano et. al. (2013) identified volumes and types of chemicals commonly present in offshore wind turbines; modeling of fate, transport, behavior, and environmental concentrations of chemicals; and an assessment of the potential consequences to ecological and socioeconomic resources arising from several spill scenarios.

Objectives: The study aims to improve BOEM's knowledge and assessment of the chemicals used in offshore oil and gas activities, as well as the potential environmental effects associated with authorized discharges and unintended releases of these chemicals. This project will update the study prepared by Boehm et al. in 2001. Specific objectives include the following:

- Establish an updated baseline inventory of the chemical products, compounds, and mixtures, types and amounts of hazardous substances stored, handled, transferred to and from, disposed of, and used on offshore oil and gas facilities in all water depths of the GOM
- Develop/update conceptual model(s) that can be used to estimate total volume usage at any time in the future, estimate the chemical usage for a particular project, and estimate potential spill risks as well as possible environmental effects for a range of chemical spill scenarios
- Re-evaluate historic and future trends in chemical usage and effects in shallow vs deep-water oil and gas activities since the Boehm et al. (2001) study

Methods: The study methods are similar to those used by Boehm et al. (2001), including participation from stakeholders, a thorough literature search and synthesis based on updated and currently available information, and the use of models or calculations as appropriate. For example, in the Boehm et al., (2001) study, models were used to estimate future use of chemicals and transport of chemicals as well as the ecological risks of chemical spills (i.e., CHEMMAP). A critical component of this study will be establishing the working group with robust regulatory and industry participation. The specific methods proposed include the following:

- Formulate a strategy to establish a working group between stakeholders, and Federal and state agencies
- Estimate the amount of such chemicals expected to be used in the future in the GOM (values should be separated between shallow and deepwater depths)
- Locate and collect technical information on chemical volumes in GOM operations (values should be separated between shallow and deepwater depths)
- Estimate the volume of each chemical disposed of and describe the common disposal method
- Compare volumes of chemicals released to the GOM by OCS oil and gas activities to other activities that input the same chemicals, or categories of chemicals, into the GOM directly or indirectly (e.g., runoff or river drainage)
- Develop updated detailed chemical profiles for selected chemicals used in offshore operations (e.g., those of highest concern) that contain background information (e.g., fate in the environment, fate in the process system, and other components), chemical and physical properties, health and safety properties, use and handling properties, environmental concentrations and toxicological effects, spill modeling results, aquatic toxicity levels, risk characterization, and references

Specific Research Question(s):

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

Affiliated WWW Sites: https://marinecadastre.gov/espis/#/search/study/100152

References:

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

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

Title	Benthic Community Characterization at BOEM "No Activity Zones"
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Alicia Caporaso (Alicia.Caporaso@boem.gov), Mark Mueller (Mark.Mueller@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2022–2026
Date Revised	February 3, 2021
PICOC Summary	
Problem	BOEM defines 13 "No Activity Zones" (NAZs; presumed to encompass the most ecologically sensitive areas of the Topographic Features) based on the best available scientific information, including recently updated bathymetry and backscatter imagery. However, in situ data collection and habitat characterization of the epifaunal benthic communities have been limited, including at locations of mutual interest to the Flower Garden Banks National Marine Sanctuary (FGBNMS) and BOEM. Improved understanding of the extent and composition of benthic species within these managed areas would improve management agencies' ability to detect and respond to environmental and anthropogenic disturbances by informing mitigation policies and practices, along with other NEPA analyses and consultations.
Intervention	Thirteen NAZs within the FGBNMS will be visually surveyed using remotely operated vehicle (ROV) methodology like that developed in the BOEM-funded Deep-Water Reconnaissance of Potentially Sensitive Biological Features study (Sammarco 2017). Scientific diving teams will also conduct demographic surveys of vulnerable Scleractinian (stony) corals. Unidentified and/or unique organisms will be collected for taxonomic identification.
Comparison	Data collection and analysis will allow BOEM to improve the current NTL 2009-G39 and associated stipulations and mitigations through the development of tailored NAZs and associated mitigations appropriate for each topographic feature.
Outcome	This study will provide BOEM with information needed to support and revise NTL 2009-G39 through quantitative characterization of benthic communities and habitats within GOM NAZs, comparison of communities at topographic features with and without NAZs, and potentially other information about the role NAZ protections are or are not playing for benthic communities and their ecological resilience.
Context	The hermatypic coral reefs of East and West Flower Garden Banks are well documented to be among the healthiest in the western Atlantic and Caribbean region. Such reefs are hot spots for marine biodiversity for a variety of fish and invertebrate species, including threatened and endangered species and species of commercial and recreational importance.

BOEM Information Need(s): Better understanding of the benthic community and habitats of Northern Gulf of Mexico (GOM) topographic features (aka banks or topographic highs) within the established

BOEM No-Activity Zones (NAZs) would improve the efficacy of resource protection and management efforts. The 13 current NAZs, as described in BOEM's Notice to Lessees (NTL) 2009-G39, were designed based on topographic data and benthic characterization methods that are now decades out of date. In the 40 years since their initial exploration, there has been relatively little additional in situ data collection and analysis by which BOEM may improve and strengthen the current NTL and associated stipulations and impact mitigations.

Background: BOEM's NTL 2009-G39 provides guidance for the protection of sensitive biological features within NAZs in the GOM through the prohibition of bottom disturbing activities and release of drilling wastes associated with oil and gas development. The NAZs are based on historical topographical data and limited characterization of associated biological communities from the 1980s and designated around topographic highs using isobaths uniquely specific for each topographic feature. The stipulations imposed within NAZs prohibit activities that may directly impact vulnerable organisms. Parts of a topographic bank located below the specified isobath are not included within an NAZ but may still be subject to mitigations applied by BOEM to minimize negative impacts. At this time, communities and habitats within most GOM NAZs are poorly understood. GM-17-07 "Multibeam Survey of Small Topographic Features to Determine Efficacy of Current "No Activity Zones") compiled existing or collected new multibeam echosounder imagery and provided updated bathymetry and (in some cases) backscatter data to illustrate the location and shapes of the underlying seafloor in order to enable updated NAZ polygon boundaries to be created. However, this effort did not provide any visual imagery or biological or geological collections/sampling.

Objectives: The primary objective of this study is to provide BOEM with additional in situ information needed to support and revise NTL 2009-G39 through quantitative characterization of benthic communities and habitats at NAZs, comparison between topographic features with and without NAZs, and potentially other information about the role NAZ protections are or are not playing for benthic communities and their ecological resilience.

Methods: The 13 NAZs within the recently expanded (January 2021) Flower Garden Banks National Marine Sanctuary (FGBNMS) will be quantitatively, visually surveyed using remotely operated vehicle (ROV) methodology similar to that developed for the BOEM-funded Deep-Water Reconnaissance of Potentially Sensitive Biological Features study (Sammarco, 2017). Specific survey methods will be developed collaboratively with the FGBNMS. In addition, scientific diving teams will conduct detailed demographic survey of vulnerable Scleractinian (stony) corals. Unidentified and/or unique organisms will be collected for accurate taxonomic identification and other potential uses.

To address the question of community resilience, the idea that biodiversity promotes ecosystem functionality and stability will be assumed and classic biodiversity metrics (alpha and beta diversity) will be examined. Further temporal variance of the community structure and diversity will be examined to assess stability.

This study will utilize BOEM-acquired assets including the new Oceanbotics ROV purchased for the FGBNMS Long-Term Monitoring project (GM-18-x01). The FGBNMS will leverage existing relationships with partner research institutions to provide technical diving and scientific planning and analysis expertise to enable robust community assessment and characterization within NAZs. The BOEM scientific dive team may also contribute to fieldwork and data collection.

Specific Research Question(s):

1. What are the distributions, abundance, and demography of coral species and other taxa within GOM NAZs?
2. Do the current GOM NAZs support resilience of the communities and habitat located within and adjacent to them?
3. Are benthic communities and habitats within and among GOM NAZs continuous, heterogenous, or on a spectrum between the two? Does identified variation between NAZ communities indicate the need for unique mitigation parameters?
4. Do GOM NAZs support undescribed species of Scleractinian corals, black corals, octocorals, or sponges that are new to science or are novel records in the GOM?

Affiliated WWW Sites:

https://opendata.boem.gov/BOEM-ESP-Ongoing-Study-Profiles-2019-FYQ3/BOEM-ESP-GM-17-07.PDF

References:

Sammarco, PW, 2017. Deepwater reconnaissance of potentially sensitive biological features surrounding shelf-edge topographic banks in the northern Gulf of Mexico. US Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2017-024. 109 p.

Title	Documenting Deep and Shallow Drill Splay: Improving Resource Guidance
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Alicia Caporaso (Alicia.Caporaso@boem.gov), Scott Sorset (Scott.Sorset@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2022–2026
Date Revised	February 4, 2021
PICOC Summary	
Problem	The spatial extent of oil and gas drilling impacts in the Gulf of Mexico is characterized by the analysis of three wells at similar water depths (CSA 2006). BOEM bases its avoidance mitigations for the protection of many benthic resources on this single study.
Intervention	Geophysical characterization of the seabed within the Area of Potential Effect (before) and Area of Impact (after) associated with well drilling activities; geological and geochemical analysis of the post-drilling sediment splay
Comparison	Comparative analysis of drill splay characteristics in variable water depth and geophysical regimes
Outcome	Development of a more accurate and precise representation of drilling impacts from sediment splay that will improve impact analysis and the application of appropriate mitigation strategies
Context	Drilling sites in shallow (<300 m) and deep water (>300 m) applicable to future forecasted Gulf of Mexico drilling locations

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 from drilling activities may impact biological resources (e.g., coral, benthic fish species, chemosynthetic communities, and other benthic habitats), cultural resources (e.g., shipwrecks) and protected and regulated resources (e.g., endangered species and Essential Fish Habitat). BOEM has relied on limited and dated studies (CSA 2006; NRC 1983; Neff 2005, Enright et al., 2006) to determine the current minimum distance(s) necessary to avoid/mitigate impacts to biologically sensitive areas and archaeological resources.

BOEM is responsible for documenting routine impacts as part of its environmental compliance practices under the National Environmental Policy Act (NEPA), Magnuson-Stevens Act, and OCS Lands Act. This study will examine multiple impact-producing factors (e.g., drilling muds and cuttings, produced water contaminants in sediment, seabed disturbance) and their potential impact on biological and cultural resources. The result will satisfy information needs on drilling disturbance for NEPA analysis and inform an evaluation on current avoidance buffers for post-lease activity.

Background: Bottom-disturbing operations can damage benthic biological and archaeological resources on or near the seabed. Biologically sensitive communities may be smothered or exposed to toxins and

archaeological resources may be damaged. BOEM provides guidance to operators for the avoidance and protection of biologically sensitive features and archaeological resources. Lease stipulations and other appropriate mitigations to avoid and protect such habitats have been made a part of OCS oil and gas leasing 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 guidance provided in Notices to Lessees & Operators. However, the efficacy of BOEM's mitigations regarding bottom impacts has not been rigorously evaluated in the Gulf of Mexico since 2006 (CSA 2006). A universal analysis of the potential benthic impacts from drilling is needed to ensure environmentally responsible development of the OCS. After seeking input from survey operators and conducting market research, we have recommended the following objectives and methods based on current technological capabilities:

Objectives: The primary objectives of this study are the following:

1. Assess the spatial extent of impact from drilling
2. Compare the impact distance of drilling at sites of differing water depth and seafloor characteristics
3. Evaluate current stipulations and mitigations and provide recommendations to management on best practices regarding bottom-disturbing activities

Methods: Through the drilling permit process, study sites will be identified that are targeted for imminent drilling. CSA (2006) sampled drilling sites in 1,000 to 1,125 m water depth. This study will target two sites each in shallow, shelf water (<200 m), deep (< 300 m) water, and very deep (>1,000 m) water for a total of six well sites.

Comparison of geophysical seabed data (multibeam bathymetry, side scan sonar, sub-bottom profiler) collected before and after drilling will allow BOEM to determine the vertical and horizontal extent of drill splay. Baseline data will be collected prior to drilling and the surveys will be repeated (with the same equipment on the same survey lines) within one year after drilling. Current meters will be deployed during survey operations.

Gravity cores will be collected within the drill splay to provide an independent assessment of vertical accumulation and to characterize the deposited muds and cuttings. Coring locations will be determined using results of the post-drilling survey. Four cores will be collected along a single transect along the radius of the maximum drill splay starting at 500' minimum distance from the drill site. A fifth, 'control' core will be taken outside of the splay at the edge of the survey area. Potential target analyses on the sediment cores include sediment type, grain size, heavy metals, trace metals, hydrocarbon compounds, and TENORMS.

Specific Research Question(s):

1. How do seafloor impacts from drill splay vary with distance from drill sites and water depth?
2. Are BOEM's current avoidance guidelines for well site surface locations sufficient to mitigate impacts to biological and archaeological resources? How should avoidance guidelines be revised to take into account water depth, hydrological regime, etc.

References:

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

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

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

Enright JM, Gearhart R II, Jones D, Enright J. 2006 Study to Conduct National Register of Historic Places Evaluations of Submerged Sites on the Gulf of Mexico Outer Continental Shelf. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, L.A. OCS Study MMS 2006- 036. 136 pp.

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

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

Title	Documenting Historic Deep and Shallow Drill Splay: Improving Resource Guidance
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Alicia Caporaso (Alicia.Caporaso@boem.gov), Scott Sorset (Scott.Sorset@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2022–2024
Date Revised	February 4, 2021
PICOC Summary	
Problem	The spatial extent of oil and gas drilling impacts in the Gulf of Mexico is characterized by the analysis of three wells at similar water depths (CSA 2006). BOEM bases its avoidance mitigations for the protection of many benthic resources on this single study.
Intervention	Geophysical characterization of the seabed within the Area of Potential Effect associated with well drilling activities. Geological and geochemical analysis of the post-drilling sediment splay.
Comparison	Comparative analysis of drill splay characteristics in variable water depth, geophysical regimes, and ages.
Outcome	Development of a more accurate and precise representation of drilling impacts from sediment splay over time that will improve impact analysis and the application of appropriate mitigation strategies.
Context	Drilling sites in shallow (<300 m) and deepwater (>300 m) applicable to future forecasted Gulf of Mexico drilling locations.

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 seabed disturbance from drilling activities which may cause impacts to biological resources (e.g., coral, benthic fish species, chemosynthetic communities, and other benthic habitats), cultural resources (e.g., shipwrecks) and protected and regulated resources (e.g., endangered species and Essential Fish Habitat). BOEM has relied on limited and dated studies (CSA 2006; NRC 1983; Neff 2005; Enright et al., 2006) to determine the current minimum distance(s) necessary to avoid impacts to biologically sensitive areas and archaeological resources.

BOEM is responsible for documenting routine impacts as part of its environmental compliance practices under the National Environmental Policy Act (NEPA), Magnuson-Stevens Act, and OCS Lands Act. This study will examine multiple impact-producing factors (e.g., drilling muds and cuttings, produced water contaminants in sediment, seabed disturbance) and their potential impact on biological and cultural resources, and how this impact may evolve over time. The result will satisfy information needs on drilling disturbance for NEPA analysis and inform an evaluation on current avoidance buffers for post-lease activity.

Background: Bottom-disturbing operations can damage benthic biological and archaeological resources on or near the seabed. Biologically sensitive communities may be smothered or exposed to toxins and archaeological resources may be damaged. BOEM provides guidance to operators for the avoidance and protection of biologically sensitive features and archaeological resources. Lease stipulations and other appropriate mitigations to avoid and protect such habitats have been made a part of OCS oil and gas leasing 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 guidance provided in Notices to Lessees & Operators. However, the efficacy of BOEM's mitigations regarding bottom impacts has not been rigorously evaluated in the Gulf of Mexico since 2006 (CSA 2006). A universal analysis of the potential seafloor impacts from drilling is needed to ensure environmentally responsible development of the OCS.

Objectives: The primary objectives of this study are the following:

1. Assess the spatial extent of impact from drilling
2. Compare the impact distance of drilling at sites of differing water depth and seafloor characteristics
3. Compare the potential variation in seafloor impacts as drilling splays age
4. Evaluate current stipulations and mitigations and provide recommendations to management on best practices regarding bottom-disturbing activities

Methods: CSA (2006) sampled drilling sites in 1,000 to 1,125 m water depth. This study will target completed drilled well sites, including those plugged and abandoned, of differing ages (~2, ~5, and ~10 years) in shallow, shelf water (<200 m), and deep (<300 m) water for up to 20 wells.

Selected well sites will be surveyed and comparison of geophysical seabed data (multibeam bathymetry, side scan sonar, sub-bottom profiler) will allow BOEM to determine the vertical and horizontal extent of drill splay compared to the surrounding sediments. Current meters will be deployed during survey operations.

Gravity cores will be collected within the drill splay to provide an assessment of vertical accumulation and to characterize the deposited muds and cuttings. Coring locations will be determined using results of the geophysical survey. Four cores will be collected along a single transect along the radius of the maximum drill splay starting at 500' minimum distance from the drill site. A fifth, 'control' core will be taken outside of the splay at the edge of the survey area. Potential target analyses on the sediment cores include sediment type, grain size, heavy metals, trace metals, hydrocarbon compounds, and TENORMS.

Specific Research Question(s):

1. How do seafloor impacts from drill splay vary with distance from drills sites and water depth?
2. How do seafloor impacts from drill splay vary with time at the drill sites at different water depths?
3. Are BOEM's current avoidance guidelines for well site surface locations sufficient to mitigate impacts to biological and archaeological resources? How should avoidance guidelines be revised to take into account water depth, hydrological regime, etc.

References:

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

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

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

Enright JM, Gearhart R II, Jones D, Enright J. 2006 Study to Conduct National Register of Historic Places Evaluations of Submerged Sites on the Gulf of Mexico Outer Continental Shelf. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, L.A. OCS Study MMS 2006- 036. 136 pp.

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

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

Title	Efficacy of Unmanned Aircraft Systems (UAS) to Improve Mitigation Measures Required for Seismic Surveying and Site Construction and Removals
Administered by	Gulf of Mexico Regional Office, Headquarters
BOEM Contact(s)	Tom Bjerstedt (thomas.bjerstedt@boem.gov), Jacob Levenson (jacob.Levenson@boem.gov), Jessica Mallindine (jessica.mallindine@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2024
Date Revised	February 12, 2021
PICOC Summary	
Problem	UAS monitoring is a new paradigm for fulfilling mitigative requirements, such as protected species observer (PSO) responsibilities, which are currently based on 2D "line-of-sight" monitoring. In conjunction or in lieu of other mitigative monitoring measures, UAS has the potential to further reduce risk to species of concern that could be impacted by activities authorized and/or associated with leased areas. It also presents large operational cost savings and much improved safety margins if displacing manned platforms.
Intervention	Determine the efficacy of use and cost of UAS technologies for mitigations, such as PSO monitoring procedures, as compared to traditional practices used within all BOEM program areas
Comparison	There has been no formal integration and assessment of UAS technology into current mitigative practices. Determination of the efficacy of UAS thermal tools for existing protocols could modify existing parameters and influence NMFS Biological Opinions and Incidental Take Regulations in the future, while reducing survey and mitigation costs across all BOEM program areas.
Outcome	A quantitative evaluation of the efficacy of UAS technology for PSO monitoring and other mitigative procedures currently employed across regions. This evaluation of UAS use to implement mitigations as compared to other common mitigation measures will provide a baseline recommendation on future use of this technology which will directly inform BOEM on mitigation strategies.
Context	All Regions: Alaska OCS, Atlantic OCS, GOM OCS, Pacific OCS

BOEM Information Need(s): Mitigation measures exist for all BOEM programs to lessen impacts on sensitive resources while supporting national energy and marine mineral program needs. The National Marine Fisheries Service Incidental Take Regulation is an outfall of increasing interdependency between resource agencies charged with protecting sensitive marine mammals and sea turtles, while allowing agency missions to be fulfilled. Mitigation measures are applied throughout BOEM consultations (e.g., Endangered Species Act Section 7) and NEPA implementation and are designed to reduce or avoid impacts on sensitive resources including endangered and protected marine mammals and sea turtles. Mitigations tend to add cost, introduce potential human error, and impose safety risks during implementation of mitigation measures in the field. Industry is exposed to risk of activity shutdown when mitigations cannot be met or maintained. Interest in maximizing UAS as a viable alternative to satisfy or improve certain mitigation requirements will expand as field deployments of UAS technology

develop. As a permitting agency, BOEM's responsibilities include gauging the effectiveness of mitigations used to protect sensitive marine mammals and sea turtles, especially when new technology allows rethinking of current practices. Further, BOEM should be seeking mitigation measures that pose the least danger to human health and safety while accomplishing mitigation goals. BOEM is obligated to take a hard look at alternative mitigation measures that can substitute for putting air crews into helicopters and aircraft.

Background: Although there are examples of UAS usage in conservation (Lopez and Muelo-Pazmany, 2019) there is virtually no published information on the use of, or suitability of, UAS system(s) to monitor the presence or types of Marine mammals in restricted areas, such as seismic buffer zones, or structural removal and foundation construction sites. The advantages offered by UASs are becoming more evident in commercial maritime operations, such as delivery of goods to isolated vessels, and inspections and surveillance of oil platforms. UAS technology is advancing quickly and regulatory bodies such as the Federal Aviation Administration are trying to keep up.

Objectives: Evaluate the efficacy of the use and cost of UAS technologies as a means of PSO monitoring procedures as compared to other common mitigation measures.

Methods: The following methods are proposed to evaluate the efficacy and feasibility of UAS technology:

- Identify current existing or future mitigations with the potential for improvement or replacement with deployment of UAS
- Conduct desktop analysis of capabilities and constraints of UAS commercially available hardware and the adaptability of available technology pertaining to current mitigations across all regions
- Identify strategies that could improve current PSO activities and practices using UAS
- Assess environmental, financial, legal and safety ramifications of UAS as it relates to existing mitigation requirements within the BOEM agency mission
- Perform a cost analysis for incremental costs to an operator running a UAS

A report will be generated outlining the findings as well as suggestions to BOEM management regarding existing and potential mitigation efficacy. This evaluation of UAS will provide a baseline recommendation on future testing and use of this technology which will directly inform BOEM on mitigation strategies.

Specific Research Question(s): The proposed work is designed to address the following questions: Can systematic use of UASs increase the effectiveness of monitoring seismic buffer zones by modifying current PSO practice? What are the decreased cost and increased safety factors UASs offer during site clearance activity for structural removal and foundation pile-driving? Can UAS platforms materially improve information on genus and species distributions with the added capability of PSO monitoring in 3D as opposed to 2D line-of-sight?

References:

Barrett E. 2019. The U.S. Interior Department has grounded its fleet of 800 drones, fearing Chinese surveillance. Fortune Magazine, Internet website posted October 31, 2019. Accessed January 30, 2020. https://fortune.com/2019/10/31/doi-grounded-china-drone-fleet-surveillance/

Lopez JJ, Mulero-Pazmany M. 2019. Drones for conservation in protected areas: present and future. Drones, 3(1). 23 pp. Doi:10.3390/drones3010010

Title	Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico (GOM)
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Contract, Inter-agency Agreement, Cooperative Agreement
Performance Period	FY 2022–2024
Date Revised	March 30, 2021
PICOC Summary	
Problem	Abandoned oil and gas wells are not typically inspected. If there are abandoned wells that leak, little is known about the environmental impact on the air and water quality.
Intervention	Identify leaks from abandoned wells and measure to determine if the leaks are significant enough to emit air pollution at the sea surface, affect water quality, or have potential to impact coastal areas.
Comparison	Comparison between the air and water quality impacts of leaking and non-leaking abandoned wells.
Outcome	Assessment of the environmental risks from abandoned oil and gas wells.
Context	Central GOM and Western GOM

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

Background: It has been shown that leaking abandoned oil and gas wells onshore in the United States emit methane (Townsend-Small et al., 2016a). In the State of Louisiana "orphan wells" are known with some located in state waters of the GOM (DNR, 2020). Orphan wells are unrestored abandoned oil and gas wells. In the federal waters of the GOM, it is not well understood if abandoned wells are leaking and if this could cause long-term impacts to the air and water quality. The GOM has thousands of abandoned oil and gas wells with some dating back to the 1960s. Due to the large number of wells, few inspections are conducted. Evaluating the environmental risks will support BOEM's future decommissioning environmental impact statement for the GOM.

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

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

Objectives:

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

Methods: This project would identify leaks from 30–50 randomly selected abandoned wells by using subsurface cameras, water column measurements (temperature, dissolved oxygen, dissolved methane, etc.), and surface measurements. This would include collecting water samples from leaking and non-leaking wells to extract volatile air pollutants (methane and volatile organic compounds) using headspace extraction methods (Townsend-Small et al., 2016b). Wells selected for this study may include areas for potential CO_2 geological storage (DOE, 2020). Contoured magnetometer surveys would be conducted to confirm the location of the abandoned wells. Video footage would be collected using a remotely operated vehicle (ROV). Water samples and water column measurements would be collected using a water sampler device and Sonde, respectively. Water column profiles would be generated. Satellite imaging may be used to identify the extent of leaks. For oil, slicks have been observable by the synthetic aperture radar (MacDonald et al., 2015). The National Aeronautics and Space Administration (NASA) plans to launch NASA-ISRO Synthetic Aperture Radar (NISAR) in 2022 (NASA).

Specific Research Question(s):

1. Are there abandoned oil and gas wells leaking in the GOM?
2. Is there a correlation between the age of well and potential for leakage? Are there other correlations?
3. Are the leaks enough to emit air pollution at the sea surface?
4. If the leaks are enough to emit air pollution at the sea surface, what are the emission rates?
5. Are the leaks enough to affect water quality in the vicinity of the well?
6. Do the leaks have the potential to reach coastal areas?
7. What biodiversity was observed in the abandoned oil and gas well area?

References:

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

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

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

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

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

NASA. NISAR: The NASA-ISRO SAR Mission. Accessed March 24, 2020. Internet website: https://nisar.jpl.nasa.gov/system/documents/files/9_NISAR_Applications_OilSpills1.pdf

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

Townsend-Small A, Ferrara TW, Lyon DR, Fries AE, Lamb BK. 2016a. Emissions of coalbed and natural gas methane from abandoned oil and gas wells in the United States. Geophysical Research Letters, 43: 2283-2290, https://doi.org/10.1002/2015GL067623.

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

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

Title	Live Forecasts of Migratory Bird Movements Offshore to Monitor Potential Avian Interactions with Wind Development
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Timothy White (timothy.white@gmail.com), Jeri Wisman (jeri.wisman@boem.gov), Tershara Matthews (tershara.matthews@boem.gov)
Procurement Type(s)	Cooperative Agreement though Cooperative Ecosystem Studies Units (CESU)
Performance Period	FY 2022–2024
Date Revised	January 25, 2021
PICOC Summary	
Problem	During spring and fall migration, significant numbers of birds migrate offshore at night in the Gulf of Mexico and the Atlantic. These diverse populations may lethally interact with offshore wind energy infrastructure.
Intervention	We propose modifying migratory bird forecasting models previously developed to track terrestrial bird migratory movements and apply them to offshore forecasting in areas with high wind energy development potential.
Comparison	We will compare the updated forecasting models of migratory bird movement and densities with NEXRAD imagery collected at coastal stations in the Gulf of Mexico and the Atlantic to determine overlap with high potential offshore wind energy sites.
Outcome	Proposed products include offshore near-real-time forecasts of migratory bird populations to inform offshore wind energy site planning and permitting. Live model predictions will consist of migration traffic rate (thousands of birds/km/hour) for offshore locations in the Gulf of Mexico and the Atlantic.
Context	Gulf of Mexico and Atlantic

BOEM Information Need(s): To determine suitable areas of offshore wind development in the Gulf of Mexico (GOM) and Atlantic, BOEM must examine potential environmental impacts to biological resources in potential Wind Energy Areas (WEAs). Wind energy installations have the potential to negatively impact avian resources through strike, habitat loss, or fragmentation of migratory corridors. The careful selection of WEAs could likely mitigate these potential impacts. BOEM can determine potential spatial conflicts between WEAs and bird migration routes by evaluating real-time forecasting of migratory bird movements with the NEXRAD network by NOAA's National Weather Service. Live forecasting of migration traffic rates near WEAs could inform the permitting process of wind energy planning and development in the GOM and the Atlantic. This project will examine the forecasting accuracy of migratory bird movements associated with data collected at individual NEXRAD stations nearest to coastal BOEM lease areas. Real time forecasting also provides mitigation options if short-term operational shutdowns could minimize significant mortality events.

Background: While the GOM has established an- active offshore conventional energy industry, no offshore renewable infrastructure yet exists in the region. However, interest in offshore wind is growing in the GOM. For example, Louisiana's governor requested that BOEM establish a renewable energy task

force for the development of offshore wind in Federal GOM waters. Two studies published in 2020 determined that offshore wind has promising resource potential in offshore areas of Texas, Louisiana, and Florida.

A critical first step to realizing an offshore wind facility in the GOM is locating a WEA. Roughly 2.1 billion migratory birds cross the GOM during spring and fall migration every year, as estimated from models derived from the NEXRAD network and visual observations (Horton et al., 2019). Cornell University has developed terrestrial real-time forecasts of migratory bird populations to help citizens and managers track daily movements with the free online tool BirdCast. These forecasts work well when applied to the identification of migratory flight volume and in-flight aggregation zones (Horton et al., 2019; Van Doren et al. 2017).

