Studies Development Plan

2023–2024

Environmental research proposed to begin in FY2023 or FY2024 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

ESP
ENVIRONMENTAL STUDIES PROGRAM

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List of Acronyms

AERMOD	American Meteorological Society/EPA Regulatory Model
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CCUTS	Carbon Capture, Utilization, Transportation, and Storage
CMA	Center for Marine Acoustics
CMI	Coastal Marine Institutes
COP	Construction and Operations Plans
DIP	Decommissioned-in-Place
DOC	Department of Commerce
DOE	Departments of the Interior, Energy
DOI	Department of the Interior
DOT	Department of Transportation
DPP	Development & Production Plan
EEZ	exclusive economic zone
EIS	Environmental Impact Statement
EJ	environmental justice
EMF	electromagnetic field
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
FY	fiscal year
G&G	geological and geophysical
GCCESU	Gulf Coast Cooperative Ecosystem Studies Unit
GOM	Gulf of Mexico
GOMR	Gulf of Mexico Region
LiDAR	light detection and ranging
LME	large marine ecosystems
MBTA	Migratory Bird Treaty Act
MMP	Marine Minerals Program
MMPA	Marine Mammal Protection Act
MOU	Memorandum of Understanding
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
NOPP	National Oceanographic Partnership Program
NOSB	National Ocean Sciences Bowl
NSL	National Studies List

OCD	Offshore & Coastal Dispersion
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEP	Office of Environmental Programs
OREP	Office of Renewable Energy Programs
PSD	Prevention of Significant Deterioration
SDP	Studies Development Plan
SME	subject matter experts
SSQ	Strategic Science Questions
USCRP	U.S. Coastal Research Program
USGS	U.S. Geologic 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: Identify potential 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 changes in the quality and productivity of these environments, and the causes of these changes.

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 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 $1.2 billion for research on environmental impacts and monitoring of energy and mineral development ($131 million over the past five years). 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: inter-agency 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 delivers 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 (FYs) 2018 and 2022.

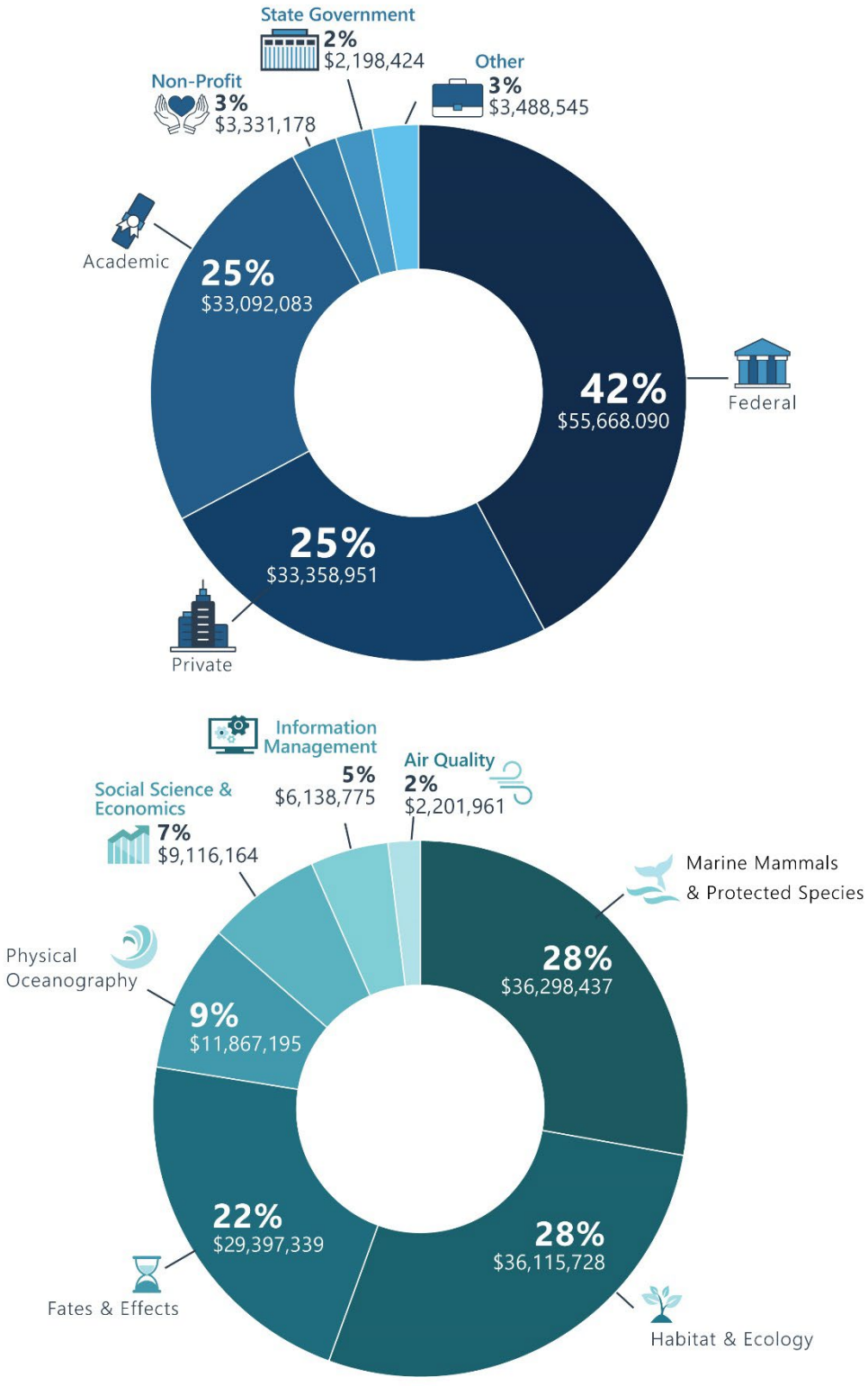


Figure 1. Cumulative ESP expenditures for FY 2018–2022 by vendor type and discipline

1.1.4 ESP Priorities

For FY 2023–2024, ESP identified four priority areas. In developing study ideas, BOEM subject matter experts (SMEs) were encouraged to consider and explain how their idea relates to these priority areas.

Climate change: Climate change adds an additional level of complexity when assessing and understanding ecosystem changes, because it becomes much harder to parse out effects of development when baselines are shifting. For example, when analyzing the effect of offshore wind power on fisheries, it is important to understand how much of an impact can be attributed to localized disturbances from offshore wind facilities and how much is due to warming ocean temperatures. It is clear that climate change will significantly impact BOEM's work, and, to adequately prepare for a more uncertain environment, ESP will need to view the future of its science through a climate change lens.

Fish and fisheries: Commercial and recreational fishing sectors remain concerned about the potential impact of a large-scale build-out of offshore wind power on the industry. ESP has invested significant resources into studies addressing commercial fishing concerns, but more work remains to be done, both in terms of understanding potential impacts to fish stocks and fishing communities.

Tribal issues: How BOEM's activities may affect traditional ways, subsistence, and indigenous cultural resources is a key element to effective decision-making. Government-to-government consultations, community meetings, public hearings, and other special activities provide government staff and leadership the opportunity to learn from Tribes and incorporate their viewpoints in the decision-making process. For over 40 years ESP has worked to engage with indigenous communities on cultural and subsistence studies prior to Federal actions and will look to continue to do so in FYs 2023–2024.

Environmental justice: Cutting across all the above is environmental justice (EJ). ESP recognizes the inter-relationships between climate change and vulnerable communities, such as low-income fishing communities, minority, and indigenous and Tribal communities. Consistent with the Environmental Protection Agency's (EPA's) definition, BOEM defines EJ as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Executive Order (EO) 12898 requires each Federal agency to make achieving environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations (59 FR 7629). BOEM seeks to apply effective, efficient and consistent consideration of EJ in the National Environmental Policy Act (NEPA) process through applying best practices for analytical methodologies, research, and best available scientific information to assessing potential impacts on EJ communities from BOEM-authorized activities. To do this, it is essential that BOEM understand how offshore energy activities may impact vulnerable communities to make determinations about whether Federal activity may have a disproportionately high and adverse impact on a community. Specifically, BOEM needs to understand the environmental, social, and cultural current and future baselines and cumulative impacts, including effects of climate change, historical land or resource use, and many other factors.

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 to provide answers to specific questions needed for management decisions while also advancing broader fundamental knowledge of phenomena being examined. A prerequisite for ESP studies is that they target a defined BOEM information need that will inform Bureau decision-making.

1.2.2 Scientific Integrity and Credibility

DOI's Scientific Integrity Policy[1] 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.

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 fulfill its mission of providing the best possible scientific information for making decisions concerning our offshore resources. ESP-PAT is an internal,

[1] For more information, visit https://www.doi.gov/scientificintegrity

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 the following:

- 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 scientific and/or technical 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 cooperation with agencies such as the National Aeronautics and Space Administration (NASA), U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), EPA, and U.S. Navy's Office of Naval Research. BOEM has established partnerships with the States of Louisiana and Alaska through their respective Coastal Marine Institutes (CMIs), and the Bureau is also a member of eight Coastal Ecosystem Studies Unit 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 oceanographic, ocean science, resource management, and ocean education missions of Federal agencies and their partners, in common pursuit of wise use of the oceans and 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. USCRP is a collaboration of Federal agencies, academics, and stakeholders, and 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, as well as links to associated publications and digital data. ESPIS facilitates information sharing for NEPA assessments, oil and gas and alternative energy leasing, and Ocean Planning initiatives. The ESPIS search tool is hosted on a shared platform with MarineCadastre.gov,[3] which is developed in partnership with the NOAA Office for Coastal Management.

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] 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. In 2022, BOEM hosted three John A. Knauss Marine Policy fellows, two in OEP and one in the Office of Strategic Policy and International Affairs.

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 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 2023 and FY 2024, 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, including criteria air pollutants and 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 systems' 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 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 urgency of the information and is intended to provide for a reasonable distribution 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 criterion 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 curating 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, in-kind contributions, or coordination of separately funded work toward common objectives.
6. **Partnerships:** Partnering is encouraged with other Federal agencies, academic organizations, non-profits, or commercial enterprises to achieve shared mission needs. 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.
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 and Initiatives

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 (except 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 exclusive economic zone (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 scheduled lease sales in the Gulf of Mexico (GOM) and Alaska Regions (BOEM 2016a). The current program expires in June 2022; a new OCS oil and gas leasing program is under development. BOEM is responsible for managing ongoing leases, reviewing and approving exploration and development plans on those leases, and preparing for decommissioning, while still minimizing or avoiding potential environmental impacts. In response to EO 14008 and after conducting its comprehensive review, DOI released the *Report on the Federal Oil and Gas Leasing Program in November 2021*. The report focuses primarily on necessary reforms to the fiscal terms, leasing process, and remediation requirements related to deficiencies with the Federal oil and gas program. It lays out actions that the Administration is considering taking, consistent with legal authorities and the Executive Branch's broad discretion, to provide a fair return to taxpayers and to steward shared resources, and also encourages Congress to act on pending legislation to provide fundamental reforms to the onshore and offshore oil and gas programs.

As of February 2022, approximately 11 million OCS acres are actively leased by BOEM for conventional energy development. Currently OCS conventional energy development provides for approximately 11% of the Nation's natural gas production and about 25% 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 exists the potential for an abundant source of renewable energy from wind, wave, and ocean currents in the offshore environment. The first two wind 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. This was followed by the Record of Decision for the South Fork Wind Farm off Rhode Island on November 24, 2021.

In March 2021, the White House released details of its plan to boost the offshore wind energy industry.[7] The Departments of the 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 28 active leases along the Atlantic Coast from Massachusetts to North Carolina. In addition to the Vineyard Wind and South Fork Wind projects, nine additional Construction and Operations Plans (COPs) are under review, and several more are expected within the next year, cumulatively representing more than 25 GW of new clean energy. BOEM recently held lease sales 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 and off North Carolina (February 2022 and May 2022, respectively).

On January 12, 2022, BOEM and NOAA signed a Memorandum of Understanding (MOU)[8] to mutually support the Biden's Administration goal to responsibly deploy 30 gigawatts of wind energy production capacity in Federal waters by 2030. The MOU commits to using the best available science, specifically calling out Traditional Ecological Knowledge to support regulatory decisions.

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 64 negotiated agreements and conveyed rights to approximately 178.2 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 2022). These projects have protected billions of dollars of infrastructure, as well as important ecological habitats, along almost 445 miles of the Nation's coastline.

In addition to non-competitive, negotiated agreements, BOEM is responsible for executing competitive lease agreements for other non-energy minerals, such as strategic mineral resources like copper, lead, and gold, as well as critical minerals (87 FR 10381) such as cobalt, manganese, platinum, zinc, 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. EO 13817 (A *Federal Strategy to*

[7] https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/
[8] https://www.boem.gov/sites/default/files/documents/about-boem/MOU-NOAA-BOEM.pdf

Ensure Secure and Reliable Supplies of Critical Minerals) and EO 14017 (*America's Supply Chains*) have spurred renewed interest in marine minerals, such as rare earth elements, and provided an impetus to identify potential domestic offshore sources of these minerals. BOEM 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.

1.4.4 Center for Marine Acoustics

Established in 2020, BOEM's Center for Marine Acoustics (CMA) strives to strengthen the Bureau's role as a driving force within the regulatory community on sound in the marine environment. It concentrates BOEM's marine acoustics expertise, leading-edge knowledge, and resources to attain and sustain world-class performance and value. CMA addresses both naturally occurring sounds and those generated by activities that BOEM regulates, including offshore oil and gas, renewable energy, and marine minerals. In recent years, the Bureau's studies and environmental risk assessment work have expanded to consider a variety of noise sources and impacts to marine species, and CMA seeks to evolve as marine acoustics issues have increased in national and international significance. CMA priorities for FY 2023–2024 are the following:

- Measure substrate vibration and particle motion during impact pile driving
- Observe potential behavioral impacts on demersal fish and invertebrates during impact pile driving (especially commercially and recreationally important species)
- Further develop a risk assessment framework for underwater noise impacts by incorporating key biological and contextual factors, as well as other, non-acoustic anthropogenic impacts
- Measure temporary threshold shifts in marine mammals to explore potential differences in impact between impulsive, non-impulsive, and complex noise sources
- Observe sea turtles' behavior and physiology in response to anthropogenic sound sources

2 Atlantic Studies

2.1 Introduction

The Atlantic OCS extends from Maine to Florida and is divided into four planning areas (**Figure 2**). 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 large marine ecosystems (LMEs) along the Atlantic as defined by NOAA.[9] On the Atlantic OCS, the renewable energy program and the Marine Minerals Program (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. On September 25, 2020, President Trump issued a memorandum withdrawing certain areas of the OCS from leasing for oil and gas and renewable energy.[10] The withdrawal is in effect from July 1, 2022, through June 30, 2032. The areas extend from off the coast of North Carolina to Florida along the Atlantic. While under this moratorium, BOEM will not be conducting baseline studies in support of oil and gas or renewable energy programs within these areas.

Appendix A includes the tables of proposed studies for FYs 2023 and 2024. **Appendix B** provides the profiles for the proposed studies.

2.1.1 Conventional Energy Activities

There is currently no offshore conventional energy development occurring in the Atlantic OCS Region, therefore BOEM does not anticipate that new information will be needed in FY 2023 or 2024.

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 programs and in areas not subject to a moratorium. Environmental research and knowledge related to OCS activities can take years to develop and are necessary components of mapping new habitats and understanding the relative sensitivity of ecosystems to potential anthropogenic and natural stressors.