Objectives: Determine migratory patterns of birds in nearshore Federal waters of the GOM and Atlantic. The specific objectives are the following:

- Modify migratory bird forecasts created by Cornell to extend the terrestrial models of BirdCast to include offshore regions
- Create real-time interactive maps of offshore migration for managers and the public to access

Methods:

- Develop an initial analytical pipeline using NEXRAD imagery at locations nearest to the coast and for locations with heavy migratory bird traffic rates (e.g., Brownsville and Corpus Christi, TX). This first step is meant to calibrate the models to detect and filter bird-like scattering in the imagery for areas with heavy seasonal migration. After calibration, the modeling framework will be applied to imagery collected from different NEXRAD stations close to the coast.
- Use synoptically occurring eBird data to verify bird-like scattering in NEXRAD imagery. Birds migrate at night and feed during the day. We will use eBird observations to infer the constituents of the NEXRAD scattering (migratory flocks) the night before, which is routine practice.
- Modify existing terrestrial bird forecasts (i.e., BirdCast) to create offshore forecasts of landbirds in the GOM and the Atlantic.

Specific Research Question(s):

1. Can imagery collected by the NEXRAD network be used to develop seasonally reliable forecasts of migratory bird movement and densities in the GOM and the Atlantic?
2. Which locations in the GOM and the Atlantic will the offshore bird migration forecast maps produce the highest confidence and be most useful for wind energy development?

Affiliated WWW Sites: NEXRAD locations: https://www.roc.noaa.gov/WSR88D/Maps.aspx; BirdCast: https://birdcast.info/

References:

Horton KG, Van Doren BM, La Sorte FA, Cohen EB, Clipp HL, Buler JJ, Fink D, Kelly JF, Farnsworth A. 2019. Holding steady: Little change in intensity or timing of bird migration over the Gulf of Mexico. Global change biology, 25(3), pp.1106-1118.

Horton KG, Nilsson C, Van Doren BM, La Sorte FA, Dokter AM, Farnsworth A. 2019. Bright lights in the big cities: migratory birds' exposure to artificial light. Frontiers in Ecology and the Environment, 17(4), pp.209-214.

Van Doren BM, Horton KG, Dokter AM, Klinck H, Elbin SB, Farnsworth A. 2017. High-intensity urban light installation dramatically alters nocturnal bird migration. Proceedings of the National Academy of Sciences, 114(42), pp.11175-11180.

Title	Reevaluating BOEM's Guidelines for Identifying Submerged Pre-Contact Archaeological Sites in the Gulf of Mexico
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Melanie Damour (Melanie.Damour@boem.gov), Jimmy Moore (James.Moore@boem.gov)
Procurement Type(s)	Cooperative Agreement (potentially through the Gulf Coast CESU)
Performance Period	FY 2022–2027
Date Revised	January 27, 2021
PICOC Summary	
Problem	Submerged pre-contact sites on the OCS are difficult to identify and confirm using traditional mapping technologies and BOEM's current survey guidelines. BOEM errs on the side of caution by assigning avoidance mitigations to potential, but unconfirmed, paleolandscapes that may or may not actually contain preserved archaeological features. This results in avoidance of areas that may not actually warrant exclusion from OCS activities across BOEM's three program areas. Additionally, the identification and preservation of pre-contact cultural resources are frequently cited as priorities by Native American tribes in BOEM's government-to-government consultations.
Intervention	Develop updated paleolandscape reconstructions for selected areas of the GOM and test a survey methodology(ies) to better delineate submerged paleolandforms potentially containing preserved archaeological remains.
Comparison	Conduct geophysical surveys, collect sediment and other appropriate samples, and investigate potential sites to compare and contrast the effectiveness of a revised survey and testing methodology in geologically distinct areas: the Western GOM and Eastern GOM, at a minimum.
Outcome	Updated paleolandscape reconstructions of selected study areas. A revised methodology(ies) is needed, potentially utilizing modern state-of-the-art technology or innovative use of existing technology, to better identify preserved paleolandscapes and potential archaeological sites for avoidance, update existing survey guidelines, and allow BOEM to design more effective archaeological mitigations to better balance OCS resource development with protection of non-renewable submerged pre-contact cultural resources. Study results will also inform and facilitate meaningful Tribal consultations.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): BOEM is required to consider the potential effects of its activities on cultural resources per the National Historic Preservation Act (NHPA) of 1966, OCS Lands Act of 1953, and National Environmental Policy Act (NEPA) of 1969. For conventional energy development in the GOM, BOEM currently requires geophysical survey line spacing of 300 m in water depths less than 60 m using traditional Chirp sub-bottom profiling systems to identify potentially preserved submerged paleolandscapes. These tentatively identified paleolandscapes *may* contain preserved landforms and

features that could have supported human populations when the OCS was subaerially exposed during the Last Glacial Maximum, but these areas are not required to be investigated to confirm their nature or to determine their spatial extent. As a result of this incomplete information, BOEM archaeologists prescribe avoidances as conditions of permit approval to ensure that no potential archaeological resources will be impacted by the proposed activity. However, these avoidances may be prescribed in areas that do not actually contain preserved paleolandforms or archaeological remains, or were misidentified due to inconsistencies in geophysical data interpretation and paleolandform identification nomenclature (see Heinrich et al. 2020), thereby unnecessarily reducing the area available for industry activities. Updated paleolandscape reconstructions (modeling that integrates past environmental conditions, geological processes, local sea level history, regional human settlement patterns and culture history, and geophysical/geotechnical data) are necessary to identify areas of the GOM more likely to contain preserved submerged landforms. In addition, BOEM requires an assessment of, and suggested revisions to, its existing survey guidelines and prescribed methodologies to better identify submerged paleolandforms that may support preservation of pre-contact archaeological remains. This information will be used to design more effective avoidance mitigations and better delineate potentially preserved landform features and archaeological remains while increasing the availability of OCS lands for conventional and renewable energy development and marine minerals utilization. State-of-the-art advances in sub-bottom acoustic technologies, paleolandscape reconstructions, and survey methodologies have been made in the 16 years since the issuance of NTL 2005-G07. Incorporating these recent advancements into revised and updated survey guidelines will better inform BOEM's archaeological avoidance mitigations and resource management responsibilities, which will further inform BOEM's government-to-government consultation responsibilities with Native American tribes under E.O. 13175, S.O. 3317, and the DOI Policy on Consultation with Indian Tribes. While the study focuses on the GOM, study results, including a revised methodology or methodologies based on empirical data and field testing, will inform all three program areas and the other BOEM regions.

Background: Several confirmed and more than a dozen potential submerged pre-contact sites have been identified by archaeologists off the northeastern Gulf coast of Florida since the 1980s, yet none have been positively identified in the northwestern GOM to date (Faught 2004, Evans 2012). In 2016, the preserved remains of a freshwater pond containing 8,000-year-old human burials was discovered eroding from the seafloor in state waters off the coast of Manasota Key (MKO), southwest Florida (Florida DOS 2020). The site is currently being investigated by the State of Florida and BOEM to determine why it exhibits such remarkable preservation in the marine environment and survived marine transgression during sea level rise. Under BOEM's existing survey guidelines for identifying potential submerged pre-contact sites—300-m survey line spacing—the site likely would not have been detected. In addition, a geophysical survey conducted after the site was discovered using a traditional Chirp sub-bottom profiler did *not* sufficiently resolve the intact strata containing the burials or independently provide evidence that archaeological features were present. The ongoing study at MKO (M19AC00014) conducted a new survey in 2019 utilizing a parametric sub-bottom profiling system to collect high-resolution acoustic data at 1-m line spacing. Using that dataset, data from various survey line increments (e.g., every 10-m, 20-m, 30-m, etc.) are being reanalyzed to determine the widest line spacing at which the known site and its preserved intact (e.g., undisturbed) strata can be sufficiently resolved for a BOEM archaeologist to recommend avoidance. Results from the MKO study will inform this proposed follow-up BOEM study to determine if revisions to BOEM's current prescribed survey methodologies can better identify and delineate submerged paleolandscapes with a high probability to support preserved archaeological remains in other areas of the GOM.

Objectives:

1. Develop updated/refined regional paleolandscape reconstructions to identify areas with a higher preservation potential for pre-contact archaeological remains.
2. Design, test the efficacy of, and compare results from a revised survey methodology(ies) conducted in geologically distinct areas of the GOM to recommend best practices to better detect and delineate preserved paleolandforms and assess their likelihood of containing archaeological materials.
3. Recommend a more effective methodology(ies) and revisions to BOEM's current survey guidelines for submerged paleolandscapes in the Gulf of Mexico Region.

Methods:

- Assess the currently available data and known/potential site locations for submerged pre-contact sites in the GOM and compile a geospatial database including preservation potential (and lack of potential), estimated age of landforms, depth of burial, and other pertinent information.
- Conduct geophysical surveys and investigations of identified potential submerged archaeological features in geologically and environmentally distinct areas in the northern GOM for a comparative analysis of methodologies: at a minimum, areas in the Eastern GOM and Western GOM.
- Ground-truth high-potential targets to determine their age, nature, and extent.
- Collect sediment samples and conduct appropriate analyses for paleoenvironmental reconstructions.

Specific Research Question(s):

1. What revisions to BOEM's current survey guidelines and recommended methodologies will better detect and delineate preserved paleolandforms likely to contain archaeological materials?
2. Which areas of the GOM are more likely to contain preserved paleolandforms with the potential for archaeological features/materials?

References:

Evans A. 2012. Out of Site but Not Out of Mind: Submerged Prehistoric Landscapes on the Northwestern Gulf of Mexico Outer Continental Shelf. PhD Dissertation. Louisiana State University, Baton Rouge, LA.

Faught M. 2004. The Underwater Archaeology of Paleolandscapes, Apalachee Bay, Florida. American Antiquity 69(2):275–289.

Florida Department of State (DOS), 2020. Manasota Key Offshore. https://dos.myflorida.com/historical/archaeology/projects/manasota-key-offshore/

Heinrich PV, Miner M, Paulsell R, McCulloh RP. 2020. Response of Late Quarternary Valley Systems to Holocene Sea Level Rise on Continental Shelf Offshore Louisiana: Preservation Potential of Paleolandscapes. Louisiana State University. Baton Rouge, LA. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, OCS Study BOEM 2020-004. https://marinecadastre.gov/espis/#/search/study/100244

Title	Scoping Study on Offshore Oil and Gas Air Emissions Factors
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Contract, Inter-agency Agreement
Performance Period	FY 2022–2024
Date Revised	April 1, 2021
PICOC Summary	
Problem	Many of the emission factors currently used to estimate air emissions from offshore oil and gas activities may be outdated or were developed for onshore applications, which could potentially create large uncertainties in estimating offshore oil and gas emissions.
Intervention	Conduct research to assess and rank which air emission factors for offshore oil and gas activities should be updated or developed to improve their accuracy.
Comparison	Using the offshore inventories, Eastern Gulf of Mexico USEPA permits (actual monitoring data), literature searches, and emission factors developed by the USEPA, rate the emission factors currently in use by BOEM for emission calculations and rank the emissions factors in terms of priority for updating.
Outcome	Identify the top five emissions factors for offshore oil and gas sources in the Gulf of Mexico that would have the most impact when improved
Context	Central GOM and Western GOM

BOEM Information Need(s): To help determine if the Outer Continental Shelf (OCS) oil and gas exploration, development, and production activities comply with the National Ambient Air Quality Standards (NAAQS) required under the Outer Continental Shelf Lands Act (OCSLA), BOEM needs to examine which emission factors used to calculate emission estimates need updating. OCSLA under section 5(a)(8) requires compliance with the NAAQS pursuant to the Clean Air Act (42 U.S.C. 7401 et. seq.). NAAQS cover six common criteria air pollutants that are considered harmful to the public. Emission estimates are important for conducting environmental assessments for the National Environmental Policy Act (NEPA) and to help BOEM evaluate air quality model predictions that have been used to determine compliance with the NAAQS.

Background: The Clean Air Act requires the USEPA to set the NAAQS for air pollutants considered harmful to the public that are released from numerous and diverse sources. The 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 emission estimates and modeling. To calculate emission estimates, activity data is 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.

Many of the emissions factors currently used by BOEM to estimate emissions from offshore sources haven't been updated in years or were developed for onshore applications. This study would conduct

research to assess and rank offshore oil and gas sources emissions factors that should be updated and suggest appropriate recommendations on how to update those emissions factors.

Objectives:

- Assess and rank which offshore emissions factors should be updated to more accurately provide estimates of emissions for BOEM's impact assessments.
- Provide 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. The following methods would be addressed:

1. Inventory all offshore emissions and emissions sources (including fugitives, flaring, cold venting, painting, welding, blasting, 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 data and likely do not represent synthetic muds today). There may not be valid fugitive factors for older facilities that have not performed routine inspection followed by maintenance.
3. Identify emission rates that depend on how the equipment is used (i.e. average rates are reasonable 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. Rank the factors needing an update based on literature searches, verification, or needing multiple factors (e.g. 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). This would include considering the number of equipment pieces that operate in the GOM.
6. Design a plan for emissions factor development/update – i.e. research, source test verification, plan to be accepted by USEPA and used in USEPA's WEBFIRE, top-down methods, or other.

Specific Research Question(s):

1. Which offshore emissions factors need updating?
2. What recommendation is given to improve those emissions factors that need updating?

Title	Study of Plastic Pollution from Abandoned Umbilicals in the Gulf of Mexico (GOM)
Administered by	New Orleans Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov), Sarah Vaughn (sarah.vaughn@boem.gov)
Procurement Type(s)	Contract, Inter-agency Agreement, Cooperative Agreement
Performance Period	FY 2022–2023
Date Revised	March 31, 2021
PICOC Summary	
Problem	Little is known about the environmental impact from the plastic degradation from abandoned umbilicals on water quality.
Intervention	Identify plastic degradation from abandoned umbilicals, and characterize and determine rate of degradation.
Comparison	Comparison between identified plastic degradation from a random sample of abandoned umbilicals.
Outcome	Assessment of the environmental risks from plastic degradation from abandoned umbilicals.
Context	Central GOM and Western GOM

BOEM Information Need(s): BOEM needs to identify if abandoned umbilicals are releasing plastics in the GOM. These activities are authorized under the Outer Continental Shelf Lands Act (OCSLA) and plastic degradation could have long-term impacts to the human and marine environment. According to OCSLA (42 U.S.C. § 1346) BOEM must conduct assessments of environmental impacts related to oil and gas development. The data collected from this study would be used in environmental analyses, prepared pursuant to the National Environmental Policy Act, because potential plastic degradation would be identified and measured to examine the environmental risks to the water quality.

Background: Offshore umbilicals are a type of cable that provides a connection to subsea infrastructure, which includes power and transfer of chemicals. These umbilicals are frequently abandoned in the Gulf of Mexico and consist of polymer layers (Frazer et al., 2015). Over time these polymer layers weaken and release plastic into the environment (Cárdenas et al., 2007). The degradation of these plastic materials in the Gulf of Mexico has not been well studied regarding their environmental risk. Studying the degradation of these plastics from abandoned umbilicals will help to further our knowledge in understanding their contribution to microplastics in the Gulf of Mexico (National Academies of Sciences, Engineering, and Medicine, 2020).

Objective: The goal of this project is to evaluate the environmental risks from plastic degradation from abandoned umbilicals.

Methods: This project would collect samples from a random sample of at least five abandoned umbilicals in the Gulf of Mexico to identify and characterize plastic degradation using microscopy, microtomography, infrared microscopy and other methods (Halle et al., 2016; Cárdenas et al., 2007). Ship time would be required to collect samples. A thermal analysis using differential scanning

calorimetry and thermal gravimetric analysis and other methods would be used to determine the rate of degradation of the abandoned umbilical at the time of sampling (Chamas et al., 2020). A literature search would also be conducted to search for toxicity studies from named plastics that match the plastic(s) being used in umbilicals.

Specific Research Question(s):

1. Is plastic degradation occurring from abandoned umbilicals?
2. Which types of plastic are degrading?
3. At what rate is the identified plastic degrading?
4. Do any known factors such as age, composition, or water depth of the abandoned umbilicals impact the degradation rate?
5. Is there any literature on toxicity studies from named plastics that match the plastic(s) being used in umbilicals?

References:

National Academies of Sciences, Engineering, and Medicine 2020. Emerging Technologies to Advance Research and Decisions on the Environmental Health Effects of Microplastics: Proceedings of a Workshop in Brief. Washington, DC: The National Academies Press. https://doi.org/10.17226/25862.

Frazer S. J., Madden D. 2015. Umbilical. United States Patent Application, Publication Pub. No.: US 2015/0354292 A1. https://patentimages.storage.googleapis.com/5a/81/59/91beb3fdafdde9/US9010439.pdf

Cárdenas N. O., Machado I. F., Goncalves E. 2007. Cyclic loading and marine environment effects on the properties of HDPE umbilical cables. Journal of Material Science. 42: 6935–6941. https://link.springer.com/article/10.1007/s10853-006-1313-z.

Halle A., Ladirat L., Gendre X., Gouduneche D., Pusineri C., Routaboul C., Tenailleau C., Duployer B., Perez E. 2016. Understanding the fragmentation pattern of marine plastic debris. 50(11): 5668–5675. https://doi.org/10.1021/acs.est.6b00594.

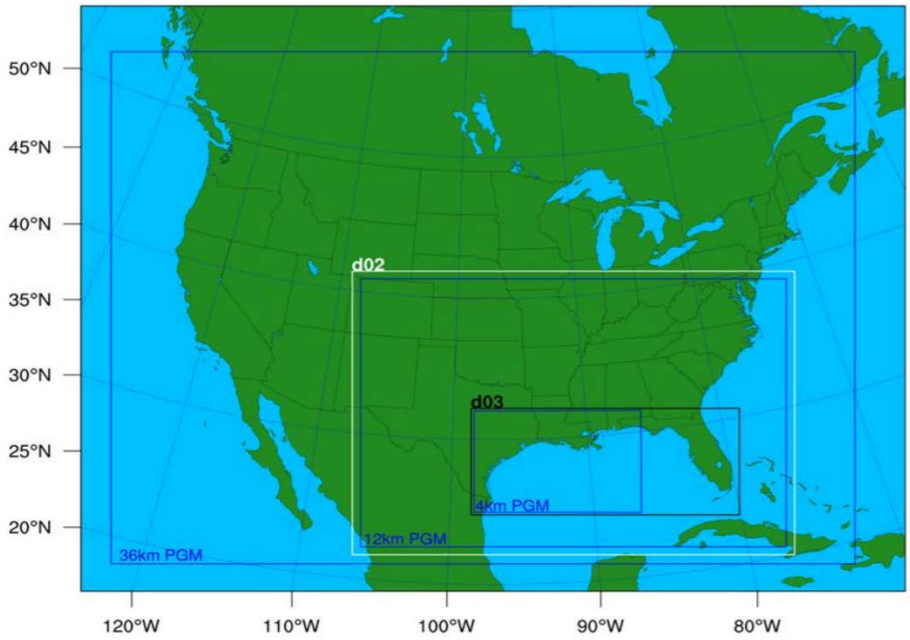
Chamas A., Moon H., Zheng J., Qiu Y., Tabassum T., Hee Jang J., Abu-Omar M., Scott S. L., and Suh S. 2020. Degradation rates of plastics in the environment. 8: 3494–3511. https://pubs.acs.org/doi/pdf/10.1021/acssuschemeng.9b06635.

Title	A Demographic Analysis Update to "*Air Quality Modeling in the Gulf of Mexico Region*"
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Contract
Principal Investigator(s)	TBD
Performance Period	FY 2023–2024
Date Revised	February 26, 2020
PICOC Summary	
Problem	BOEM has new air quality modeling data on the impacts of oil and gas OCS activities in the Gulf of Mexico Region, but the study did not specify the OCS contribution to the air quality in Environmental Justice communities.
Intervention	Use air quality modeling results from the *Air Quality Modeling in the Gulf of Mexico Region Study* to determine the air pollutant concentrations from oil and gas OCS activities to geographic areas containing Environmental Justice communities.
Comparison	The *Air Quality Modeling in the Gulf of Mexico Region Study* provided an impact analysis for air quality in the region; however, it was not targeted to Environmental Justice communities. Adding a consideration of impacts within and outside Environmental Justice communities will help define direct impacts of BOEM's activities.
Outcome	BOEM will gain understanding of the pre-lease air quality impacts of oil and gas OCS activities on Environmental Justice communities in the Gulf of Mexico Region.
Context	Gulf Coast of the United States

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

Background: In the *Air Quality Modeling in the Gulf of Mexico Region Study* (Wilson et al. 2019), air quality modeling was conducted to assess the existing and future impacts (based on the 2017-2022 E&D mid-price scenario) from OCS oil and gas development to the states, as required under OCSLA section 5(a)(8), which requires compliance with the National Ambient Air Quality Standards (NAAQS) pursuant to the Clean Air Act (42 U.S.C. 7401 et. seq.). NAAQS cover six common criteria air pollutants (carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide) that are considered harmful to the public (EPA, 2020). The *Air Quality Modeling in the Gulf of Mexico Region Study* has been peer reviewed by the National Academy of Sciences (National Academies of Sciences, Engineering, and Medicine, 2019). Utilizing data from this existing study is valuable because the data is timely and it is a study of high public interest.

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



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

Methods: Using the six demographic indicators from the Environmental Protection Agency's (EPA) EJSCREEN tool, identify census block groups containing concentrations of these populations according to principles laid out by the Council on Environmental Quality (EPA 2016, 2019). Use existing photochemical modeled data from the *Air Quality Modeling in the Gulf of Mexico Region Study* to determine the air pollutant concentrations of criteria air pollutants from new sources in single-sale and 10-sale scenarios in areas of EJ communities (Wilson et al. 2019). These sources are described in Table 4-13 in the *Air Quality Modeling in the Gulf of Mexico Region Study* (Wilson et al. 2019). The different modeled scenarios, with focus on areas of EJ communities, will be compared, as will results for EJ communities and non-EJ communities in NAAQS nonattainment areas.

Specific Research Question(s):

1. What are the air quality impacts for a no-sale scenario on areas with EJ communities?

2. What are the air quality impacts for a single-sale scenario on areas with EJ communities?
3. What are the air quality impacts for a 10-sale scenario on areas with EJ communities?
4. Do EJ communities located in NAAQS nonattainment areas in the Gulf Coast have air quality impacts from OCS activities? If so, are the impacts disproportionate compared to impacts experienced by other communities in the NAAQS nonattainment areas?

References:

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

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

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

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

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

Title	Developing a Machine Learning Tool for Identifying Shipwrecks and Anthropogenic Features in Multibeam Echosounder (MBES) Datasets
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Melanie Damour (Melanie.Damour@boem.gov), Jimmy Moore (James.Moore@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2023–2028
Date Revised	February 5, 2021
PICOC Summary	
Problem	BOEM needs more efficient and accurate analysis and interpretation of MBES and Backscatter data to identify potential cultural resources and anthropogenic features on the seafloor.
Intervention	Design and test a Machine Learning (ML) tool to analyze MBES/Backscatter data for archaeological purposes
Comparison	Compile existing MBES/Backscatter datasets from multiple sources (e.g., NOAA, oil and gas industry) collected from a variety of areas (e.g., GOM, Atlantic, Pacific) with confirmed/potential shipwrecks and anthropogenic features, as well as datasets from areas devoid of these features to train the ML algorithm
Outcome	Successfully develop an ML tool for identifying shipwrecks and other anthropogenic features in MBES/Backscatter datasets to aid in more accurately identifying potential submerged cultural resources and shallow hazards for decision-making purposes
Context	All BOEM regions and programs

BOEM Information Need(s): BOEM is required to consider the potential effects of its activities on cultural resources per the National Historic Preservation Act (NHPA) of 1966, OCS Lands Act of 1953, and National Environmental Policy Act (NEPA) of 1969. Accurately identifying submerged cultural resources within a proposed activity's Area of Potential Effects is key to ensuring that potential effects on these "affected resources" can be adequately considered during the decision-making process. In addition, BOEM is a partner and stakeholder in the National Strategy on Ocean Mapping, Exploring, and Characterizing the U.S. Exclusive Economic Zone (EEZ) (hereafter NOMEC) as part of the 2019 Presidential Memorandum (NOMEC 2020). BOEM and other stakeholders such as NOAA and offshore industries (oil and gas, renewables, marine minerals, etc.) would benefit from the development of a more efficient and accurate means to identify potential submerged cultural resources in acoustic datasets. Specifically, NOMEC Goal 4: Develop and Mature New and Emerging Science and Technologies to Map, Explore, and Characterize the U.S. EEZ would be addressed. The proposed study would inform all three of BOEM's program areas and all regions as well as support the NOMEC effort to map, explore, and characterize the EEZ. The study additionally addresses the BOEM Strategy for Emerging Technology (STRETCH) goal of implementing emerging and innovative techniques and technologies in BOEM studies and ESP Strategic Science Question #8: How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?

Background: The NOMEC National Strategy calls for a coordinated effort among Federal agencies, academia, the private sector, and other partners to map the EEZ, identify priority areas, and explore and characterize these areas. In support of this effort, in FY 2021 BOEM funded "Facilitating Strategic Partnerships in Support of the Presidential Memo on Ocean Mapping, Exploration, and Characterization" (NT 21-01). This funding vehicle supports partnerships and efforts primarily addressing deepwater benthic habitats and hard-bottom communities.

Multibeam Echosounder (MBES) systems are commonly used during hydrographic and geophysical surveys to collect bathymetric data and identify seafloor features. Backscatter data indicate the acoustic reflectivity of exposed features such as benthic habitats and geological features in relation to the surrounding seafloor. Scientists analyze these datasets to identify potential shipwrecks and other anthropogenic features (e.g., artificial reefs, modern debris, unexploded ordnance, etc.) that could create shallow hazards for Federally permitted seafloor-disturbing activities such as oil and gas operations, marine minerals dredging, and installation of renewable energy infrastructure. BOEM relies on the accurate interpretation of these datasets to identify cultural resources that might be impacted by a proposed activity. BOEM then assigns avoidance mitigations as conditions of permit approval to ensure that no seafloor-disturbing activities occur within a prescribed distance of their location. Depending on the data resolution, quality, and method of collection, structures such as shipwrecks may appear as amorphous, acoustically reflective features that can be misinterpreted by an analyst as geological or biological in nature. In some cases, the misidentification of historic shipwrecks as geological features or "not cultural" in nature in other acoustic datasets such as side scan sonar has resulted in irreversible damage to the sites during bureau-permitted activities (e.g., Mica Wreck, Mardi Gras Wreck).

Machine Learning (ML), also known as artificial intelligence or deep learning, is a computer algorithm that finds patterns and correlations in a given dataset. Varieties of ML include Random Forest, K-Nearest Neighbor, and Neural Networks. The algorithm must be trained to recognize the pattern of interest as compared and contrasted with background or baseline data lacking that pattern. ML tools are being developed for seabed mapping and classification, identifying benthic habitats and hard-bottom communities, and predicting bathymetric changes in dynamic deltaic environments using MBES acoustic data (Landmark 2016; Marsh and Brown 2009; Obelcz et al. 2020). ML tools are only beginning to be developed for identifying potential cultural resources in datasets such as side scan sonar (Nayak et al 2021; Zhu et al. 2019) and sediment microbiomes (Wood 2019). ESRI reported the ability to automatically identify shipwrecks using the "Detect Objects Using Deep Learning" tool in ArcGIS. This tool, however, focuses on elevation values in bathymetric data processed using the shaded relief function and could misidentify shipwrecks exhibiting little discernible seafloor relief (ESRI 2020). Another recent effort utilized a sinkhole extraction algorithm to identify shipwrecks in up to 50 m water depth by inverting the bathymetric data (Davis et al. 2020). To date, ML tools have not yet been developed to identify potential shipwrecks and other anthropogenic features in MBES and Backscatter datasets by focusing on reflectivity of seafloor features. Considering the NOMEC and other global mapping efforts (e.g., Seabed 2030) to fully map and characterize the seafloor and our oceans, substantial quantities of MBES datasets will be produced under varying methods and standards (sensor types, resolution, etc.) and require accurate and efficient data interpretation for a wide range of scientific, environmental assessment, resource management, and spatial planning purposes, including identifying cultural resources. Development of an ML tool could result in more efficient, less time-consuming analysis of MBES and Backscatter data to identify potential anthropogenic features that could then be targeted for more detailed analysis by a human analyst (e.g., NOAA hydrographic surveys; geophysical surveys conducted for oil and gas, renewable energy, and marine minerals; etc.).

The proposed study asks the question: What bathymetric/reflectivity acoustic factors constitute an anthropogenic feature in MBES and Backscatter data? BOEM, in partnership with NOAA, industry (oil and gas, renewables, and marine minerals sectors), and other relevant entities could provide MBES/Backscatter acoustic datasets—including those with previously confirmed historic shipwrecks and anthropogenic features—to train and develop an ML tool to identify these features. Potential study partners with ML expertise include academic institutions and the U.S. Naval Research Lab, with whom BOEM is currently collaborating to develop an ML tool for identifying cultural resources in sediment microbiome data (Wood 2019).

Objectives:

1. Develop and test a ML tool that can analyze and interpret MBES and Backscatter acoustic datasets to identify shipwrecks and other anthropogenic features
2. Determine the minimum standards of MBES data collection and resolution that would allow successful application of an ML tool to support archaeological analyses of these data

Methods:

- Compile existing MBES and Backscatter datasets from multiple sectors (Federal, industry, academia, etc.) exhibiting a variety of data collection methodologies and qualities (e.g., hull-mounted vs. AUV-integrated MBES systems, bin sizes, etc.)
- Annotate MBES/Backscatter acoustic datasets with known historic shipwrecks and anthropogenic features for training the ML tool
- Identify the range of reflectivity values for materials commonly found on the seafloor (e.g., steel, copper alloys, wood, rock, carbonate outcrops, etc.) representing anthropogenic, biological, and geological sources
- Develop and test an algorithm that can distinguish these materials from the surrounding seafloor in a given acoustic dataset and identify them as anthropogenic versus geological or biological in nature

Specific Research Question(s):

1. Can analysts achieve more accurate and efficient, and less time-consuming, data interpretation using an ML tool that will effectively identify shipwrecks and anthropogenic features in MBES and Backscatter acoustic datasets?
2. Can the resulting ML tool be successfully applied to BOEM analyses across its programs and regions?