[9] https://www.st.nmfs.noaa.gov/ecosystems/lme/
[10] https://www.boem.gov/sites/default/files/documents/about-boem/MOU-NOAA-BOEM.pdf

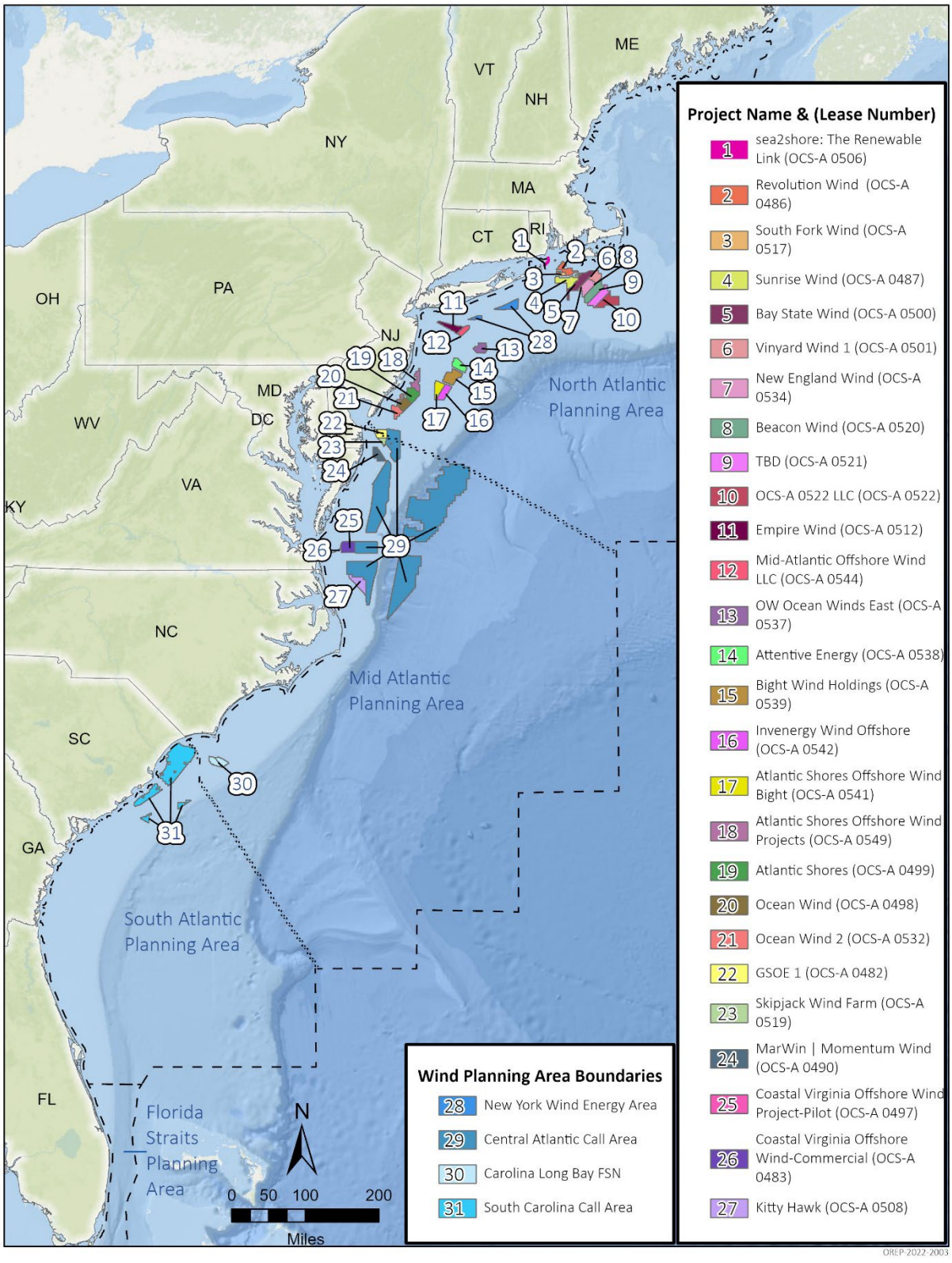


Figure 2. Atlantic Region OCS planning areas for renewable energy and Renewable Energy Areas

2.1.2 Renewable Energy Activities

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 2**). The focus of the program is currently on wind projects.

OREP now has 24 active commercial leases along the Atlantic Coast extending from Massachusetts to North Carolina. A lease sale was held off the Carolinas in May. 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 May 2021 and the second for the South Fork Wind project in January 2022. BOEM is reviewing an additional 11 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 wind 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 the socioeconomic effects on fisheries, surveying habitats, and understanding tourism and recreation.

2.1.3 Marine Minerals Activities

BOEM 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 3**). 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.

BOEM is also beginning to examine critical and heavy minerals in the Atlantic. The Bureau is collaborating with NOAA and USGS on a study examining an historic deep-sea mining test site containing polymetallic nodules on the Blake Plateau offshore the southeast Atlantic Coast. This study offers a unique opportunity to examine long-term environmental impacts of deep-sea mining. There is also growing interest in heavy minerals found in inner shelf sand shoals and sheets along the mid-Atlantic.

Figure 3. NASA's Wallops Island Flight Facility before and after restoration

2.2 Decision Context

2.2.1 Current/Relevant Issues

Leasing for renewable energy along the Atlantic is expanding from the Gulf of Maine to Virginia. With two projects approved and nine others under consideration, offshore wind is no longer a potential activity but an actual activity. While all aspects of protecting the environment and addressing social concerns are important, our current focus is on addressing the concerns of the fishing community and ensuring Tribal concerns are incorporated in our decision process. BOEM is also investing resources in the issue of declining population of the highly endangered North Atlantic right whales by allocating staff resources and working with our Federal partners. BOEM continues to address the concerns about visual impacts as well as impacts to avian species.

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 EO 13817 and EO 14017, there is also increased attention from the Biden Administration on the economic potential of heavy and critical offshore minerals.

2.2.2 NEPA/Consultation Information Needs

For renewable energy, BOEM continues to consider the potential impacts as we move from leasing to construction. Each COP is going through a full environmental review and associated consultations for endangered species, essential fish habitat, and historic properties. Information from BOEM's environmental studies will aid in addressing the concerns raised by the public.

For marine minerals, several proposed studies are designed help improve our understanding of the persistence of benthic impacts and the practical implications of long-practiced mitigation for dredging activities that support beach nourishment and coastal restoration projects.

2.3 Alignment With SSQs

2.3.1 Renewable Energy Activities

Tables 1 and 2 show how 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 visual impacts to coastal communities, impacts to commercial fishing, and protecting the environment against potential impacts of wind turbine installation and operation.

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.[11] New studies are not proposed for this cycle while we move ahead with the studies from previous years.

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[12] and Mid-Atlantic Fishery[13] 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

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

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. BOEM is expanding our previous studies on habitat and economic impacts to fisheries into the Gulf of Maine. In recognition that benthic infauna are an important food source for fish and a critical part of the ecosystem, evaluating changes to the benthic environment from offshore wind development is needed. To begin this effort, first there needs to be an evaluation of existing information starting with a database of the benthic information from the Atlantic OCS.

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. Impacts from vessel strikes is a major concern for protected marine species, especially whales. Recently, a BOEM-funded study produced a vessel risk model and tool.[14] An update is needed to provide training and additional features to the tool. As construction and operations of wind facilities comes to fruition, additional information about sea turtles and their distribution in the development areas will be needed. Sea turtles may be attracted to the structures for food and shelter. They may also be impacted by construction activities. Tagging is the best method to fully understand how sea turtles are using these areas.

Socioeconomics

The visual impacts from offshore wind facilities are a major concern for coastal communities who may rely on the ocean view for their economic wellbeing. While siting of lease areas takes into account this concern, environmental assessments must evaluate visual impacts and provide appropriate mitigation measures, including removal of closer turbines and the use of systems to only turn the aviation lights on when aircraft are nearby. With proposed turbine sizes (and therefore heights) increasing, an update of "Offshore Wind Turbine Visibility and Visual Impact Threshold Distances" (Sullivan 2013) is needed. Besides understanding the view from shore, the potential impacts to recreation and tourism are evaluated in environmental assessments. A recent study of Block Island[15] developed methodologies for evaluating the impacts to recreation and tourism. With the future development in the Gulf of Maine, this is an area to establish a baseline using these methodologies and evaluate again after development.

Ports along the Atlantic are not designed to support the future offshore wind development. While a few locations (such as New Bedford) have facilities, many ports will need to be modified to support the needed infrastructure. These modifications will have environmental consequences that must be included in our environmental evaluations. A report on the potential port modifications was completed in 2016 (ESS Group, Inc. 2016). New information is now available, and this report should be updated.

Fates and Effects

Although offshore wind development does not have the potential environmental consequences like operational discharges and oil spills from oil and gas development, there are still concerns about the

[14] https://espis.boem.gov/final%20reports/BOEM_2021-034.pdf
[15] https://espis.boem.gov/final%20reports/BOEM_2018-068.pdf

chemicals used and potential for spills, the sound produced by activities, and the electromagnetic fields from cables. A study was completed examining the fate of chemicals from offshore wind development in 2013 (Bejarano et al. 2013). At the time, there was limited information about the chemicals and the proposed size of the components was smaller. New information is now available to revisit this issue.

Regional Wildlife Science Collaboration

While industry is required to collect baseline information about wildlife prior to development and to monitor post-development, these efforts are focused on the immediate vicinity of the project. A need to understand the impacts regionally was identified by the scientific community to better inform impacts to wildlife and address cumulative impacts. In July 2021, New York Energy Research and Development Authority and Massachusetts Clean Energy Center selected Northeast Regional Ocean Council, Mid-Atlantic Regional Council on the Ocean, and the Coastal States Stewardship Foundation to administer the collaboration. BOEM engaged in the planning and participates in the working groups generated from this collaboration. Continuing this effort will require management funds as well as funding for the needs identified such as data portal products.

2.3.2 Marine Minerals Activities

Table 3 shows MMP studies proposed for this SDP; two studies focus on the Atlantic OCS Region (a third on the GOM OCS Region and a fourth study on the Pacific OCS Region). The first study focuses on analyzing existing data from prior studies and dredge-related monitoring at various scales to understand how the scale of research and activities matches (or mismatches) the scale of habitats and species distributions. The scale of MMP studies affects the interpretation of results and understanding of impacts (SSQ #1, 4). For example, a scale mismatch between the research footprint and the scale of habitat and species' scales can lead to mischaracterizations of species distributions or habitat associations that are necessary to assess dredge impacts. Understanding how scale affects study and monitoring methods will thus improve the accuracy of previous study interpretation, while informing the design of future MMP studies resulting in data sets that may more appropriately inform environmental analyses and leasing decisions.

The second study focuses on developing a model of benthic recovery relative to different dredge activity measured by depth of dredging and frequency of events. Dredging activities directly remove benthos from the immediate dredge cut area, which may also have productivity and indirect food web effects (SSQ #4). The type of dredge, frequency of dredging events, time of year, and volume or depth of sediment removal may affect the rate, nature, or phase of benthic community recovery (SSQ #1, 4). Field work at every site and for every dredge event is not feasible, so a model would allow for quantified estimates of recovery in the absence of monitoring (SSQ #9). Current impact assessments infer recovery patterns without the ability to make more accurate conclusions based on project-specific conditions. If we better quantify the rate of recovery relative to dredging conditions (considering natural fluctuations), we can improve our impact assessments and make better decisions on future dredge events.

Both studies propose to analyze existing data to develop and employ best available resources, measurements, and systems that could be used for future long-term monitoring efforts (SSQ #9).

Table 1. 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	Gulf of Maine Socioeconomic Impacts of OCS Wind Development on Fishing		✓		✓						✓		
2	Update of Port Modification Study		✓		✓						✓		
3	Risk Assessment to Model Encounter Rates Between Large Whales and Vessel Traffic from Offshore Wind Energy – PHASE II		✓		✓			✓					
4	Baseline Tourism and Recreation Along the Gulf of Maine		✓		✓						✓		✓
5	Gulf of Maine Fish and Invertebrate Benthic Habitat Baseline Data Collection		✓					✓					
6	Offshore Wind Turbine Visibility Study		✓								✓		
7	Support for Regional Wildlife Science Collaborative Ocean Portal Products and Services		✓		✓			✓					✓
8	Assessment of Chemicals Associated with Offshore Wind Facilities and Potential Environmental Impacts on the Atlantic Outer Continental Shelf (OCS)		✓				✓						
9	Seasonal Residency and Movement of Highly Migratory Sea Turtles in the New York Bight Wind Energy Areas		✓					✓					

ESP STRATEGIC SCIENCE QUESTIONS

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

Table 2. Alignment of proposed FY 2024 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 Landscape, Seascape, and Visual Impact Mitigation Study		✓								✓		
2	Environmental Monitoring Study for Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)								✓	✓		✓	
3	Fugitive CO_2 Emissions Analyses from Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)								✓	✓		✓	
4	Cumulative Impacts Analyses of Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)								✓	✓		✓	
5	Mobilization of Chemical Contaminants Associated with Offshore Wind Farms		✓				✓		✓				

ESP STRATEGIC SCIENCE QUESTIONS

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

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

		BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
1	Evaluating Sediment Mobility on the Gulf of Mexico Outer Continental Shelf (OCS)	✓	✓	✓	✓			✓		✓			✓
2	Minerals and Ecosystems of the Remote Pacific			✓	✓			✓					✓
3	Accounting for Scale Bias in Marine Minerals Studies			✓	✓			✓					✓
4	Modeling Benthic Recovery with Variable Dredge Conditions			✓	✓			✓		✓			✓

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

3 Pacific Studies

3.1 Introduction

BOEM's Pacific Region includes the OCS areas offshore California, Oregon, Washington, and Hawaii (**Figure 4**). The region's current responsibilities encompass three BOEM programs: ongoing conventional energy operations, renewable energy leasing and development, and potential leasing of marine mineral resources. ESP started in the Pacific Region in 1973. Over its 49-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, Washington, and Hawaii; (5) recent interest in sand resources offshore California; and (6) anticipation of stakeholder interest in critical marine minerals in geographic areas of high economic potential.

For this FY 2023–2024 SDP, the Pacific Region received and considered 87 study ideas from stakeholders, including Federal, state, and local agencies, Tribal organizations, universities and other research institutions, nonprofit organizations, stakeholder alliances, and private companies. Additionally, 8 BOEM staff proposed 10 Pacific 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. Those manageable from a workload perspective are proposed in this SDP.

Appendix A includes the tables of proposed studies for FY 2023. **Appendix B** provides the profiles for the proposed studies.

3.1.1 Conventional Energy Activities

The 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 30 active oil and gas leases in the region, all in the Southern California Planning Area (**Figure 5**). 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, 2021, cumulative production was 1.4 billion barrels of oil and 1.9 trillion cubic feet of gas; annual production was 4.0 million barrels of oil and 2.8 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 May 2015 break and shut-in of an onshore pipeline that transported oil from offshore (affecting Platforms Harvest, Hermosa, Hidalgo, Harmony, Heritage, and Hondo); (2) relinquishment of five leases in January 2018 (affecting Platforms Gail and Grace); (3) the January–April 2019 shut-in of Platform Irene; (3) the shut-in of Platforms Hogan and Houchin starting in October 2019; and (4) the October 2021 break and shut-in of the San Pedro Bay Pipeline (affecting Platforms Edith, Ellen, and Eureka).

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, Houchin, and Habitat is now underway. BOEM will maintain close coordination with the Bureau of Safety and Environmental Enforcement (BSEE) and other Federal, state, and local permitting agencies throughout the decommissioning process.

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

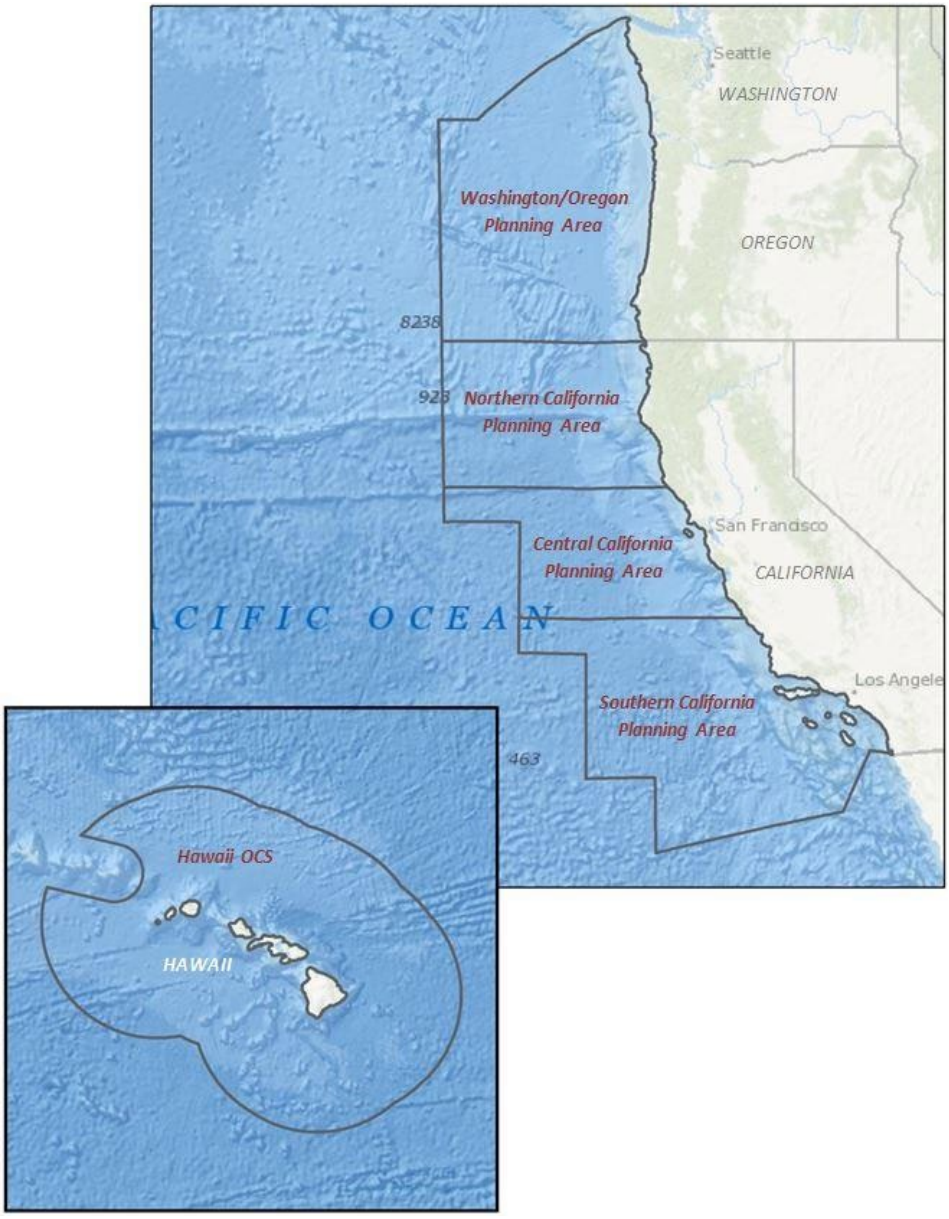


Figure 4. Pacific Region OCS planning areas

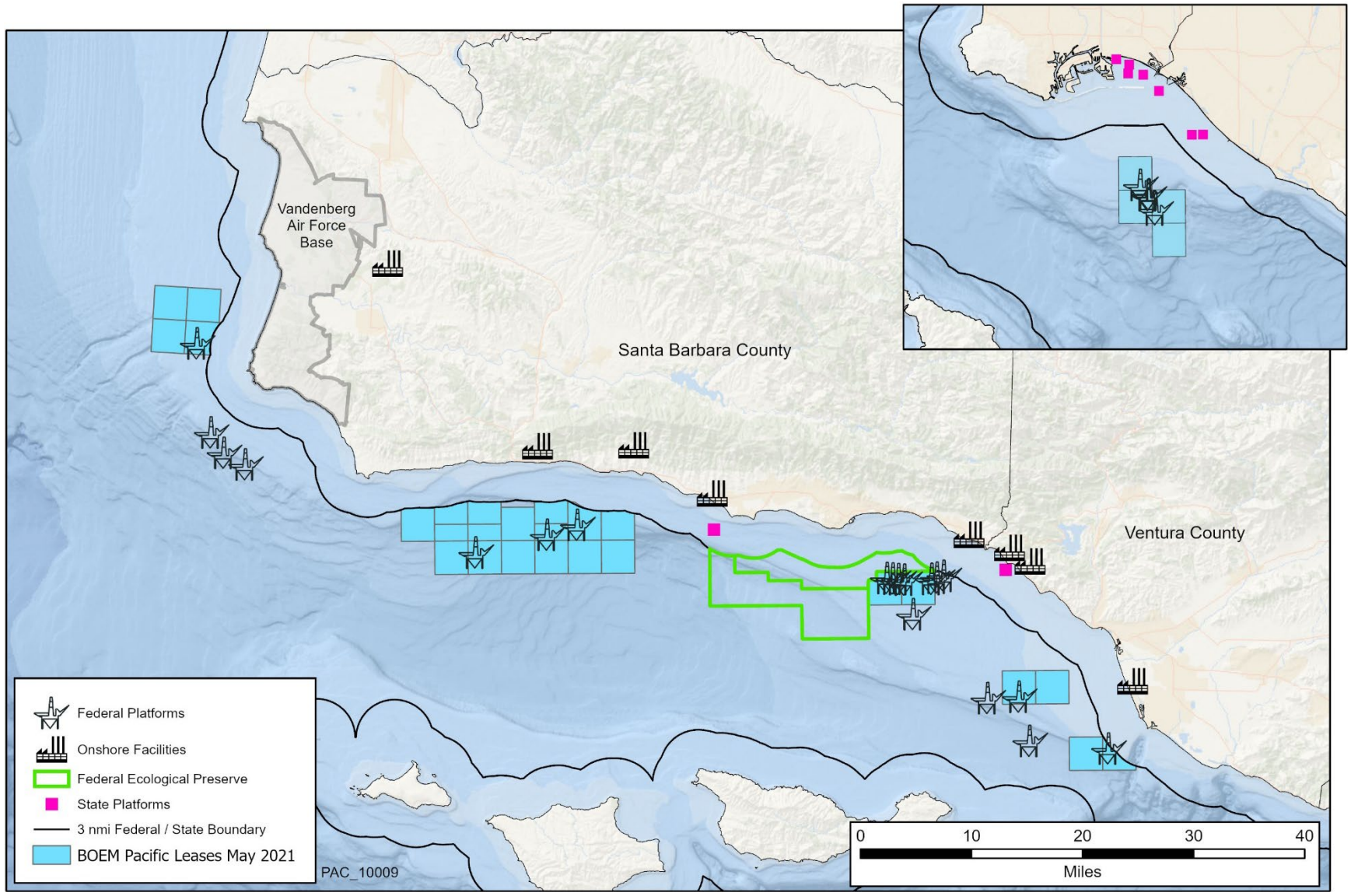


Figure 5. Oil and gas leases and facilities in the Pacific Region

3.1.2 Renewable Energy Activities

Substantial wind and wave potential along the U.S. West Coast and offshore Hawaii has stimulated interest from renewable energy developers. In January 2021, BOEM issued the first Federal marine hydrokinetic energy (MHK) research lease to Oregon State University for the PacWave South project, a proposed open ocean wave energy test center, to be located approximately six nautical miles off Newport, Oregon. Wind energy planning and potential development is at various stages of discussion offshore California, Oregon, Washington, and Hawaii (**Figure 6**). BOEM anticipates a lease sale associated with Wind Energy Areas offshore Central and Northern California in the fall of 2022. BOEM requested public comment on draft Call Areas offshore Oregon in early spring 2022. The potential for wind energy offshore Hawaii has been under consideration since 2016. Prompted by industry interest in wind energy development offshore Washington, BOEM recently began informational discussions about potential offshore wind energy development with the State of Washington, local government, and stakeholder groups.

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.

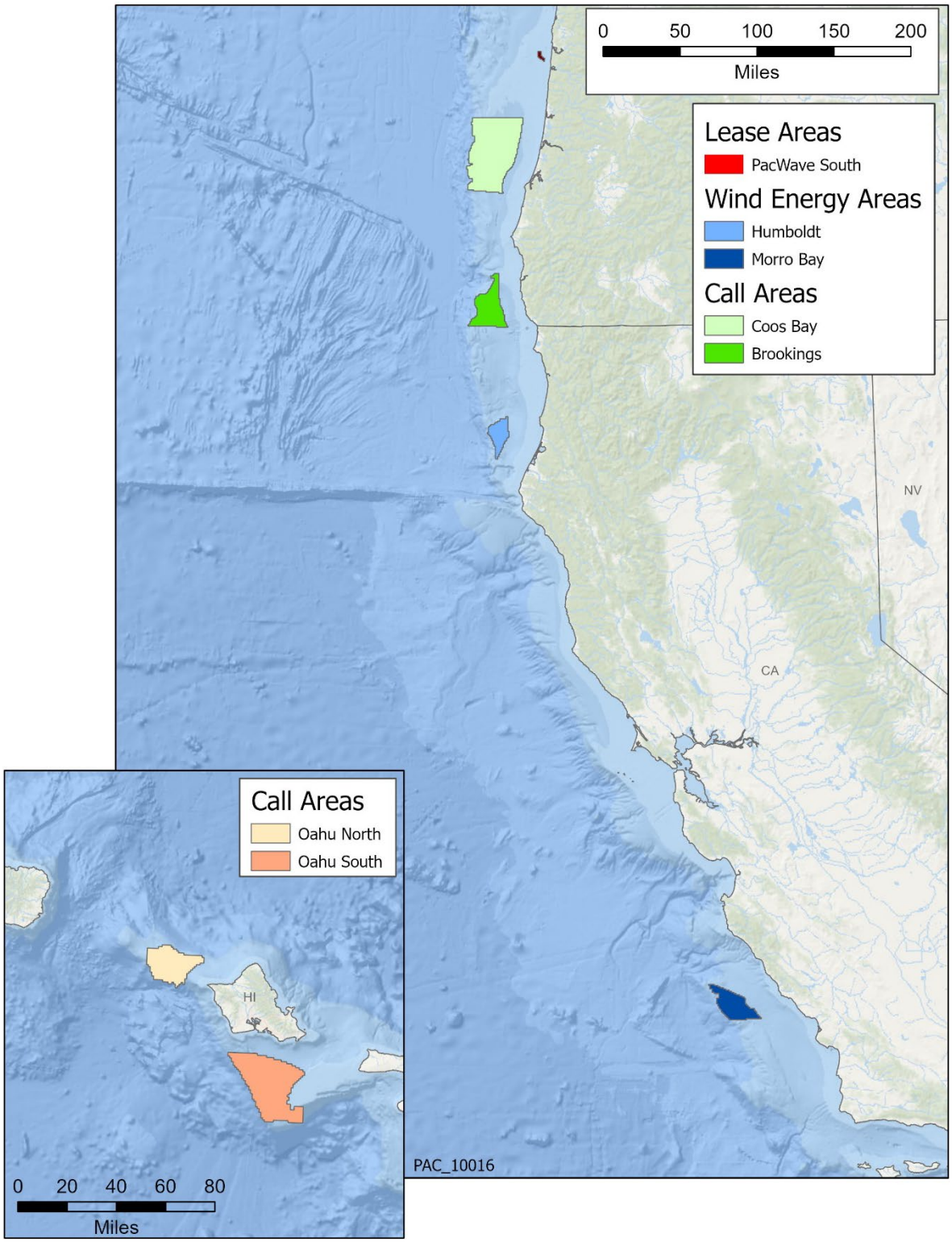


Figure 6. Areas of interest for renewable energy in the Pacific OCS, including Call Areas for wind energy offshore Oregon and Hawaii, Wind Energy Areas offshore California, and a wave energy research lease offshore Oregon

3.1.3 Marine Minerals Activities

Despite more than 50 years of marine minerals exploration, 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 previously expressed interest in offshore sand resources for nourishment of severely eroded coastal beaches. BOEM and the State of California subsequently co-funded an effort to identify sand resources in three areas offshore of California.

The Marine Minerals Program and Pacific OCS Region are currently co-funding several critical marine mineral resource evaluations efforts in partnership with USGS. These include: a tri-agency (USGS, NOAA, and BOEM) field effort to the Escanaba Trough; an opportunistic effort seeking to improve the USGS prospectivity models by capitalizing on pre-existing ship transits through remote areas of the Pacific to collect mineral data in areas anticipated to have a high resource potential; and a USGS-led effort focused on evaluating the potential for polymetallic nodules at the southern extreme of the US EEZ south of Hawaii. BOEM is considering environmental studies and resource evaluation efforts to inform potential future industry interest in critical marine minerals.

3.2 Decision Context

3.2.1 Conventional Energy Science Strategy & Decision Context

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. 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., Endangered Species Act [ESA], Marine Mammal Protection Act [MMPA], Magnuson-Stevens Fishery Conservation & Management Act [MSFCMA], Migratory Bird Treaty Act [MBTA], National Historic Preservation Act [NHPA], and EJ)
  - 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

3.2.2 Renewable Energy Science Strategy & Decision Context

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 the West Coast and Hawaii and (2) obtaining baseline information about cultural resources and human uses adjacent to areas of potential wind energy development offshore the West Coast and Hawaii. 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 the West Coast and Hawaii
  - Potential environmental and socioeconomic impacts of wind energy development offshore the West Coast 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 the West Coast 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 EJ)
  - Compliance with DOI-level strategic plan regarding mitigation policies and practices

3.2.3 Marine Mineral Science Strategy & Decision Context

Given the prospective status of marine mineral efforts in the Pacific Region, the strategy and decision context differ substantially from conventional and renewable energy.

While marine minerals occurrences are ubiquitous in the oceans, the areas with likely resource (economic) potential are much more limited. Due to the limited information on marine minerals on the Pacific OCS and the broader EEZ, BOEM Pacific marine mineral-related activities are focused on resource evaluation efforts exclusively in geographies anticipated to have the greatest resource potential or industry interest. In relatively shallow waters, from where sand and gravel resources are often sought, we first fund resource evaluation efforts. If sufficient sand and gravel resource are identified, we would subsequently organize environmental studies to assess potential environmental impacts of extraction. For example, the State of California and BOEM are co-funding a USGS-led effort to identify offshore sand resources for nourishment of severely eroded coastal beaches. To date, no complementary environmental studies have been pursued.

The high cost and complexity of deepwater work—such as for critical marine minerals—requires a slightly different strategy. Although resource evaluation efforts in areas of high resource potential are the focus, the Pacific Region, in partnership with the Marine Minerals Division, tries to organize concurrent environmental studies to complement any resource evaluation efforts. This enhances the scientific value and return on investment of ocean and global-class ship time as well as submersible time. For example, BOEM, USGS, and NOAA co-funded a recent critical marine minerals expedition to the Escanaba Trough. BOEM and USGS funding focused on resource evaluation efforts, whereas NOAA funding targeted the complementary environmental work. A similar interagency approach to funding simultaneous resource evaluation and environmental work in the Central Pacific is currently being considered in this SDP.

3.3 Alignment With SSQs

Current and forecasted activities in the Pacific Region (see **Section 3.1**), 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 2023, the proposed studies inform conventional energy (four) and renewable energy (five). Of the five proposed studies in the portfolio, four have potential applicability to more than one program (**Table 4**).

As shown in **Table 4**, each proposed study addresses more than one of BOEM's SSQs (themes), including the following areas:

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

Table 4. Alignment of proposed FY 2023 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	BOEM-MARINe (Multi-Agency Rocky Intertidal Network)	✓	✓		✓			✓		✓	✓	✓	✓
2	Facilitating Resilience and Adaptation in Commercial Fisheries in Response to Offshore Renewable Energy Development and Climate Change	✓	✓		✓					✓	✓		✓
3	Pacific Marine Assessment Partnership for Protected Species (PacMAPPS) II	✓	✓		✓	✓		✓		✓			✓
4	Characterization of the Distribution, Movements, and Foraging Habitat of Endangered Leatherback Turtles in Designated Critical Habitat off the U.S. West Coast	✓	✓		✓					✓		✓	✓
5	Evaluating Hawaiian Fisheries and Potential Impacts 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**?

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 USGS provided new opportunities for partnership in biological research. 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.

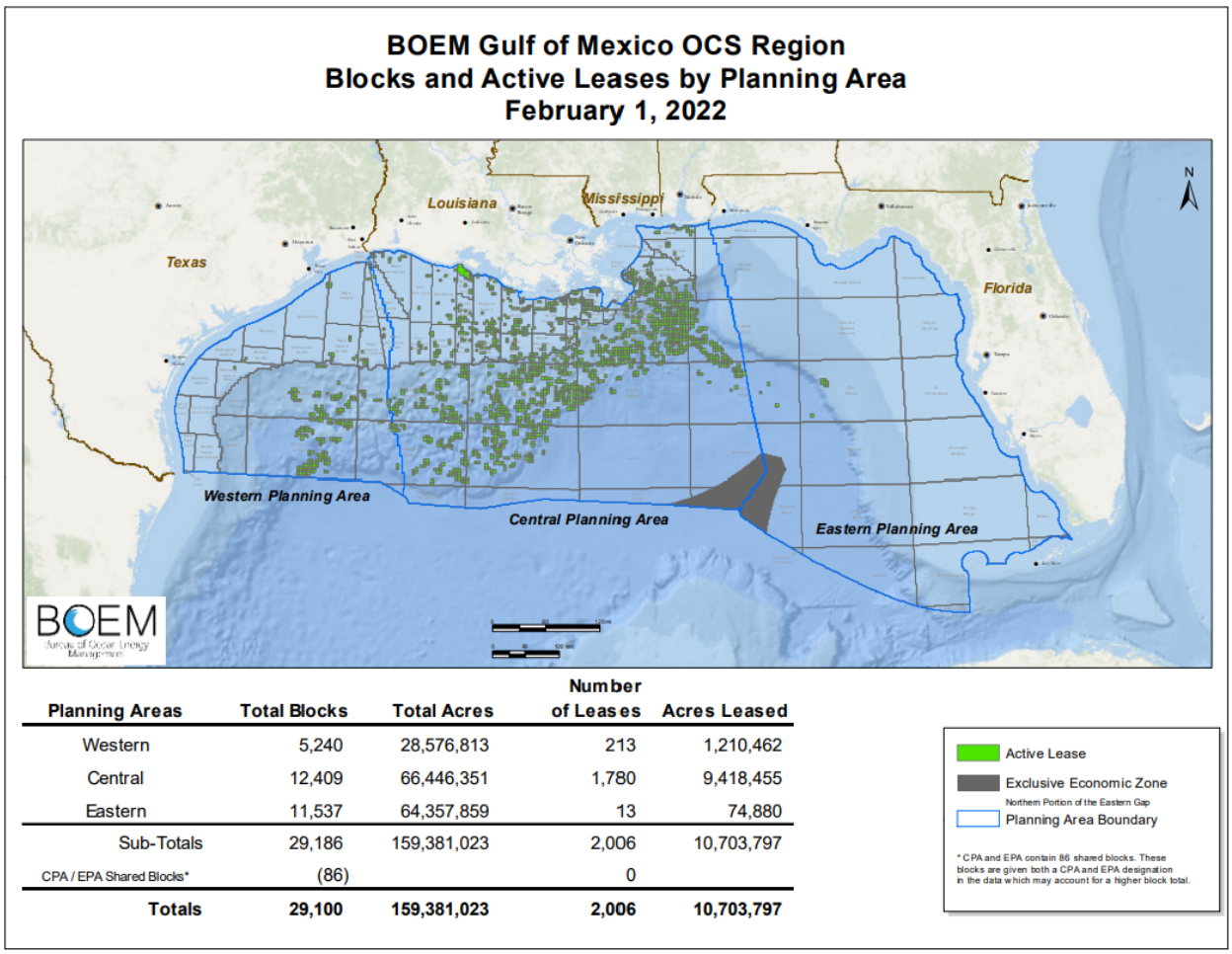
In 2010, BOEM joined the Gulf Coast Cooperative Ecosystem Studies Unit (GCCESU) as a Federal partner. Membership in the GCCESU creates additional opportunities for interdisciplinary and multi-agency research, technical assistance, and education through collaborations within a network of member Federal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

Appendix A includes the tables of proposed studies for FYs 2023 and 2024. **Appendix B** provides the profiles for the proposed studies.