References:

Davis DS, Buffa DC, Wrobleski AC. 2020. Assessing the Utility of Open-Access Bathymetric Data for Shipwreck Detection in the United States. Heritage 3(2):364-383. https://dx.doi.org/10.3390/heritage3020022

ESRI. 2020. How we did it: Detecting Shipwrecks using Deep Learning at UC 2020. Blog published at: https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/detecting-shipwrecks-using-deep-learning/

Landmark K. 2016. Machine Learning and Image Processing Methods for Acoustic Seafloor Mapping and Classification. PhD Dissertation. University of Oslo, Norway.

Marsh I, Brown C. 2009. Neural Network Classification of Multibeam Backscatter and Bathymetry Data from Stanton Bank (Area IV). Applied Acoustics 70:1269-1276. http://dx.doi.org/10.1016/j.apacoust.2008.07.012

Masetti G, Calder B. 2012. Remote Identification of a Shipwreck Site from MBES Backscatter. Journal of Environmental Management 111:44-52. https://dx.doi.org/10.1016/j.jenvman.2012.06.037

Nayak N, Nara M, Gambin T, Wood Z, Clark CM. 2021. Machine Learning Techniques for AUV Side-Scan Sonar Data Feature Extraction as Applied to Intelligent Search for Underwater Archaeological Sites. In Ishigami G, Yoshida K (eds.), Field and Service Robotics, Springer Proceedings in Advanced Robotics 16. https://dx.doi.org/10.1007/978-981-15-9460-1_16

NOMEC. 2020. National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone.

https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/01/20200611-FINAL-STRATEGY-NOMEC-Sec.-2.pdf

Obelcz J, Wood WT, Phrampus BJ, Lee TR. 2020. Machine Learning Augmented Time-Lapse Bathymetric Surveys: A Case Study from the Mississippi River Delta Front. Geophysical Research Letters 46. https://dx.doi.org/10.1029/2020GL087857

Wood W. 2019. Machine Learning and Shipwreck Microbiomes. June 24 Mission Log for the Microbial Stowaways Project, NOAA Office of Ocean Exploration and Research.

https://oceanexplorer.noaa.gov/explorations/19microbial-stowaways/logs/june24-2/june24-2.html

Zhu B, Wang X, Chu Z, Yang Y, Shi J. 2019. Active Learning for Recognition of Shipwreck Target in Side-Scan Sonar Image. Remote Sensing 11, 243. https://dx.doi.org/10.3390/rs11030243

Title	Long-Term Coral Reef Monitoring at Flower Garden Banks (FGB), Gulf of Mexico: 2022–2025
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Alicia Caporaso (Alicia.Caporaso@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2027
Date Revised	February 5, 2021
PICOC Summary	
Problem	BOEM requires annual community characterization and condition baseline information on the hermatypic coral communities and associated community assemblages at Flower Garden Banks National Marine Sanctuary for the purpose of monitoring the health of these communities and enabling detection of short- and long-term responses to environmental and anthropogenic disturbances. These data inform BOEM NEPA analyses of potentially affected environment, impact mitigation development, and various consultations.
Intervention	Observations will be made to continue evaluating coral reef diversity, long-term changes in individual coral colonies, fish assemblages, water quality parameters, and general coral reef community health during years 2023–2026.
Comparison	BOEM and NOAA will collaborate to analyze observations within the context of short-term environmental disturbances and anthropogenic factors (e.g., BOEM-permitted activities). This level of monitoring enables informed decision making amid threats such as climate change, invasive species, water quality degradation, and natural disturbances such as storms (Johnston et al., 2021).
Outcome	The objectives for this continued long-term monitoring effort are to collect data that will enable BOEM and NOAA to assess the long-term health of the coral reefs and, in the event of disturbance, detect any response, evaluate contributing factors, and assess impacts and significance.
Context	The hermatypic coral reefs of East and West Flower Garden Banks are well documented to be among the healthiest in the western Atlantic and Caribbean region. Such reefs are marine biodiversity hot spots, providing habitat for a variety of fish and invertebrate species, including threatened and endangered species and species of commercial and recreational importance.

BOEM Information Need(s): The need for ongoing monitoring at Flower Garden Banks National Marine Sanctuary (FGB) is critical to ensure adequate baseline information continues to be available. Such a baseline enables federal resource managers to discern among natural and anthropogenic drivers of variation within the ecosystem of the northern Gulf of Mexico, especially among the topographic features of the Outer Continental Shelf (OCS) edge. This information is used by BOEM and NOAA to conduct environmental assessments for NEPA analyses and design management policies that minimize any negative impacts to hermatypic coral reefs from permitted energy activities.

The continued high coral cover documented at East and West FGBs makes these banks unique among the northern Gulf of Mexico's coral reefs and justifies the need for continued monitoring and protection. Sustained monitoring allows researchers to document changes in reef community condition, link changes to oceanographic events, and compare to historical baselines. This level of monitoring enables resource managers to make informed decisions regarding management and research amid threats such as climate change, water quality degradation, and natural disturbances such as storms (Johnston et al., 2021).

Background: Thanks in part to long-term DOI monitoring funding, the hermatypic coral reefs of East and West FGB have been documented as among some of the healthiest in the western Atlantic and Caribbean region. Evaluation of coral reef health includes several measurable parameters including coral growth, mortality, and condition, bleaching, and pressure from predation and competition (AGRRA 2021). Many comparable coral reefs throughout the region have experienced significant declines in coral cover in recent decades, East and West FGB have suffered minimally from hurricanes, recovered from coral bleaching events, and shown no signs of disease, with the exception of a localized mortality event at EFGB in 2016 (Johnston et al., 2021). The health of coral reefs may be threatened by a variety of potential sources including direct and indirect impacts from anthropogenic activities. Due to concern about potential impacts resulting from offshore oil and gas development, DOI (through the Minerals Management Service – now BOEM) started systematic monitoring at East and West FGB in 1988 to assess the health of the coral reefs and to establish baseline data to better detect any impacts from nearby OCS exploration and production activities. For example, long-term monitoring data collected before, during, and after the 2016 coral bleaching event allowed the sanctuary to examine levels of and variability in bleaching at monitoring stations and subsequent recovery (Johnston et al., 2019). Overall, some of the most important trends documented in the program's 30 years of monitoring include stable coral cover at EFGB and significantly increasing coral cover at WFGB, significantly increasing macroalgae cover at both banks, and significantly increasing seawater temperatures at reef depth.

Objectives: The primary objective of this study is to assess the health of the hermatypic coral reefs, evaluate water quality parameters, potentially expand baseline understanding of the adjacent mesophotic zone (< 100 ft. depth), and provide an analysis of the status of the coral reefs in comparison with historical data, within the context of OCS oil and gas exploration, development, and production.

Methods: The monitoring protocols will be detailed in a joint BOEM-NOAA document and shall be generally consistent with the most recent agreement IA M19PG00001 for monitoring the coral reefs of East and West FGB, with additional updated methods for randomized reef-wide benthic surveys to meet current monitoring needs and to evolve the program. BOEM and NOAA shall review protocols annually to ensure methods achieve program objectives, incorporating changes as appropriate to adapt to dynamic and evolving conditions and information needs. The physical health of the coral reef community shall be monitored to detect any significant effects from natural and/or anthropogenic disturbances that could potentially endanger coral community integrity. Surveys of random sites and established repetitive stations at East and West FGB shall be performed over a four-year period. Annual data collection cruises (both diver and ROV) on each bank shall be conducted during summer or early fall each year of the study, and water quality shall be monitored quarterly. NOAA shall continue to publish an annual report in the Marine Sanctuaries Conservation Series, detailing observations, analyses, and results following the completion of each field season. As appropriate, historic long-term monitoring data may be reanalyzed to develop statistically comparable long-term data series that try to address any detectable trends related to impacts and changes over time. Collected data shall be submitted to and archived by the National Centers for Environmental Information (NCEI).

Specific Research Question(s):

1. What is the current baseline condition of hermatypic corals, their habitat, and associated benthic reef community?
2. How are benthic percent cover, fish community dynamics, water quality parameters, and coral community demographics changing over time?
3. How have acute events impacted the reefs?
4. What might current ecological trends tell BOEM and NOAA about potential short- and long-term impacts of OCS oil and gas activities and cumulative natural and anthropogenic impacts?

Affiliated WWW Sites: Previous FGB Long-term monitoring reports (2011-2018) are located at the below websites.

https://flowergarden.noaa.gov/science/sciencereports.html

https://sanctuaries.noaa.gov/science/conservation/conservation_reports.html

References:

Atlantic and Gulf Rapid Reef Assessment (AGRRA), 2021. Coral indicators to assess reef health. https://www.agrra.org/coral-reef-monitoring/coral-indicator/ Accessed April 2, 2021.

Johnston MA, Hickerson EL, Nuttall MF, et al. 2019. Coral bleaching and recovery from 2016 to 2017 at East and West Flower Garden Banks, Gulf of Mexico. Coral Reefs 38, 787–799. https://doi.org/10.1007/s00338-019-01788-7

Johnston, MA, O'Connell K, Blakeway RD, et al. 2021. Long-Term Monitoring at East and West Flower Garden Banks: 2019 Annual Report. National Marine Sanctuaries Conservation Series ONMS-21-02. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Flower Garden Banks National Marine Sanctuary, Galveston, TX. 88 pp.

Title	Ancient Landscapes off the Washington Coast
Administered by	Pacific OCS Region
BOEM Contact(s)	Dave Ball (david.ball@boem.gov)
Procurement Type(s)	Cooperative and Inter-agency Agreements
Performance Period	FY 2022–2025
Date Revised	April 28, 2021
PICOC Summary	
Problem	Oral histories from Tribes along the U.S. West Coast tell of places that once existed beyond the current coastline. Now submerged by rising post-glacial sea levels, evidence of these places may remain as submerged cultural landscapes within the seafloor of the continental shelf. Offshore wind energy development and marine mineral extraction have the potential to impact these significant cultural resources.
Intervention	This study will build on similar efforts to more fully understand inundation processes along the U.S. West Coast by synthesizing geological, geophysical, and environmental data (including environmental DNA analysis) from offshore Washington and integrate that information with Tribal oral histories and traditional knowledge to further refine the model for identifying intact submerged landform potential off the Pacific Coast.
Comparison	Results from this study will be compared with a soon-to-be-completed study offshore central Oregon and southern California (BOEM 2021). This type of work has never been undertaken in this area and will fill critical data gaps in our current model. This effort will also provide essential information on the effects of climate change and sea level rise through time.
Outcome	This effort will further improve identification of submerged paleolandforms and provide a model for consultation and incorporation of traditional Tribal knowledge to better describe the affected environment, analyze potential effects, and develop mitigation measures in support of NEPA and NHPA consultations.
Context	Fieldwork for this study will occur offshore Washington; however, the study will be applicable to the entire Pacific OCS Region, except Hawaii. Findings could also have applicability across all BOEM regions and programs.

BOEM Information Need(s): BOEM has received applications for both offshore wind and offshore wave projects on the Pacific OCS. To better understand the potential impacts this development can have on submerged paleolandforms, a holistic assessment of these potential resources that incorporates science-based exploration, research, and traditional Tribal knowledge is necessary. A holistic assessment of submerged landforms will assist BOEM, individual States, and Tribal communities in evaluating proposed offshore renewable energy projects, and with developing appropriate information-gathering protocols and survey measures to avoid or mitigate adverse effects to National Register (eligible or listed) Native American sites during Pacific OCS development. BOEM will use this information in (National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) documents, as

well as government-to-government consultations with Native American Tribes. Further, this information will inform decisions regarding lease sales, notices to lessees, and information to lessees, and will be useful in developing mitigation measures.

Background: Investigations of submerged paleolandform features offshore southern California and central Oregon are nearing completion, and the results from that study (BOEM 2021) will improve our understanding of how to identify intact submerged landform features with a high potential for new discoveries using geophysical surveys. However, critical data gaps exist, as no similar surveys have yet been conducted offshore Washington. Recent research on environmental DNA (eDNA) (Orlando et al. 2021) suggests that it may also be possible to more accurately characterize these submerged landform features and determine the potential association of nearby human activities, which was not part of the previous effort. Additionally, oral histories from many West Coast Tribes tell of places that once existed beyond today's current coastline. Integration of traditional Tribal knowledge with geophysical survey data and eDNA analysis of sedimentary core samples will further and more accurately refine the current model for discovering potential submerged landform features that could be associated with pre-contact archaeological sites. Information acquired from this effort has the potential to inform all BOEM programs across all regions, address stakeholder comments, and support the National Strategy for Ocean Mapping, Exploring, and Characterizing the US EEZ.

Objectives: The objective of this study is to fill an existing data gap in our regional model of submerged paleolandforms off the U.S. West Coast by incorporating industry-standard geophysical survey data with traditional Tribal knowledge and ground-breaking research on eDNA.

Methods: Through consultation with coastal Washington Tribes, this study will identify appropriate methods for, and incorporation of, traditional knowledge and oral histories into the identification of high-probability areas for testing and identify additional research questions, as appropriate. The science team will then evaluate any existing remote sensing data, if available, and review current theories on sea level rise during the Last Glacial Maximum (LGM) to further refine the identification of high-probability areas for further testing. Coarse- and fine-scale geophysical survey data will be collected from at least four locations offshore Washington, and sediment cores will be acquired from target areas of interest. Analysis of core samples will include standard processes and innovative eDNA analysis to identify possible indicators of paleolandform features. Finally, researchers will incorporate traditional Tribal knowledge with geophysical survey data and results from sediment core analysis data to further refine and better identify intact submerged paleolandform features, and where possible develop appropriate mitigation measures to address potential impacts from renewable energy development offshore the U.S. West Coast.

Specific Research Question(s):

1. How can traditional Tribal knowledge inform our understanding and identification of submerged landform features offshore coastal Washington?
2. Can eDNA analyses of sediment core samples be used to better identify and refine our understanding of submerged paleolandform features?
3. How can we better locate submerged paleolandform features in order to avoid or minimize impacts from BOEM-permitted activities?

References:

BOEM. 2021. Archaeological and Biological Assessment of Submerged Landforms off the Pacific Coast (NSL #PC-14-04). US Department of the Interior, Bureau of Ocean Energy Management. https://marinecadastre.gov/espis/#/search/study/100088

Orlando L, Allaby R, Skoglund P, Der Sarkissian C, Stockhammer PW, Avila-Arcos MC, Fu Q, Krause J, Willerslev E, Stone AC, Warinner C. 2021. Ancient DNA analysis. Nature Reviews Methods Primers 1, 14.

Title	Birds, Bats, and Beyond: Networked Wildlife Tracking in the Southern California Bight
Administered by	Pacific OCS Region
BOEM Contact(s)	David Pereksta (david.pereksta@boem.gov)
Procurement Type(s)	Intra-agency Agreement
Performance Period	FY 2022–2026
Date Revised	April 28, 2021
PICOC Summary	
Problem	Offshore wind energy infrastructure poses a variety of threats to birds and bats. Small-bodied migratory species are especially vulnerable, and determining potential impacts to these species is a challenging data gap given the historical size of tracking equipment and formative challenges in tracking logistics and data recovery. Equally important is quantifying available, risk-free areas (and hot-spot areas) at sea associated with normal movements of birds and bats tied to specific populations.
Intervention	Recent technological advances in wildlife tracking using relatively low-cost tags allow delineation of migratory and movement pathways, assessment of regional connectivity, and determination of behaviors.
Comparison	Birds and bats utilize at-sea areas during migration and while foraging and resting. Habitat use at sea is non-random, and high-use areas can be species- and population-specific. Delineating habitat use at sea can help quantify coastal and oversea movement patterns of shorebirds, marine birds, and migratory bats along the Pacific Coast of the U.S., and spatially linked data can be used to evaluate hotspots and limited-use areas.
Outcome	With the expansion of networked VHF (e.g., Motus) and cellular (e.g., GSM) tracking capabilities on the West Coast and initiating several directed tracking efforts, BOEM and others will have the ability to fill critical data gaps for small-bodied, high-vulnerability species and allow for value-added projects in the future by increasing the capacity for large-scale, regional tracking networks.
Context	Southern California Planning Area

BOEM Information Need(s): BOEM lacks information needed to analyze bird and bat interactions with offshore wind energy infrastructure off the U.S. West Coast. Birds and bats are susceptible to displacement and collision risks from offshore wind energy infrastructure. Small-bodied species are especially vulnerable, but determining potential impacts is challenging given the limited range in size of tracking tags and associated challenges in survey methodologies and data recovery. Information about temporal and spatial scales of bird and bat movements collected by this study could inform siting of offshore wind energy areas, inform impacts assessments for proposed projects, describe potential interactions between birds and bats and wind energy facilities, and inform options for minimization and mitigation measures.

Background: Tracking movements of marine birds and bats remains a key challenge for understanding potential wildlife effects of offshore energy development in the Pacific OCS. Bats and birds are known to fly offshore during migration, with frequent and historical accounts of bats flying more than 20 miles offshore. Shorebirds including Red Phalaropes, Red-necked Phalaropes, and Red Knots also migrate offshore during spring and fall, but information about timing and locations of movements is lacking. Marine birds also redistribute seasonally, with less known about post-breeding dispersal and important population-specific wintering locations. More information informing movement ecology will benefit comprehensive assessments of offshore energy project effects.

The Motus Wildlife Tracking System (Motus) is an international collaborative network that uses coordinated, automated VHF radio-telemetry arrays to study movements of small flying organisms including birds, bats, and insects. Motus has been successfully used to gather information about bird movements, stopover sites, migratory routes, timing of migration in relation to environmental conditions, and post-fledging dispersal for a variety of birds including shorebirds and seabirds. Motus has also been employed to investigate seabird use of offshore wind energy areas in the western North Atlantic. Although there are over 1,000 Motus receiving stations around the world (https://motus.org/data/receiversMap), only a few exist on the West Coast of the United States. BOEM has supported Motus tracking along the Atlantic Coast (e.g., Paton et al 2021 and Loring et al 2021); and since 2018, the Pacific Region has received several external stakeholder ideas for Motus-related studies.

Development of a Motus network along the Pacific Coast could elucidate timing and scale of movements for shorebirds, marine birds, and migratory bats in relation to offshore energy and other coastal development projects. A recent initiative led by the Partners in Flight, Western Working Group is expanding the Motus network in the interior west and a new coastal and offshore network would be integrated to better develop flyway-scale efforts. Additionally, the use of animal-borne Cellular Tracking Technology (CTT) in conjunction with Motus-type arrays could expand the reach of automated receivers beyond fixed locations on the mainland, islands, and infrastructure, by including mobile bird-borne receivers that can census VHF tags far from land throughout the expansive ocean ranges. For example, deployment of CTT “Life Tags” on larger birds can greatly expand the spatial extent of receivers at sea to help locate unique ID’s transmitted by tiny (<3 g) solar-powered VHF transmitters attached to smaller co-occurring species.

Objectives:

1. Expand Motus and related (e.g., CTT) tracking capabilities along the U.S. Pacific Coast.
2. Support data-collection efforts on the timing and scale of movements for shorebirds, marine birds, migratory bats, and other taxa in relation to offshore energy and other coastal development projects.
3. Foster collaboration with a variety of partners to enhance a tracking network in the Pacific Region.

Methods: We propose a geographically phased approach to expand Motus and related tracking capabilities along the U.S. Pacific Coast. This study, focused in the Southern California Bight (Channel Islands, Santa Barbara Channel, and adjacent mainland) would allow quantification of movements and area use among breeding and migratory seabirds and migratory bats including delineation of migratory connectivity, proportion of bats that migrate offshore, and timing of offshore migratory movements associated with seasonal and environmental conditions (e.g., wind speed, barometric pressure, moon phase, and temperature). For breeding and migratory seabirds we will use Motus and complementary

tracking technology to investigate population-specific time spent within designated areas at sea. Motus technology can also be used to evaluate survival among bats that occur offshore. With expanded infrastructure in the future, Motus and related VHF tracking can identify where and when shorebirds and other marine birds (e.g., loons, grebes, seaducks) disperse outside of the breeding season. Expansion of Motus and related VHF tracking to offshore energy infrastructure, coupled with bird-borne tracking could also be used to examine offshore movements for any avian species, especially those identified as potentially vulnerable to offshore wind energy development by Adams et al. (2017). This project will allow for the deployment of Motus and integrated VHF tracking to improve knowledge of aerial wildlife movements in offshore environments and help address data gaps associated with the expansion of energy development in the Pacific Ocean.

The first phase of establishing an array of receiving stations along the U.S. Pacific Coast will focus on a network of Motus towers throughout the Southern California Bight (SCB), including mainland, island, and oil platform stations. The SCB area will be a "lab" of densely sited receivers to address finer-scale movements and habitat use and to develop tracking methodologies. During this first geographically constrained study, tracking efforts will focus first on bats and small, most vulnerable breeding marine bird species (Ashy Storm-Petrel, Scripps's Murrelet, Cassin's Auklet). We will use integrated VHF-GSM technology to include Western Gulls as mobile stations to increase detections for small birds at sea beyond the range of fixed receiving stations. Results would provide increased resolution of high-use areas within range of the network (near islands, Santa Barbara Channel, interisland passages, and use of areas in the vicinity of energy and oil platform infrastructure). Tracking efforts could be expanded to include other breeding and migratory seabird species also at local scale (e.g., pelicans, cormorants, murres, shearwaters). Partners for this regional effort would include Channel Islands National Park and the U.S. Navy. In the future, following network infrastructure and proof of concept, networked VHF tracking could be scaled up to include Trinidad Head near the Humboldt Call Area, the Pacific Coast, and ocean waters throughout the Pacific OCS.

Specific Research Questions:

1. How can networked VHF tracking technology (e.g., Motus) best be applied to studying birds and bats in the marine environment of the Pacific OCS?
2. How do movements and habitat use at sea of small-bodied birds and migratory bats overlap with offshore energy infrastructure (e.g., platform structures in the SCB)?
3. How much time do tracked animals spend within areas at sea covered by networked receiving stations? Does habitat use reveal sufficient areas available for vulnerable breeding populations (e.g., Ashy Storm-Petrel, Cassin's Auklet, and Scripps's Murrelet) at sea that would be free from potential risks associated with offshore energy development?
4. Can we use networked VHF and GSM technology to expand the range of fixed towers and to better estimate flight-height for animals at sea (e.g., co-tagging of Western Gull)?
5. How frequently do resident bats on the Channel Islands fly offshore or make interisland flights?
6. What are the proportions of migratory bats that migrate offshore throughout the SCB and what is the survival rate of individuals moving offshore?

References:

Adams J, Kelsey EC, Felis JJ, Pereksta DM. 2017. Collision and displacement vulnerability among marine birds of the California Current System associated with offshore wind energy infrastructure (ver.

1.1, July 2017): U.S. Geological Survey Open-File Report 2016-1154, 116 p., https://doi.org/10.3133/ofr20161154.

Loring PH, Lenske AK, McLaren JD, Aikens M, Anderson AM, Aubrey Y, Dalton E, Dey A, Friis C, Hamilton D, Holberton B, Kriensky D, Mizrahi D, Niles L, Parkins K.L. Paquet J, Sanders F, Smith A, Turcotte Y, Vitz A, Smith PA. 2020. Tracking Movements of Migratory Shorebirds in the US Atlantic Outer Continental Shelf Region. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-008. 104 p.

Paton PWC, Cooper-Mullin C, Kouhi S, Loring PH, Moore J, Miller J, Potty G. 2021. Assessing movements of birds using digital VHF transmitters: A validation study. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021- 009. 222 p.

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 and Inter-agency Agreements
Performance Period	FY 2022–2025
Date Revised	April 28, 2021
PICOC Summary	
Problem	No baseline cultural resources/heritage information (including database of underwater cultural heritage) currently exists for the U.S. Pacific Island territories of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI).
Intervention	Compile baseline data of underwater cultural heritage and potential viewshed historic property concerns and identify best practices for consultation with indigenous communities.
Comparison	This effort will be similar to the 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 and Marine Minerals Programs.

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 Commonwealth of the Northern Mariana Islands (CNMI) have each set aggressive renewable energy goals to lessen this dependence. In support of this transition, the U.S. Congress has been 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.

Additionally, the OCS around these island territories may contain an abundance of critical mineral resources that may be of interest for future industry extraction; BOEM, NOAA, and USGS are coordinating efforts to identify these areas. Given the increased interest to the OCS around the Pacific Island territories, BOEM needs to gather baseline information on archaeological and cultural resources that could be affected by these activities. This information will directly support National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) assessments and consultation.

Background: Baseline desktop cultural resources studies and updates have been completed for the Atlantic OCS (TRC Environmental Corporation 2012), Gulf of Mexico OCS (Pearson et al. 2003), Hawaii (NOAA Maritime Heritage Program 2017; Watson et al. 2017; Van Tilburg et al. 2017), and Pacific OCS (ICF International et al. 2013). The information resulting from these previous studies has been crucial for NHPA Section 106 and NEPA 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. Additionally, BOEM has no experience working with indigenous communities in this area and identifying protocols for consultation with these communities will be a critical first step for meaningful and respectful engagement. Information acquired from this effort will address stakeholder comments and support the National Strategy for Ocean Mapping, Exploring, and Characterizing the US EEZ.

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 leasing activities.

Methods: The proposed study will accomplish the following:

1. Compile data from archival and secondary sources of known, reported, and potential underwater sites on the Pacific OCS within the EEZ of American Samoa, Guam, and the CNMI, and synthesize this information into a geo-referenced database.
2. Collect data from archival and secondary sources to develop a geo-referenced database of terrestrial properties listed and potentially eligible for listing on the NRHP.
3. Compile and summarize ethnographic information from indigenous communities regarding traditional use and traditional cultural properties that could be impacted by offshore development.
4. Working with indigenous communities (Carolinian, Chamorro, and Samoan), develop guidance documents that identify best practices and protocols for incorporating traditional knowledge into indigenous cultural landscape analyses for NHPA and NEPA reviews.
5. Prepare a final report(s) of findings that details these efforts and provides an historic context of site types that can be expected in the project areas.

Specific Research Question(s):

1. What are the types and potential locations of underwater cultural heritage sites within the EEZ of the U.S. Pacific Island territories that could be impacted by offshore wind development or marine mineral extraction?
2. What types of terrestrial archaeological sites or historic properties could be affected 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 or marine mineral extraction?

References:

ICF International, Davis Geoarchaeological Research, and Southeastern Archaeological Research. 2013. Inventory and analysis of coastal and submerged archaeological site occurrence on the Pacific Outer Continental Shelf. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2013-0115. 280 p. plus appendices. https://espis.boem.gov/final%20reports/5357.pdf

NOAA Maritime Heritage Program. 2017. The unseen landscape: inventory and assessment of submerged cultural resources in Hawai`i. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2017-021. 240 p. with appendices. https://espis.boem.gov/final%20reports/5620.pdf

Pearson CE, James Jr. SR, Krivor MC, El Darragi SD, Cunningham L. 2003. Refining and revising the Gulf of Mexico Outer Continental Shelf Region high-probability model for historic shipwrecks: Final Report. Volume II: Technical Narrative. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-061, 195 p., 3 volumes. https://espis.boem.gov/final%20reports/3034.pdf

TRC Environmental Corporation. 2012. Inventory and analysis of archaeological site occurrence on the Atlantic outer continental shelf. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-008. 324 p. https://espis.boem.gov/final%20reports/5196.pdf

Van Tilburg H, Watson TK, Faria K, Hoomanawanui K, Ho-Lastiama I, Ritte W, Maly K, Nahoopii, M, Horcajo K, Kaupiko K, Ball D. 2017. A guidance document for characterizing native Hawaiian cultural landscapes. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2017-023. 208 p. with appendices. https://espis.boem.gov/final%20reports/5621.pdf

Watson TK, Hoomanawanui K, Thurman R, Thao B, Boyne K. 2017. Na ʻIkena I Kai (Seaward Viewsheds): inventory of terrestrial properties for assessment of marine viewsheds on the eight Main Hawaiian Islands. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2017-022. 137 p. with appendices. https://espis.boem.gov/final%20reports/5619.pdf

Title	Multi-Criteria Decision Analysis (MCDA) Tool for Informing Spatial Planning of Offshore Wind Energy Development
Administered by	Pacific OCS Region
BOEM Contact(s)	Lisa Gilbane (lisa.gilbane@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022–2024
Date Revised	April 28, 2021
PICOC Summary	
Problem	In order to analyze alternatives and make decisions regarding planning and potential impacts of renewable energy, BOEM needs a tool to perform a comprehensive analysis that accounts for multiple interacting environmental and socioeconomic factors.
Intervention	A flexible geospatial MCDA decision tool for BOEM that would enable comparison of the factors and consideration of different sectors and resource areas, and that is scalable to cover the region being assessed
Comparison	Different energy project scenarios will be compared across the spatial area of interest to identify unique environmental and socioeconomic considerations.
Outcome	A spatial decision tool that provides comprehensive and objective information for energy impact assessments and alternatives for BOEM and other decision-makers to facilitate local, state, and Federal agency stakeholder input on energy impact assessments and alternatives.
Context	U.S. West Coast, initially focused offshore Oregon

BOEM Information Need(s): Decisions regarding siting and potential impacts of renewable energy could be informed by a tool to conduct a comprehensive trade-off analysis that accounts for multiple interacting environmental and socioeconomic factors. The tool would allow BOEM to quantitatively evaluate multiple criteria associated with identifying potential lease areas and range of alternatives in environmental documents.