4.1.1 Conventional Energy Activities

As of February 1, 2022, there are a little over 2,000 active oil and gas leases on the GOM OCS (**Figure 7**). Within active leases, there are more than 1,600 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. One lease sale was proposed for 2022 in the 2017–2022 National OCS Oil and Gas Leasing Program (BOEM 2016a). For more information on GOMR, please visit the region's web page.[16]

[16] 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	213	1,210,462
Central	12,409	66,446,351	1,780	9,418,455
Eastern	11,537	64,357,859	13	74,880
Sub-Totals	29,186	159,381,023	2,006	10,703,797
CPA / EPA Shared Blocks*	(86)		0	
Totals	**29,100**	**159,381,023**	**2,006**	**10,703,797**

Figure 7. GOM OCS Region planning areas and active oil and gas leases (February 1, 2022)

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 and others, that may also be optimum sites for oil and gas platforms and associated pipelines (**Figure 8**). These challenges are becoming more complex and deserving of rigorous and integrated environmental study, monitoring, and management.

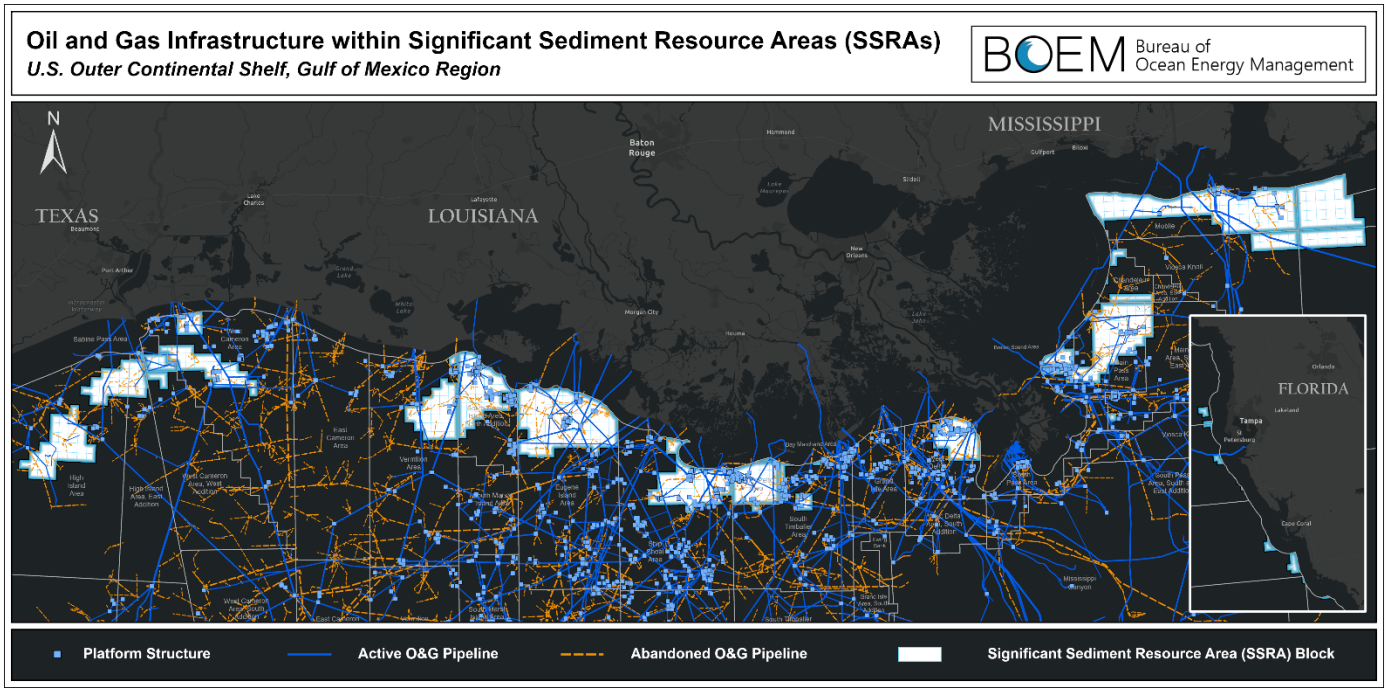


Figure 8. Complex, competing-use challenges in the GOM

4.1.3 Renewable Energy Activities

BOEM published two studies conducted by the National Renewable Energy Laboratory 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 EO 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. The first GOM Regional Task Force meeting was held on June 15, 2021, and included the States of Louisiana, Texas, Mississippi, and Alabama. A second Task Force meeting was held on February 2, 2022. BOEM published a Request of Interest in June 2021 and a Call for Information and Nominations (Call) in November 2021; the Bureau is currently developing an Environmental Assessment on the Call. **Figure 9** shows the renewable energy planning areas in the GOM.

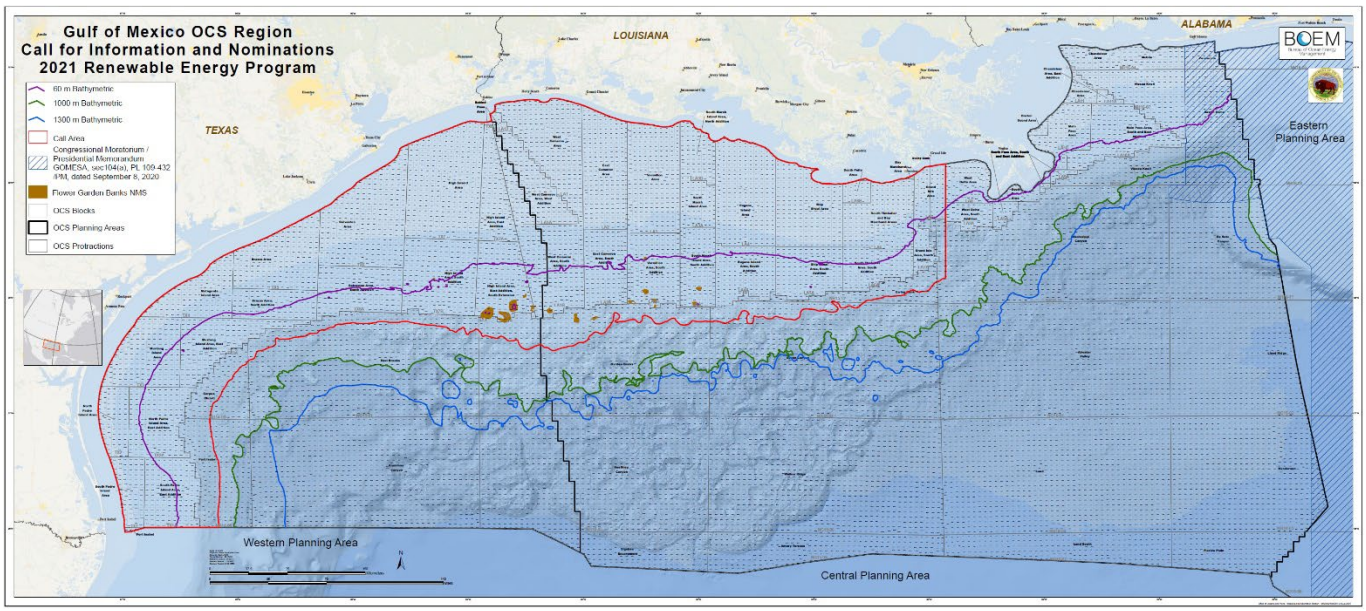


Figure 9. GOM renewable energy planning areas

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 to better identify potential resources that could be affected by BOEM decision-making. A new study proposed for FY 2023 will develop a public-facing geodatabase of benthic community habitat in the GOM and develop standardized procedures for reporting and recording benthic features. Another study will compile a literature review and synthesis of existing information about the potential environmental impacts of carbon sequestration using former oil and gas reservoirs on the marine environment.

4.2.2 NEPA/Consultation Information Needs

BOEM needs new data to better understand and disclose the potential for impacts to natural and cultural resources and air quality from sources such as offshore vessel traffic, climate-change-related coastal land loss and migration, and environmental impacts from abandoned oil and gas infrastructure such as pipelines and umbilicals. Other studies will assess the risk of avian collisions with potential offshore wind energy infrastructure and gather socioeconomic information to inform future wind 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 and other laws, including NEPA and the NHPA. Information provided by these studies will enable BOEM to conduct more comprehensive and informed environmental impact assessments, associated NEPA analyses, and Tribal/EJ 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 of 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 Activities

GOMR is proposing 11 study profiles for the FY 2023 NSL and no profiles for FY 2024 and beyond at this time. All profiles address at least one national SSQ, while several of the profiles address two or more questions (**Table 5**). Eight studies will inform the conventional energy program, while six studies will inform the MMP and/or renewable energy program.

Several profiles propose to assess potential pollution risks and other impacts on sensitive resources and ecosystems and assess the adequacy of existing sources of oil- and gas-related vessel traffic data to inform ESA and MMPA consultations. Another profile proposes a new method to improve pollutant emission estimates and air quality models to inform cumulative impact analyses. Finally, other profiles address climate change, whether from direct impacts to cultural resources due to coastal land loss or potential environmental impacts from broader climate change response efforts. 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 2023. This proposal addresses four SSQs (**Table 5**) and focuses on developing a regional modeling tool that predicts the seabed state across the GOM OCS over a given time period to identify regions of high, moderate and low sediment mobility (SSQ #1, 6, 9). A comprehensive evaluation of seafloor mobility across the Gulf of Mexico OCS to the shelf break (200 m isobath) is needed to inform optimal buffer distances around critical assets, such as infrastructure and cultural resources (SSQ #4). Output from the tool will also inform the conventional and renewable energy programs by supporting evaluation of the physical and environmental impacts to critical assets, such as existing infrastructure and cultural resources (e.g., displacement/damage of pipelines, shipwrecks and telecommunication cables, and pipeline leakage vulnerabilities), and in the placement of future infrastructure, such as wind energy transmission lines and oil and gas pipelines. While the seabed state predictive tool would be developed for the GOM OCS, it could be adapted in the future to the Pacific or Atlantic OCS Regions.

4.3.3 Renewable Energy Activities

GOMR is proposing several studies that will assess the risk of avian collisions with offshore wind turbines, engage with coastal communities and Tribes to better understand how coastal land loss and climate change are affecting communities and their cultural heritage, address climate-change-related migration and trends related to EJ communities, develop a project-level socioeconomic data collection process, and consider the potential utilization of existing onshore infrastructure to inform potential offshore wind development in the region.

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	Archaeology and Coast in Crisis: Traditional Cultural Properties at Risk, Part 1	✓	✓	✓	✓			✓		✓	✓		✓
TBD	Assessing Avian Collision-Risk for Offshore Wind Development in the Gulf of Mexico: A Remote Sensing Approach		✓		✓			✓				✓	
TBD	Census of Decommissioned-in-Place (DIP) Pipelines and Appurtenances Approved for DIP under 30 CFR 250 Subpart Q	✓			✓		✓	✓					
TBD	Characterization of BOEM and BSEE Oil- and Gas-Related Vessel Traffic in the Gulf of Mexico	✓			✓	✓					✓		
TBD	Climate Migration and Dynamic Environmental Justice Considerations	✓	✓		✓					✓	✓		
TBD	Geodatabase of Benthic Community Habitat in the Gulf of Mexico	✓		✓				✓					✓
TBD	Impacts of Offshore Carbon Sequestration on the Marine Environment: Literature Review and Synthesis for Management				✓		✓		✓				✓
TBD	Offshore Wind Energy Data Collection for the Gulf of Mexico Region for Economic Impact Analysis		✓		✓						✓		✓
TBD	Onshore Infrastructure Utilization, Development, and Potential Scenarios Related to Gulf of Mexico Outer Continental Shelf Wind Energy Projects		✓		✓						✓		

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	Study of Plastic Pollution from Abandoned Umbilicals in the Gulf of Mexico (GOM)	✓			✓		✓						✓
TBD	The Top-Down Air Emission Method: A New Approach to Upgrade Pollutant Emission Inventories in the Gulf of Mexico	✓			✓				✓				

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 Alaska Studies

5.1 Introduction

The Alaska OCS encompasses 15 planning areas in the Arctic, Bering Sea, and Gulf of Alaska sub-regions (**Figure 10**). 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 10. Alaska OCS Region planning areas

Since 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.[17] An alternate location for browsing Alaska Region study reports by year is the Alaska Regional Office's website.[18]

When conducting research projects in Alaska, ESP 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 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 125 studies—including 13 student-led projects—and leveraged approximately $23 million of Bureau funds into almost $47 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 the LME scale, and environmental conditions and other anthropogenic stressors keep changing over time. Climate change also entrains many socioeconomic issues. Some immediate concerns include the following: 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 20 active leases: 14 in the Cook Inlet Planning Area and 6 in the Beaufort Sea Planning Area.

In January 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

[17] http://www.boem.gov/espis/
[18] http://www.boem.gov/AKpubs

hazards, and archaeological resources prior to consideration of any further exploration activities. Hilcorp completed the survey on October 24, 2021.

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 is planned to 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. On January 29, 2021, a decision by the U.S. Court of Appeals for the Ninth Circuit vacated the previous approval of the DPP for the Liberty Prospect and remanded the action to BOEM for further proceedings. In December 2021, Hilcorp received from BSEE a Suspension of Production that remains in effect for up to three years.

Northstar is a joint Federal/State of Alaska production unit located in the Beaufort Sea about 12 miles northwest of Prudhoe Bay. The Northstar Unit includes three OCS leases, which account for nearly 18% of total Northstar production, while the remaining 82% is allocated to state leases. Total production of crude oil from Northstar through February 2022 is 180 million barrels, with the Federal portion comprising more than 32.3 million barrels.

Appendix A includes the tables of proposed studies for FYs 2023 and 2024. **Appendix B** provides the profiles for the proposed studies.

5.2 Decision Context

5.2.1 Current/Relevant Issues

Many current issues faced by the Alaska OCS Region are tied to the effects of observed environmental changes. These issues include ongoing impacts from 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. Information is especially needed to understand the renewable tidal energy potential within the Cook Inlet OCS to inform possible future decisions about development, facilitate appropriate engineering design, and support environmental analyses both for potential renewable tidal and conventional energy development. Furthermore, industry has expressed renewed interest in potentially prospecting for gold and critical minerals in OCS waters off the coast of Nome, Alaska.

5.2.2 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 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.

BOEM needs information about the potential frequency of pipeline gas release and related impacts. Additional detail about natural gas impacts to the environment and quantitative scenario factors from gas pipeline release models will facilitate informed and refined NEPA analyses.

In anticipation of potential oil and gas 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 and coastal species; ecological responses to the presence of oil and gas platforms; baseline social and economic information about recreation and tourism activities associated with Cook Inlet marine resources; baseline information about potential impacts from oil- and gas-related activities to community health in the Cook Inlet region; and changes in sea ice climatology.

Information about variability and long-term trends in oceanographic conditions and biological communities is sought for the Arctic. Specifically, updated information is needed about the current population size and age structure of polar bears in the Southern Beaufort Sea region, which are listed as

threatened under the ESA due to loss of sea ice habitat. Timely, comprehensive, accurate demographic information for vulnerable populations exposed to multiple stressors is especially important for ESA, MMPA, and NEPA analyses.

5.3 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 Arctic conditions such as cold temperatures and presence of sea ice influence the fate of spilled oil?

5.4 Alignment With SSQs

In recent years, BOEM has placed primary emphasis on studying the Cook Inlet, Beaufort Sea, and Chukchi Sea 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 2023 and 2024. The studies proposed for the Alaska Region inform a broad repertoire of knowledge and address each of the SSQs to varying extents. **Tables 6 and 7** contain matrices indicating the strongest intersections between each study and the strategic questions.

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 6. 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	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: **Arctic Conditions and Spilled Oil**
1	Pipeline Gas Release Frequency, Scenarios, and Impacts	✓			✓							✓				✓
2	Sea Ice Climatology within Cook Inlet, Alaska	✓			✓					✓		✓		✓	✓	✓
3	Tidal Flow Characteristics and Associated Biological Use of Cook Inlet	✓	✓		✓							✓				
4	Cook Inlet Area-wide Recreation and Tourism Inventory	✓			✓			✓			✓					
5	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 **Arctic conditions** such as cold temperatures and presence of sea ice **influence the fate of spilled oil**?

Table 7. Alignment of proposed FY 2024 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: **Arctic Conditions and Spilled Oil**
1	Seabird and Forage Fish Distribution, Trends, and Community Structure in Lower Cook Inlet	✓			✓					✓			✓			
2	Linking Summer and Winter Foraging Areas to Diet and Annual Survival of Seabirds from Colonies in the Lower Cook Inlet Area	✓			✓			✓								
3	Using Predator Diets to Monitor Trends in Forage Fish Composition in Lower 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 **Arctic conditions** such as cold temperatures and presence of sea ice **influence the fate of spilled oil**?

6 National Studies

6.1 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 Oil and Gas Leasing Programmatic EIS currently under development, other NEPA analyses, and associated consultations led to the development of this cycle's 16 study profiles. Furthermore, OEP considered study needs associated with the 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. OEP is also substantially supporting renewable energy initiatives, such as the development and implementation of the NOAA/BOEM collaborative research and management strategy for North Atlantic right whales and offshore wind. OEP's 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. Lastly, OEP remains agile and responsive in developing the knowledge base necessary for fulfilling BOEM's emerging and increasing responsibilities in the areas of climate change, carbon capture, utilization, and storage, and EJ.

Appendix A includes the tables of proposed studies for FY 2023. **Appendix B** provides the profiles for the proposed studies.

6.2 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.

6.2.1 Upcoming Decisions

- Programmatic MMPA and ESA consultations and streamlining initiatives across BOEM programs for decisions related to permitting and mitigation measures
- Development of the National OCS Oil and Gas Leasing Program, including identification of potential areas for activity exclusions or programmatic mitigation
- Offshore wind energy leasing and development in the Atlantic, Pacific, and GOM Regions

6.2.2 Current/Relevant Issues

The ongoing expansion of offshore renewable energy requires 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. Additionally, 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 address information needs and understand the direct and indirect impacts of these activities, especially if they occur in areas that have not been leased in many years.

Air quality and greenhouse gas emissions remain an important area of study for the Bureau. One priority is to replace the outdated Offshore & Coastal Dispersion (OCD) modeling with EPA's American Meteorological Society/EPA Regulatory Model (AERMOD), which will require installing platform downwash and coastal fumigation algorithms. BOEM is also working with NASA to assess offshore pollutants using high-resolution satellite data for offshore air quality management in the GOM, Pacific, and Atlantic Regions. Later this year, BOEM is expecting the publication of a greenhouse gas harm document from DOE's Argonne Laboratory, which could provide BOEM with justification for a rulemaking regulating greenhouse gas emissions from OCS sources. BOEM has spent considerable time and effort to develop the Outer Continental Shelf Air Quality System (OCS AQS) web-based emissions reporting tool. This tool will streamline the emissions reporting process by instantaneously performing quality checks and calculation of emissions data and will display all emissions data in reports and maps. In addition, OCS AQS has a new modeling module, which will allow BOEM to conduct dispersion modeling for impact assessments on one or more facilities offshore. DOE's Argonne Laboratory is also developing mitigation strategies (e.g., repairs, monitoring, and replacement) to reduce greenhouse gas emissions from offshore oil and gas activities to help BOEM meet the Biden Administration's mandate of reaching net zero emissions by 2050 (The White House 2021).

On November 15, 2021, President Biden signed the Infrastructure Investments and Jobs Act (Act) into law. The Act amended OCSLA to grant BOEM authority to issue leases, easements, and rights-of-way for activities that "provide for, support, or are directly related to the injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration." Carbon sequestration is defined as "the act of storing carbon dioxide that has been removed from the atmosphere or captured through physical, chemical, or biological processes that can prevent the carbon dioxide from reaching the atmosphere." Under the Act, BOEM is required to promulgate regulations to govern carbon sequestration within one year of the Act's passage. While new studies proposed in this SDP will not be completed in time to provide input into the new regulations, BOEM will require acquisition and synthesis of additional scientific information regarding carbon capture, utilization, and sequestration moving forward.

Lastly, BOEM continues to support priorities and directives of the Biden Administration, such as 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. In BOEM's case, the last of these relates specifically to helping enable growth of the blue economy (the sustainable development of ocean resources resulting in economic growth, job creation, and improved livelihoods). The Bureau is committed to supporting studies that contribute to these priorities and advance our understanding of potential effects from offshore energy projects, especially to underserved and EJ communities. BOEM needs more information to accurately identify all EJ communities that may be impacted by permitted activities and the potential for disproportionate impacts on those communities. BOEM is also supporting the President's "America the Beautiful" initiative and its stated goal of conserving at least 30 percent of our lands and oceans by 2030 (The White House 2021). To support this effort, the Bureau needs to better understand how sound from offshore wind development could potentially impact marine and coastal species, especially those that are endangered or threatened.

6.2.3 NEPA/Consultation Information Needs

OEP requires robust, up-to-date 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, with the exception of the upcoming New York Bight Offshore Wind Programmatic EIS, which is being led by OEP. Often, the acquisition of these data is in support of known information needs or to continue monitoring of previous impacts. Assessing potential impacts, through the review of additive concerns from other anthropogenic impacts or the continuation of monitoring studies, helps the Bureau to analyze potential cumulative impacts from offshore activities. In addition, 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 2023–2024 SDP, OEP's NEPA and consultation needs focus on air quality, ecological concerns for marine mammals and fishes, EJ, commercial fishing, climate change, human health impacts from offshore activities, and Tribal relations. This information will enable BOEM to conduct more comprehensive NEPA analyses and associated consultations.

6.3 Alignment With SSQs

The suite of studies proposed by OEP for FYs 2023 and 2024 include a strong focus on marine acoustics (SSQ #2), with six proposed studies investigating impacts of noise in the ocean. BOEM's acoustic research needs include investigating both impacts to marine species (such as marine mammals, sea turtles, fish, and invertebrates) and the effect that vibrations might have on the substrate. Six proposed studies focus on potential habitat or landscape alteration (SSQ #4) and would address topics such as climate change risk, improved animal telemetry, and updating BOEM's environmental sensitivity methods and model to support renewable and conventional energy development.

In recent years, BOEM has 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. Two proposed studies for FY 2023 address air quality (SSQ #5). One of these intends to use the Carbon Mapper instrument to provide BOEM with methane and carbon dioxide observational data for the GOM Region; the other looks to improve the offshore functionality of the AERMOD dispersion model as discussed in **Section 6.2.2**.

Two proposed studies focus on the human side of BOEM's research (SSQ #7). The first of these seeks to characterize EJ communities potentially impacted by BOEM activities, and the second is related to potential health risks and associated exposure pathways in EJ communities resulting from OCS activities. Advancing our understanding of how permitted activities may potentially impact EJ and underserved communities is a priority this year, which these proposed studies would help address.

Lastly, cumulative impacts (SSQ #1) and long-term monitoring (SSQ #9) remaining important focus areas for OEP with four and six studies, respectively, addressing each of these research areas. A full list of the studies proposed by OEP and their alignment with the SSQs can be seen in **Tables 8 and 9**. Study profiles can be viewed by clicking on the study titles.

Table 8. Alignment of proposed FY 2023 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	Addressing Key Information Gaps in Acoustic Ecology of North Atlantic Right Whales	✓	✓			✓							✓
2	Carbon Mapper and Air Measurements in the Gulf of Mexico (GOM)	✓							✓			✓	✓
3	Updating BOEM's Environmental Sensitivity Methods and Models to Support Oil, Gas, and Wind Energy Development	✓	✓		✓			✓					
4	Next Generation of Animal Telemetry: Year II	✓	✓	✓				✓					✓
5	Piloting an Approach to Community-Informed Characterization of Environmental Justice (EJ) Communities Potentially Impacted by BOEM-Authorized Activities	✓	✓	✓	✓						✓		✓
6	Qualitative Risk Assessment Approach Refining Acoustic Processes and to Explore the Inclusion of Cumulative Effect Analysis for Offshore Windfarm Construction and Operations		✓		✓	✓							
7	Investigating Shoreline Fumigation Algorithms in Offshore and Coastal Dispersion Model for AERMOD – Part 2 of the U.S. Environmental Protection Agency's Inter-agency Agreement to Improve AERMOD for Overwater Applications	✓	✓	✓					✓				✓
8	Understanding Potential Health Impacts of Outer Continental Shelf (OCS) Energy Activities on Environmental Justice (EJ) Populations	✓	✓	✓	✓			✓			✓		✓
9	Building an Integrated, Sustained, Marine-life-observing Capability for U.S. Territorial Waters	✓	✓	✓	✓			✓				✓	✓

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	Feel the Vibrations: Behavioral Response by Fish and Invertebrates to Particle Motion/Substrate Vibration from Pile-Driving	✓	✓			✓		✓					
11	Substrate-Borne Vibroacoustic Disturbances from Offshore Wind Construction: Measurements, Physical Characteristics, and Propagation		✓			✓		✓					
12	Assessing Climate Change Risk and Information Gaps in Habitats of Concern on the Outer Continental Shelf	✓	✓	✓	✓			✓		✓			
13	Behavioral and Physiological Responses of Sea Turtles to Sound	✓	✓			✓							
14	Marine Mammal Hearing Temporary Threshold Shift from Complex Noise Exposure	✓	✓			✓							
15	Marine Environmental Data Internet Access and Environmental Study Capability Ecosystem (MEDIASCapE) Phase I	✓	✓	✓									✓

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 2024 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	Integrating Dimethyl Sulfide (DMS) Gradients into Dynamic Management to Predict North Atlantic Right Whale Occurrence in Cape Cod Bay	✓	✓			✓							✓

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**?

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APPENDIX A: Tables of Proposed Studies for FYs 2023 and 2024

Table A-1. Atlantic (OREP) studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
66	FE	Assessment of Chemicals Associated with Offshore Wind Facilities and Potential Environmental Impacts on the Atlantic Outer Continental Shelf (OCS)
69	SE	Baseline Tourism and Recreation Along the Gulf of Maine
72	HE	Gulf of Maine Fish and Invertebrate Benthic Habitat Baseline Data Collection
74	SE	Gulf of Maine Socioeconomic Impacts of OCS Wind Development on Fishing
76	SE	Offshore Wind Turbine Visibility Study
79	MM	Risk Assessment to Model Encounter Rates Between Large Whales and Vessel Traffic from Offshore Wind Energy – PHASE II
82	HE	Seasonal Residency and Movement of Highly Migratory Sea Turtles in the New York Bight Wind Energy Areas
85	IM	Support for Regional Wildlife Science Collaborative Ocean Portal Products and Services
88	SE	Update of Port Modification Study

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. Atlantic (OREP) studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
90	FE	Cumulative Impacts Analyses of Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)
94	FE	Environmental Monitoring Study for Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)
98	FE	Fugitive CO2 Emissions Analyses from Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)
102	FE	Mobilization of Chemical Contaminants Associated with Offshore Wind Farms
105	SE	Offshore Landscape, Seascape, and Visual Impact Mitigation Study
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. Atlantic (MMP) studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
108	HE	Accounting for Scale Bias in Marine Minerals Studies
112	PO	Evaluating Sediment Mobility on the Gulf of Mexico Outer Continental Shelf (OCS)
116	HE	Minerals and Ecosystems of the Remote Pacific
119	HE	Modeling Benthic Recovery with Variable Dredge Conditions
Discipline Codes		
AQ = Air Quality FE = Fates & Effects HE = Habitat & Ecology IM = Information Management		MM = Marine Mammals & Protected Species PO = Physical Oceanography SE = Socioeconomics

Table A-4. Pacific studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
122	HE	BOEM-MARINe (Multi-Agency Rocky Intertidal Network)
126	MM	Characterization of the Distribution, Movements, and Foraging Habitat of Endangered Leatherback Turtles in Designated Critical Habitat off the U.S. West Coast
129	SE	Evaluating Hawaiian Fisheries and Potential Impacts of Offshore Wind Energy Development
133	SE	Facilitating Resilience and Adaptation in Commercial Fisheries in Response to Offshore Renewable Energy Development and Climate Change
136	MM	Pacific Marine Assessment Partnership for Protected Species (PacMAPPS) II

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. Gulf of Mexico studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
139	SE	Archaeology and Coast in Crisis: Traditional Cultural Properties at Risk, Part 1
143	HE	Assessing Avian Collision-Risk for Offshore Wind Development in the Gulf of Mexico: A Remote Sensing Approach
147	FE	Census of Decommissioned-in-Place (DIP) Pipelines and Appurtenances Approved for DIP under 30 CFR 250 Subpart Q
150	IM	Characterization of BOEM and BSEE Oil- and Gas-Related Vessel Traffic in the Gulf of Mexico
153	SE	Climate Migration and Dynamic Environmental Justice Considerations
157	HE	Geodatabase of Benthic Community Habitat in the Gulf of Mexico
160	IM	Impacts of Offshore Carbon Sequestration on the Marine Environment: Literature Review and Synthesis for Management
164	SE	Offshore Wind Energy Data Collection for the Gulf of Mexico Region for Economic Impact Analysis
168	SE	Onshore Infrastructure Utilization, Development, and Potential Scenarios Related to Gulf of Mexico Outer Continental Shelf Wind Energy Projects
171	FE	Study of Plastic Pollution from Abandoned Umbilicals in the Gulf of Mexico (GOM)
173	AQ	The Top-Down Air Emission Method: A New Approach to Upgrade Pollutant Emission Inventories in the Gulf of Mexico

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. Alaska studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
177	SE	Cook Inlet Area-wide Recreation and Tourism Inventory
180	FE	Pipeline Gas Release Frequency, Scenarios, and Impacts
183	PO	Sea Ice Climatology within Cook Inlet, Alaska
186	PO	Tidal Flow Characteristics and Associated Biological Use of Cook Inlet
189	HE	Using Emerging Technologies to Update Lower Cook Inlet Seabird Colony Counts
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. Alaska studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
192	HE	Linking Summer and Winter Foraging Areas to Diet and Annual Survival of Seabirds from Colonies in the Lower Cook Inlet Area
194	HE	Seabird and Forage Fish Distribution, Trends, and Community Structure in Lower Cook Inlet
197	HE	Using Predator Diets to Monitor Trends in Forage Fish Composition 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-8. National studies proposed for FY 2023, alphabetized by title

Profile Page #	Discipline	Study Title
200	MM	Addressing Key Information Gaps In Acoustic Ecology of North Atlantic Right Whales
203	HE	Assessing Climate Change Risk and Information Gaps in Habitats of Concern on the Outer Continental Shelf
208	MM	Behavioral and Physiological Responses of Sea Turtles to Sound
212	HE	Building an Integrated, Sustained, Marine-life-observing Capability for U.S. Territorial Waters
214	AQ	Carbon Mapper and Air Measurements in the Gulf of Mexico (GOM)
217	HE	Feel the Vibrations: Behavioral Response by Fish and Invertebrates to Particle Motion/Substrate Vibration from Pile-Driving
221	AQ	Investigating Shoreline Fumigation Algorithms in Offshore and Coastal Dispersion Model for AERMOD – Part 2 of the U.S. Environmental Protection Agency's Inter-agency Agreement to Improve AERMOD for Overwater Applications
225	IM	Marine Environmental Data Internet Access and Environmental Study Capability Ecosystem (MEDIASCapE) Phase I
228	HE	Marine Mammal Hearing Temporary Threshold Shift from Complex Noise Exposure
231	MM	Next Generation of Animal Telemetry: Year II
234	SE	Piloting an Approach to Community-Informed Characterization of Environmental Justice (EJ) Communities Potentially Impacted by BOEM-Authorized Activities
238	HE	Qualitative Risk Assessment Approach Refining Acoustic Processes and to Explore the Inclusion of Cumulative Effect Analysis for Offshore Windfarm Construction and Operations
242	HE	Substrate-Borne Vibroacoustic Disturbances from Offshore Wind Construction: Measurements, Physical Characteristics, and Propagation
246	SE	Understanding Potential Health Impacts of Outer Continental Shelf (OCS) Energy Activities on Environmental Justice (EJ) Populations
249	IM	Updating BOEM's Environmental Sensitivity Methods and Models to Support Oil, Gas, and Wind Energy 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. National studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
251	MM	Integrating Dimethyl Sulfide (DMS) Gradients into Dynamic Management to Predict North Atlantic Right Whale Occurrence in Cape Cod Bay

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

APPENDIX B: FY 2023–2024 Study Profiles Organized by Region

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Assessment of Chemicals Associated with Offshore Wind Facilities and Potential Environmental Impacts on the Atlantic Outer Continental Shelf (OCS)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Jennifer Draher (jennifer.draher@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	December 27, 2021
PICOC Summary	
Problem	Offshore wind facilities use and store chemicals that have the potential to impact the environment in the event of a spill.
Intervention	This study will utilize literature review, discussions with offshore wind developers and equipment manufacturers, and modeling to identify chemicals used and stored on offshore wind facilities and their associated environmental risks.
Comparison	Assess the impacts that the identified chemicals may have on benthic habitats, marine flora and fauna, and water quality, and the environments likely affected by transport of these hazardous materials in the event of a spill.
Outcome	The goal of the study is to understand the types and volumes of chemicals used and stored on offshore wind facilities and the impacts those chemicals may have on the environment.
Context	This study will focus on currently proposed offshore wind facilities on the Atlantic Outer Continental Shelf (OCS) and reasonably foreseeable technological advancements over the next 10 years.