Background: There is strong and growing interest from industry in pursuing leases for offshore wind energy development along the U.S. West Coast. This region is also host to vibrant fisheries, biodiverse marine wildlife, shipping activities, military operations, and other ocean-based sectors that could be impacted by energy development. A quantitative MCDA could comparatively evaluate the objectives by these sectors and by the energy industry to identify location(s) and/or scenarios given a range of factors (e.g., wind speeds, points of interconnection) and considerations (e.g., bathymetry, socioeconomics, wildlife density). BOEM and the State of Oregon, led by the Oregon Department of Land Conservation and Development, have developed the Oregon Offshore Wind Mapping Tool (OROWindMap) to provide public access to the best available data throughout the planning process. The OROWindMap planning tool accesses relevant datasets and provides visualization capabilities to inform the planning process for offshore wind energy leasing in federal waters offshore Oregon and has compiled data on spatial and temporal patterns of ocean wind, fisheries, whales, seabirds, and other factors. The MCDA tool would

add to the OROWindMap effort providing increased comparative and location-specific results over the BOEM authorization process. The initial focus in Oregon is due to its early phase in planning with data gathering in 2020-2021 to inform leasing decisions. BOEM has explored this approach through a Bayesian model (BOEM 2013) and recently with an ongoing study of offshore wind scenarios (Far et al. 2021).

Objectives: The study objective is to develop a tool for BOEM or other users to perform a MCDA in order to support the planning and analysis of potential wind energy areas (WEAs). The tool will interface with existing geospatial databases to synthesize technical, economic, and biological data into predictive spatial models of potential effects of offshore wind farms on sectors potentially impacted (e.g., commercial fisheries, shipping and military activities, and marine wildlife populations). The tool will integrate the wind energy and other sector models into designing a multi-criteria analysis framework with weighted factors for multiple factors and considerations expected from various scenarios in the area of interest. BOEM will work with the State of Oregon as a focus application.

Methods: This study will integrate existing geospatial data (e.g., OROWindMap and MarineCadastre). Example datasets may include: offshore wind resource, levelized cost of wind energy, points of interconnection, ports, bathymetry and other seafloor geological data, existing ocean uses (e.g., recreational and commercial fishing, vessel traffic), and biological information (e.g., benthic species and habitats, seabird and marine mammal distribution). Fisheries data will incorporate layers developed from ongoing BOEM-funded studies (e.g., Scenarios for Offshore Renewable Energy along the Central California Coast), which can be applied offshore Oregon and other areas of interest to generate similar information quickly and efficiently.

Open-source spatial models will estimate potential impacts to other sectors by offshore wind projects. For example, random utility models of fishing importance using fisheries landings, revenue and effort data will allow estimation of spatial patterns of potential impacts on fisheries from displacement by energy infrastructure. Models will integrate empirical spatial data of whale and seabird abundances with conservation indicators of their population viability and behavioral data on their vulnerability to entanglement, collision, and displacement by turbines to estimate spatial patterns of potential impacts to whale and bird populations from offshore wind.

A MCDA tool will be developed for BOEM to apply weighting factors for these data and model outputs to assess factors and considerations of offshore energy theoretical siting locations. This tool would provide the user the ability to determine the weighted factors and considerations, and offshore wind energy designs (e.g., turbine size, wind farm size, configuration) over a range of locations to evaluate the planning area offshore Oregon. The geospatial tool will inform BOEM of areas for development that may inform decisions for potential lease areas under a range of inputs (e.g., given weighted factors, area, offshore wind energy project size). The model will be dynamic to demonstrate trade-offs now and the impacts of leasing decisions and other activities in the future (i.e., not static).

Specific Research Question(s):

1. What are effective strategies to advance MCDA for offshore Oregon renewable energy environmental analysis?
2. How effective is MCDA for renewable energy planning? How can a spatial decision tool provide comprehensive and objective information to support impact assessment and siting for different offshore wind project scenarios?

References:

[BOEM] Bureau of Ocean Energy Management. 2013. Bayesian Analysis for Spatial Siting (BASS) Project Report v1.3. Prepared by Parametrix, Portland, Oregon. Bureau of Ocean Energy Management, OCS Study 2013-201. https://espis.boem.gov/final%20reports/5306.pdf

Farr H, Ruttenberg B, Walter RK, Wang Y-H, White C. 2021. Potential environmental effects of deepwater floating offshore wind energy facilities. Ocean and coastal management 207 105611 https://opendata.boem.gov/BOEM-ESP-Ongoing-Study-Profiles-2020-FYQ2/BOEM-ESP-PC-16-01.pdf

[NREL] National Renewable Energy Laboratory. Wind Resource Data, Tools, and Maps. U.S. Department of Commerce, National Renewable Energy Laboratory. https://www.nrel.gov/gis/wind.html Accessed April 28, 2021.

NREL. Marine and Hydrokinetic Resource Data, Tools, and Maps. U.S. Department of Commerce, National Renewable Energy Laboratory. https://www.nrel.gov/gis/maps-marine.html Accessed April 28, 2021.

OROWindMap. Oregon Offshore Wind Mapping Tool. State of Oregon and Bureau of Ocean Energy Management. https://offshorewind.westcoastoceans.org/visualize/#x=-124.50&y=40.50&z=5&logo=true&controls=true&basemap=ocean&tab=data&legends=false&layers=true Accessed April 28, 2021.

Title	O`ahu's Traditional Cultural Landscapes
Administered by	Pacific OCS Region
BOEM Contact(s)	Dave Ball (david.ball@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2024
Date Revised	April 28, 2021
PICOC Summary	
Problem	Native Hawaiians have strong cultural ties to the ocean and its natural resources, and any development offshore Hawai`i has the potential to impact cultural and natural resources of significance to their communities. It is important for BOEM to fully understand the implications future offshore energy development may have on these resources in order to make informed decisions and comply with Federal and state environmental regulations.
Intervention	Implementing a cultural heritage landscape approach, researchers (including a lead knowledgeable and experienced in Hawaiian language and knowledge systems) will synthesize archival materials, oral histories, and traditional knowledge of the O`ahu viewshed and offshore environment.
Comparison	This research will build on the previous BOEM-funded Maritime Hawai`i study (Van Tilburg et al. 2017), focus specifically on the waters surrounding O`ahu, and include, among other things, O`ahu-vicinity cultural paddling and voyaging locations and the O`ahu cultural viewshed to/from neighboring islands.
Outcome	This study will blend traditional scientific research methodologies with traditional indigenous knowledge and methodologies to develop a holistic assessment of the cultural significance of resources offshore O`ahu in the areas that could be affected by wind energy development. BOEM will use this information to enhance consultation with the Native Hawaiian community and to better understand and describe the affected environment, develop alternatives to proposed actions, analyze potential effects, and develop mitigation measures.
Context	This research will focus specifically on the waters surrounding O`ahu and the islands neighboring O`ahu (vicinity of O`ahu in the area of potential offshore O`ahu wind energy development).

BOEM Information Need(s): The State of Hawai`i has mandated a goal of achieving 100% renewable energy by 2045. In order to meet this goal, development of offshore renewable energy resources may be necessary. BOEM has received several unsolicited proposals for wind energy development offshore O`ahu and identified two wind energy call areas. Under the National Historic Preservation Act (NHPA), BOEM has an obligation to consult with Native Hawaiian Organizations on any undertaking that has the potential to impact historic or traditional cultural properties. To better understand the potential impacts this development may have on tangible and intangible heritage resources of significance to Native Hawaiian communities, it is necessary to conduct archival research and oral history interviews with these communities. This information will assist BOEM, the State of Hawai`i, and Native Hawaiian communities in evaluating proposed offshore renewable energy projects, and to avoid or mitigate

adverse effects to National Register (eligible or listed) Native Hawaiian sites during offshore energy development. BOEM will use this information in (National Environmental Policy Act (NEPA) and NHPA documents, as well as consultations with Native Hawaiian communities. This research will also support the State's requirement for cultural impact assessments.

Background: In 2017, BOEM completed an initial research effort designed, in part, to develop best practices for consultation with Native Hawaiian communities and to provide a general understanding of Hawai`i's maritime cultural resources (Van Tilburg et al. 2017). The island of O`ahu consists of six distinct moku (traditional island districts) and as stated in the 2017 study, "consultation on the island poses unique challenges." From the 2017 study, we also know that wayfinding navigation and ocean patterns are important to Native Hawaiian practitioners like the Polynesian Voyaging Society; however, the identification of specific navigation routes and areas of importance were beyond the scope of that effort. Integration of traditional knowledge with archival research data will enhance BOEM's understanding and likelihood of identifying the presence of potentially significant cultural resources and identify appropriate mitigation measures to address those impacts. This proposed research will provide an opportunity to implement the consultation practices developed under the 2017 study, identify tangible and intangible cultural heritage sites of importance to Native Hawaiian communities, address stakeholder comments, and support the National Strategy for Ocean Mapping, Exploring, and Characterizing the US EEZ.

Objectives: The objective of this study is to develop a cultural landscape assessment of the environment surrounding O`ahu in support of potential future offshore renewable energy development.

Methods: To achieve the objectives of this study, researchers will implement the steps for characterizing Native Hawaiian cultural landscapes (Van Tilburg et al. 2017). This will include, among other things, identifying and engaging with Native Hawaiian community leaders to determine appropriate methods for incorporating traditional knowledge and oral histories. An examination of archival research will also be completed, which will include a review and transcription of Hawaiian language documents, as appropriate. Information acquired through this research will be incorporated into a cultural landscape assessment of the island of O`ahu and surrounding waters, including as appropriate, the neighboring islands of Kaua`i and Moloka`i.

Specific Research Question(s):

1. How can traditional knowledge and different perspectives of knowing the world inform our understanding of Native Hawaiian cultural landscapes surrounding the island of O`ahu?
2. What is the best culturally appropriate methodology to use when engaging Native Hawaiian communities (while also respecting the ethics, laws, and policies that acknowledge and protect traditional knowledge) in order to avoid or minimize impacts from BOEM-permitted activities?

References:

Van Tilburg H, Watson TK, Faria K, Hoomanawanui K, Ho-Lastiama I, Ritte W, Maly K, Nahoopii M, Horcajo K, Kaupiko K, 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. https://espis.boem.gov/final%20reports/5621.pdf

Title	Seafloor Condition OCS Monitoring: BIGHT'23
Administered by	Pacific OCS Region
BOEM Contact(s)	Lisa Gilbane (lisa.gilbane@boem.gov), Susan Zaleski (susan.zaleski@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2025
Date Revised	April 28, 2021
PICOC Summary	
Problem	Incomplete information about the condition of the seafloor near existing Pacific OCS platforms affects BSEE's ability to decide on alternatives for Decommissioning Plans and BOEM's ability to develop a scientifically up-to-date programmatic Environmental Impact Statement for decommissioning.
Intervention	Make existing information accessible, and additionally sample sites near Pacific OCS platforms, in coordination with the already funded regional sampling, to create a platform-specific comparison to the regional condition
Comparison	Compare the similarities of communities and sediments in undisturbed and disturbed sediments and over time
Outcome	Assess the condition of the seafloor near Pacific OCS platforms relative to reference conditions using data collected over 20 years offshore southern California, and make the results accessible to the public
Context	Southern California OCS (focus on Santa Barbara Channel)

BOEM Information Need(s): This study implements BOEM's Outer Continental Shelf Lands Act charge to monitor the marine environments adjacent to OCS operations and to have some measure of evaluating impacts from past and ongoing operations. Information on seafloor invertebrate species and their abundances in the vicinity of most existing platforms in the Pacific OCS was last collected over 17 years ago yet is still the basis of current environmental assessments. This proposed study builds on BOEM's prior involvement in the 2018 regional monitoring (Bight'18)to regionally assess and rank the degree of disturbance for biological communities in areas surrounding platforms, with a focus in the Santa Barbara Channel portion of the southern California OCS. This information will be used in planned decommissioning Environmental Impact Statements, specifically to address potential sediment contamination.

Background: The use of regional reference condition is a well-established method in southern California for evaluating impacts from stream and offshore areas. A regional reference condition captures the full range of natural variability, enables a more robust analysis, and prevents potential false-positive findings from a single site comparison. To assess impacts from multiple sources and to improve capacity for regional assessments, the Southern California Coastal Water Research Project (SCCWRP) facilitates a regional seafloor effort every five years to sample fishes, invertebrates, and sediments. Local, state, and Federal agencies partner through SCCWRP to sample over 350 locations in southern California, from estuaries to beyond the continental slope (Gillett et al. 2017). A regional reference condition termed "Benthic Response Index" is used regularly for inner- and mid-shelf impact studies out to 200 m. As a

pilot effort and part of the previous monitoring effort (BIGHT'18), soft-sediment samples were taken 0.25-3 km from four platforms in the Santa Barbara Channel. The pilot design was successful and should be repeated at more platforms, with results indicating a lower toxicity response yet overall good condition relative to regional sampling (Gillett et al. 2020). This pilot also revealed there is missing and incorrect mapping of the structures and habitats surrounding some of the platforms. These errors need to be corrected at some platforms with remote sensing and video data resampled to verify the seafloor habitat near the platforms.

Prior work (Gillett et al. 2019) analyzed 20 years of samples in depths from 200 to 500 m depicting three distinct biogeographic communities in the Santa Barbara Channel that separate generally by depth. As a result, infaunal communities' response to impacts are different depending on their depth, and existing indices are likely not applicable to depths greater than 400 m (Gillett et al. 2021). Distinct climate-related shifts to the oceanography in this region also may impact assessment approaches (Bograd et al. 2008, 2019). The methodologies for assessing bottom disturbance impacts in outer shelf (200-400 m) and upper slope (> 400 m) environments need to be advanced among regional regulators and scientists to develop a common understanding and evaluate potential approaches.

Objectives: The question to be answered by this study is: What is the ecological condition of the seafloor near platforms in Federal (OCS) waters of the Santa Barbara Channel in southern California? Two other important questions must be addressed to answer the above question: how do we best evaluate outer shelf and upper slope impacts with an approach that is systematic and regional (200–500 m); and can data collected in the 1970–1990s be recovered and added to these analyses?

Methods: This effort will gather and assess the feasibility of and need for incorporating and standardizing historic samples and collecting new ground truth samples to verify the accuracy of hard bottom and structures and to determine temporal trends.

Prior to the regional sampling in 2023 (Bight'23), effort is needed to develop an assessment approach for impacts to the outer shelf and slope depths from 200 to 1,200 m. Multiple options will be presented to regulators and scientists working in upper slope depths (~400–1,200 m) to develop a common understanding and evaluate potential approaches.

Taxonomic and chemical data will be collected in soft sediments by multiple state agencies in the summer of 2023. Statistical analyses will include processed data for organismal, physical, toxicology (including PAHs), and location data in the depth regions of platforms in Federal waters of the Santa Barbara Channel. Analyses will utilize multivariate statistical testing and correlations among biological, physical, and chemical parameters to test for similarities and differences among infauna samples.

There will be a focus on GIS and visual deliverables. Public display will be created to highlight all results in coordination with the West Coast Ocean Data Portal, existing SCCWRP, and other local portal efforts.

Specific Research Question(s):

1. How does the seafloor condition near platforms in Federal waters of the Santa Barbara Channel compare to the regional background?
2. What is the best methodology for assessing impacts in outer shelf (200-400 m) and upper slope (> 400 m) environments?
3. How can data collected prior to 2000 benefit future assessments?

References:

Bograd SJ, Castro CG, Di Lorenzo E, Palacios DM, Bailey H, Gilly W, Chavez FP. 2008. Oxygen declines and the shoaling of the hypoxic boundary in the California Current. Geophysical Research Letters 35:1–6.

Bograd SJ, Schroeder ID, Jacox MG. 2019. A water mass history of the Southern California current system. Geophysical Research Letters 46:6690–6698.

Gillett DJ, Lovell LL, Schiff KC. 2017. Southern California Bight 2013 Regional Monitoring Program: Volume VI Benthic Infauna. Southern California Coastal Water Research Project, Costa Mesa, CA. http://www.sccwrp.org/ResearchAreas/RegionalMonitoring

Gillett DJ, Gilbane L, Schiff KC. 2019. Benthic infauna of the Southern California Bight continental slope: Characterizing community structure for the development of an index of disturbance. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2019-050. 166 p. https://espis.boem.gov/final%20reports/BOEM_2019-050.pdf

Gillett DJ, Gilbane L, Schiff KC. 2020. Benthic habitat condition of the continental shelf surrounding oil and gas platforms in the Santa Barbara Channel, southern California. Marine Pollution Bulletin 160 (111662). doi: 10.1016/j.marpolbul.2020.111662

Gillett DJ, Gilbane L, Schiff KC. 2021. Characterizing community structure of benthic infauna from the continental slope of the Southern California Bight. Frontiers in Marine Science 8:605858. doi: 10.3389/fmars.2021.605858

Environmental Studies Program: Studies Development Plan | FY 2022–2023

Title	Social Values, Perceptions, and Likelihood of Social Action in Potential Wind Energy Areas in the Pacific Outer Continental Shelf Region
Administered by	Pacific OCS Region
BOEM Contact(s)	Kimberly Marshall McLean (kimberly.marshallmclean@boem.gov), Sara Guiltinan (sara.guiltinan@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2024
Date Revised	April 28, 2021
PICOC Summary	
Problem	As the potential for offshore wind energy development expands, there is a need to better understand what is important to potentially affected communities. Information is needed on how differing values and perceptions across and within communities influence local receptivity to proposed development.
Intervention	Although BOEM currently engages with stakeholders through public participatory processes such as public meetings and webinars, it can be difficult to identify the full set of stakeholders and determine and address their concerns. Spatially explicit data on seascape values, perceptions, and opinions needs to be collected to inform the planning process for offshore wind energy leasing in Federal waters in the Pacific.
Comparison	Identify factors predictive of support level and intention to take future action to advance a position on offshore wind energy
Outcome	Predict which communities may be more or less receptive to offshore wind development. Document the relevance and importance of local contextual factors on the possible reception of proposed local offshore wind energy development among residents in affected coastal communities. This will include aspects such as place attachment, proximity, and perception of potential impacts.
Context	Pacific Region

BOEM Information Need(s): To better understand and document meaningful social information related to coastal communities within the Pacific Region to inform renewable energy projects to accomplish the following:

1. Meet BOEM's requirements for preparing environmental assessments under NEPA (can also be leveraged to inform OCSLA requirements)
2. Analyze environmental justice under Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations; address requirements of Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (Jan 20, 2021)
3. Executive Order on Tackling the Climate Crisis at Home and Abroad

As the potential for offshore wind energy development expands, there is a need to better understand what is important to potentially affected communities. Further, information is needed on how differing

values and perceptions across and within communities influence local receptivity to proposed development. This study will help decision-makers better understand the relationships between how people use marine spaces, the type and intensity of seascape values, and the motivations of particular stakeholder groups to support or oppose offshore wind energy projects. The results of this study would help BOEM and developers understand and negotiate the cultural landscape of areas targeted for offshore wind energy projects.

Using an enhanced understanding of public perceptions, decision-makers could tailor outreach efforts for issues important to local communities. They could use the results to address perceptions of negative impacts by encouraging targeted public dialogue on those issues and offering information and applicable science (Gonyo et al. 2021; Goedeke et al. 2019).

- Social and environmental justice: due to the proposed study methodology, the perspectives from minority communities often underrepresented in political decision-making can be explicitly documented with relatively little burden to them.
- Climate change: as pressures from a changing climate heighten and the US shifts its energy production focus to forms of green energy, understanding the wider spectrum of American perceptions of offshore wind energy is now more important than ever.

Background: BOEM is currently engaged in offshore wind planning activities in the Pacific, including California, Oregon, and Hawaii. The typical process for identifying potential Call Areas focuses primarily on understanding wind energy potential, technical feasibility, and potential natural environment effects, such as impacts to fish, marine mammals, and birds. While visual simulations are sometimes incorporated to explore potential effects on the human environment, other potential concerns of coastal communities, including vulnerable populations, are often inadequately addressed. Outside of official public engagement forums, specific preferences relating to offshore wind energy development remain relatively unknown for members of the general public and other groups who may not perceive themselves as stakeholders. Failure to gain these perspectives regarding potential benefits or impacts of offshore wind energy development is problematic, particularly when relevant stakeholders emerge late to the planning process for local projects.

Results from the Carolina study (Gonyo et al. 2021; Goedeke et al. 2019) showed that those who attend BOEM stakeholder engagement efforts are likely not representative of the population as a whole. Findings from the proposed research would help BOEM identify different stakeholder groups and how to engage with them. Therefore, the proposed work would be complementary to BOEM's existing stakeholder engagement processes and not duplicative. It is especially important to get buy-in from these local communities to avoid potential conflicts that may complicate and delay projects. Therefore, spatially explicit data on seascape values, perceptions, and opinions needs to be collected to inform the planning process for offshore wind energy leasing in federal waters in the Pacific. This study is modeled after research previously conducted by NCCOS in the Carolina coast region (Goedeke et al. 2019).

Objectives:

- Document the relevance and importance of local contextual factors on the possible reception of proposed local offshore wind energy development among residents in affected coastal communities. This will include, but not be limited to, aspects such as place attachment, proximity, and perception of potential impacts.

- Identify factors predictive of support level and intention to take future action to advance a position on offshore wind energy.
- Predict which communities may be more or less receptive to offshore wind development.

Methods: As with the previous Carolina study (Gonyo et al. 2021; Goedeke et al. 2019), this study would conceptualize Devine-Wright's (2009) framework of place change, which begins with awareness before transitioning through interpretation, evaluation, coping, and action. The cooperating agency would coordinate closely with BOEM on: overall timing and the timing and *strategy* for engagement; ensuring Region-specific content needs are addressed; and the timing, design and delivery of the survey to ensure results inform decision-making. A geographically stratified, random household survey will be conducted in a predefined coastal region of the West Coast adjacent to potential offshore wind development areas. Residents 18 years of age and older will be invited to take a survey, consisting of questions on place attachment, recreational activities, social value of favorite places, awareness, perceived impact to important quality of life items, support level, past and future action, and demographic and household characteristics. A very large sample size is targeted. Weighted data will be analyzed. Logistic regression will be used to test hypotheses related to the conceptual model. Spatial data will be analyzed and visualized using ArcMap and ArcGIS Pro**.**

Specific Research Question(s): The survey will consist of questions on topics such as:

1. What are the demographics of stakeholders and their communities in areas potentially affected by offshore wind energy development?
2. What are the levels of awareness and perceptions of different stakeholder groups to offshore wind energy development?
3. How do stakeholders view the potential benefits and impacts of offshore wind energy development?
4. Which communities may favor or be opposed to offshore wind energy development? Which communities may be more or less likely to engage in social action for or against local wind energy development?

References:

Devine-Wright P. 2009. Rethinking NIMBYism: the role of place attachment and place identity in explaining place-protective action. Journal of Community & Applied Social Psychology. 19:426– 41.

Goedeke TL, Gonyo SB, Loerzel J, Freitag A, Fleming CS, Ellis C. 2019. Resident perceptions of local offshore wind energy development: support level and intended action in Coastal North and South Carolina. 116 p. OCS Study BOEM 2019-054. Obligation No.: M15PG00022. https://espis.boem.gov/final%20reports/BOEM_2019-054.PDF

Gonyo SB, Fleming CS, Freitag A, Goedeke TL. 2021. Resident perceptions of local offshore wind energy development: Modeling efforts to improve participatory processes. Energy Policy 149: 112068. DOI:10.1016/j.enpol.2020.112068

Kurtz HE. 2003. Scale frames and counter-scale frames: constructing the problem of environmental injustice. Political geography, 22(8), p.887-916.

Walker G. 2009. Beyond distribution and proximity: exploring the multiple spatialities of environmental justice. Antipode, 41(4), p.614-636.

Title	Tag You're It! Habitat Use of Large Whales of the Santa Barbara Channel and Hawai'i
Administered by	Pacific OCS Region
BOEM Contact(s)	Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	Sole-source Cooperative Agreement
Performance Period	FY 2022–2024 (18 months)
Date Revised	April 28, 2021
PICOC Summary	
Problem	There are currently no commercially operational offshore floating wind facilities to inform the siting of potential wind energy sites offshore Hawai'i as it relates to the potential impacts of these developments on humpback whales. Additionally, with the beginning of decommissioning activities on the horizon in the Santa Barbara Channel area, the potential impacts to large whale species need to be assessed.
Intervention	Collate and analyze existing whale telemetry data to identify residence times, home ranges, seasonal shifts, hot spots of aggregation, and dive profiles of large whale species to better understand habitat usage.
Comparison	These results can be used as baseline data and compared with during and/or post construction monitoring to evaluate and/or validate potential impacts from these and other activities.
Outcome	Derive spatially and temporally consistent data products or layers of whale occurrence, movements, and behavior offshore Hawai'i and in the Santa Barbara Channel area to help inform decisions about the siting of offshore floating wind development as well as the timing of conventional energy decommissioning activities.
Context	Santa Barbara Channel and Hawai'i

BOEM Information Need(s): BOEM needs data on large whale occurrence, movement, and dive behavior in order to site offshore floating wind development offshore Hawai'i and conduct decommissioning activities in the Santa Barbara Channel area in a way that minimizes any potential impacts to these species from these activities. This information will allow for compliance with BOEM's regulatory responsibilities under the MMPA, ESA, and National Environmental Policy Act. This information is applicable to all BOEM Programs.

Background: BOEM has funded, and is currently funding, efforts to collect seasonal data on the occurrence and distribution of cetacean (whale, dolphin, and porpoise) species (BOEM 2021a; 2021b; 2020a; 2020b; 2017; 2014a; 2014b; 1999; 1983), as well as ambient soundscape data (BOEM 2021a), within the California Current Ecosystem. These efforts provide an important baseline and large-scale context for BOEM's assessment of potential impacts to marine protected species. However, to make this information even more valuable, it is critically important to gain finer-scale, high-quality information at sufficient spatial resolution (nominal grids of 10-25 km depending on application) on whale movements, home ranges, residency times, seasonal shifts, hot spots of aggregation, and dive behaviors and relate

these metrics to environmental variables such as sea surface temperature, chlorophyll-a concentrations, and seafloor depth and slope (ideally over multiple concurrent years). These data would provide a 3-D look into how large whale species in the Santa Barbara Channel area and offshore Hawai'i use their habitat. The importance of this data, presented as spatially and temporally explicit layers, cannot be overstated when considering offshore floating wind development and the identification of potential mitigative strategies to minimize any potential impacts to these species as a result of these activities, as well as the timing of future conventional energy decommissioning activities.

Oregon State University (OSU) has been collecting telemetry data for four species of baleen whales along the U.S. West Coast for the past 30 years. Additionally, in the last 3-4 years, advanced satellite tags have enabled the collection of dive behavior data. Cascadia Research Collective and MarEcoTel also have telemetry data in these areas. These data need to be collated, analyzed, and interpreted in order to be available to inform management decisions. Being the lowest cost element of this process, this represents large financial savings and large returns for BOEM.

Objectives: The purpose of this study is to use existing telemetry data to gain a better understanding of how four large whale species (fin, blue, humpback, and gray whales) that occur off the U.S West Coast use their habitat in the Santa Barbara Channel area and in areas offshore Hawai'i, with specific interest around the island of O'ahu.

Methods: Consolidate OSU's existing telemetry data (movement metrics and dive behavior) for fin, blue, humpback, and gray whales. Integrate these data with telemetry data from Cascadia Research Collective and MarEcoTel for the same species. Undertake data integrity validation using approved QA/QC methodologies. Analyze the data by using state-of-the-art analytical methods to derive metrics such as residence time, home range, seasonal shifts, and hot spots of aggregation, and to relate these metrics to environmental variables (e.g., sea surface temperature, chlorophyll-a concentrations, and seafloor depth and slope). ArcGIS will be used to produce temporally and spatially explicit layers.

Specific Research Question(s):

1. At what rate are the whales moving?
2. What is the seasonal occupation rate in the areas of interest?
3. Are any whale species resident in the areas of interest? If so, where and for how long?
4. Can home ranges be identified for the different whale species?
5. How deep and how long do these whale species dive?
6. Does feeding occur in the areas of interest? If so, where, at what depths, and how often do they feed?
7. What is the spatial/geographic spread of the dives?
8. What are the drivers behind the identified movements/behaviors? Are the drivers biotic or abiotic?

References:

BOEM. 1983. Central and Northern California Marine Mammal and Seabird Study. https://marinecadastre.gov/espis/#/search/study/20375

BOEM. 1999. Oregon and Washington Marine Mammal and Seabird Studies. https://marinecadastre.gov/espis/#/search/study/20204

BOEM. 2014a. 2014 California Current Cetacean & Ecosystem Assessment Survey (CalCurCEAS): Final Report to Bureau of Ocean Energy Management regarding surveys of Windfloat and Wave Energy Areas. https://www.boem.gov/PR-14-OBS/

BOEM. 2014b. Pacific Continental Shelf Environmental Assessment (PaCSEA): Aerial Seabird and Marine Mammal Surveys off Northern California, Oregon, and Washington, 2011-2012. https://espis.boem.gov/final%20reports/5427.pdf

BOEM. 2017. Spatial Database for the At-Sea Distribution and Abundance of Seabirds and Marine Mammals off Southern California: 1999-2002. https://www.sciencebase.gov/catalog/item/57c75faae4b0f2f0cebed52e

BOEM. 2020a. Pacific Marine Assessment Partnership for Protected Species. Bureau of Ocean Energy Management. https://marinecadastre.gov/espis/#/search/study/100179

BOEM. 2020b. California Current Cetacean and Ecosystem Assessment Survey and Use of Data to Produce and Validate Cetacean and Seabird Density Maps. Bureau of Ocean Energy Management. https://marinecadastre.gov/espis/#/search/study/100116

BOEM. 2021a. Spatial and Temporal Distribution of Cetaceans in the California Current Ecosystem Using Drifting Archival Passive Acoustic Monitoring. https://www.boem.gov/PC-20-04

BOEM. 2021b. Seabird and Marine Mammal Surveys Near Potential Renewable Energy Sites Offshore Central and Southern California. https://www.boem.gov/pc-17-01/

Title	The California Current Marine Biodiversity Observing Network for Offshore Energy
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	NOPP (BAA process with multiple agencies selecting individual proposals for funding)
Performance Period	FY 2022–2025
Date Revised	April 28, 2021
PICOC Summary	
Problem	Because ongoing and prospective energy and mineral activities in the California Current System (CCS) may disrupt ecosystem function and services, a cost-effective system is needed to determine the magnitude of these impacts.
Intervention	Studies that characterize areas and monitor trends in marine ecosystems are necessary to distinguish between changes caused by natural processes, climate change, and other human activities. By leveraging existing datasets and building upon previous work, appropriate indicators will be identified and 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 and trends expected from climate change. 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 DNA, acoustic monitoring, satellite-tracked animal tags, and other remote sensing methodology, will enable cost-efficient observation at an ecosystem scale.
Outcome	Study products will assist BOEM in performing 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 California, Central California, and Southern California

BOEM Information Need(s): BOEM needs a comprehensive yet rigorous observing system for the OCS to help discern and understand patterns and changes in critical environmental and biodiversity indicators, and to separate 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.