BOEM Information Need(s): Offshore wind facilities will contain various chemicals and hazardous fluids such as electrical insulating oils, diesel fuel, and lubricating oils. As part of its environmental assessments, BOEM must assess the impacts offshore wind facilities may have on the environment, specifically the impact of these chemicals in the event of a spill or other release such as material degradation. BOEM must analyze the impacts these chemicals may have on benthic habitats, marine flora and fauna, and water quality, and the environments likely affected by transport of these hazardous materials. This study will provide an assessment of the likely chemicals found on an offshore wind facility and their environmental risks, fates, and effects. BOEM will incorporate this information into future EISs.

Background: In 2013, BOEM completed a study titled "Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf" (Bejarano et al. 2013) that provided an evaluation of the chemicals typically found on offshore wind turbines and the potential consequences of a spill. This study was based on offshore wind facility information available at the time, such as the Cape Wind project which proposed the use of 130 3.6 MW turbines.

Turbine and substation technology has changed since the conclusion of the previous study. Turbine

capacity has increased, such as the 14 MW turbines commercially available and proposed for use, and larger turbines are in development. This increase in turbine capacity means an increase in chemical volumes required to be used and stored on an individual turbine. With the increase in turbine size and mitigations to address stakeholder concerns, overall facility design has also changed. For example, the spacing between turbines has increased to an average of 1 nautical mile at many Atlantic OCS project locations. Multiple offshore substations (also known as electrical service platforms, offshore service platforms, etc.) are proposed at some project locations, including both high voltage alternating current (HVAC) and high voltage direct current (HVDC) designs. Changes to facility design may also impact the volume and type of chemicals stored at the facility and may change the risk profile of a spill.

Due to the evolution of offshore wind facility design, BOEM needs to determine whether the analyses and conclusions of the 2013 BOEM study remain applicable, and where needed, update those analyses.

Objectives: To provide an updated assessment of the chemicals used and stored on offshore wind facilities and the impacts those chemicals would have on the environment in the event of a spill.

Methods: This study will assess the applicability of the 2013 BOEM study to proposed offshore wind projects currently under review by BOEM and, where necessary, provide updated assessments of 1) the chemicals and quantities that could be present on different types of offshore wind turbines and offshore substations proposed for use on the Atlantic OCS; 2) chemical transfer, storage, and disposal methods 3) the risk of a spill or other release (i.e. material degradation) of the identified chemicals; and 4) the transport, fate, and impacts of the identified chemicals in the event of a spill.

To identify the chemicals and quantities, methods may include literature review, discussions with offshore wind facility developers and component manufacturers, and discussions with relevant government agencies such as the U.S. Environmental Protection Agency. Modeling may be used to provide a comprehensive assessment of spill risk and the fate of the identified chemicals in the event of a spill. Modeling methods may be similar to those used by the 2013 BOEM study. The study will base its assumptions and analysis on facility designs proposed in the Construction and Operations Plans currently under review by BOEM, which can be found on BOEM's website at https://www.boem.gov/renewable-energy/state-activities, and on reasonably foreseeable technological advancements over the next 10 years.

Specific Research Question(s):

1. What chemicals are used and stored on offshore wind facilities?
2. What is the risk of a spill or other release of chemicals contained on offshore wind facilities?
3. How will a spill or release of chemicals from an offshore wind facility impact the environment?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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. Herndon (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 355 p. Report No.: OCS Study BOEM 2013-213.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

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)	Cooperative Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	April 21, 2022
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 and recreation 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 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: The objective of this study is 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 three phrases: study design, data collection & analysis, and closeout. The 'study design' phase would include a body of integrated and iterative activity, namely: site selection; stakeholder engagement; indicator identification, refinement, and testing; and development of a sensitivity assessment (vetting the accuracy and reliability measurement). The 'data collection and analysis' phase would include the following: 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 Outer Continental Shelf 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?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

ICF Incorporated, LLC. 2012. Atlantic Region wind energy development: recreation and tourism economic baseline development. Herndon (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 35 p. Report No.: OCS Study BOEM 2012-085.

Industrial Economics, Inc. 2012. Identification of Outer Continental Shelf renewable energy space-use conflicts and analysis of potential mitigation measures. Herndon (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 414 p. Report No.: OCS Study BOEM 2012-083.

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. 52 p. Report No.: OCS Study BOEM 2018-013.

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. Sterling (VA): U.S. Department of Interior, Bureau of Ocean Energy Management. 88 p. Report No.: OCS Study BOEM 2018-068.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Gulf of Maine Fish and Invertebrate Benthic Habitat Baseline Data Collection
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brandon Jensen (brandon.jensen@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	January 21, 2022
PICOC Summary	
Problem	There is a lack of integrated baseline information about benthic habitats and associated fauna in potential wind energy areas in the Gulf of Maine.
Intervention	This study will summarize existing information and collect additional baseline information in potential wind energy areas.
Comparison	Information will be compared to data provided by developers during their pre-plan surveys.
Outcome	Improved evaluation of the potential impacts of offshore wind on the local habitats
Context	Gulf of Maine

BOEM Information Need(s): At present, there is a lack of a systematic independent baseline benthic habitat characterizations of potential offshore wind energy areas in the Gulf of Maine. This information is not only important for the evaluation and assessment of a lessee's construction and operations plan, but also necessary for consultations with the National Marine Fisheries Service (NMFS) pursuant to the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

Background: This project will build upon previous efforts to collect baseline habitat data and to analyze the data in the context of potential impacts from renewable energy development (Guida et al. 2017). There is a lack of standard baseline benthic habitat data that includes areas for potential wind energy development in the Gulf of Maine. Previous habitat characterization efforts have primarily been inshore or designed for other specific purposes in areas that do not overlap with potential wind energy lease areas.

The study will assess and characterize benthic habitat and the epibenthic fish and macroinvertebrate communities in potential wind energy areas (WEAs) in the Gulf of Maine. Surveys will be conducted via multibeam sonar and optical (still and video) imaging of the seafloor. Data collected from these surveys will establish a baseline for the benthic macrofaunal species presence, abundance, and sediment/seabed type. The location of the baseline surveys could also be used to establish a control study site to compare and measure impacts from future offshore wind development in the region. This study may include analysis of previously collected data of similar type as well as new data collection and analysis. For example, a data gap analysis of the Gulf of Maine, "*A Comprehensive Assessment of Existing*

Gulf of Maine Ecosystem Data and Identification of Data Gaps to Inform Future Research (AT-22-11)" will kick-off this year and could be used to inform this study.[1]

Objectives: The objective of this study is to establish baseline benthic habitat characteristics at regional/WEA scales (10s of km). These data would allow for improved siting, impact assessments, and provide a baseline to evaluate project-scale habitat surveys submitted by lessees. Additionally, the results of this study would enhance our scientific understanding of these habitats, improve our EFH consultations with NMFS under the MSA in the region, and inform the National Environmental Policy Act process with the best available information regarding benthic resources in the Gulf of Maine.

Methods: The study would synthesize existing information regarding the benthic habitat types and macrofaunal (fish and invertebrate) species in the potential Gulf of Maine WEAs. The study will conduct multibeam sonar data and imaging surveys (video and still photography) of benthic habitat at potential WEAs within a regional scale of 10s of km (Harris and Stokesbury, 2010). Survey methods should also consider Sediment Profile and Plan View Imaging (SPI/PV) techniques where substrate types are conducive to this approach. Physical sampling of sediments may be warranted but is not required. Surveys would occur on a minimum of a 3 nautical mile (5.6 km) grid or along a continuous transect. Sampling resolution may be increased based upon diversity of habitat types found. The survey would use high resolution geophysical survey methods, videography, and still imagery of each station/transect. This survey will provide distribution and density estimates of prevalent benthic fish and invertebrate species as well as a classification of substrate types across the survey domain using the Coastal and Marine Ecological Classification Standard (CMECS) system. The number of stationary quadrats per station and/or length of survey tows will be refined prior to a formal request for quotes. Final products of this project will include at a minimum, a report characterizing the benthic habitat in the identified WEAs, a list of species identified within the study area to the lowest practicable taxonomic level, a data catalog of video and still imagery, and the classification of habitat using a habitat classification model following the CMECS system.

Specific Research Question(s): What habitats as well as fish and invertebrate species are present in potential offshore wind development areas in the Gulf of Maine?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Harris BP, Stokesbury KDE. 2010. The spatial structure of local surficial sediment characteristics on Georges Bank, USA. Continental Shelf Research. 30(17):1840–1853. https://doi.org/10.1016/j.csr.2010.08.011.

Guida V, Drohan A, Welch H, McHenry J, Johnson D, Kentner V, Brink J, Timmons D, Estela-Gomez E. 2017. Habitat Mapping and Assessment of Northeast Wind Energy Areas. Sterling (VA: U.S. Department of the Interior, Bureau of Ocean Energy Management. 312 p. Report No.: OCS Study BOEM 2017-088.

[1] https://www.boem.gov/sites/default/files/documents/environment/environmental-studies/AT-22-11.pdf

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Gulf of Maine Socioeconomic Impacts of OCS Wind Development on Fishing
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
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	
Problem	The socioeconomic impact of offshore wind on fishing is a concern.
Intervention	The study will collate information about fishing activity and estimate the socioeconomic impact from offshore wind development.
Comparison	The study will provide baseline information about fishing activity.
Outcome	This study will provide information about the socioeconomic impacts of future offshore wind development on commercial and recreational fisheries in the Gulf of Maine.
Context	Gulf of Maine

BOEM Information Need(s): Offshore wind (OSW) development will have impacts on commercial and recreational fishing and shoreside dependents in the Gulf of Maine; potential socioeconomic impacts from the presence of structures in the offshore environment is of primary concern. Results of the study will be used by BOEM in environmental assessments of the potential impacts of OSW, for stakeholder engagement, and to inform potential mitigation measures.

Background: The Atlantic Outer Continental Shelf (OCS) Region extends from the Canadian border to the tip of Florida. The diversity of fisheries resources is large and the manner of fishing is varied. In New England, offshore banks and major inshore marshes and estuaries are important habitats and fishing areas. Fishing along the Atlantic seaboard supports direct and indirect food sales, industrial processing, and provides valuable recreational experiences. In the Gulf of Maine there are approximately 18,000 licensed fishermen, seafood dealers, processors, aquaculture operators and charter fishing operators that make up region's seafood industry, which nets an estimated $788.2 million a year in revenues. Additionally, fishermen from along the Atlantic seaboard fish on George's Bank and other areas within the Gulf of Maine.

BOEM is pursuing leasing for renewable energy development in the Gulf of Maine. Key challenges relative to Atlantic fisheries are the minimization of space-use conflicts, analysis of artificial reef effects, avoidance of habitat alteration, and reduction of noise impacts from pile driving. Offshore wind facilities could be de facto protected areas due to some fishers' avoidance of wind facilities and thus may benefit recreational fishers or the fishery resource itself due to that exclusion. For the Gulf of Maine, the most noteworthy knowledge gap related to fisheries is that regarding potential space-use conflicts for commercial fishing, which may result in lost revenue for the industry. The potential socioeconomic

impact was addressed by BOEM for the Mid-Atlantic (Kirkpatrick et al. 2017), but this study did not include the Gulf of Maine.

This study will assess the socioeconomic impacts to both commercial and recreational fishers from potential OSW development in the Gulf of Maine. Impacts will be assessed primarily through revenue exposure, defined as the potential for an impact, in this case from offshore wind. Components of revenue exposure for this study could include total revenue for a wind energy area, commercial revenue by ports, commercial revenue by fisheries management plan, commercial revenue by permit and gear type, total recreational expenditures, and/or recreational expenditures by ports. These impacts may be negative to commercial fishers due to loss of fishing revenue, extending to shoreside dependents such as seafood processors and bait dealers, or may be positive for recreational fishers and their shoreside dependents, as has been observed at Block Island Wind Farm.

Objectives: The objective of this study is to assess the potential socioeconomic burdens and/or benefits from OSW development in the Gulf of Maine on commercial and recreational fishing. Offshore wind facility assessments not only must evaluate impacts on essential fish habitat and fish stocks, but also must evaluate potential displacement/fishing effort changes and socioeconomic impacts from OSW site development.

Methods: The primary methods for this study would be modeled after Kirkpatrick et al. (2017), although it is expected that some analyses would differ, as certain components of that study were exploratory and improved statistical methods may be warranted for the proposed study. Methods would include exposure and impact analyses. Exposure analysis is a quantitative assessment that would identify the likelihood of individuals and groups of being affected by OSW development. Impact analysis would estimate the magnitude and gain/loss due to exposure. It is anticipated, based on availability and quality of data, that impacts to commercial fisheries and their shoreside dependents would be analyzed quantitatively while impacts to recreational fisheries and their shoreside dependents would be analyzed qualitatively.

Specific Research Question(s): How will offshore wind development in the Gulf of Maine impact commercial and recreational fishing industries?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Kirkpatrick AJ, Benjamin S, DePiper GS, Murphy T, Steinback S, Demarest C. 2017. Socioeconomic impact of Outer Continental Shelf wind energy development on fisheries in the U.S. Atlantic. Volume I—report narrative. Sterling (VA): U.S Department of the Interior, Bureau of Ocean Energy Management. 150 p. Report No.: OCS Study BOEM 2017-012.

Kirkpatrick AJ, Benjamin S, DePiper GS, Murphy T, Steinback S, Demarest C. 2017. Socioeconomic impact of Outer Continental Shelf wind energy development on fisheries in the U.S. Atlantic. Volume II—appendices. Sterling (VA): U.S Department of the Interior, Bureau of Ocean Energy Management. 191 p. Report No.: OCS Study BOEM 2017-012.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

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 2023–2025
Final Report Due	TBD
Date Revised	February 18, 2022
PICOC Summary	
Problem	In 2013, BOEM published co-funded research 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 2013 study to support impact assessment conclusions on impact levels. However, the current generation of wind turbines proposed in the COPs are now two to three times taller that those studied in the 2013 report. Visual impact reports continue to reference antiquated findings.
Intervention	Supplement the 2013 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 2013 evaluation protocol and compare the new findings to those of the 2013 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 include U.S. 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): There is a need to update the 2013 study titled "Offshore Wind Turbine Visibility and Visual Impact Threshold Distances" (Sullivan 2013) funded by BOEM in 2011. The study has been widely cited for in visual impact assessments (VIA) of offshore wind energy facilities in BOEM COPs. The VIAs use the 2013 study as a basis for establishing potentially affected areas for impact assessments and predicting visual impacts of proposed projects. The 2013 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 2013). The height of wind turbines proposed in recently submitted COPs range from approximately 853 feet to 1,042 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 and 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 2013 and 2023–2025 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 large-scale 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 1,047 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 2023–2025 studies.

Methods: To maintain consistency, the new study would use the same basic methods from the 2013 study to evaluate visibility of the latest in wind turbine technology and recently built projects. The 2013 study was conducted by three individuals that included a landscape architect, geospatial visualization developer, and archaeologist. Data recorded included descriptions of the location of the viewpoint; weather, general lighting, and visibility conditions; and the backdrop content and color. The solar azimuth and elevation, the layout and height of the visible turbines, the shading and/or sunlight on the turbines, and the overall lighting angle were documented. Aviation and marine navigation marking/lighting was also included, as well as blade movement and other transitory effects. Additional data collected for nighttime observations included the number, type, and cycle of the aviation and/or marine lighting. For each observation, single-frame photographs and panoramic sequences were taken at a variety of focal lengths; at many locations, short videos also recorded the motion of the turning blades. Visibility assessments evaluated the effects of distance and atmospheric variables on the visibility and visual contrast levels of offshore wind facilities on a numeric rating a scale of 1 to 6. The ratings were conducted through naked-eye observations of the facilities in the field.