Green oval depicts California Current System. Credit Cormorant24

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 5-year demonstration MBON in the Santa Barbara Channel ("SBC-MBON", ending in 2021; BOEM 2021), 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), NSF's Long-term Ecological Research, NASA's 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. Notable accomplishments of the demonstration BON include dozens of published scientific papers and data integration support for other BOEM studies including BOEM-MARINe (Multi-Agency Rocky Intertidal Network (PC-19-01)); An Overview of Ecological Research Associated with Oil and Gas Platforms Offshore California (BOEM 2019-

052); Understanding Biological Connectivity Among Offshore Structures and Natural Reefs (PC-19-04); DOI Partnership: Distinguishing between Human and Natural Causes of Changes in Nearshore Ecosystems Using Long-term Data from DOI Monitoring Programs (BOEM 2019-063); The Response of Kelp Forest Organisms to Spatial and Temporal Variation in Wave Energy in the California Channel Islands (BOEM 2019-064); Archaeological and Biological Assessment of Submerged Landforms off the Pacific Coast (PC-14-04); and Net Environmental Benefit Analysis of Pacific Platform Decommissioning Scenarios (PC-16-x07).

Objectives: The objective of this study is to build on the initial SBC-MBON framework to extend data integration and biodiversity observing into new areas (Central California, Northern California, and Washing/Oregon Planning Areas) important to ongoing or prospective energy or mineral activities in the CCS.

Methods: The project will build upon the framework and methodology developed and described in the BOEM-funded study "A Demonstration Marine Biodiversity Observation Network (BON) for Ecosystem Monitoring" (BOEM 2021), which was a proof-concept study limited to the Santa Barbara Channel, and expand lessons learned from biodiversity data collection, synthesis, and integration to areas prospective for renewable energy across the California Current System. Existing technological and methodological approaches deemed exceptionally successful in meeting BOEM information needs during the initial demonstration study include acoustic and optical imaging, genomics/eDNA, and essential biodiversity variables. Coordination across separate funded proposals within the California Current System will be ensured via direct participation of BOEM's Pacific Region in the proposal competition process.

Specific Research Question(s):

1. What essential biodiversity and ocean variables are important to monitor in the California Current System (CCS) with respect to offshore energy and mineral activities?
2. How can we refine and use machine-learning techniques to analyze and synthesize biodiversity data from imagery to improve cost effectiveness of CCS monitoring?
3. How can we integrate survey technologies (e.g., AUVs) with genomics and environmental DNA techniques to describe spatial patterns of marine biodiversity (whales to microbes) in areas of interest in the Pacific Region to support BOEM energy and mineral programs?
4. How can we leverage existing programs, including BOEM's Center for Marine Acoustics, to describe the baseline acoustic environment for marine fishes that may be impacted by offshore energy and mineral activities?
5. How can we continue to optimize data management and synthesis through collaboration with Federal partners (NOPP, DOE, NOAA, NPS, USFWS, USGS, DoD, Smithsonian), State partners (California, Oregon, and Washington), existing consortia (ATN, IOOS, MARINe), and other relevant programs?

Affiliated WWW Sites: https://marinebon.org/; http://sbc.marinebon.org/

References:

Anderson K, Ryan B, Sonntag W, Kavvada A, 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

BOEM. 2021. A Demonstration Marine Biodiversity Observation Network (BON) for Ecosystem Monitoring. U.S. Department of the Interior, Bureau of Ocean Energy Management. https://marinecadastre.gov/espis/#/search/study/100092. Accessed February 2021.

Duffy JE, Amaral-Zettler LA, Fautin DG, Paulay G, Rynearson TA, Sosik HM, Stachowicz JJ. 2013. Envisioning a marine biodiversity observation network. Bioscience 63:350-361.

Geijzendorffer IR, Regan EC, Pereira HM, Brotons L, Brummitt N, Gavish Y, Haase P, Martin CS, Mihoub JB, Secades C, Schmeller DS. 2016. Bridging the gap between biodiversity data and policy reporting needs: an Essential Biodiversity Variables perspective. Journal of Applied Ecology 53:1341-1350.

Palumbi SR, Sandifer PA, Allan JD, Beck MW, Fautin DG, Fogarty MJ, Halpern BS, Incze LS, Leong JA, Norse E, Stachowicz JJ. 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 1/25/2021).

Title	Baseline Tourism and Recreation Along the Gulf of Maine
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022–2025
Date Revised	January 23, 2020
PICOC Summary	
Problem	The availability and quality of tourism and recreations activities and the revenues of tourism- and recreation- dependent businesses may be reduced due to the presence of offshore wind farms.
Intervention	Determine if offshore wind development negatively affects recreation and tourism and quantify the results.
Comparison	The study will document necessary baseline (i.e., before) tourism/rec data so that any changes after an offshore wind farm is installed can be measured and compared to determine if tourism/rec opportunities, quality, and/or associated revenues are reduced.
Outcome	Baseline tourism and recreation information before offshore wind farm construction to facilitate future comparison after wind farm construction
Context	Gulf of Maine, which is in the early stages of planning for a lease sale with only one task force meeting held thus far.

BOEM Information Need(s): The National Environmental Policy Act (NEPA) requires BOEM to consider the environmental impacts of proposed actions before making decisions, which includes understanding impacts on the Human Environment, such as "aesthetic, historic, cultural, economic, social, or health" impacts (40 CFR 1508.8). This study will provide empirical data regarding the impacts or non-impacts (e.g., recreation, employment, small businesses, property values, heritage tourism) from offshore wind development in the Gulf of Maine including Maine, New Hampshire, and Massachusetts. This information will also be critical when responding to the concerns of state and local governments, citizens, and various stakeholder groups (e.g., property owners, small business owners, boaters).

Background: Potential impacts to tourism and recreation are a concern expressed by coastal communities. Evaluation of the potential impacts requires baseline information about the recreation use in an area as well as post construction information to determine the impacts. BOEM collected some baseline information about tourism and recreation to provide baseline information (ICF Incorporated, LLC. 2012), but this did not include the Gulf of Maine. The 2018 BOEM report, Methodology for Analyzing the Effects of Block Island Wind Farm (BIWF) on Rhode Island Recreation and Tourism Activities (Smythe et al. 2018), identifies an extensive list of potential indicators of tourism and recreation impacts and notes the importance of establishing baseline data prior to development. BOEM held the first task force meeting for the Gulf of Maine in December of 2019 and anticipates offshore wind development to occur within the next decade in the area. Since BOEM is in the early stages of planning, this provides an opportunity to apply the methodology developed in the BOEM report.

Objectives: To enhance our understanding of impacts on the human environment through a longitudinal study of the areas surrounding the Gulf of Maine.

Methods: This research will enable observation, and documentation of the human environment in the Gulf of Maine pre-development, during construction and for several years after operations. These observations will establish baseline conditions and will characterize conditions of the human environment over multiple years, allowing BOEM to capture trends and gauge change through time.

This study would be organized into 3 phrases: study design, data collection & analysis, and closeout. The 'study design' phase would include a body of integrated and iterative activity, namely: site selection; stakeholder engagement; indicator identification, refinement, and testing; and development of a sensitivity assessment (vetting the accuracy and reliability measurement). The 'data collection and analysis' phase would include: collection of primary and secondary data capturing baseline conditions (pre-construction); conditions during construction and operations; and analysis—along with simultaneous sensitivity testing. The 'closeout' phase would include: final analysis; synthesis; and report writing.

Specific methods include:

- Identify and circumscribe the area/population of study that captures the area of impacts from two wind farm sites, and a representative control site, to ensure the pre-development observations are applicable to two or more of the upcoming projects in the development pipeline.
- Conduct stakeholder engagement to ground, vet, and refine indicators produced from the Block Island Study (Smythe et al., 2018), and to ensure that local and regional concerns are identified in the study, and to consider additional indicators if needed. The specific approach to engage could include an advisory committee, focus groups, or outreach meetings.
- The anticipated domains or impact areas of study would include: recreation (fishing, diving, boating, sailing, beach going), visitation, property values/rental rates, wind farm specific commerce (*i.e.*, merchandise, tours, employment), and cultural/historic sites.
- Collect secondary (*e.g.*, local property values, rental rates, visitation rates, proprietary industry data) and primary data (*i.e.*, direct observation and participant observation of historic sites, recreation areas) over four observation periods, covering pre-construction, construction, and operations.

Specific Research Question(s):

1. How does the construction and operation of a large OCS wind farm impact the human environment?
2. What is the nature of the impact (*e.g.*, significance, persistence, qualitative change)?
3. Are the indicators valid (*i.e.*, do they measure what they are intended to measure)? Are some indicators more sensitive than other indicators to development and/or operations activity?
4. Is there regional variation? Do impacts or relationships appear to be patterned? Does socioeconomic (*i.e.*, social, cultural, historic, economic) context play a discernible role in the impacts?

References:

ICF Incorporated, LLC. 2012. Atlantic Region Wind Energy Development: Recreation and Tourism Economic Baseline Development. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2012-085, 35 pp. M11PD00223

Industrial Economics, Inc. 2012. Identification of Outer Continental Shelf renewable energy space-use conflicts and analysis of potential mitigation measures. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. OCS Study BOEM 2012-083. 414 pp. M09PC00037

Parsons G, Firestone J. 2018. Atlantic Offshore Wind Energy Development: Values and Implications for Recreation and Tourism. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-013. 52 pp. M12AC00017

Smythe T, Smith H, Moore A, Bidwell D, McCann J. 2018. Analysis of the Effects of Block Island Wind Farm (BIWF) on Rhode Island Recreation and Tourism Activities. U.S. Department of Interior, Bureau of Ocean Energy Management. Sterling, VA. OCS Study BOEM 2018-068. 88 pp. M16PC00016

Title	Clam Industry Spatial Needs Analysis – NY Bight
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker (brian.hooker@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2023
Date Revised	February 12, 2021
PICOC Summary	
Problem	Commercial surfclam and ocean quahog fisheries performance within and around offshore wind facilities is a concern raised by the fishing community.
Intervention	Learn more about the spatial needs of the commercial clam industry in the NY Bight for planning and mitigation for offshore wind facilities.
Comparison	This is a baseline study for understanding the spatial needs of the commercial clam industry.
Outcome	The outcome will be an understanding of the spatial needs of the clam industry in order to better understand impacts and potential mitigation around offshore wind facilities in the NY Bight.
Context	Commercial fishing impacts from offshore wind energy development in the NY Bight

BOEM Information Need(s): BOEM relies on the best information available to assess impacts from offshore wind energy to the commercial fishing industry. Over the years, the data products regarding fishing vessel operations and landed value have improved dramatically. However, these data products can always be improved to provide high quality information that BOEM can use in impact assessments. The New York bight lease sale is anticipated in 2021 with construction anticipated five years after.

Background: In 2018, the New York State Energy Research and Development Authority (NYSERDA) funded the Responsible Offshore Development Alliance (RODA) to develop a "Data Trust for Effective Inclusion of Fishermen's Knowledge in Offshore Wind Energy Decision Making." The project has developed a standardized and industry-owned data platform that allows fishermen to own, use, and market their data while retaining control over who has access to it. The Fisheries Knowledge Trust (https://rodafisheries.org/portfolio/fisheries-knowledge-trust/), as it is now known, has successfully integrated data from the Atlantic herring and Atlantic surfclam industries. The Atlantic surfclam industry has been identified as a significant user group in the New York Bight Offshore Wind Energy Call Areas (see: https://www.boem.gov/renewable-energy/state-activities/new-york-bight). The use of this data, derived directly from the fishermen and provided by them, has an advantage over using data from NOAA, which has restrictions on usage. Acquisition of high-resolution fishing data for the New York Bight will inform BOEM leasing decisions and plans submitted by future lease holders in the area. Specifically, this information will be able to identify spatial use, constraints, and operational mode of the surfclam fleet in the New York Bight Call Areas.

Objectives: The objective of this study is to use the best available information on commercial surfclam fishing activity in the New York Bight.

Methods: This study would use the Fisheries Knowledge Trust to obtain high resolution fisheries data for future offshore wind impact assessments. This information can produce 1) trip shape analysis, 2) ship travel path density, 3) travel direction, 4) proportion of fishing within Ocean Wind lease area.

Specific Research Question(s): How does the commercial Atlantic surfclam industry use space within the New York Bight?

Title	Coastal Landscape/Seascape Character Classification and Assessment Methodology Development
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	John McCarty (john.mccarty@boem.gov)
Procurement Type(s)	Cooperative Agreement for developing the methodology and field testing
Performance Period	FY 2022–2024
Date Revised	February 5, 2021
PICOC Summary	
Problem	Standardized methods for inventorying and classifying baseline scenic/ visual resource character of seascapes and landscapes have not been established to properly describe the affected visual environment. As a result, the visual impact assessments (VIA) submitted to BOEM by renewable energy developers describe the affected visual environment in different ways for the same area of ground. Not having a uniform and repeatable method for describing the affected visual environment may lead to inaccuracies and inhibits BOEM from maintaining consistency between projects when assessing significance of visual impact in environmental impact statements (EIS). This situation also inhibits BOEM's ability to adequately assess cumulative effects and monitor and evaluate trends in the condition of the seascape/ landscape visual character as deployment of offshore wind development increases.
Intervention	Develop a standardized method to inventory and classify scenic/ visual quality and condition of seascape and landscape environments to serve as a baseline for visual impact assessment. The standardized method will fill the gap presently found in National Environmental Policy Act (NEPA) assessments for offshore wind energy development in U.S. Federal waters.
Comparison	This study is not inherently premised on an experimental research design, thus comparison is not wholly relevant. Comparisons may be supported by the study's baseline characterizations of the maritime visual environment.
Outcome	Baseline information of current quality and condition of seascape and landscape environments for use in NEPA analysis, monitoring change, and tracking trends
Context	Atlantic coastline in proximity to BOEM offshore renewable energy leases

BOEM Information Need(s): BOEM must assess the potential visual impacts from offshore wind development on seascape and landscape character along the Atlantic coast. BOEM needs to establish a standardized and repeatable method for collecting a seascape and landscape inventory baseline required to produce a defensible NEPA impact assessment (Sullivan 2021). After a consistent inventory methodology is established, the method needs field testing.

Background: Seascape and landscape impact assessments (SLIA) analyzes and evaluates impacts on both the physical elements and features that make up a landscape or seascape and the aesthetic, perceptual, and experiential aspects of the landscape or seascape that make it distinctive. These impacts affect the "feel," "character," or "sense of place" of an area of landscape or seascape. In SLIA, the impact

receptors (the entities that are potentially affected by the proposed project) are the seascape/landscape itself and its components, both its physical features and its distinctive character (DTI 2005).

In order to produce a defensible VIA, BOEM needs to establish a uniform and repeatable method for inventorying the visual environment that would be potentially affected by offshore renewable energy development (Sullivan 2021). Not having a standardized set of procedures to inventory seascape and landscape character, VIA practitioners have had to develop their own set of procedures or adapt existing onshore systems to address impacts from offshore renewable energy development. Different projects inventorying the affected environment in different ways may cause inaccuracies in the degree of visual impact to existing coastal landscape areas and for landscape user groups. It also leads to inconsistencies in analyzing and disclosing levels of impact between projects leading to public confusion and challenge.

Establishing a uniform method to inventory, classify, and describe the affected environment (Smardon 1988) with standardized GIS data entry will enable BOEM to monitor and map changes, forecast trends, and properly assess impacts from past, present and foreseeable development in order to properly disclose effects on seascapes and landscapes, curtail undesired future outcomes, and defend BOEM's analysis and impact disclosures to the visual environment.

Objectives: The objective of this study is to use a consistent methodology across all offshore wind projects to inventory baseline conditions of the Atlantic coastal seascape and landscape visual resources to support NEPA impact assessments, monitor change, and track trends.

Methods: Under current practice, those producing the visual impact assessments (VIA) describe the affected visual environment in different ways for the same common area of ground and sea. BOEM is in the process of releasing a framework for conducting a visual impact assessment titled Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States. The framework includes assessing impacts to seascape and landscape character areas (SLAs and LCAs, respectively), but does not provide details on how to inventory, delineate, and describe SLAs and LCAs. The study will supplement the SLVIA and fill this gap. Developing the method to inventory will involve evaluating the various baseline-collection methods already used in construction and operation plans submitted to BOEM, as well as conduct a literature search on methods used by other US federal agencies, state and local governments, and foreign governments (e.g., United Kingdom). A BOEM methodology will be built from existing procedures identified during the literature search and tailored to meet BOEM's specific needs. The study will include developing a data standard to guide data entry into an ArcGIS geodatabase for data storage, management, and use. The data collection will occur under a separate and future contract for implementing the inventory methodology.

Specific Research Question(s): What criteria and procedures should be used for collecting SCA and LCA inventory baseline data to establish a repeatable and defensible impact assessment?

References:

[DTI] Department of Trade and Industry. 2005. Guidance on the assessment of the impact of offshore wind farms: seascape and visual impact report. http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file22852.pdf.

Smardon RC, Palmer JF, Knopf J, Henderson JE, Peyman-Dove LD. 1988. Visual Resource Assessment Procedures for the US Army Corps of Engineers. Instruction Report EL-88-1USACOE Waterways Experiment Station, Vicksburg MS [on line] http://www.esf.edu/via

Sullivan RG. 2021. Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States. Sterling (VA): Bureau of Ocean Energy Management. Report No. OCS Study BOEM 2021-032.

Title	Comparative Study of Aerial Survey Techniques
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2022–2024
Date Revised	January 5, 2020
PICOC Summary	
Problem	With the installation of offshore wind turbines, the traditional method of aerial surveys will not be possible in those areas.
Intervention	Adjust survey techniques to use cameras
Comparison	Comparison of aerial surveys with observers to those with camera systems
Outcome	Change in methodology that can be integrated into historical data bases
Context	The region of focus will be the Atlantic where construction may occur in the foreseeable future

BOEM Information Need(s): Future offshore wind development will include wind turbines with a height of 850 feet or more. These turbines will interfere with survey methods that are used to develop population estimates for protected species. BOEM, NOAA and FWS use aerial surveys as part of consultations, to determine population levels and make take estimates which is important across all BOEM programs. BOEM has a need to execute survey requirements in a safe and cost-effective manner while considering current and future constraints. Development of new techniques will enable BOEM to have the information needed for protected species consultations with NOAA and FWS, which support all BOEM programs.

Background: With the future construction of offshore wind facilities that will extend over many square miles, areas that were previously surveyed for marine species using observers will no longer be able to be surveyed by this traditional method. Historical surveys used for marine observations for protected species and avian species have flown at heights of 200 to 300 meters. New camera systems allow for flight heights of 1500 m or more. NOAA has raised the concern to BOEM that they have decades of survey data using protocols that involve observers in planes. Although new techniques have been in use for over a decade, NOAA has not moved to adopting these new techniques. They have cited that offshore wind development will result in a significant impact to their surveys and their ability to collect the data used to determine stock assessments of marine mammals and to closely monitor the highly endangered North Atlantic Right Whale.

BOEM has conducted some comparison surveys and examined the use of high definition surveys in a previous study (Normandeau Associates, Inc. 2012) and determined that for sea turtles, using a higher flight height, significantly increased the number of sea turtles observed.

Objectives: The objective is to develop a methodology for aerial surveys that is compatible with offshore wind farm presence and can be used to integrate with historical data sets.

Methods: While BOEM funded a comparative study (Normandeau Associates, Inc. 2012) and is pursuing methods to process the large volumes of data collected through aerial surveys. NOAA has not adopted this new methodology primarily because of the cost of equipment and the challenges of integrating historical data. The methods will include conducting comparison surveys using old and new methodologies and developing a means to integrate the data collected from aerial surveys using cameras with those using observers.

Specific Research Question(s): Can camera systems at higher flight heights replace the current observer methodology?

References:

Normandeau Associates, Inc. 2012. High-resolution Aerial Imaging Surveys of Marine Birds, Mammals, and Turtles on the US Atlantic Outer Continental Shelf—Utility Assessment, Methodology Recommendations, and Implementation Tools for the US Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M10PC00099. 378 pp.

Title	Ecological Baseline Study of the U.S. Outer Continental Shelf Off Maine
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov)
Procurement Type(s)	Existing IDIQ Contract for AT 15-05
Performance Period	FY 2022–2024
Date Revised	April 16, 2021
PICOC Summary	
Problem	Despite previous efforts in the Gulf of Maine (e.g., Atlantic Marine Assessment Program for Protected Species [AMAPPS]), spatial and temporal gaps in survey effort exist near an area identified by the state of Maine for floating offshore wind energy development on the OCS. Collection of these data are essential to understand the potential effects of floating offshore wind activities on wildlife species in the Gulf of Maine.
Intervention	Conduct aerial surveys using high-resolution cameras and/or boat-based wildlife surveys.
Comparison	These data will help form a baseline for future comparisons (e.g., pre-construction vs. post-construction).
Outcome	Baseline data to estimate density and distribution of wildlife (marine mammals, sea turtles, and seabirds) adjacent to and within the area identified by the state of Maine for research floating offshore wind energy research on the OCS.
Context	OCS off Maine in the North Atlantic Plan Area

BOEM Information Need(s): Baseline information is needed on the distribution and abundance of marine mammal, bird, and sea turtle species in the Gulf of Maine to assist in the environmental review of impacts from floating offshore wind energy development. The State of Maine identified a research area for floating offshore wind development on the OCS. The data collected from this effort will be used to inform BOEM's planning processes, NEPA analyses (including cumulative effects), region specific environmental assessments, review of applications for permits, and ESA consultations.

Background: There is interest in a regional approach to develop floating offshore wind energy in the Gulf of Maine. In December 2019, an Intergovernmental Renewable Energy Task Force for the Gulf of Maine was convened to facilitate coordination and consultation among Federal, state, local, and tribal governments. The state of Maine has announced its intention to apply for the country's first offshore floating wind research array in the Gulf of Maine. BOEM has funded several regional efforts (e.g., AMAPPS, GoMMAPPS , South Atlantic Baseline) that are critical to improving our understanding of seabird, marine mammal, and turtle distributions on the OCS.

For this effort, seasonal High-Resolution Aerial and/or Boat-based Wildlife Surveys will be conducted for two years to cover the near and in the area identified by the state of Maine for research array and implement those surveys to obtain spatially explicit density and abundance estimates. The approach will be consistent with BOEM's Survey Guidelines (http://www.boem.gov/Survey-Guidelines/).

Objectives: The objective of this study is to obtain contractor support to design and conduct multi-season boat-based and/or aerial-digital marine wildlife surveys and to establish an ecological baseline describing the distribution and abundance of marine seabirds, mammals, and sea turtles on the US OCS off Maine.

Methods: The surveys will cover approximately 5,000 km^2 starting from Federal-state boundary (3 nautical miles) and will include the area identified by the state of Maine for research array. The area has been surveyed sporadically, and there are large spatial gaps in relative bird distribution and abundance, particularly in winter and spring (NROC 2009).

The effort will coordinate with USFWS and others that may be surveying in the Gulf of Maine. The data collected from these baseline surveys will be added into databases like the Compendium of Avian Occurrence Information database and the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP). Ultimately, the baseline data could then be used to update avian and other wildlife distributional maps like those developed through BOEM's interagency agreement with NOAA (Winship et al. 2018) and distributed to the regional planning bodies (e.g., http://midatlanticocean.org/ and http://devel.northeastoceandata.org/) and http://marinecadastre.gov/).

Specific Research Question(s): What is the abundance and distribution of wildlife species using the OCS off Maine?

References:

NROC (Northeast Regional Ocean Council). 2009. Northeast Ocean Data Portal, www.northeastoceandata.org. Date accessed: 04/16/2021.

Winship AJ, Kinlan BP, White TP, Leirness JB, Christensen J. 2018. *Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning: Final Report*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2018-010. x+67 pp.

Title	Evaluating Effectiveness of Nature Inclusive Design Materials
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker (brian.hooker@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2027
Date Revised	February 11, 2021
PICOC Summary	
Problem	Some cable protection and scour protection materials may inhibit or not promote epifaunal growth and utilization as fish habitat.
Intervention	Test the effectiveness of different materials in promoting marine growth and enhancing habitat. Materials will be monitored for epifaunal growth and habitat utilization.
Comparison	The results can be compared to materials currently used at two offshore wind energy installations in operation.
Outcome	The outcome is recommendations for materials that enhance fisheries habitat.
Context	Offshore wind energy facilities on the Atlantic OCS

BOEM Information Need(s): BOEM has an obligation to ensure that the wind energy facilities it authorizes uses the best available information and technologically feasible methods of reducing negative environmental effects from offshore wind energy. This information is especially needed as part of assessments to essential fish habitat pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. Current studies (e.g., RODEO, https://www.boem.gov/rodeo) have shown that cable protection materials may inhibit marine growth and may not provide habitat benefits generally associated with the introduction of hard substate (e.g., artificial reef programs). This study would evaluate the effectiveness of different materials used for cable protection and scour protection in enhancing hard bottom fisheries habitat.

Background: BOEM monitoring studies at the Block Island Wind Farm indicate that standard cable protection concrete mattresses inhibit marine growth. Materials used in offshore infrastructure should provide conservation benefits to the maximum extent practicable. This concept has significant development in the North Sea where the Dutch have developed a Nature Inclusive Design (NID) catalog for use by regulators and the offshore wind industry. A similar catalog is being developed by The Nature Conservancy in the U.S. This study would evaluate the effectiveness of materials included in NID catalog under development in the U.S. Furthermore, this study would be able to evaluate the use of various materials by non-native species (e.g., *Didemnum vexillum*), which is commonly found on the northeast shelf to better understand trade-offs of promoting habitat utilization.

Objectives: The objective is to evaluate the effectiveness of cable protection and scour protection materials in providing beneficial habitat to living marine resources while recognizing that not all marine organisms (e.g., non-natives) are not necessarily beneficial to the environment. Thus, both the positive and negative outcomes of habitat promotion can be evaluated.

Methods: This study would procure and deploy various cable protection and scour protection materials on the seafloor, where they would be monitored for marine growth and habitat utilization by not only commercially or ecologically important species, but by non-native species as well. This study may be carried out directly with a lessee implementing such measures, or independently. Results would be compared with completed and ongoing monitoring programs at the Block Island Wind Farm and the Coastal Virginia Offshore Wind facility.

Specific Research Question(s): Are the materials effective in providing/enhancing habitat for structure/hard bottom species? Are the attracted species a positive or negative for the system in which they were deployed?

Title	Exploring the Connectivity Among Offshore Wind Turbines
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2024
Date Revised	February 8, 2021
PICOC Summary	
Problem	Offshore wind turbines provide new habitat through artificial reef effects that attract fish. The overall impacts to ecosystems may be localized but could be additive if species interact with multiple structures.
Intervention	Trace the interactions of fish species between structures. Do they have high fidelity or move among structures?
Comparison	The interactions between turbine structures may be compared to interactions with natural structure such as rock outcrops.
Outcome	Does turbine spacing increase or decrease these interactions?
Context	Northeast Atlantic Coast, where the majority of offshore turbines are proposed

BOEM Information Need(s): BOEM reviews and conducts an environmental analysis on each construction and operation plan submitted by developers. The review evaluates the environmental impacts from the proposed project and offers mitigation measures to reduce or eliminate those impacts. Impacts of the structures on ecosystems is an important environmental consideration, and a possible mitigation is to examine the proximity of turbines to each other.

Background: Offshore wind turbines introduce hard substrate into an environment that is usually composed of soft sediment. The structure also provides vertical habitat through the entire water column. As has been observed for all man-made structures introduced in the marine environment, marine growth is rapid, and a complex habitat is formed. Specifically for wind facilities, researchers in Belgium have observed a rapid succession of marine life over a ten-year period (Kerckhof et al. 2019). Besides the reef effect from encrusting organisms, fish species are often attracted to the structures.

One concern raised is whether the proximity of structures is additive and, as such, results in a restructuring of the ecosystem at larger scales than just the immediate vicinity of the turbine. In other words, is there connectivity between the turbines for mobile species such as fish. Although the Gulf of Mexico has thousands of oil and gas structures, and in some locations there are clusters of structures, changes to the environment have focused on alterations at individual structures. In the Pacific, oil and gas structures are studied in relation to nearby natural reefs for comparisons. Because offshore wind turbines are not installed as solitary structures as oil and gas wells or reefing of individual vessels are, but as groups of structures that may number 100 or more within a close proximity, a reasonable question to ask is whether these structures have an additive effect.

Objectives: The objective of this study is to determine if there is an additive effect on fish from multiple structures in an offshore wind facility.

Methods: The evaluation of connectivity should be conducted on species that may move between turbines and nearby natural reefs. For this study, telemetry and tagging of a fish species of concern, for example black sea bass, would be used to examine whether the bass show high fidelity to a single turbine or move between turbines. This study could be conducted at Block Island Wind Farm.

Specific Research Question(s): Is there connectivity for some species between turbines and does this result in a larger impact to ecosystems than if impacts are localized to each turbine?

References:

Kerckhof F, Rumes B, Degraer S. 2019. About “mytilisation” and “slimeification”: A decade of succession of the fouling assemblages on wind turbines off the Belgian coast. Pp. 73–84 in Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Marking a Decade of Monitoring, Research and Innovation. S. Degraer, R. Brabant, B. Rumes, and L. Vigin, eds., Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management, Brussels.