The method for the new study would require minor refinements to address unique circumstances not present during the 2013 study. For instance, the viewing locations may be 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, for instance 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, or substantially changed)?
3. How does the elevation of the onshore viewer factor into in long range visibility?
4. Can a multiplier be extracted from a comparison of the two studies to calibrate the updated findings as new and taller generations of wind turbines are manufactured?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Dominion Energy. 2018. Amendment to the Coastal Virginia Wind Offshore Wind Project, May 21, 2018. Glen Allen (VA): Dominion Energy Services, Inc. 170 p. 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. 101(4):907–917. 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. http://dx.doi.org/10.1017/S1466046612000464

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Risk Assessment to Model Encounter Rates Between Large Whales and Vessel Traffic from Offshore Wind Energy – PHASE II
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	February 8, 2022
PICOC Summary	
Problem	The National Oceanic and Atmospheric Administration (NOAA) has identified increases in vessel traffic as a significant threat to the recovery of North Atlantic right whales and other large whales. BOEM must have a rigorous analysis tool to evaluate risk to whales from offshore vessel activity that supports wind development. The Phase I calculator needs further development to conduct updates and expand the geographic utility of the calculator.
Intervention	Using the existing calculator (version 1, AT 19-01), conduct peer review and expert elicitation on calculator improvements, interpretation of calculator results, and conduct trainings on calculator use to targeted user groups.
Comparison	The risk from vessels supporting offshore wind will be put into context of increases in project-specific vessel traffic increases, as well as comparison to overall vessel traffic.
Outcome	Phase II will result in an improved calculator based on expert review and elicitation, and train industry, contractors, National Environmental Policy Act (NEPA) practitioners, NOAA, and BOEM personnel on its use to support consistent application of scientifically rigorous results.
Context	National

BOEM Information Need(s): The approval of offshore wind projects involves an assessment of the environmental risks, including any potential impacts to wildlife. BOEM prepares environmental impact analyses (Environmental Impact Statements, Environmental Assessments, and Biological Assessments) for renewable energy projects throughout the U.S. Atlantic Outer Continental Shelf (OCS). Improved assessment tools would support these analyses to assess project-level, regional, and cumulative impact analyses for Atlantic renewable energy activities.

Background: The effects of vessel operations on large whales and sea turtles has been identified as an important impact on the conservation and recovery of these species. Vessel strike is an identified source of injury and mortality affecting population of large whales and sea turtles. The reported number of annual vessels strikes with whales and sea turtles in the U.S. Atlantic is believed to represent a small percentage of the actual lethal and non-lethal strikes that may be occurring. BOEM funded development of version 1 of the calculator (AT 19-01) (Barkaszi et al. 2021) to primarily assess the risk of vessel interactions between wind energy areas on the Atlantic OCS with protected species of marine mammals

and sea turtles. Calculator updates, expansion of the calculator to meet BOEM needs nationally, increased capabilities to translate the calculator outputs for use in environmental assessments are the primary objectives of Phase II of the calculator development. to improved assessment tools are needed to better evaluate the spatial and temporal risks from these vessel operations. Phase II will include additional development to assess the influence of both vessel and animal aversions related to vessel strikes. Additionally, the model would be expanded to include emerging wind development areas (WDAs) outside of the Atlantic OCS, such as the Gulf of Mexico, U.S. west coast, and Hawaii. Results of continued development will be able to produce a comprehensive and robust examination of the potential impact to the marine environment in the form of an industry-standard vessel strike risk assessment modelling tool. Encounter rates between vessels and protected species may depend on a number of species-specific parameters, as well as factors including the location of ports, transit areas, the size of vessels, vessel numbers, geographic region, time of year, etc. There is a high level of industry interest in a model that can provide a risk assessment tool for vessel risks that uses appropriately applied animal and vessel aversion. Phase II (this study) will conduct a comprehensive analysis of vessel operations and develop the necessary improvements and training materials to train users that would allow BOEM and stakeholders to adequately evaluate the relative risks of OCS vessel operations.

New density estimates planned to be published by Duke University, regional densities for other species, and the BOEM-identified need of transforming the probabilities of encounters into a risk framework, and an essential need to train user groups in the operation of the calculator is required. Calculator improvement through expert elicitation and review or via meetings or a workshop will be required. Coordination with NEPA practitioners, federal endangered species biologists, and developers will also be required to identify training needs under Phase II of the calculator development.

Objectives: The objective of this study is to improve the calculations, interpretation of results, and assessment of risk to protected species from vessel strikes related to offshore wind development by 1) providing a tool for a more robust analysis of aversion behaviors of large whale and sea turtle species relative to different classes of vessels traveling at different speeds; 2) conducting a literature compilation to inform model inputs; 3) convening workshops with subject matter experts to validate model inputs; and 4) incorporation of new WDAs and OCS areas along the U.S. east and west coasts, Gulf of Mexico, and Hawaii, and 5) produce improved outputs and expanded ARC GIS-based calculator with the ability to customize user-defined scenarios, and a risk assessment framework to translate calculator outputs for use in environmental assessments.

Methods: This project will include a literature compilation, expert elicitation through meetings and/or workshops, and a desktop study to improve and expand the capabilities of the Phase I calculator. risk assessment associated with vessel operations in the offshore renewable energy in the Atlantic, focusing on existing and potential future development areas of both leased and unleased wind energy areas. The study will be conducted in five stages:

1. Conduct a literature compilation of marine mammal and sea turtle density and behavioral information.
2. Conduct an elicitation of subject matter experts through meetings and/or a workshop to review the available information and identify species-specific or group-specific calculator parameters.
3. Identify the needs of users including BOEM, NOAA, the offshore wind industry, and environmental assessment experts. This needs assessment will also include the development of a risk assessment framework based on the probabilities produced by the calculator. Calculator

outputs will be refined as needed, based on this assessment.

4. Conduct the calculator improvements.
5. Develop training materials and conduct trainings to targeted user groups.

Specific Research Question(s):

1. How can regional sea turtle and marine mammal density estimates be incorporated into the current calculator?
2. How can new Duke density estimates at the 5 km^2 resolution be incorporated into the calculator with other estimates, such as sea turtles or other areas, that may be at a lower spatial resolution?
3. How can the vessel risk calculator be improved through expert elicitation to better address behavioral inputs and scientific and management concerns surrounding vessel strikes?
4. How can the probability of encounter risk be translated into a scale of relative risk to protected species for analysis of risk?
5. How can training best prepare and meet the needs of calculator users (NEPA contractors, NOAA, ENGOs, developers, and BOEM personnel)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Barkaszi MJ, Fonseca M, Foster T, Malhotra A, Olsen K. 2021. Risk assessment to model encounter rates between large whales and vessel traffic from offshore wind energy on the Atlantic OCS. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. Report No.: OCS Study BOEM 2021-034.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Seasonal Residency and Movement of Highly Migratory Sea Turtles in the New York Bight Wind Energy Areas
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov), Greg Fulling (gregory.fulling@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025 (with option to continue for additional years)
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	
Problem	Sea turtles are common in the New York Bight, yet seasonal movement and residency patterns of individuals in wind energy areas are not well understood.
Intervention	Implement a rigorous tagging program of loggerhead, green, and Kemp's ridley sea turtles and deployment of sonic receivers in the New York Bight wind energy areas
Comparison	Assess movement and residency patterns for multiple species, different geographic areas of wind development, and compare data before and after wind farm construction
Outcome	Determine the magnitude and extent of beneficial or adverse impacts wind farm construction (e.g., noise) and operation (e.g., the reef effect) may have on sea turtles to support NEPA analyses and ESA consultations
Context	North- and Mid-Atlantic Wind Energy Areas

BOEM Information Need(s): Offshore wind is rapidly developing in the Atlantic and construction and operation levels will quickly ramp up. BOEM needs to understand the pre-construction baseline conditions and monitor any resulting ecosystem changes that construction and operation of offshore wind farms may have on the marine environment, particularly on species of concern. 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. There is a need to better understand sea turtle movement, habitat use, and seasonal residency in offshore wind energy areas. For example, it is believed Kemp's ridley use many of the areas proposed for offshore wind, but the species is often not detected during aerial digital surveys due to their small size. For all sea turtle species, the low availability of sea turtles to be resighted results in an incomplete ecological story of sea turtle movement and seasonal residency in wind energy areas. Consistent and long-term data collection from a rigorous tagging effort would provide vital information to BOEM's renewable energy and marine minerals 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 movement of large marine vertebrates (Baker et al. 2014; Barco and Lockhart 2017). 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. 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. The primary goal is to establish a large "sonic net" and tag sea turtles to capture a wide range of movement of individuals throughout the North and Mid-Atlantic wind energy areas. 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. 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 increase the understanding of sea turtle usage of offshore wind energy areas by strategically deploying moored sonic receivers in targeted wind energy areas and tagging large numbers of sea turtles that move throughout the Atlantic at different times of year. Coordination with other partners in the Animal Telemetry Network and RWSC can leverage existing and planned work with receivers deployed for other species. 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. The lifetime of the receiver and tags may continue past the funding period and options for additional study may be provided contingent upon available funding.

Methods: Conduct dedicated vessel trips to tag turtles, coordinate with existing studies to attach sonic tags on sea turtles during other research efforts, tag turtles on nesting beaches, and tag turtles released from stranding networks. Strategically deploy moored sonic receivers and/or attach receivers to existing moorings in wind energy areas in the New York Bight (https://www.boem.gov/renewable-energy/state-activities/new-york-bight) would maximize detections of sea turtle movements in targeted areas. Focus areas are Leases OCS-A 0538, 0539, 0532, and 0541. Coordination with Animal Telemetry Network partners, the RWSC, and available funding may permit additional data collection through additional tag deployments and utilization of existing receivers to collect additional data on turtle movements in other wind energy areas. Experimental investigations into tag attachment methods and locations to improve the duration of transmitting tags that may be currently limited by biofouling or tag detachment will be conducted to improve the duration of data received from tagged turtles. Some studies have shown that tags can be detached during mating and location of attached tags can be important to their longevity (Hamelin and James 2018).

Specific Research Question(s):

1. What are sea turtle residency and movement patterns in wind energy areas before construction begins? What months do sea turtles appear in different wind energy areas?
2. How long do sea turtles remain in wind energy areas?
3. How can the longevity of tag attachment be improved?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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. Norfolk (VA): US Fleet Forces Command, Naval Facilities Engineering Command Atlantic.

Hamelin KM, James MC. 2018. Evaluating outcomes of long-term satellite tag attachment on leatherback sea turtles. Animal Biotelemetry. 6(1):18.

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.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Support for Regional Wildlife Science Collaborative Ocean Portal Products and Services
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	
Problem	Regional wildlife science collaboration does not have the necessary planning, collaboration, and visualization tools to cooperate on past, current, and future studies occurring in offshore wind energy areas.
Intervention	Provide support to the Regional Wildlife Science Collaborative (RWSC) to develop products and maintenance of products in the Ocean Data Portals
Comparison	The portal products will be compared to RWSC compilations of Atlantic research efforts and planned research efforts developed through experts on the RWSC taxa subcommittees.
Outcome	The study will improve regional wildlife science collaboration to better address regional ocean science goals.
Context	North- and Mid-Atlantic Wind Energy Areas

BOEM Information Need(s): BOEM needs to better coordinate science priorities and research objectives to better understand stakeholder concerns and coordinate with researchers to understand the potential behavioral, physical, and physiological impacts to marine protected species from offshore wind construction. An effective means to accomplish these goals is to leverage the existing structure of the RWSC and its coordination with subject matter subcommittees to identify priorities and coordination with the ocean data portals to create the necessary products and tools to facilitate better regional science. This information in turn will aid in environmental impact analyses for National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), and Marine Mammal Protection Act (MMPA) compliance.

Background: In July 2021, the Northeast Regional Ocean Council, the Mid-Atlantic Regional Council on the Ocean, and the Coastal States Stewardship Foundation were selected to host the newly establishment RWSC. The RWSC governance structure is dependent upon financial contributions from participating sectors for continued support of costs and needs of the RWSC (https://neoceanplanning.org/wp-content/uploads/2021/09/Final-RWSE-Governance-Structure_July-2021.pdf). There are many overlapping goals BOEM shares with the RWSC that can provide support to develop products and tools to assist BOEM in its mission to manage development of U.S. Outer Continental Shelf (OCS) energy and mineral resources in an environmentally and economically responsible way. BOEM has already begun to work collaboratively with NOAA, States, and the RWSC to

create an ocean data portal mapping tool to facilitate planning and research discussions with stakeholders (https://www.northeastoceandata.org/CC43tZuT) and has held workshops in support of RWSC efforts (Field et al. 2021a; Field et al. 2021b). The initial feedback on this early version of the passive acoustic monitoring tool was extremely positive and has assisted States and BOEM coordinate better to determine PAM deployment locations. Stakeholders has indicated that such tools are direly needed to facilitate better science coordination for offshore wind. Clearly, such efforts would not only benefit BOEM, but also provide valuable service to a multitude of other stakeholders involved with offshore wind development. Areas of coordination needed include oceanic data collection, passive acoustic monitoring, tagging efforts of birds, turtles, and marine mammals, aerial and shipboard surveys completed or planned to occur in the Atlantic. Preliminary discussions between BOEM and stakeholders has also explored the types of data products that would be most useful in providing information for analyses under NEPA, ESA, MBTA, MMPA, and for construction and operations plan development by industry. A complementary effort to provide support for the development of research priorities for taxa groups including the development of portal products and analytical tools would ensure stakeholder outreach and communication occurs in the development of such plans.

Objectives: Coordinate with stakeholders to create ocean data portal products and tools to support regional science collaboration and availability of ocean data products.

Methods: The RWSC will convene subject matter experts from different disciplines to develop research-priorities. Existing and planned research will be compiled. Completed research data will be assessed for the development of ocean data portal products. Priority work products and services through the ocean data portals will be completed. Additional work may be identified and developed subject to the availability of future funding. Additionally, planning tools for future research will be developed and made available on the ocean data portals. Products and serves will include tools for passive acoustic monitoring, aerial and vessel-based surveys, tagging studies and tracking data, and oceanic data collection. The information needs, and products created will be developed with input from BOEM and the RWSC taxa subcommittees and may include the following:

- Comprehensive data base of all ongoing and planned wildlife research in the Atlantic
- Visualization/information system for offshore wind & environmental research and data collection
- Developing interactive web tools to visualizing ongoing research activities that may include PAM, tagging, timing and footprint of wind farm construction, VENMCO receiver network, and vessel and aerial survey transects
- Focal species of tagging efforts and the location of tagging from BOEM ESP projects and OCS operators
- Developing interactive mapping tools showing the locations of the research with popups that display information on who, what, where, why the research or data collection activity is occurring
- Hosting spatial data and make available as web services leveraging existing platforms whenever possible
- Hosting meetings and workshops as required

Specific Research Question(s):

1. What are the research priorities and strategies for different geographically located wind energy areas (e.g., Maine, New England, New York Bight, and Mid-Atlantic)?
2. How will the development of research planning tools benefit the offshore wind research community?
3. Coordinating with the RWSC subcommittees and BOEM, what ocean data portal products and tools will facilitate improved research coordination, data analysis, and data products?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites:

Northeast Ocean Data Portal Passive Acosutic Monitoring Planning Tool: https://www.northeastoceandata.org/NkVAqcoC

Regional Wildlife Science Collaborative: https://neoceanplanning.org/rwse/

References:

Field P, Baker K, Van Parijs SM, Staaterman E, Cody MB. 2021a. Improving monitoring, data consistency, archiving, and access for improved regional integration of renewable energy Science. Workshop summary on passive acoustic monitoring and marine mammals - June 2-3, 2021. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management.

Field P, Bigger D, Loring P, Cody MB, Baker K, Shumchenia E. 2021b. Improving monitoring, data consistency, archiving, and access for improved regional integration of renewable energy science: workshop on satellite and GPS tracking of avian species - June 29-30, 2021. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Update of Port Modification Study
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Mary Boatman (mary.boatman@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 21, 2022
PICOC Summary	-
Problem	Increased potential for offshore wind development requires a reassessment of port impacts.
Intervention	Update the existing study of port impacts from offshore wind development
Comparison	The study will evaluate changes in the port capacity and planned updates to ports with the previous study.
Outcome	The product will be a more up to date evaluation of port modifications anticipated along the Atlantic Coast.
Context	Atlantic Coast from Maine to Florida

BOEM Information Need(s): As the offshore wind energy industry develops, it will be important for Federal, state, and local stakeholders to understand the environmental and socioeconomic consequences of such development, including the impacts from port expansion and changes in port operations. BOEM will need to evaluate the potential environmental and socioeconomic impacts of port expansions as connected actions in project specific and programmatic environmental impact statements.