Title	Investigating Persistent Super Aggregations of Right Whales and Their Prey in Lease Areas OCS-A 0521 and OCS-A 0522 in the North Atlantic
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2024
Date Revised	April 20, 2021
PICOC Summary	
Problem	In the recent years, up to 50% of the highly endangered North Atlantic right whale population has been sighted in the southern New England region in or near BOEM wind energy lease areas OCS-A 0521 and OCS-A 0522. Prey resources are currently undocumented in these areas in winter and thought to be different than prey that Right whales typically feed on in spring and summer.
Intervention	Conduct multidisciplinary research to gain insight into the prey resources that compress right whales into super aggregations in wind energy lease areas OCS-A 0521 and OCS-A 0522.
Comparison	Target super aggregations in lease areas OCS-A 0521 and OCS-A 0522 and compare to other right whale feeding areas outside lease areas.
Outcome	Identification of key prey resources currently undocumented in right whale hotspots that intersect wind energy lease areas OCS-A 0521 and OCS-A 0522. Prey composition, prey density, and prey energetic value will inform right whale energetics models to determine the importance of these critical feeding areas.
Context	Atlantic/Massachusetts lease areas OCS-A 0521 and OCS-A 0522

BOEM Information Need(s): This research may challenge the current perception of right whale prey resources and could help evaluate whether this foraging region is likely to persist under changing ecosystem conditions by better understanding the mechanisms and prey resources that drive foraging by right whale super aggregations in lease areas OCS-A 0521 and OCS-A 0522 (Leiter et al. 2017; White and Veit 2020). The Nantucket Shoals system and others like it will likely increase in importance due to ecosystem resilience as the larger oceanographic regime changes (Record et al. 2019). NEPA/ESA/MMPA assessments will more routinely need to account for the attraction of immense persistent aggregations of listed species to resilient areas due to the concentrated food resources they provide and competing interests for the space with industry.

Background: In the ongoing BOEM study with the Massachusetts Clean Energy Center (AT-17-x10), the New England Aquarium and Woods Hole Oceanographic Institution investigated potential prey of right whales in the northern Massachusetts Wind Energy Areas; however, their sampling locations were distant from the super aggregations of right whales that persist in lease areas OCS-A 0521 and OCS-A 0522. It is worth noting that at the right whale consortium, Mark Baumgartner commented that he did not know what the whales were feeding on in this area that we propose to target.

Objectives: Our primary objective is to examine the prey resources and persistent aggregations of right whales in OCS-A 0521 and OCS-A 0522 in winter, during a time when their usual prey (*Calanus finmarchicus*) is in diapause at much deeper depths. Nearly 50% of the right whale population feeds along the southwest quadrant of Nantucket Shoals and intersects Wind Energy Areas. Documentation of this unidentified prey patch and its primary zooplankton densities will help inform and update right whale energetics models.

Methods: Shipboard sampling of plankton and oceanography (e.g., currents, temperature, depth) will be conducted using a combination of nets, active acoustics, and underwater video. Sampling will be paired with NOAA aerial survey effort, AMAPPS aerial imagery surveys, satellite imagery of whales, and right whale individual identification to help build a comprehensive portrait of right whale demographics as it pertains to habitat use. Recent deployments of moored acoustic sensors and autonomous acoustic gliders currently patrolling the wind management area will aid our field efforts and sampling could also be expanded to incorporate eDNA water collection. This study will contribute to and benefit from BOEM projects by providing and receiving whale sighting information to the research projects on Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery (NT-19-04) and AMAPPS III B and C—Photogrammetric Aerial Surveys to Improve Detection and Classification of Seabirds, Cetaceans, Sea Turtles (AT-20-02).

Specific Research Question(s):

1. Which prey species are right whale aggregations targeting in lease areas OCS-A 0521 and OCS-A 0522?
2. Are these feeding areas becoming more important to right whales as the larger oceanographic regime changes?
3. How does species composition and energetic value of targeted prey swarms in these areas translate to right whale condition and survival?

Affiliated WWW Sites: Maps of current right whale locations on Nantucket Shoals in winter:

https://whalemap.ocean.dal.ca/

https://www.nefsc.noaa.gov/psb/surveys/MapperiframeWithText.html

References:

Leiter, S.M., Stone, K.M., Thompson, J.L., Accardo, C.M., Wikgren, B.C., Zani, M.A., Cole, T.V.N., Kenney, R.D., Mayo, C.A. and Kraus, S.D., 2017. North Atlantic right whale Eubalaena glacialis occurrence in offshore wind energy areas near Massachusetts and Rhode Island, USA. Endangered Species Research, 34, pp.45-59.

Record, N.R., Runge, J.A., Pendleton, D.E., Balch, W.M., Davies, K.T., Pershing, A.J., Johnson, C.L., Stamieszkin, K., Ji, R., Feng, Z. and Kraus, S.D., 2019. Rapid climate-driven circulation changes threaten conservation of endangered North Atlantic right whales. Oceanography, 32(2), pp.162-169.

White, T.P. and Veit, R.R., 2020. Spatial ecology of Long-tailed Ducks and White-winged Scoters wintering on Nantucket Shoals. Ecosphere 00 (00): e03002, 10.

Title	Offshore Wind Impacts on Oceanographic Processes: North Carolina to New Jersey
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Jennifer Draher (jennifer.draher@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2023
Date Revised	February 11, 2021
PICOC Summary	
Problem	Offshore wind facilities have the potential to alter the local and regional physical oceanographic processes that drive larval and sediment transport.
Intervention	Hydrodynamic and particle tracking models will be utilized to assess how the introduction of commercial scale offshore wind energy facilities affect local and regional hydrodynamics under average seasonal conditions.
Comparison	These models will be used to examine oceanographic conditions prior to offshore wind construction, post-installation of a single facility, and post full build-out of all current offshore lease areas, using representative turbine array layouts.
Outcome	To understand the potential and cumulative impacts to physical oceanography and transport processes due to commercial scale development of offshore wind
Context	Modeling efforts will cover the U.S. Mid-Atlantic Bight, focusing on the renewable energy leases offshore North Carolina northward through New Jersey.

BOEM Information Need(s): BOEM needs to understand potential changes in physical oceanographic processes, both local and regional, that may affect the transport of organic and inorganic matter. BOEM also has a need to adequately assess individual and cumulative impacts of offshore wind projects as part of impact assessments pursuant to the National Environmental Policy Act and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: BOEM has issued sixteen offshore commercial wind energy leases in southern New England and the Mid-Atlantic. Stakeholders have expressed concerns regarding the alteration of oceanographic processes in the Mid-Atlantic Bight between Cape Hatteras and Cape Cod as a result of offshore wind construction projects. In order to address these concerns, BOEM needs to be prepared to understand potential changes in hydrodynamic flows resulting from the build-out of one or several offshore wind energy facilities. Though this topic has not been extensively studied, available evidence shows that offshore structures change local current velocities and flows, as well as wind velocities and their effect on the water surface and vertical motions (Segtnan and Christakos 2015). Less understood are the cumulative impacts of large and multiple projects on regional circulation patterns. This is especially important in relation to how changes in flow may impact the transport of juvenile fish and larvae to and from habitats used at different life stages and the transport of nutrients and sediments throughout the region.

A previous BOEM-funded study (Chen and Beardsley et al. 2016) examined the potential impacts of a representative wind energy facility offshore southern New England on particle transport during storm

conditions using the Finite Volume Community Ocean Model (FVCOM). Since the conclusion of this study, interest in potential impacts due to average seasonal conditions and the cumulative impacts of multiple offshore wind facilities have been expressed, both offshore southern New England and elsewhere along the Atlantic coast of the US.

BOEM is currently funding a study on this topic that covers the lease areas offshore Rhode Island and Massachusetts (AT-19-04), but the need to study the impacts to the areas offshore North Carolina, Virginia, Maryland, Delaware, and New Jersey remains, particularly where offshore wind energy development may interact with the Cold Pool. Baseline hydrodynamic and particle transport modeling is currently being conducted offshore New York through other research efforts but may require further analysis in future studies.

Objectives: The objective of this study is to assess how the construction of multiple offshore wind energy facilities in the Mid-Atlantic Bight will affect local and regional hydrodynamics under average seasonal conditions and the resultant impact on circulation and sediment, nutrient, and larval transport. The results from this study will be validated using empirical data and used to evaluate the need for and the formation of mitigation measures.

Methods: Three model segments will be necessary to address the objective: wind wake, ocean circulation, and particle tracking. A wind wake model or wind wake parameterization will be used to estimate the change in surface wind velocities for input into a high resolution (est. 100-m resolution in the immediate area of the turbines), three-dimensional ocean circulation model capable of resolving small-scale physical processes throughout the water column. The particle tracking model will be an individual-based model used to release and track particles representing sediment, nutrients, and larvae. The particle tracking model will be capable of representing different particle characteristics such as size, location and timing of release, and location and duration in the water column. The baseline regional hydrodynamic and particle tracking models developed through BOEM's prior and current studies on this topic may be utilized where applicable.

The prospective model domain is an area covering the current lease areas offshore North Carolina, Virginia, Maryland, Delaware, and New Jersey. The domain may encompass nearby waterbodies such as bays, rivers, and the regional continental shelf to the extent necessary to capture influencing ocean circulation and input.

This study will include literature review and statistical analysis of particles of interest (*i.e.*, larval species and sediment grain sizes) relevant to the study area. This study will also incorporate average seasonal conditions and examine scenarios involving realistic layouts of multiple facilities. Example scenarios include an initial condition absent any wind energy facilities and full build-out of existing lease areas. Additional scenarios may include layouts of varying turbine sizes (9–15 MW turbines) with appropriate number and spacing, varying particle characteristics, or a partial build-out of existing lease areas.

This study will assess the scale of change of offshore wind development on particles traveling through and near to the facilities. Information from the model should also permit an assessment of the susceptibility of sediment in Wind Energy Areas (WEAs) to resuspension as a result of offshore wind facility operation. Models should be grounded in empirical evidence from the region(s) assessed, such as acoustic Doppler current profiles, wind measurements, and geophysical data including surficial sediment and bathymetry, which should be available from existing partners/projects.

Specific Research Question(s):

1. How do offshore wind energy facilities affect local and regional hydrodynamic processes, such as currents and mixing rates in the Mid-Atlantic Bight?
2. What will be the cumulative impacts of a full build-out of all current offshore wind lease areas in the Mid-Atlantic Bight on regional hydrodynamic processes?
3. How will these changes affect the transport of sediment, nutrients, and larvae during average seasonal conditions?

References:

Ole Henrik Segtnan, Konstantinos Christakos, 2015. Effect of Offshore Windfarm Design on the Vertical Motion of the Ocean. Energy Procedia, Volume 80, Pages 213–222, ISSN 1876-6102. http://dx.doi.org/10.1016/j.egypro.2015.11.424

Changsheng Chen, R. C. Beardsley, J. Qi and H. Lin, 2016. Use of Finite-Volume Modeling and the Northeast Coastal Ocean Forecast System in Offshore Wind Energy Resource Planning. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. BOEM 2016-050. 131pp.

Title	Offshore Wind Turbine Visibility Study
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	John McCarty (john.mccarty@boem.gov)
Procurement Type(s)	Inter-agency agreement
Performance Period	FY 2022–2024
Date Revised	February 5, 2021
PICOC Summary	
Problem	BOEM co-funded research in 2011 that evaluated the visibility of wind turbines located off the shores of the United Kingdom (Sullivan et al. 2013). The study evaluated wind turbines that are 351 feet to 502 feet tall and determined six different visibility thresholds measured in miles/kilometers from shore. Visual impact reports in the construction and operation plans (COP) submitted to BOEM commonly reference the findings of the 2011 study to support impact assessment conclusions on impact levels. However, the current generation of wind turbines being proposed in the COPs are now two to three times taller that those studied in the 2011 report. Visual impact reports continue to reference antiquated findings.
Intervention	Supplement the 2011 study with a new field evaluation on the visibility of the current generation of taller wind turbines and calibrate the visibility thresholds accordingly.
Comparison	The proposed study would use 2011 evaluation protocol and compare the new findings to those of the 2011 results.
Outcome	Revised visibility thresholds measured in miles/kilometers
Context	When funds are made available, the study would be conducted in areas where the larger generation of wind turbines are constructed and available to study. This may be in US Federal waters or those of foreign nations (most likely Europe). Research will be transferrable to all areas where BOEM has authority to permit offshore renewable energy development.

BOEM Information Need(s): Update the 2011 study titled "Offshore Wind Turbine Visibility and Visual Impact Threshold Distances" (Sullivan et al. 2013) funded by BOEM in 2011. The study has been widely cited in visual impact assessments (VIA) of offshore wind energy facilities in BOEM COPs. The VIAs use the 2011 study as a basis for establishing potentially affected areas for impact assessments and predicting visual impacts of proposed projects. The 2011 study evaluated the daytime and nighttime visibility thresholds of wind turbines located off the shores of the United Kingdom that ranged in height from approximately 351 feet to 502 feet tall (Sullivan et al. 2013). The height of wind turbines proposed in recently submitted COPs range from approximately 853 feet to 1042 feet, or two to three times the height of the original study. Supplementing the original study with evaluations of the larger more current wind turbines would provide wind energy developers with new thresholds to incorporate into viewshed modeling, delineate affected viewsheds, and serve as a basis for impact assumptions. The study will also investigate the ability to generate a calibration coefficient from a comparison of the

results from the 2011 and 2023 studies to adjust the findings for future generations of taller wind turbines.

Background: Apart from the two 617 feet wind turbines placed in Federal waters 27 statute miles offshore from the Virginia coast as a part of the Coastal Virginia Offshore Wind Pilot Project (Dominion Energy 2018), large-scale deployment of offshore renewable energy is absent, but inevitable. Equally inevitable is public perception of the potential visual impacts, which may rouse public opposition for some offshore wind projects (Pasqualetti 2011). Coastal communities may be guarded against the perceived industrialization of a seascape that is otherwise thought of as a pristine or special seaside environment (Firestone 2012). The potential scrutiny from these coastal communities compounds the need to have current and accurate research for VIAs to reference. As the U.S. begins largescale deployment of offshore wind energy facilities, accurately representing potential visual effects is critical to facilitating proper public understanding of the size and scale of offshore renewable energy development and produce defensible assessments of visual impacts.

Objectives:

- Assess the visibility of utility-scale offshore wind facilities that range in height from 850 to 1047 feet or taller that are currently operating in actual seascape settings.
- Assess the effects of distance, onshore viewing elevation, and variable atmospheric and lighting conditions on offshore wind turbine visibility.
- Formulate a calibrating equation for determining visibility and visual prominence of future taller wind turbines from a comparison of the results of the 2011 and 2023 studies.

Methods: In order to maintain consistency, the new study would use the same basic methods from the 2011 study to evaluate visibility of the latest in wind turbine technology and recently built projects. However, the 2011 method would require some minor refinements to address unique circumstances not present during the 2011 study. For instance, the viewing locations may need to be observed from a sea vessel if the modern wind turbines are placed further offshore with older developments obstructing their view from shore. This study will also incorporate viewing from different onshore elevations to evaluate elevational influence on visibility distances. The study protocol may also be supplemented with new considerations or tools, such as supplementing the still photos with video technology. The study would focus on visibility distances and impact thresholds for the tallest offshore turbines and projects in the U.S. and/or Europe at the time the study is conducted.

Specific Research Question(s):

1. How far distant can modern wind turbines be visibly detected?
2. What are the incremental distances that define the visual impact thresholds of offshore wind turbines to the seascape character (seascape character is preserved, retained, modified, and/or substantially changed)?
3. How does onshore viewer elevation factor into long range visibility?
4. Can a multiplier be extracted from a comparison of the two studies to help calibrate the updated findings as new and taller generations of wind turbines are manufactured?

References:

Dominion Energy. 2018. Amendment to the Coastal Virginia Wind Offshore Wind Project, May 21, 2018. https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/VA/CVOW_RAP_Amendment_Memo.pdf

Firestone J, Kempton W, Lilley MB, Samoteskul K. 2012. Public acceptance of offshore wind power across regions and through time, Journal of Environmental Planning and Management, 55:10, 1369-1386.http://dx.doi.org/10.1080/09640568.2012.682782

Pasqualetti, MJ. 2011. Opposing Wind Energy Landscapes: A Search for Common Cause, Annals of the Association of American Geographers. http://dx.doi.org/10.1080/00045608.2011.568879

Sullivan RG, Kirchler LB, Cothren J, Winters SL. 2013. Research Articles: Offshore Wind Turbine Visibility and Visual Impact Threshold Distances, Environmental Practice, 15:1, 33-49, DOI: 10.1017/S1466046612000464. https://blmwyomingvisual.anl.gov/docs/EnvPractice_Offshore%20Wind%20Turbine%20Visibility%20and%20Visual%20Impact%20Threshold%20Distances.pdf

Title	Seasonal Residency and Movement of Highly Migratory Sea Turtles in Atlantic Offshore Wind Areas
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2024
Date Revised	April 9, 2021
PICOC Summary	
Problem	Sea turtle movement and residency patterns in wind energy areas are not well understood to determine the impacts of wind farm construction and operation on sea turtles.
Intervention	Implement a rigorous tagging and analysis program of leatherback, loggerhead, green, and Kemp's ridley sea turtles and deployment of sonic receivers in Atlantic wind energy areas of development
Comparison	Assess movement and residency patterns for multiple species, different geographic areas, and compare data across years in respect to offshore wind energy areas
Outcome	Determine the magnitude and extent of beneficial or adverse impacts wind farm construction (e.g., noise) and operation (e.g., use of the habitat created for foraging or resting, change in habitat use or residency time, etc.) may have on sea turtles
Context	North- and Mid-Atlantic Wind Energy Areas

BOEM Information Need(s): Offshore wind development is quickly developing in the Atlantic and construction and operation levels will quickly ramp up. BOEM needs this information to not only understand the pre-construction conditions, but also to monitor any resulting ecosystem changes that construction and operation of offshore wind farms may have on habitat use by marine species. There is a need to better understand fine-scale sea turtle movement, habitat use, and seasonal residency in offshore wind energy areas to complement other broad scale survey efforts previously conducted under AMAPPS and some ongoing satellite tagging by NOAA in coordination with AMAPPS resources. This study would provide greater sample sizes and fine-scale data within wind energy areas (and other areas where sonic receivers are already stationed). Sea turtle presence and habitat use changes with season and water temperature, yet sea turtle use in many offshore wind energy areas is not well understood. For example, it is believed Kemp's ridley sea turtles use many offshore wind areas, but the species is often not detected during surveys due to their small size. For all species, the low availability of sea turtles detected by aerial surveys does not provide a complete ecological story of sea turtle movement and seasonal residency in wind energy areas. Sample sizes are relatively low and movements patterns have been obtained from relatively low numbers of satellite tagging of leatherback and loggerhead sea turtles. Consistent and long-term collection of information before, during and after wind farm development projects from a rigorous tagging program using sonic tags (e.g., VEMCO tags) and acceleration-depth-temperature data loggers (ADLs) would provide much greater sample sizes and fine-

scale behavioral information that is vital to BOEM's renewable energy activities, as well as developers and other stakeholders concerned with development on the Outer Continental Shelf, for National Environmental Policy Act analyses, and consultations under the Endangered Species Act.

Background: The use of sonic tags has been very successful in tracking the long-term movement of large marine vertebrates (Baker et al. 2014; Barco and Lockhart 2017). Shorter-term attachment of ADLs allow for monitoring immediate fine-scale behavior and physiology of marine animals. Long-term sonic tags transmit a specific coded signal that is used to identify individuals as they move within the range of the receivers. Sonic tags can also emit a signal that indicates the approximate depth of the turtle and provides multiple location if individuals within the range of receivers over time. A sonic tagging program will provide crucial data on sea turtle migratory movements, habitat use, residency patterns, and changes over time in wind energy areas. A goal is to establish a larger "sonic net" to capture a wider range of movement of individuals throughout the North and Mid-Atlantic wind energy areas. Unlike sonic tags that are deployed once and do not need to be recovered, pop-off ADLs need to be recovered but provide a more detailed fine-scale behavior history of sea turtles (Hart et al. 2020) that may be essential to understanding habitat use within wind farm areas. A better overall quantification of long- and short-term fine scale movements can be obtained with both sonic tags and short-term pop-off ADLs to provide a better understanding of habitat use in wind farm areas than is possible with satellite telemetry alone. A secondary goal of the study would be to increase the longevity of tag attachment. A study has shown that the duration of tag attachment varies greatly by species (Smith et al. 2019), but in many cases the tags life is much longer than the attachment life resulting in a shorter data series for the individuals. Encrusting organisms and other factors other than battery life may limited tag life. The improvement of the longevity of tag attachment will provide better and more cost-efficient data collection under the tagging program.

Objectives: The overall objective of the project is to better understand sea turtle movement, habitat use, and seasonal residency in offshore wind energy areas at different development stages (e.g., current condition versus changes after foundation structures are installed). A secondary objective would be to improve existing tagging methods to increase the longevity of tag attachment on animals for overall improvement of data, efficiency, and cost savings.

Methods: Tag large numbers of sea turtles with sonic tags that move throughout Atlantic wind energy areas at different times of year. Strategically deploy moored sonic receivers and/or attach receivers to existing moorings in wind energy areas. Conduct tagging trips to tag turtles and/or coordinate with existing studies to attach sonic tags on sea turtles, and tag turtles released from stranding networks. Conduct short-term ADL tagging within wind energy areas and analyze recovered tag data. Sonic tags can be placed on numerous stranding released turtles in coordination with the USFWS and sea turtle stranding organizations. Tagging can also be conducted with wild-caught turtles via existing tagging efforts from the AMAPPS Turtle Ecology task members including the Northeast and Southeast Fishery Science Centers at NMFS, New England Aquarium, Virginia Aquarium & Marine Science Center, Coonamessett Farm Foundation, and partnerships with the South Carolina Department of Natural Resources, the Department of Fisheries and Oceans Canada, and the University of Massachusetts Dartmouth. For a subset of turtles tagged in wind farm areas, ADLs will be paired with sonic tags to collect continuous data once the ADLs are released from the turtles. ADL packages will release after a set period of time, allowing it to float to the surface for recovery.

Specific Research Question(s):

1. What are sea turtle residency and movement patterns in wind energy areas before construction begins?
2. What months do sea turtles appear in different wind energy areas?
3. How long do sea turtles remain in wind energy areas with and without foundations present?
4. How can the longevity of tag attachment be improved?

References:

Baker, LL, Jonsen ID, Mills Flemming JE, Lidgard DC, Bowen WD, Iverson SJ, Webber DM. 2014. Probability of detecting marine predator-prey and species interactions using novel hybrid acoustic transmitter-receiver tags. PLoS One. 9(6):e98117.

Barco, S, Lockhart G. 2017. Turtle tagging and tracking in Chesapeake Bay and coastal waters of Virginia: final contract report. Prepared for US Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, under contact No. N62470-10-3011, Task Order 50, issued to HDR Inc., Virginia Beach, VA.

Hart, KM, Cherkiss MS, Crowder AG, Lamont MM. 2020. Tracking Sea Turtles: New Data-Collection Techniques Provide Fine-Scale Data. Sound Waves. https://www.usgs.gov/center-news/tracking-sea-turtles-new-data-collection-techniques-provide-fine-scale-data: United States Geological Survey.

Smith, BJ, Selby TH, Cherkiss MS, Crowder AG, Hillis-Starr Z, Pollock CG, Hart KM. 2019. Acoustic tag retention rate varies between juvenile green and hawksbill sea turtles. Animal Biotelemetry. 7(1):1-8.

Title	Sediment-borne Wave Disturbances and Propagation and Potential Effects on Benthic Fauna
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov), Shane Guan (shane.guan@boem.gov), Hsing-Zen Lee (hsing-zen.lee@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2022–2023
Date Revised	February 12, 2021
PICOC Summary	
Problem	Marine engineering activities (e.g., offshore wind farm construction, subsea drilling and dredging, and structure removal) generate intense and/or long-lasting vibroacoustic disturbances that could affect marine life. While many studies have been conducted on the free-field water-borne acoustic waves from impact pile driving, very little is known about the characteristics and propagation of substrate-borne vibroacoustic disturbances from these activities. Without such knowledge, we will not be able to address the potential physical, physiological, and behavioral effects of many ecologically and commercially important benthic species.
Intervention	This study would gain theoretical perspectives of substrate-borne vibroacoustic (including interface and compressional waves) characteristics and propagation on seabed through comprehensive data analyses and numerical modeling. The results would be applied to current knowledge in sensory biology of various benthic species to provide valid basis for impact assessment.
Comparison	The proposed study would build on Real-time Opportunity for Development Environmental Observations (RODEO) research at the Block Island Wind Farm (BIWF) and Coastal Virginia Offshore Wind Project (CVOW) to conduct comprehensive data analysis on substrate-borne particle velocity measurements. The study would also compare seafloor and sediment ambient vibroacoustic dynamics during pile driving and non-activity time periods.
Outcome	The proposed study would provide theoretical understanding of substrate-borne vibroacoustic characteristics from impact pile driving, with the acquired knowledge to be used to develop numerical models for predicting disturbances and propagation.
Context	Atlantic Seaboard, and potentially nation-wide

BOEM Information Need(s): BOEM is responsible for conducting thorough and scientifically sound environmental impact assessments on living marine resources that could be affected by its regulated activities. Marine engineering activities (e.g., offshore wind farm construction, subsea drilling and dredging, structure removal, and unexploded ordinance [UXO] detonation) on OCS waters have the potential of adversely impact marine life in the affected areas. Although BOEM has funded several studies in the past to obtain knowledge on underwater sound field from in-water pile driving, information remains scarce in terms of substrate-borne vibroacoustic disturbances, especially concerning the propagation of interface and compressional wave on seabed and in sediment.

Background: Pile driving for offshore wind farm construction produces high-intensity underwater acoustic disturbances that are known to have adverse effects to marine life (Casper et al., 2013; Branstetter et al.; 2018; Kastelein et al., 2018). Over the years, many studies have been carried out to understand pile driving sound field characteristics and sound propagation to address these environmental concerns and to assess the impacts. However, most of these studies to-date were focused on acoustic pressure waves in the water column (e.g., Reinhall and Dahl, 2011; Lippert et al., 2016; 2018; Martin and Barclay, 2019; Heaney et al., 2020).

Apart from the high acoustic pressure field being generated in the water column, these disturbances also include water-borne particle disturbances, compressional and shear waves in the sediment, as well as interface (Scholte) waves on the seabed. These non-pressure wave phenomena are generally known as particle motion (Miller et al., 2016). Some of these wave disturbances could contain high energy that, in cases of land-based impact pile driving, could cause structure damage to nearby buildings (Whyley and Sarsby, 1992). There is also increasing evidence that fishes and marine invertebrates primarily sense sound as a form of particle motion (Nedelec et al., 2016; Popper and Hawkins, 2018). Benthic dwelling species are particularly sensitive to, and could potentially be impacted by, substrate-borne particle motion (Roberts and Breithaupt, 2016; Roberts et al., 2016a; 2016b; Roberts and Elliott, 2017).

Notwithstanding such relevance of particle motion detection by fish and invertebrates in relation to noise impacts from marine engineering activities, these types of vibroacoustic disturbances have largely been overlooked and rarely monitored. A few studies that investigated particle motion from in-water pile driving or offshore wind farm operations were only limited to describing the amplitudes and frequency contents of such disturbances being at measurement locations (MacGillivray and Racca, 2005; Sigray and Andersson, 2011; Yang et al., 2018; HDR, 2019; Potty et al., 2020). Results from recent BOEM funded studies show that at ranges of 500 m and 1,500 m, particle acceleration levels measured on seabed were well above the behavioral sensitivity for the Atlantic salmon, plaice, dab, and Atlantic cod up to a frequency of approximately 300 Hz (HRD, 2019; 2020). However, in comparison to acoustic pressure wave propagation, there are very few studies on the propagation or modeling of sediment-borne particle motion that can be used to assess the range to impact (e.g., Miller et al., 2016; Hazelwood and Macey, 2016; Hazelwood et al., 2018).

Objectives: The objectives of this study are to obtain theoretical understanding substrate-borne vibroacoustic disturbances from impact pile driving activities and to acquire essential knowledge that can be used to develop numerical models to predict substrate-borne vibroacoustic propagation for impact assessments.

Although environmental impacts from substrate-borne particle motion from pile driving have been widely recognized as potential major effects on marine benthic organisms, very little research has been conducted to address these types of vibroacoustic disturbances (Popper & Hawkins, 2018). Therefore, the proposed study reflects ESP's vision statement to be "first in class" in being the best research program possible in the context of BOEM's mission and constraints.

In addition, though this study is proposed to address substrate-borne vibroacoustic characteristics and propagation from offshore wind farm construction (pile driving), results from this study have wide application for many marine engineering activities that are coupled with seabed, such as subsea drilling and dredging, offshore structure removal, and UXO detonation.

Methods: The study would build on RODEO I & II research at the BIWF and CVOW wind farm constructions by conducting comprehensive data analyses on substrate-borne particle motion data that have been previously collected to understand the detailed characteristics the vibroacoustic disturbances using advanced signal processing. In addition, a Finite Element Method would be used to understand the attenuation of the particle velocity field as a function of range.

Specific Research Question(s):

1. What are the main parameters to consider when estimate impact ranges from various substrate-borne vibroacoustic disturbances?
2. Does the model(s) developed accurately reflect empirical measurements collected? If so, can the range to effect of particle motion on seabed and in substrate in general be predicted using the model(s) developed?
3. If the model(s) developed do(es) not provide a generic prediction of range to effect of particle motion on seabed and in substrate at any sites, what are the factors that likely drive the model(s), and can any interaction relationship among these factors be qualitatively identified?
4. Can the values derived from the model(s) be used in the future to assess potential environmental impacts to benthic organisms and EFH from offshore wind farm construction activities involving pile driving?
5. Do some of the current approaches of using water column pressure gradients to estimate particle motion levels underestimate the measurements by accelerometers (e.g., Ocean Bottom Recorders Geophone and Hydrophone Sensor System, or OBX), thus underestimate the potential effects?
6. Would the model(s) developed from pile driving datasets on substrate-borne vibroacoustic disturbance and propagation be suitable to use for long-term effects from wind farm operations?

References:

Branstetter, BK, Bowman, VF, Houser, DS, Tormey, M, Banks, P, Finneran, JJ, Jenkins, K. 2018. Effects of vibratory pile driver noise on echolocation and vigilance in bottlenose dolphins (*Tursiops truncatus*). J Acoust Soc Am. 143(1):429–439.

Casper, BM, Smith, ME, Halvorsen, MB, Sun, H, Carlson, TJ, Popper, AN. 2013. Effects of exposure to pile driving sounds on fish inner ear tissues. Comp Biochem Physiol A Mol Integr Physiol. 166(2):352–360.

Hazelwood, RA, Macey, PC. 2016. Modeling water motion near seismic waves propagating across a graded seabed, as generated by man-made impacts. J Mar Sci Eng. 4,47. doi:10.3390/jmse4030047.

Hazelwood, RA, Macey, PC, Robinson, SP, Wang, LS. 2018. Optimal transmission of interface vibration wavelets – A simulation of seabed seismic response. J Mar Sci Eng. 6,1. doi:10.3390/jmse6020061.

HDR. 2019. Underwater Acoustic Monitoring Data Analyses for 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 2019-029. 110 pp. https://espis.boem.gov/final%20reports/BOEM_2019-029.pdf.

HDR. 2020. Field Observations During Offshore Wind Structure Installation and Operation, Volume I. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2020-0XX. XXX pp. (in draft).

Heaney KD, MA Ainslie, MB Halvorsen, KD Seger, RAJ Müller, MJJ Nijhof, T Lippert. 2020. A Parametric Analysis and Sensitivity Study of the Acoustic Propagation for Renewable Energy Sources. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. Prepared by CSA Ocean Sciences Inc. OCS Study BOEM 2020-011. 165 p. https://espis.boem.gov/final%20reports/BOEM_2020-011.pdf.

Kastelein, RA, Helder-Hoek, L, Kommeren, A, Covi, J, Gransier, R. 2018. Effect of piledriving sounds on harbor seal (*Phoca vitulina*) hearing. J Acoust Soc Am. 143(6):3583–3594.

Lippert, S, Nijhof, M, Lippert, T, Wilkes, D, Gavrilov, A, Heitmann, K, Ehrlich, J. 2016. COMPILE—A generic benchmark case for predictions of marine pile-driving noise. IEEE J Oceanic Eng. 41(4):1061–1071.

Lippert, T, Ainslie, MA, von Estorff, O. 2018. Pile driving acoustics made simple: Damped cylindrical spreading model. J Acoust Soc Am. 143:310–317.

MacGillivray, A, Racca, R. 2005. Sound Pressure and Particle Velocity Measurements from Marine Pile Driving at Eagle Harbor Maintenance Facility, Bainbridge Island WA. Prepared by JASCO Research Ltd., Victoria, British Columbia, Canada, for Washington State Department of Transportation, November 2005. 13 pp.

Martin, SB, Barclay, DR. 2019. Determining the dependence of marine pile driving sound levels on strike energy, pile penetration, and propagation effects using a linear mixed model based on damped cylindrical spreading. J Acoust Soc Am. 146(1):109–121.

Miller, JH, Potty, GR, Kim, H-K. 2016. Pile-driving pressure and particle velocity at the seabed: Quantifying effects on crustaceans and groundfish. In AN Popper and AD Hawkins (Eds.), The Effects of Noise on Aquatic Life II, Springer, New York, pp. 719-728.

Popper, AN, Hawkins, AD. 2018. The importance of particle motion to fishes and invertebrates. J. Acoust. Soc. Am. 143, 470-488.

Potty, GR, Miller, JH, Lin, YT, Newhall, AE. 2020. Characterization of particle motion near offshore wind farm sites in the Untied States east coast. J Acoust Soc Am. 148:2550 (abstract).

Reinhall, PG, Dahl, PH. 2011. Underwater Mach wave radiation from impact pile driving: Theory and observation. J Acoust Soc Am. 130:1209–1216.

Roberts, L, Breithaupt, T. 2016. Sensitivity of crustaceans to substrate-borne vibration. In AN Popper and AD Hawkins (Eds.), The Effects of Noise on Aquatic Life II, Springer, New York, pp. 952-114.

Roberts, L, Cheesman, S, Elliott, M, Breithaupt, T. 2016a. Sensitivity of *Pagurus bernhardus* (L.) to substrate-borne vibration and anthropogenic noise. J Experi Mar Biol Ecol. 474,185-194.

Roberts, L, Harding, HR, Voellmy I, Bruintjes, R, Simpson SD, Radford, AN, Breithaupt, T, Elliott, M. 2016b. Exposure of benthic invertebrates to sediment vibration: From laboratory experiment to outdoor simulated pile-driving. Proc Mtgs Acoust. 27,010029. doi:10.1121/2.0000324.

Roberts, L, Elliott, M. 2017. Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos. Sci Total Environ. 595,255-268.

Sigray, P, Andersson, MH. 2011. Particle motion measured at an operational wind turbine in relation to hearing sensitivity in fish. J Acoust Soc Am. 130:200–208.

Whyley, PJ, Sarsby, RW. 1992. Ground borne vibration from piling. Ground Eng. 1992,32-37.

Yang, C-M, Liu, Z-W, Lü, L-G, Yang, G-B, Huang, L-F, Jiang Y. 2018. Observation and comparison of tower vibration and underwater noise from offshore operational wind turbines in the East China Sea Bridge of Shanghai. J Acoust Soc Am. 144:EL522–EL527.

Title	Tracking Movements of Common Terns Staging on Muskeget Island
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov)
Procurement Type(s)	Inter-Agency Agreement
Performance Period	FY 2022–2024
Date Revised	April 16, 2021
PICOC Summary	
Problem	There are significant information gaps regarding whether migrating terns pass through areas leased for wind energy development and what proportion of the population may be exposed to this development. Movements derived from nano-tagged birds and the network of automated receiving stations (MOTUS) give clues on migration.
Intervention	Deploy PinPoint GPS-Argos tags to more precisely describe post-breeding offshore movements of terns.
Comparison	Compare predicted movements derived from MOTUS technology to movements described with newer technology (GPS-Argos).
Outcome	Detailed maps describing offshore movements of individual post-breeding terns; validation of movements derived from MOTUS technology with the new GPS-Argos tracking technology.
Context	Northeast Atlantic

BOEM Information Need(s): BOEM has a responsibility to assess the risks of offshore wind energy development to migratory bird species. Shorebird species, including terns, migrate through areas that will be developed for offshore wind. Information from this effort will be used to inform NEPA analyses and ESA Section 7 consultations on the risk of offshore wind development projects to migratory shorebirds while exploring the use of emerging technology to better track the movements of shore birds during fall migration.

Background: The common tern (*Sterna hirundo*) is a high-priority species for monitoring at existing and potential offshore Wind Energy Areas (WEAs) in the U.S. Atlantic Outer Continental Shelf (OCS) due to its offshore habitat use and life history similarities with the federally endangered roseate tern (*Sterna dougallii dougallii*). Previous studies on the movements of common and roseate terns in the U.S. Atlantic OCS have primarily used digitally coded radio transmitters and land-based automated telemetry stations in coordination with the Motus Wildlife Tracking System (Loring et al. 2017, 2019). Although these studies provided new information on regional movements of terns, information on offshore movements was limited by detection range of land-based telemetry stations (generally < 15 km). Recent advances in tracking technologies are increasing opportunities to track terns in offshore environments: newly available GPS-Argos transmitters that use GPS technology to acquire high-resolution location data and the Argos system to relay data via satellite to the internet. This study will use both types of technology (automated radio telemetry and GPS-Argos) to collect new information on offshore movements of

common terns captured during the post-breeding period at staging areas in the Cape Cod and Islands region of southeastern Massachusetts.

Muskeget Island is a small island between Martha's Vineyard and Nantucket Islands and was historically one of the largest tern colonies in Massachusetts until it was abandoned in 1948; yet, the island is still used consistently as a staging site during the post-breeding period (Jedrey et al. 2010) and is one of the only known roost sites for terns in Massachusetts (J. Spendelow, pers. comm.). Terns have recently begun recolonizing Muskeget, with Mass Audubon reporting approximately 500 pairs of common and 40 pairs of roseate nesting in 2020 (P. Loring, pers. c); Muskeget Island is also <30 km north from the boundary of the Massachusetts WEA.

Objectives:

1. Summarize meteorological conditions (wind speed, wind direction, visibility, and precipitation) and timing (time of day, day of year) of offshore flights in the Atlantic OCS.
2. Map movement patterns and flight altitudes of common terns during the post-breeding period and fall migration.

Methods: Field crews will conduct surveys on Muskeget Island to locate staging flocks of common terns and specific sites to deploy mist nets. Target timing for trapping is 15 August to 15 September to attempt to maximize the number of transmitters deployed on terns that are likely to depart from the Atlantic coast. PinPoint Argos-75 GPS Transmitters (Lotek Wireless, Ontario, Canada) will be attached to a subset (n=30) of After Hatch Year common terns. Shell, in partnership with USFWS, is currently using this technology on red knots near their lease off New Jersey. These transmitters collect a total of 60 GPS locations and will be programmed to optimize data collection during time periods when migratory departure is most likely to occur (e.g., within 4 hours of local sunset) to increase likelihood of collecting location data while birds are offshore. Location data will be relayed online in via the Argos satellite system (https://www.argos-system.org/). In addition, digitally coded radio tags ('PowerTags'; Cellular Tracking Technologies; Rio Grande, NJ) will be attached to a subset (n=30) of common terns. PowerTags will be programmed to transmit UHF signals (434 MHz) every 5 seconds for a total of 5 months. Signals from PowerTags will be monitored by automated radio telemetry stations within the Motus Wildlife Tracking System (www.motus.org).

Data collected by field surveys will be used to document the timing, abundance, and distribution of common terns staging on Muskeget Island between Aug 15 and Sept 15. Prey composition will be summarized using observations of prey deliveries in tern flocks and results from DNA analysis of fecal samples collected from terns during trapping. Data collected by GPS transmitters will be analyzed using R and mapped using ArcGIS. Data from CTT PowerTags will be used to quantify length of stay of tagged terns on Muskeget and to monitor regional movements from stations on Nantucket, Nomans Land Island, offshore monitoring buoys in the Equinor lease area in the Massachusetts WEA, and the Block Island Wind Farm. These efforts will contribute towards the development of a monitoring framework for automated radio telemetry studies at offshore wind areas throughout the US Atlantic by the USFWS and partners with funding from NYSERDA. In addition, GPS and radio-telemetry data will be coordinated with a current BOEM-funded effort to develop a stochastic collision risk model in partnership with the USFWS and University of Rhode Island. Lastly, the methodologies developed in this study will be used to develop a future tracking study on the endangered roseate tern.

Specific Research Question(s): How do predicted tern movements derived from older technology compare to movement described with newer technology?

References:

Loring PH, Ronconi RA, Welch LJ, Taylor PD, Mallory ML. 2017. Postbreeding dispersal and staging of Common and Arctic Terns throughout the western North Atlantic. Avian Conservation and Ecology 12(2):20.

Loring PH, Paton PWC, McLaren JD, Bai H, Janaswamy R, Goyert HF, Sievert PR. 2019. Tracking offshore occurrence of Common Terns, endangered Roseate Terns, and threatened Piping Plovers with VHF Arrays. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia.

Jedrey E, Harris R, Ray E. 2010. Roseate Terns--Citizens of the world: the Canada to Cape Cod connection. Bird Observer 38(3):146-150.

Title	A Comprehensive Assessment of Existing Gulf of Maine Ecosystem Data and Identification of Data Gaps to Inform Future Research
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Ursula Howson (ursula.howson@boem.gov)
Procurement Type(s)	Interagency agreement
Performance Period	FY 2023–2025
Date Revised	February 12, 2021
PICOC Summary	
Problem	The Gulf of Maine (GOM) is an area of interest for offshore wind development by BOEM and GOM states. In order to evaluate potential impacts of offshore wind development on the GOM marine ecosystem, existing GOM baseline biological and oceanographic data should be compiled and synthesized to develop an understanding of the GOM marine ecosystem before development occurs and to identify areas of focus for future environmental studies.
Intervention	This study proposes to address the need for baseline marine ecosystem information in the GOM to enable the evaluation of potential impacts of offshore wind development by coordinating with regional partners to leverage existing GOM ecosystem data to develop and synthesize a baseline compilation and to identify data gaps.
Comparison	The data compiled through this study will enable comparisons with future studies in the GOM.
Outcome	A compilation and synthesis of biological and oceanographic data that will serve as a baseline for future studies and will identify data gaps to inform future renewable energy use in the GOM
Context	Gulf of Maine, including nearshore and OCS

BOEM Information Need(s): BOEM conducts environmental analyses as part of the identification process of potential sites for offshore wind development. There is a need for baseline biological and oceanographic data in order to fully assess potential impacts of offshore wind on biological resources in areas of potential development. It is also important to identify data gaps in order to inform future environmental studies.

Background: The GOM has a robust and highly productive ecosystem that harbors many protected species and is an important driver of the economy of the region through sustainable regional fisheries (Thompson 2010, NMFS 2020). Considerable effort by Federal and state agencies, NGOs, and academia has gone in to developing long-term biological and oceanographic regional data sets. BOEM (as the Bureau of Land Management) had previously supported studies in the region as part of the New England Outer Continental Shelf Physical Oceanography Program (1975 – 1979) (e.g., Flagg et al. 1982, Cura and Ryther 1982, and others). Coordination with regional partners is necessary to compile the existing data sets in order to develop a comprehensive assessment of the GOM ecosystem and to identify data gaps that will support justification for future environmental studies.

GOM monitoring efforts and studies that would be leveraged for this project include a range of oceanographic, fishery, and marine mammal regional surveys from both ships and aerial platforms that provide expansive multispecies coverage. Examples include the decades-long NMFS/Northeast Fisheries Science Center (NEFSC) ecosystem monitoring and fisheries stock assessment surveys, NEFSC PlatOpus program, and recently installed passive acoustic receivers that monitor for the presence of North Atlantic right whales. The NEFSC PlatOpus program, started in 2005, uses acoustic receivers on the Northeastern Regional Association of Coastal Ocean Observing Systems and other platforms and has detected over 1,100 acoustic transmitters released by 50 organizations representing 17 species including endangered Atlantic salmon, Atlantic sturgeon, and shortnose sturgeon.

Objectives: The objective of this study is to develop a comprehensive assessment of current and historical environmental conditions in the Gulf of Maine. This will be accomplished by the following:

- Compiling existing data and assessments
- Developing a structured data model to facilitate future use of the data
- Identifying data gaps important for assessing offshore wind impacts to inform future environmental studies of the region

Methods: Coordination will occur with Federal and state agencies, NGOs, and academia to identify biological and oceanographic data sets for the GOM ecosystem, such as the NMFS/NEFSC ecosystem monitoring and fisheries stock assessment surveys and passive acoustic monitoring program. Data requirements will be defined, and an organizational system for compiling the data will be developed. Data will be synthesized into a report to develop a comprehensive assessment of the current and historical environmental conditions in the GOM, and to identify data gaps that will inform future studies of the GOM ecosystem. Additional products would include a spatial analysis or the creation of a geodatabase.

Specific Research Questions:

1. What are the baseline biological and oceanographic conditions in the GOM ecosystem, and how can that information be leveraged for analysis of potential impacts of future renewable energy use?
2. How should BOEM focus future environmental studies to inform future renewable energy use in the Gulf of Maine?

Affiliated WWW Sites:

Gulf of Maine Information sources:

http://www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report/

https://www.integratedecosystemassessment.noaa.gov/regions/northeast/gulf-of-maine

NOAA Surveys:

https://apps-nefsc.fisheries.noaa.gov/rcb/publications/tm265.pdf

https://www.fisheries.noaa.gov/feature-story/monitoring-northeast-shelf-ecosystem

https://www.fisheries.noaa.gov/new-england-mid-atlantic/population-assessments/fishery-stock-assessments-new-england-and-mid-atlantic

BOEM Studies:

https://www.boem.gov/sites/default/files/non-energy-minerals/States-documents/ME-M14AC00008-Summary-Report-Revised-opt.pdf

https://www.boem.gov/sites/default/files/non-energy-minerals/ME_1987_Kelley.pdf

https://www.boem.gov/sites/default/files/non-energy-minerals/ME_2004_Kelley.pdf

https://www.boem.gov/sites/default/files/non-energy-minerals/ME_2007_Kelley.pdf

https://www.boem.gov/sites/default/files/non-energy-minerals/ME_2007_Nathan.pdf

References:

Cura Jr JJ, Ryther Jr JH. 1982. Relationships between phytoplankton distribution and production and the physical oceanography in the Georges Bank region. 92 p. OCS Study 1982-34. Obligation No.: 14-12-0001-29188 CT1-39.

Flagg CN, Magnell BA, Frye D, Cura Jr JJ, McDowell SE, Scarlet RI. 1982. Interpretation of the physical oceanography of Georges Bank, final report, Volume 1. 648 p. OCS Study 1982-21. Obligation No.: 14-12-0001-29188 CT1-39.

NMFS. 2020. State of the Ecosystem Report: New England. Northeast Fisheries Science Center.

Thompson C. 2010. The Gulf of Maine in Context: State of the Gulf of Maine Report.

Title	Estimating Bird and Bat Flight Heights from Wildlife Strike Data
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov)
Procurement Type(s)	Contract, Inter-Agency Agreement, Cooperative Agreement
Performance Period	FY 2023–2025
Date Revised	April 16, 2021
PICOC Summary	
Problem	Flight height information is important in assessing risk to birds and bats posed by wind energy development. Despite the various methods to obtain this information, it is difficult to obtain species specific information for small nighttime migrants.
Intervention	Mine the FAA wildlife strike database for the heights of when birds were reportedly struck by commercial aircraft.
Comparison	1) Compare the bird and bat flight heights recorded via traditional methods (radar, range finder, etc.) to wildlife strikes identified by the FAA; and 2) compare aircraft strikes to strikes with structures like onshore and offshore turbines, communication towers, and skyscrapers.
Outcome	Distribution of heights of birds and bats struck by aircraft that could feed ongoing efforts including collision risk models.
Context	National

BOEM Information Need(s): BOEM has a responsibility to assess the risks of offshore wind energy development to migratory bird and bat species. Many species migrate through areas developed for offshore wind. Information from this effort will be used to inform NEPA analyses on the risk of offshore wind development projects to migratory shorebirds.

Background: Bird flight heights are regularly used to assess the risk of collision with wind turbines. This information is collected using a variety of methods including eyeballing by ground observers, using of a laser range finder, fitting birds with altimeters and GPS devices (Borkenhagen et al., 2018), radar (Fijn et al., 2015), and lidar (Cook et al., 2018). However, these methods for various reasons are ineffective in measuring bats that migrate at night and high-flying small passerines.

Aircraft regularly strike wildlife, especially birds, and in essence "sample" the airspace. Because wildlife strikes represent a significant safety risk to the aircraft, detailed data are collected to document each incident (e.g., time, altitude, weather conditions, etc.) and carcasses collected imbedded in the aircraft, feathers, and/or tissue smears on the aircraft are sent to the Smithsonian for identification. The FAA maintains a searchable public database containing each incident. This study will use the FAA wildlife strike data to describe the flight heights and conditions that may influence how small nocturnal migrants (i.e., birds and bats) and other birds use the airspace. This study will also be used to inform the development of data requirements for the reporting of bird and bat carcasses found at projects permitted by BOEM on renewable infrastructure and vessels.

Objectives: The objective of this study is to understand how small nocturnal migrants may be using the same airspace as potential wind turbines permitted by BOEM.

Methods: The data for this study will primarily come from the FAA wildlife strike database (https://wildlife.faa.gov/home). The National Wildlife Strike Database (NWSD) covers strikes with civil aircraft in the US and spans 3o years from 1990 to 2019 with records of 231,320 strikes. The vast majority of the strikes are with birds (94% of the strikes in 2019 were with birds). The database contains records of 591 bird species and 36 bat species. Additional databases may be available from Canada and countries in Europe that share similar species, perhaps records from DOD for strikes with military aircraft can be obtained too. Criteria will be developed to prepare the data for analysis and to fill in "blank cells" (e.g., missing weather information). For each species (or group as appropriate), information such as the time of year and day, and other relevant information that could be used to describe the flight heights and conditions that may influence how small nocturnal migrants use the airspace will be mined. In addition, the resulting database may be used to address questions related to migration or to validate the predictions of bird migration derived from on the ground observations (e.g., eBird's Status and Trends abundance animations and BirdCast). The final products will be an analytical report, maps, and a database. The report will also include a comparison of aircraft strikes to strikes with structures like onshore and offshore turbines, communication towers, and skyscrapers. The list of data fields and information could be used towards the development of data requirements for the reporting of bird and bat carcasses found at projects permitted by BOEM on renewable infrastructure and vessels.

Specific Research Question(s):

1. How do flight heights of birds and bats when struck by aircraft compare to observed flight heights (i.e., estimated from ground, hi-resolution aerial imagery, telemetry)?
2. How does the ranking of birds that are struck by aircraft compare to those with onshore wind turbines (e.g., Loss et al 2013; Choi et al 2020), communication towers, and skyscrapers?
3. How do weather conditions influence bird strikes? Are strikes more likely to occur at lower altitudes during poor weather conditions?

References:

Borkenhagen K, Corman AM, Garthe S. Estimating flight heights of seabirds using optical rangefinders and GPS data loggers: a methodological comparison. Mar Biol 165, 17 (2018). https://doi.org/10.1007/s00227-017-3273-z

Choi DY, Wittig TW, Kluever BM. 2020. An evaluation of bird and bat mortality at wind turbines in the Northeastern United States. PLoSONE 15(8): e0238034. https://doi.org/10.1371/journal.pone.0238034

Cook ASCP, Ward RM, Hansen WS, Larsen L. Estimating seabird flight height using LiDAR. Scottish Marine and Freshwater Science 9 (2018): 14-66.

Fijn, RC, Krijgsveld KL, Poot MJM, Dirksen S. Bird movements at rotor heights measured continuously with vertical radar at a Dutch offshore wind farm. Ibis 157, no. 3 (2015): 558-566.

Loss SR, Will T, Marra PP. 2013. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biol Conserv. 168: 201–209.

Title	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Cody (mary.cody@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2023–2027
Date Revised	February 26, 2020
PICOC Summary	
Problem	A lack of information regarding the distribution and abundance of gray seals (*Halichoerus grypus atlantica)*.
Intervention	Developing baseline information about gray seals and their use of the marine environment.
Comparison	Compare the baseline condition of gray seals before and after wind development.
Outcome	An understanding of the level of impact from offshore wind on gray seals.
Context	Areas along the Atlantic where gray seals occur near current and proposed wind energy areas.

BOEM Information Need(s): Information regarding the distribution and foraging ecology of the rapidly increasing gray seal population in northeast U.S. waters will provide insight into the role of this species in the marine ecosystem, and allow BOEM to more effectively evaluate the potential for impacts to gray seals from offshore wind farms. It is important for BOEM to understand the distribution, abundance, and movements of gray seals on the Outer Continental Shelf (OCS) in order to assess any impacts from offshore wind development. Additionally, the study would meet the ESP goal of implementing more citizen science projects by supporting fishers to collect information from the bycatch of seals.

Background: The number of gray seals (*Halichoerus grypus atlantica*) in the Northeast has risen dramatically in the last 2 decades, with few being observed in the early 1990s to at least 25,000 on a single Massachusetts beach in 2016 . They range from New Jersey north to Labrador. Gray seals use beaches and waters in the northeast to breed, pup, and forage in areas that overlap with BOEM WEAs based on a small satellite tagging study (Puryear et al. 2016) as well as NMFS bycatch estimates from commercial fisheries. Since 2001, NMFS has conducted aerial surveys to monitor gray seal pup production on Muskeget Island and adjacent sites in Nantucket Sound, and Green and Seal Islands off the coast of Maine (Wood et al. 2007). Previous surveys to monitor marine mammal distributions in WEAs off Massachusetts and Rhode Island did not survey seals (Krause et al. 2016, current AMAPPS efforts). The installation of foundations for offshore energy structures can create foraging habitat for seals (Russell et al. 2014). Increases in the habitat use, distribution, or abundance of animals around foundations can increase the potential for human interactions with gray seals from offshore wind activities (e.g., construction) and fisheries (e.g., entanglement) in wind energy areas (WEAs). To better understand the population, ecological, and anthropogenic effects of the rapidly increasing population of gray seals, there is a pressing need to obtain basic demographic and ecological information of this

increasing seal population in northeast Outer Continental Shelf (OCS) waters prior to further development of offshore wind facilities.

Objectives: The objective of this study are to:

- Collect baseline information on the distribution, abundance, and movements of gray seals.
- Support citizen science reporting of human interactions with seals in northeast OCS waters.

These seasonal and behavioral patterns form the basis for the implementation of strategies to monitor or reduce adverse interactions between seals and activities occurring within wind energy areas. Funding this project during the current time frame would provide some pre-construction baseline information, and additional comparative information during construction.

Methods: Survey and tracking data can provide much needed distribution and abundance data on gray seals. Additionally, seal movements from satellite-tagged animals, combined with commercial fishing effort data can be used to predict times and areas of co-occurrence inside of the WEA's. Information collected will determine if the distribution of gray seals in WEAs changes throughout the year depending on the forage base, presence of predators, and other factors, or if it changes during construction. The study will provide information on changes in density over time, given the population appears to be growing rapidly with an uncertain trajectory. A multi-year study is proposed including satellite tagging of individual seals to understand their seasonal distributions and movements on the OCS, aerial surveys of haul out areas combined with radio tagging efforts to correct for the portion of the population at sea during surveys would be used to estimate total abundance in the region. Additionally, an opportunity for citizen science is available to support commercial fishermen who have expressed interest in working with the scientific and regulatory communities to retrieve carcasses of animals in nets to improve diet information and to help inform solutions to reduce interactions between seals and fisheries. An additional fifth year would be dedicated to data synthesis and final reporting with minimal field operations.

The project would be completed over a 4-year period plus an additional year for data analysis and reporting of results. Three years would be devoted to satellite tagging and tracking of individual seals to understand their seasonal distributions in the pelagic environment. One year would be dedicated to aerial surveys of haul-out areas and radio tagging to correct for portion of the population hauled out during the aerial surveys. Haul-out areas will be identified and abundance estimates derived through the aerial survey and radio tagging efforts High resolution photography may be used during surveys. A fifth year would be dedicated to synthesis, analysis, and final reporting. In addition to the above work, a citizen science component from fishers would be integrated into the study to support the collection and transport of seals entangled in fishing nets. This dimension of the project will add baseline information on seal bycatch, the diet, and food web interactions in WEA regions. Samples will be transported, stored, information collected on seals, and a diet analysis completed from stomach contents. Data synthesis, analysis, and preparation of a final report would occur in the fifth year of the study.

Specific Research Question(s): What are the important ecological areas for gray seals?

References:

Kraus SD, Leiter S, Stone K, Wikgren B, Mayo C, Hughes P, Kenney RD, Clark CW, Rice AN, Estabrook B, Tielens J. 2016. Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054. 117 pp. + appendices.

Puryear WB, Keogh M, Hill N, Moxley J, Josephson E, Davis KR, Bandoro C, Lidgard D, Bogomolni A, Levin M, Lang S, Hammill M, Bowen D, Johnston DW, Romano T, Waring G, Runstadler J. 2016. Prevalence of influenza A virus in live-captured North Atlantic gray seals: a possible wild reservoir. Emerging Microbes and Infection 5, e81; doi:10.1038/emi.2016.77

Russell D, Brasseur S, Thompson D, Hastie G, Janik V, McClintock B, Matthiopoulos J, Moss S, McConnell B. 2014. Marine mammals trace anthropogenic structures at sea. Current Biology 24(14):638-639.

Wood SA, Brault S, Gilbert JR. 2007. 2002 aerial survey of grey seals in the northeastern United States. Pages 117–121 in: T. Haug, M. Hammill and D. Ólafsdóttir, (eds.) Grey seals in the North Atlantic and Baltic. NAMMCO Sci. Pub. 6, Tromsø, Norway.

Title	Offshore Landscape, Seascape, and Visual Impact Mitigation Study
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	John McCarty (john.mccarty@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2023–2025
Date Revised	February 5, 2021
PICOC Summary	
Problem	Options for mitigating impacts from offshore wind facilities to landscape, seascape, and viewsheds are limited. Increasing the distance between proposed wind projects and the viewer and reducing the number of wind turbines are the customary mitigation measures for reducing visual impact. (UKDB, 2020). The lack of available mitigation measures may be due to the scarcity of research devoted to examining ideas beyond conventional onshore visual mitigation measures, which in of themselves have minimal applicability to offshore situations.
Intervention	Examine possibilities for new and innovative mitigation measures to reduce offshore wind turbine visibility and evaluate alternatives to conventional wind turbine layout configurations. Test the conceptual mitigation measures against the public sense for aesthetic appeal, compatibility with avian protection, and flight safety.
Comparison	Comparing hypothetical mitigation measures against public perception of aesthetic appeal while being mindful of avian protection and flight safety assurances
Outcome	Innovative and pragmatic mitigation measures to reduce visual impact from offshore renewable energy development
Context	The study would be conducted in the Atlantic Region, but results would be transferrable to all regions where BOEM has authority to permit offshore renewable energy development.

BOEM Information Need(s): This study seeks to research, develop, and test the public's sense for aesthetic appeal for innovative measures for visually mitigating offshore wind energy facilities using photo-realistic representations and public engagement methods. Relatively little is known about the variables that affect the degree of perceived visual impact from offshore development. Though the perception of blade motion has abundant research, no research was found on manipulating the reflective properties of wind turbines blades to reduce with visible range of wind blade motion. Other examples of what this study would investigate include the effectiveness of visual impact mitigation methods, such as using light gray instead of white turbines, advancements in light bending technology to visually shield portions of wind turbines (e.g., blades), changing the alignment of turbines relative to a viewpoint, or maintaining visible gaps between adjacent projects.

Ocean views from vast stretches of the U.S. coastline that include heavily populated areas, tourism-dependent businesses, and important protected scenic, historic, and cultural resource areas may be subjected to major change from renewable energy development. Given the magnitude of stakeholder

sensitivity to these potential visual impacts (including cumulative effects), it is essential for BOEM and wind developers to understand what the key variables are that affect impacts, and what the most effective mitigation measures are to reduce or avoid them.

The new and innovative mitigation measures and visually acceptable layout alternatives that emerge from this study would be published for industry to consider and incorporate into construction and operation plans, as well as to build awareness in BOEM when negotiating mitigation options with a developer. The results would also be available for consideration during National Historic Preservation Act Section 106 consultations.

Background: The past two decades of modern onshore wind energy development has afforded onshore developers and regulatory agencies time to discover and formulate a range of mitigation options to reduce visual impact (USDOI, 2013). However, most of these onshore mitigation measures are not applicable to offshore situations. Proper siting, layout, and design are often pointed to as the means to mitigate visual impacts; however, no known research has been dedicated to the specifics that would achieve favorable outcomes other than siting the project further away from the viewer.

Given stakeholder sensitivity to these impacts, engaging stakeholders when exploring innovative options will accelerate discovery and lend credibility to the best possible mitigation measures to help foster public acceptance (Firestone et al. 2012).

The study would use existing data and virtual platforms already in BOEM's possession to create and test new ideas for mitigating visual impacts from offshore wind energy development. The study team would also work in partnership with wind energy developers willing to share their data to jointly develop realistic and pragmatic alternatives. The proposal anticipates

- investigating various color treatments to reduce visual contrast and special treatments that also reduce avian mortality (e.g., painting a single blade black [May et al. 2020])
- evaluating numerous wind turbine layout configurations relative to publicly accessible viewing locations
- integrating visual gaps between wind turbine arrays that interrupt the curtain effect
- testing public toleration and acceptance of visual change at targeted visibility thresholds
- researching public perception of blade motion and night lighting, and more
- considering flight safety when developing mitigation treatments

Objectives: The objective of this study is to produce a suite of innovative and pragmatic mitigation measures to reduce visual impact from offshore wind energy facilities.

Methods: The study team would generate and use photorealistic and video simulation technology to develop and study innovative mitigation concepts. These tools would be used to illustrate multiple impact scenarios and options to mitigate the impacts. Simulations would be shared with stakeholders, industry, and members of the public to appraise the mitigation options in a controlled study environment. The study would systematically identify the factors that have the greatest effects on perceived visual contrast, and the mitigation measures that are most effective for impact mitigation while accounting for bird protection and flight safety concerns. In addition, the study would include a cost assessment of mitigation measures considered effective and worthwhile to incorporate into offshore wind development approvals.

Specific Research Question(s): What measures can be developed that would effectively mitigate visual impacts from offshore wind development and resonate with stakeholder visual sensitivities?

References:

Firestone J, Kempton W, Lilley MB, Samoteskul K. 2012. Public acceptance of offshore wind power across regions and through time, Journal of Environmental Planning and Management, 55:10, 1369-1386 http://dx.doi.org/10.1080/09640568.2012.682782

May R, Nygård T, Falkdalen U, Åström J, Hamre Ø, Stokke BG. 2020. Paint it black: Efficacy of increased wind-turbine rotor blade visibility to reduce avian fatalities. Ecology and Evolution 10:8927–8935. doi.org/10.1002/ece3.6592.

[UKDB] UK Department for Business, Energy and Industrial Strategy's Offshore Energy Strategic Environmental Assessment Programme. 2020. Offshore Energy Strategic Environmental Assessment: Review and Update of Seascape and Visual Buffer study for offshore wind farms. White Consultants, Northumbria University.

(USDOI) United States Department of the Interior. 2013. Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands. Bureau of Land Management. Cheyenne, Wyoming. 342 pp, April.

Title	Post-Construction Wildlife Surveys Outside of the MA WEA
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov)
Procurement Type(s)	Existing IDIQ Contract for AT 15-05
Performance Period	FY 2023–2026
Date Revised	April 19, 2021
PICOC Summary	
Problem	Offshore wind energy developers conduct pre- and post-construction wildlife surveys within their leases. However, some marine birds (e.g., seaducks, loons) may shift their use of the lease areas to undeveloped areas in response to development.
Intervention	Conduct pre- and post-construction avian surveys in an area north and outside of the Massachusetts Wind Energy Area (WEA) while the developer conducts the same type of surveys inside the Vineyard Wind 1 project.
Comparison	Compare survey data collected during pre- and post-construction periods within and outside of the project area.
Outcome	A report comparing estimates of density and distribution of wildlife (marine mammals, sea turtles, and seabirds) in both areas.
Context	Northeast Atlantic

BOEM Information Need(s): Post-construction information is needed on the distribution and abundance of marine mammal, bird, and turtle species to assist in the environmental review of sites for potential wind energy development on the OCS. The data collected from this effort will be used to inform NEPA analysis, region specific environmental assessments, review of applications for permits, and ESA consultations. Results from this study could inform future mitigations outside of immediate project areas.

Background: In preparation for offshore wind energy development on the Atlantic OCS, BOEM, DOE, states, and developers have funded previous wildlife survey campaigns to describe the relative distribution and abundance of wildlife species (e.g., Mid-Atlantic Wildlife Studies, AMAPPS, GoMMAPPS, South Atlantic Baseline). On the site-specific project level, developers will collect data to assess the impacts of such development. Developer data in combination with information collected by others, including BOEM, will contribute to the assessment of impacts of wind energy development in the Northeast Atlantic OCS at the regional scale. For this study, wildlife surveys will be conducted off Martha's Vineyard and Nantucket Islands between Massachusetts WEA to cover an area similar to the area surveyed by Viet and Perkins (2014).

Objectives: The objective of this study is to better understand changes in the environment as a result of offshore wind development. This will be accomplished by conducting boat-based marine wildlife surveys in an area adjacent to the Vineyard Wind 1 project and comparing the survey results to post-construction survey data being conducted by the developer within the lease area.

Methods: The pre- and post-construction surveys will cover an area similar to that covered by Viet and Perkins (2014), approximately 800 km^2 north of the Vineyard Wind 501 lease area. The area has been partially surveyed in other BOEM studies (e.g., Viet and Perkins [2014], Veit, et al [2016], AMAPPS) and has relatively high numbers of seaducks, loons, and other species compared to the Vineyard Wind 1 project area (see Figure A.8.3-3, in BOEM 2021).

Pre- and post-construction surveys will monitor for shifts in distribution occurring from the presence of turbines. The boat surveys will complement in methodology (e.g., use of SeaScribe, consistent with BOEM's Survey Guidelines (http://www.boem.gov/Survey-Guidelines/, etc.) and frequency (i.e., monthly for three years) to the pre- and post-construction boat-based surveys required Vineyard Wind within lease OCS-A 0501 in the Massachusetts WEA (see Vineyard Bird Monitoring Plan in Appendix F, BOEM 2021) but without spatial overlap. Like the surveys in the Vineyard Wind 1 project, the monthly boat surveys will be conducted for one-year pre-construction and up to three years post-construction.

All species observed will be identified (i.e., birds, marine mammals, and sea turtles) to the lowest possible taxonomic group. The data collected from these surveys will be added to the databases like the Northwest Atlantic Seabird Catalog and the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP). These data can be used to update avian and other wildlife distribution maps, like those developed through BOEM's interagency agreement with NOAA (Winship et al., 2018) and distributed to the regional planning bodies (e.g., http://midatlanticocean.org/ and http://devel.northeastoceandata.org/) and http://marinecadastre.gov/.

Specific Research Question(s): How does the distribution and abundance of wildlife marine species differ between undeveloped areas and areas with wind energy development in the Atlantic OCS? What is the magnitude of potential displacement of birds from the developed area?

References:

BOEM. 2021. Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement Volume II. https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-1-feis-volume-2

Veit RR, Perkins SA. 2014. Aerial Surveys for Roseate and Common Terns South of Tuckernuck and Muskeget Islands July-September 2013. US Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2014-665. 13 pp.

Veit RR, White TP, Perkins SA, Curley S. 2016. Abundance and Distribution of Seabirds off Southeastern Massachusetts, 2011-2015. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-067. 82 pp.

Winship AJ, Kinlan BP, White TP, Leirness JB, Christensen J. 2018. *Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning: Final Report.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2018-010. x+67 pp.

Title	Using Acoustic Monitoring to Evaluate Ecosystem Changes from Offshore Wind Development
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2027
Date Revised	February 2, 2021
PICOC Summary	
Problem	The presence of offshore wind turbines may alter the local ecosystem by providing a different substrate for marine life, especially considering the number of turbines and their proximity to each other. The new substrate extends the from the surface to seafloor and can include introduction of a rocky substrate as scour protection. The changes in ecosystem structure may be subtle and difficult to measure with standard sampling techniques.
Intervention	The use of novel techniques, such as monitoring the alterations in natural sound from changes in species, may be one tool to address this question.
Comparison	The evaluation of the change in sound will require a control location for comparison.
Outcome	Measurable changes in the acoustic environment would be representative of the changes in the ecosystem.
Context	Examine one of the first facilities to be constructed

BOEM Information Need(s): BOEM will use the data to evaluate whether offshore wind facilities are altering the ecological community in a measurable way. The acoustic information will provide a baseline of sounds in an area and alterations to those sounds.

Background: With the potential for several thousand wind turbines being installed in the Mid-Atlantic over the next decade, there is concern about the changes that may result at the ecological community level. Evaluating ecological communities is challenging because they represent all trophic levels and have an inherit variability directly related to the various timescales of oceanographic changes, such as decadal oscillations and other document shifts in species distribution. The introduction of new substrate because of the presence of the turbines will definitely change the ecological community in the vicinity of the turbine, but the question is whether these changes occur at the level of a wind facility or regionally where multiple facilities will be in operation. Each turbine, assuming a cylindrical structure, will provide about 1000 m^2 of surface area (in 30 meters of water), which is a 10-fold increase in area; plus, it will be a hard surface in areas that are generally soft sediment.

Whether this alteration of the environment is significant enough to measurably change the ecological community at regional scales is undetermined. One aspect of the environment that may be examined at a facility level or regional scale is the soundscape. However, the use of passive acoustic monitoring for this purpose is worth investigating. The first commercial offshore wind facility is anticipated to be

constructed in off the coast of Massachusetts/Rhode Island in the foreseeable future. The area is currently under study by BOEM (Movement Patterns of Fish in Southern New England). This study may be augmented with strategically placed hydrophones near anticipated locations of turbines and used to develop a baseline of sound for the area.

Objectives: The objective of the study is to test the use of acoustic measurements to evaluate ecosystem changes around wind turbines.

Methods: Hydrophones would be strategically located within the future wind farm location to collect sound at frequencies related to expected species present, such as cod. Monitoring in the area would be continued post-construction as well as at control sites, essentially doing a BACI method. Simultaneously, video of the locality would be needed to aid in verifying the species making the sound.

Specific Research Question(s): Do offshore wind farms measurably change ecological communities?

Title	Efficacy of Thermal Detection Technology for Nighttime Protected Species Observer Surveys
Administered by	Marine Minerals Program
BOEM Contact(s)	Jessica Mallindine (Jessica.Mallindine@boem.gov), Ana Rice (Ana.Rice@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2022–2024
Date Revised	February 12, 2021
PICOC Summary	
Problem	BOEM needs to evaluate emerging thermal detection technology alternatives for Protected Species Observers (PSOs) to provide more effective and efficient nighttime surveillance of mammals and sea turtles during BOEM authorized activities (e.g., geophysical and geotechnical (G&G) surveys, dredging, and relocation trawling operations). In conjunction or in lieu of other mitigative monitoring measures, this method has the potential to further reduce risk to species of concern that could be impacted by activities authorized and/or associated with leased areas. It also may reduce costs of mitigative practices put in place to safeguard protected species.
Intervention	Determine the efficacy of use and cost of new thermal detection technologies for nighttime PSO monitoring procedures as compared to traditional visual monitoring during daylight hours and nighttime Passive Acoustic Monitoring (PAM) technologies used within all BOEM program areas.
Comparison	There has been no formal integration and assessment of new thermal detection technology into current mitigative practices. Determination of the efficacy of thermal tools for PSO protocols could modify existing PSO parameters and influence NMFS Biological Opinions and Incidental Take Regulations in the future, while reducing survey and mitigation costs across all BOEM program areas.
Outcome	A quantitative evaluation of the efficacy of thermal detection technology for PSO monitoring procedures. This evaluation of alternative nighttime mitigations as compared to other common mitigation measures will provide a baseline recommendation on future use of this technology, which will directly inform BOEM on mitigation strategies.
Context	Gulf of Mexico and Atlantic OCS

BOEM Information Need(s): Enhanced and continuous cetacean and sea turtle monitoring using new thermal detection technologies during nighttime surveys has been proposed and requested (e.g. by the Texas General Land Office (GLO)) as an alternative or improved method to be used by Protected Species Observers (PSO) during geological and geophysical (G&G) surveys. This method, in conjunction or in lieu of other nighttime mitigative monitoring measures, has the potential to further reduce risk to species of concern that could be impacted by not just G&G surveys but any activities authorized and/or associated with leased areas, and likely reduce costs of mitigative practices put in place to safeguard protected species. To date, there has been no formal assessment and integration of thermal detection technologies into current mitigative practices. This study aims to establish a quantitative evaluation of

the efficacy of thermal detection technology for incorporation into future project management practices. The adoption of this technology could improve PSO standards and influence future NMFS Biological Opinions and Incidental Take Regulations.

Background: In April of 2019 BOEM published The Final Environmental Assessment, Sand Survey Activities for BOEM's Marine Minerals Program, Atlantic and Gulf of Mexico (hereby referred to as the EA). This EA was prepared to evaluate the potential environmental impacts of G&G survey activities that support identification, delineation, monitoring, and scientific investigation of sand resources on the Atlantic and Gulf of Mexico Outer Continental Shelf (OCS). The EA also sets forth the proper environmental mitigation measures required to perform high-resolution G&G sediment search surveys. Since its publication, requests have been submitted to BOEM to replace current nighttime mitigations, which are both limiting and expensive, by adding thermal detection measures to the nighttime protocol requirements outlined in the EA.

Thermal imaging technology, for example, allows up to 24-hour marine mammal and sea turtle surveillance by utilizing thermal imaging, real-time automated distance estimation at sea, and automated recognition of cetaceans as far as 2.5 km away. The technology would allow survey scientists to continually monitor a thermal imaging camera mounted on the vessel which would allow for additional visual observations near the survey equipment source. Although the thermal imaging cameras are designed for cetaceans, sea turtles maintain a higher temperature than seawater allowing the thermal imagining software to detect the small reptiles (Mrosovsky, 1980). The software's ability to detect both cetaceans and sea turtles combined with the relatively small Acoustic Exclusion Zone (AEZ) of 100 m potentially allows for enhanced monitoring at nighttime.

In addition to G&G surveys there are other activities authorized and/or associated with BOEM leased areas that maintain types of mitigative suites to reduce impacts to protected species. Such activities include dredging and relocation trawling operations. Thermal imaging technology was specifically recommended to be incorporated into the suite of available tools to use during nighttime monitoring as a means of enhanced PSO monitoring.

Objectives: Evaluate the efficacy of the use and cost of thermal detection technologies as a means of robust nighttime PSO monitoring procedures as compared to other common mitigation measures, including visual monitoring standards, used during daylight hours and Passive Acoustic Monitoring (PAM) techniques.

The following hypotheses will address the above objective. The use of thermal detection technology at night is 1) comparable to daylight visual standards; 2) increases likelihood of detection of marine mammals and sea turtles by PSOs at night; and 3) a viable alternative to PAM.

Methods: The following methods are proposed to evaluate the efficacy and feasibility of thermal detection technology:

- Conduct research on current available thermal technology to provide metrics, costs, benefits, and tool limitations to ascertain feasibility of implementation relative to current PSO practices
- Conduct field tests of thermal technology to determine range and functionality in various environmental conditions (e.g., fog, sea state, temperature, etc.). Information on sea turtle distribution and behavior from ongoing BOEM studies in the Gulf (i.e., NT-16-07 and MM-19-03) could be used to guide and influence thermal technology field test locations

- Develop and conduct testing to evaluate operations using trained PSOs utilizing thermal detection tools compared to nighttime PAM for marine mammal and sea turtle observations
- Provide a cost-analysis of use of alternative nighttime mitigation practices as compared to traditional mitigations currently being used for activities authorized and/or associated with leased areas within all BOEM program areas

A report will be generated outlining the findings as well as suggestions to BOEM management regarding existing and potential mitigation efficacy following equipment synthesis, testing and analysis of observation data gathered. This evaluation of alternative nighttime mitigations will provide a baseline recommendation on future testing and use of this technology which will directly inform BOEM on mitigation strategies.

Specific Research Question(s):

1. What is the efficacy of thermal detection technologies for PSO monitoring compared to common mitigation measures, such as visual monitoring standards and PAM techniques?
2. Would adoption of thermal imaging technology reduce risk to species of concern impacted by activities authorized and/or associated with leased areas?
3. Would thermal detection technology, in lieu of other mitigations, reduce total costs of mitigative practices put in place to safeguard protected species?

References:

Mrosovsky N. 1980. Thermal Biology of Sea Turtles. Amer. Zool. 20:531-547.

Title	Fish Fry: Frying Pan Shoals Ecosystem Dynamics
Administered by	Headquarters
BOEM Contact(s)	Deena Hansen (Deena.Hansen@boem.gov), Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Inter-agency Agreement/Cooperative Agreement/Contract
Performance Period	FY 2022–2025
Date Revised	April 22, 2021
PICOC Summary	
Problem	Offshore sand resource alternatives in sand-starved Southeast North Carolina (NC) are limited to thin sand sheets, buried channels, and a cape-associated shoal complex. Frying Pan Shoals (FPS), a large cape associated shoal complex designated by the National Marine Fisheries Service (NMFS) as Essential Fish Habitat (EFH) and Habitat Area of Particular Concern (HAPC), contains a significant volume of Outer Continental Shelf (OCS) sand and has been identified as a potential long-term resource to support future coastal resiliency planning efforts. Physical and biological ecosystem function drivers of this highly productive and dynamic system are poorly understood and could be affected by potential dredging activities.
Intervention	Gather and synthesize existing data and collect new baseline data related to physical, biological, chemical, and human coupled natural systems, including fisheries independent and dependent data. Examine the relationship of seafloor and water column disturbance to ecosystem services and dynamically model ecosystem trade-offs associated with potential dredging scenarios.
Comparison	Existing data is limited. Data obtained from this study will establish reference conditions to analyze and compare potential dredging impacts.
Outcome	Inform impact analyses through the collection of baseline information, evaluation of dredging scenarios and associated ecosystem trade-offs, and development of targeted mitigation measures.
Context	Frying Pan Shoals, North Carolina, Atlantic OCS.

BOEM Information Need(s): In anticipation of future lease requests within the next 2–5 years, BOEM's Marine Minerals Program (MMP) needs to better understand the relationships between fish habitat use and OCS sand resource management decisions at FPS, a cape-associated shoal feature off of southeast NC. Offshore sand resources are limited in southeast NC, and the coastal communities of Brunswick County require more sand to support their coastal resiliency initiatives over the next 50 years than is currently available. In order to fill this deficit, sand resource alternatives have been identified in state and Federal waters at FPS, a dynamic system with complex physical and biological drivers that support a unique and highly productive habitat. Existing physical and biological data that are needed in order to understand the relationship of future dredging related disturbance to ecosystem services is severely limited. Research on biological activity and human use can strengthen future National Environmental Policy Act (NEPA), ESA, and EFH analyses that consider the potential effects of dredging on fisheries resources and inform the development of targeted mitigation measures.

Background: FPS is currently designated by the South Atlantic Fishery Management Council and the NMFS as EFH and HAPC for many fish species. NMFS has expressed concern that long-term and repeated dredging operations could significantly impact the habitat value that supports several important commercial and recreational fisheries. Realizing that long-term coastal resiliency strategies include the use of high valued OCS sand resources at FPS, the MMP implemented the following study as a first phase effort to evaluate existing data, solicit perspectives from relevant stakeholders, and assess the science needs: "*Workshop and Research Planning to Improve Understanding of the Habitat Value and Function of Frying Pan Shoals, NC on the Atlantic Outer Continental Shelf* (MM-19-x06)." This initial study summarized the current physical and biological characteristics of FPS, the potential dredging implications/concerns, and the priority data gaps and research questions that may serve as a long-term science strategy to support future decision making. The technical report was informed by consultations with scientific experts, state and Federal agency officials, and local project proponents. The literature review and workshop results reinforce prior assumptions regarding the demand for future sand at FPS, limited baseline data set to inform future impact analyses, and need for developing a science strategy to fill data gaps.

The research prioritization and data collection approach for this currently proposed phase II study leverages stakeholder feedback provided in MM-19-x06 along with lessons learned from two ongoing studies evaluating ecological function and recovery of shoal habitat in the South Atlantic Bight (NT-14-x12) and the Gulf of Mexico (MM-19-01).

Objectives: Inform potential dredging scenarios using a dynamic systems model that informs trade-offs across ecosystem services.

Methods: This study will begin by developing a sampling design methodology report for ecological data collection leveraging existing data and technical insight gathered during prior workshops. The methodological approach includes sampling chemical (chlorophyll, N, etc.), biological (ichthyoplankton, benthic invertebrates, macroinvertebrates, fishes, stable isotope analyses, fish acoustic tagging, eDNA, etc.), and physical parameters (ADCP and multibeam surveys), along with modeling dredging scenarios and associated ecosystem tradeoffs. Icthyoplankton, longline, and trawl surveys will be used to gather data on fish communities, including temporal variation and potential correlation to the Cape Fear River plume discharge. Acoustic tagging may also be used if the shoal can support a telemetry array. Existing and/or new geophysical and geological surveys will be used to collect shoal morphology data. Other sampling methods may include the following:

- Benthic grabs – infauna composition, sediment grain size
- Leveraging existing current and wave data – sediment transport, larval dispersal, "fronts" associated with concentration of fish/prey
- Turbidity – water quality, natural fluctuations/background conditions, influence of riverine system to ecosystem
- Glider based fish tracking (ASV *Melvin*) – fine-scale fish distribution and seasonal occurrence of various species
- Fisher interviews – engage local shrimpers and fishermen about species use of the area
- Food web dynamics – understand the connection between benthic resources and fish that may be transiting the area via isotope testing and diet studies

Specific Research Question(s):

- What is the baseline seasonal variability of benthic community species composition and distribution relative to the physical environment of Frying Pan Shoals, and how does it relate to interannual variability of the Cape Fear River plume?
- What is the habitat and spatial distribution of key species, including pelagic fish and sharks?
- What are the linkages and interplay between benthic and higher trophic levels?
- What are the sediment recharge rates based on hypothetical dredging scenarios located at various locations within the Frying Pan Shoals complex?
- How sensitive is the mesoscale morphology on Frying Pan Shoals to affecting broader sediment pathways, biological impacts, and recovery rates?

Title	Sturgeon Response to Dredge Activities and Recovery After Trawl Capture Near Outer Continental Shelf (OCS) Sand Resources
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.Hansen@boem.gov)
Procurement Type(s)	Inter-agency Agreement (NOAA Fisheries)
Performance Period	FY 2022–2025
Date Revised	April 22, 2021
PICOC Summary	
Problem	Sturgeon, which are listed under the Endangered Species Act (ESA), rely on the habitat associated with OCS sand resources. Potential direct impacts to sub-adult and adult sturgeon from dredging and relocation trawling are neither well documented nor well understood.
Intervention	Implement parallel Atlantic and Gulf field studies to observe behaviors in high-risk areas that propose dredging when Atlantic/Gulf sturgeon may be present and trawling is proposed.
Comparison	Investigate sturgeon behavior in non-dredge years relative to dredge years. Observe condition following trawl capture and behavior upon release. Compare Atlantic and Gulf sturgeon post-trawl behavior characteristics.
Outcome	Improved understanding and assessment of impacts to Atlantic sturgeon, which may influence lease decisions and mitigation measures
Context	Sand resources on the Atlantic and Gulf OCS in waters <50 m deep

BOEM Information Need(s): Activities associated with BOEM leases for OCS sediment resources, like dredging and relocation trawling, may overlap with the ESA-listed Atlantic and Gulf sturgeon. An improved understanding of these interactions could help BOEM and resource agencies improve sturgeon conservation, inform and improve leasing decisions, and refine mitigation measures. Information on the dredge-induced response and relocation trawl recovery would strengthen impact analyses used in National Environmental Policy Act (NEPA) and ESA consultations. BOEM's leases, executed by the Marine Minerals Program (MMP), would then incorporate improved mitigation measures.

Background: Direct entrainment of sturgeon during dredging has been documented in navigation dredging and has occasionally been documented on the OCS (e.g., Gulf sturgeon lethally taken in the Mississippi Coastal Improvement Program [MsCIP]). Additionally, relocation trawling is a common mitigation measure initially implemented to capture and relocate sea turtles to avoid dredge entrainment. Trawling is sometimes used to primarily relocate sturgeon (e.g., South Atlantic Regional Biological Opinion). Though a common mitigation requirement, the effects of this disruption to sturgeon are poorly understood.

Sturgeon regularly occur on and near BOEM-leased borrow areas both in the Atlantic and Gulf regions, though no critical habitat has been designated in these areas. Relocation trawling, a mitigation measure

to move protected species away from sand dredging in a BOEM lease area off Carteret County, NC, captured and released 34 individual Atlantic sturgeon over three seasons. In the Gulf of Mexico, the U.S. Army Corps of Engineers is executing a comprehensive monitoring of Gulf sturgeon, since sturgeon were found associating with bathymetric features offshore of the MsCIP Barrier Island Restoration project (USACE 2013).

Through cooperative efforts within the MMP and the Office of Renewable Energy Programs (OREP), Atlantic sturgeon have been tracked on active lease areas: Sandbridge shoal, VA (ongoing study NSL# AT-15-01) and Canaveral Shoals, FL (ongoing study NSL# NT-14-x12). Off Long Island, NY, an area of potential sediment leasing interest, Atlantic sturgeon were tracked near a Wind Energy Area; some of the highest frequencies of occurrence and residence events were at shallower depths along a proposed cable route (BOEM 2019-074; Frisk et al., 2019). While some regional models predict Atlantic sturgeon occur in water depths where dredging could occur, as well as in active or historic lease areas (Breece et al. 2017), fine-scale behavior near sand resources needs investigation. In addition to these ongoing efforts, other BOEM studies have focused on tracking sturgeon via telemetry (e.g., BOEM_2019-074, BOEM_2020-020) and can be used to complement the proposed study.

Objectives:

1. Characterize Atlantic and Gulf sturgeon behavior before, during, and after dredging.
2. Estimate recovery following relocation via trawl.
3. Determine the condition of captured sturgeon in parallel field studies in the Atlantic and Gulf regions.

Methods: To achieve the three major objectives, methods include:

- Analyze previous captures of Atlantic and Gulf sturgeon in relocation trawls from BOEM, USACE, and other stakeholder records to determine factors (e.g., oceanographic or physical) that may contribute to trawl capture and condition upon release.
- Use acoustic tags to track Atlantic and Gulf sturgeon residency around sand features among years; observe behavior when dredging occurs (e.g., approach, avoidance, foraging changes, etc.).
- Measure body condition (e.g., via Fulton's condition factor), response to stimuli, and physiological indicators (e.g., blood hormone levels) of captured sturgeon to determine fitness and level of stress.
- Use fine-scale tags like accelerometers or pop-up satellite archival tags (e.g., Erickson et al., 2011) to track sturgeon immediately after relocation trawl release to observe greater detail of the type and duration of behavioral changes, including potential mortality.

Specific Research Question(s):

1. What is the occurrence and residency time around sand resources, both during dredging and without dredging?
2. What conditions, both physical and physiological, are sturgeon in when captured by relocation trawl?

3. How do sturgeon behave after being relocated, and what are the differences in behavior between Atlantic and Gulf sturgeon? How does this behavior differ from other observed behaviors?
4. Where do sturgeon move after relocation, relative to dredging activity (e.g., attraction, avoidance)?

References:

Breece MW, Fox DA, Haulsee DE, Wirgin II, Oliver MJ. 2017. Satellite driven distribution models of endangered Atlantic sturgeon occurrence in the mid-Atlantic Bight. ICES J Mar Sci, 75: 562–571.

Erickson DL et al. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic Sturgeon, Acipenser oxyrinchus oxyrinchus Mitchell, 1815. J Appl Ichthyol. 27: 356–365.

Frisk MG, Ingram EC, Dunton K. 2019. Monitoring endangered Atlantic sturgeon and commercial finfish habitat use in the New York Lease Area. Stoney Brook (NY): US Department of the Interior, Bureau of Ocean Energy Management. 88 p. OCS Study BOEM 2019-074.

USACE. 2013. EL monitoring program provides valuable insights for disparaged fish. US Army Corps of Engineers, Engineer Research and Development Center (ERDC) Website. Published 02 December 2013. Accessed 30 March 2021. https://www.erdc.usace.army.mil/Library/Article/476594/el-monitoring-program-provides-valuable-insights-for-disparaged-fish/