Background: Facilities to support activities related to offshore wind energy development will more often than not be located at existing ports near the areas leased. Development activities will lead to port expansion to accommodate the size of construction vessels, space required for staging and maneuvering turbine components, and cranes capable of handling the weight of the nacelles and other components. The potential expansion and changes in operations resulting will produce a variety of environmental effects (e.g., air, soil and water quality) and socioeconomic effects (land use changes, employment changes, strain on existing infrastructure, conflict with other port uses, increased vessel traffic). BOEM previously evaluated these potential port expansions (ESS Group, Inc. 2016). Since the publication of this report, industry has submitted over ten construction and operations plans that identify potential ports that may be used for construction and operation activities. In addition, some states such as New Jersey have announced the creation of hubs to support the industry. BOEM is assessing these port modifications as connected activities in National Environmental Policy Act assessments and needs this updated report to improve these evaluations.

Objectives: This study will update our understanding of:

- Current port capacity for handling offshore wind facility construction and the necessary modifications required to support this function.
- Environmental and socioeconomic impacts including environmental justice from port modifications and the consequences of alterations to port operations.
- Effectiveness of potential mitigation measures for port modifications impacts based on experience to date.

Methods: The study will update the port characteristics (e.g., distance to likely project locations, size of staging/storage areas, quayside length, access channel depth and width) necessary to support offshore energy facility construction based on the past report (ESS Group, Inc. 2016). At this point, 11 construction and operations plans from developers are available to determine the ports being considered. Several states including New Jersey and Virginia have proposed dedicated ports or port modifications to support offshore wind. Additional research will be conducted to determine any co-benefits or potential conflicts related to modifications and operational changes as some ports prepare for larger post-Panamax ships. Additional discussions. potentially through focus groups, will be held with port authorities, wind energy developers, and turbine manufacturers to update assumptions and to collect additional insights on desired port characteristics, potential environmental and socioeconomic impacts, and mitigations for these impacts.

Information from the construction and operations plans currently in review will be used to identify and prioritize the ports that are proposed for use. BOEM will select 20 of these ports for a detailed assessment. The more detailed port profiles will discuss other port users, financial structure and health, any environmental justice concerns and sociocultural contexts, along with the likely environmental and socioeconomic impacts that may occur if the port becomes a wind energy hub.

A comprehensive final report will be prepared combining the information collected from the literature search, stakeholder discussions, port rankings, port profiles, and recommendations for further research.

Specific Research Question(s): How will ports be modified to support offshore wind development, and what will the environmental impacts be?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

ESS Group, Inc. 2016. The identification of port modifications and the environmental and socioeconomic consequences. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 99 p. Report No.: OCS Study BOEM 2016-034.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Cumulative Impacts Analyses of Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Melissa Batum (Melissa.Batum@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	April 14, 2022
PICOC Summary	
Problem	BOEM has new authority, under the 2021 Bipartisan Infrastructure Law, to oversee carbon dioxide (CO_2) capture, utilization, transportation, and sub-seabed sequestration (storage) on the OCS. Information on potential impacts of these activities on the human and marine environment is needed to inform leasing and management decisions.
Intervention	• Determine the most likely cumulative impacts scenario for the buildout of CO_2 CCUTS activities for each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska) • Perform a literature review and synthesis of the cumulative impacts of CCUTS activities on the human and marine environment over the lifetime of the projected cumulative impacts scenario for each OCS Region; include considerations on Region-specific impacts • Use modeling techniques, as necessary, to determine cumulative effects across the scenario of potential impacts to specific environmental resources • Identify information needs that will guide future environmental studies
Comparison	BOEM needs more information about the potential cumulative environmental impacts of CCUTS activities for each OCS Region, in particular how CO_2 leaking may affect environmental resources.
Outcome	The cumulative analysis will aid BOEM's ongoing rulemaking efforts, program development, and future operational needs (National Environmental Policy Act [NEPA] analyses, consultations, etc.). These cumulative analyses can be incorporated (directly or by reference) into programmatic and site-specific NEPA analyses at the national and regional levels. In addition, they may be referenced for rulemaking analyses (cost-benefit, etc.) and may inform strategic planning for leasing and program development. Identified knowledge gaps will provide direction for future studies to include field and/or laboratory analyses.
Context	Negative emissions technologies such as CCUTS will be an important part of the United States' efforts to mitigate the climate change crisis and reach its net-zero emissions goal by 2050. The focus of this study is at the national level (all OCS Regions, including Atlantic, GOM, Pacific, Alaska).

BOEM Information Need(s): Carbon dioxide (CO_2) capture and removal is an essential part of current climate mitigation models (IPCC 2005, NAS 2019, IEA 2021) and thus a strong component of the United

States' goal to mitigate the climate crisis and reach net-zero carbon emissions by 2050. Congress and the current Administration have advanced on numerous fronts to promote the capture, utilization, transportation, and storage (CCUTS) of CO_2 on the OCS. Namely, BOEM was given new authority, under the Bipartisan Infrastructure Law, which amended the Outer Continental Shelf Lands Act (OCSLA), to authorize and manage the capture, utilization, and storage of CO_2 in the sub-seabed of the OCS. To support this new authority, information on environmental impacts of these activities is needed to inform rulemaking and leasing and management decisions.

In 2021, the Council on Environmental Quality (CEQ) delivered the *Report to Congress on Carbon Capture, Utilization, and Sequestration* (CEQ 2021). In addition, CEQ recently issued a memorandum in the Federal Register to relevant Federal agencies to provide guidance on the facilitation of reviews associated with the deployment of CO_2 capture, utilization, and storage (CCUS) projects and CO_2 pipelines, and to support the efficient, orderly, and responsible deployment of CCUS projects and CO_2 pipelines. "To facilitate the deployment of CCUS in the United States in line with the Administration's climate and economic goals, agencies should consider developing programmatic environmental reviews, such as tiered documents or programmatic environmental impact statements(PEISs) under NEPA, or programmatic biological opinions under the ESA [Endangered Species Act], where such analyses can facilitate more efficient and effective environmental reviews of multiple projects while maintaining strong community engagement" (87 FR 8808).

To support BOEM's new authority and rulemaking, inform leasing and management decisions, facilitate reviews associated with the deployment of CCUTS projects, environmental studies and analyses will be needed to comply with NEPA and other environmental statutes. Under NEPA, cumulative impacts analyses are required to determine potential impacts on the human and marine environment over the lifetime of the projected cumulative impacts scenario, developed in this project, for each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska). These cumulative analyses can be incorporated (directly or by reference) into programmatic and site-specific NEPA analyses at the national and regional levels. In addition, the cumulative analyses results may be referenced for rulemaking analyses (e.g., cost-benefit analysis).

Background: The INVEST in America Act (i.e., Bipartisan Infrastructure Law) of 2021 amended OCSLA's leasing provisions to authorize the Department of Interior (DOI) to grant leases, easements, and rights-of-way on the OCS for the purpose of carbon sequestration. (See 43 U.S.C. § 1337(p)(1)), granting BOEM management authority over carbon sequestration in subsea reservoirs on the OCS. The Act also specified that DOI develop rules within one year of enactment. Rulemaking efforts are currently under way to create the regulations for CCUTS leasing and associated reporting/information requirements. The BOEM Director has made this a high priority for BOEM.

CO_2 is the most commonly produced, atmospheric greenhouse gas. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global warming (climate change) impacts created by the greenhouse gas effect. BOEM's authority specifically includes geologic carbon sequestration in the sub-seabed. Geologic carbon sequestration on the OCS is the process of storing CO_2 in sub-seabed geologic formations. BOEM must gain understanding of potential cumulative impacts of CCUTS projects; the results of this research will inform strategic planning for leasing, leasing stipulations, program development, and environmental reviews and mitigations.

Objectives: The goal of this research is to produce viable cumulative impacts analyses that can be used in programmatic and regional level environmental review documents that will assess the potential impacts of CCUTS projects on the marine and human environment in each OCS Region. These cumulative impact analyses will also aid the current rulemaking effort, strategic planning, and program development. This effort will also guide development of future environmental studies that would include field and/or laboratory analyses in the priority areas identified in this report.

Specific objectives to achieve this goal include:

- Develop cumulative scenarios for the full buildout of potential carbon capture and storage projects for each OCS Region that include considerations of Region-specific CO_2 storage capacity, other uses of the OCS, environmental concerns, etc.
- Run cumulative analyses (may involve modeling for certain resources).
- Determine/Conclude potential cumulative impacts to the human and marine environment based on the cumulative scenarios and analyses.
- Determine and develop measures to mitigate potential impacts discovered during this research.

Methods: The study will compile existing knowledge on CCUTS activities impacts on the human and marine environment, via literature review and synthesis, over the lifetime of the projected cumulative impacts scenario, developed in this project, for each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska). Modeling will also be conducted, as needed, to determine cumulative effects across the scenario of potential impacts to specific environmental resources. Knowledge gaps that are relevant to the BOEM environmental program will be identified from the literature review and modeling analyses. Future BOEM studies to address these gaps may include field, laboratory, or modeling analyses.

Specific Research Question(s):

1. What is the most likely cumulative impacts scenario for the buildout of potential CCUTS projects in each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska)?
2. What information and data are currently available on the potential environmental impacts from offshore CCUTS activities on the human and marine environment?
3. What information and data are currently available regarding potential environmental impacts from CCUTS activities in the onshore environment that can be translated to the offshore environment?
4. What are the potential cumulative effects of the environmental impacts caused by CCUTS activities when considered as part of all Federal and non-Federal activities?
5. What are measures that may mitigate the effects of cumulative impacts?
6. What are the gaps in understanding potential environmental impacts from CCUTS activities on the human and marine environment?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

[CEQ] Council on Environmental Quality. 2021. Report to Congress on carbon capture, utilization, and sequestration. Delivered to the Committee on Environment and Public Works of the Senate and the Committee on Energy and Commerce, the Committee on Natural Resources, and the Committee on Transportation and Infrastructure of the House of Representatives, as directed in Section 102 of Division S of the Consolidated Appropriations Act, 2021. Washington (DC): Council on Environmental Quality. 84 p. https://www.whitehouse.gov/wp-content/uploads/2021/06/CEQ-CCUS-Permitting-Report.pdf.

[IEA] International Energy Agency. 2021. Net zero by 2050: a roadmap for the global energy sector. Paris (FR): International Energy Agency. https://www.iea.org/reports/net-zero-by-2050.

[IPCC] Intergovernmental Panel on Climate Change. 2005. Carbon dioxide capture and storage. Cambridge (UK): Cambridge University Press. 431 p. https://ipcc.ch/report/carbon-dioxide-capture-and-storage/

[NAS] National Academies of Sciences, Engineering, and Medicine. 2019. Negative emissions technologies and reliable sequestration: a research agenda. Washington (DC): The National Academies Press. https://doi.org/10.17226/25259.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Environmental Monitoring Study for Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Melissa Batum (Melissa.Batum@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 14, 2022
PICOC Summary	
Problem	BOEM has new authority to oversee carbon dioxide (CO_2) capture, utilization, transportation, and sub-seabed sequestration (storage) on the OCS. Information on potential impacts of these activities on the human and marine environment is needed to inform leasing and management decisions.
Intervention	Through a literature review, the study will determine the human and environmental resources that may be impacted; the monitoring that will be required during each phase of a CCUTS project, pre-injection, during injection, and post-injection; and the most effective monitoring methods and protocols for the CO_2 plume and pressure front as well as each resource from CO_2 CCUTS activities.
Comparison	BOEM needs more information about the potential environmental impacts of CCUTS activities for each OCS Region, in particular, how a CO_2 plume migrates and potential leaking may affect environmental resources during each phase of a CCUTS project, pre-injection, during injection, and post-injection.
Outcome	The analysis will aid BOEM's ongoing rulemaking efforts, program development, and future operational needs (National Environmental Policy Act [NEPA] analyses, lease planning, lease stipulations, consultations, plan approvals, etc.). Study results will also provide direction for future studies to include field and/or laboratory analyses.
Context	All OCS Regions (Atlantic, GOM, Pacific, Alaska)

BOEM Information Need(s): Carbon dioxide (CO_2) capture and removal is an essential part of current climate mitigation models (IPCC 2005, NAS 2019, IEA 2021) and thus a strong component of the United States' goal to mitigate the climate crisis and reach net-zero carbon emissions by 2050. Congress and the current Administration have advanced on numerous fronts to promote the capture, utilization, transportation, and storage (CCUTS) of CO_2 on the OCS. Namely, BOEM was given new authority, under the 2021 Bipartisan Infrastructure Law, which amended the Outer Continental Shelf Lands Act leasing provisions to authorize the Department of Interior (DOI) to grant leases, easements, and rights-of-way on the OCS for the purpose of CO_2 sequestration on the OCS (See 43 U.S.C. § 1337(p)(1)), thus granting BOEM management authority over CO_2 sequestration in subsea reservoirs on the OCS. The Act also specified that DOI develop rules within one year of its enactment. Rulemaking efforts are currently under way to create the regulations for CCUTS leasing and associated reporting/information

requirements. To support this new authority, information on environmental impacts of these activities is needed to inform rulemaking, program development, and leasing and management decisions.

The Council on Environmental Quality recently issued a memorandum in the Federal Register to relevant Federal agencies to provide guidance on the facilitation of reviews associated with the deployment of CO_2 capture, utilization, and storage (CCUS) projects and CO_2 pipelines, and to support their efficient, orderly, and responsible deployment. "To facilitate the deployment of CCUS in the United States, in line with the Administration's climate and economic goals, agencies should consider developing programmatic environmental reviews, such as tiered documents or programmatic environmental impact statements (PEISs) under NEPA, or programmatic biological opinions under the ESA [Endangered Species Act], where such analyses can facilitate more efficient and effective environmental reviews of multiple projects while maintaining strong community engagement" (87 FR 8808).

To support BOEM's new authority and rulemaking, inform leasing and management decisions, facilitate reviews associated with the deployment of CCUTS projects, environmental studies and analyses will be needed to comply with the NEPA and other environmental statutes. Under NEPA, potential impacts to the human and marine environment over the lifetime of the project will need to be assessed for each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska). These analyses can be incorporated (directly or by reference) into programmatic and site-specific NEPA analyses at the national and regional levels. In addition, the results may be used as lease stipulations and/or terms and conditions of plan approvals. The results may also be referenced for rulemaking requirements and program development. Identified knowledge gaps will provide direction for future studies to include field and/or laboratory analyses.

Background: CO_2 is the most commonly produced, atmospheric greenhouse gas. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global warming (climate change) impacts created by the greenhouse gas effect. BOEM's authority specifically includes geologic carbon sequestration in the sub-seabed. Geologic carbon sequestration on the OCS is the process of storing CO_2 in sub-seabed geologic formations. The CO_2 is pressurized until it becomes a supercritical fluid, and then it is injected into porous rock formations in geologic basins forming a subsurface plume of CO_2 within the formation. Monitoring and tracking the CO_2 plume and its zone of elevated pressure that surrounds it is paramount to proving the success of permanent and safe storage of CO_2. Monitoring the CO_2 plume and pressure front is also paramount in prioritizing the environmental resources that will require monitoring. In order to develop effective and efficient regulations, environmental reviews, and a new program for CCUTS, BOEM must be informed of the most effective monitoring methods and protocols for tracking the migration of the CO_2 plume and pressure front during the injection and post-injection phases of a CCUTS project. BOEM also must be informed of the most effective monitoring methods and protocols for potentially impacted human and environmental resources during the pre-injection, injection and post-injection phases for CCUTS projects in each OCS Region. This study will help meet these paramount information needs.

Objectives: The objectives of this research include:

- Evaluate potential impacts to the human and marine and coastal environments and identify potentially impacts resources.
- Based in the resources that may be impacted, determine the most effective monitoring methods and protocols that may be implemented during each phase of a CCUTS project, pre-injection, during injection, and post-injection.

- Determine the best monitoring methods and protocols for tracking the CO_2 plume and pressure front during and after injection operations.
- Research and synthesize information on potentially impacted resources and best monitoring methods and protocols for each project phase in a manner that may be used in the current rulemaking, new program development, and programmatic and regional level environmental analyses that will assess the potential impacts of CCUTS activities on the marine and human environment.
- This effort will also guide development of future environmental studies that would include field and/or laboratory analyses in the priority areas identified in this report.

Methods: The study will compile existing knowledge on CCUTS impacts on the human and marine environment, via literature review and synthesis, over the lifetime of individual projects as well as the potential cumulative scenario of projects in each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska). The study will identify and determine the most effective monitoring methods and protocols for tracking the migration of the CO_2 plume and pressure front as well as each potentially impacted resource in each Region. Region specific impacts and monitoring will be evaluated. Relevant onshore technologies that are translatable to the offshore will also be included. For example, the study may look to active and planned offshore projects in Norway and Australia to gather existing information.

Information needs that are relevant to the BOEM environmental program will also be identified from the literature review. Future BOEM studies to address these gaps may include field, laboratory, or modeling analyses.

Specific Research Question(s):

1. What information and data are currently available on the potential environmental impacts from offshore CCUTS activities on the human and marine environment?
2. What are the most effective monitoring methods and protocols for tracking the migration of the CO_2 plume and pressure front during the injection and post-injection phases of a CCUTS project?
3. What are the most effective monitoring methods and protocols for each potentially impacted human and environmental resources pre-injection and during injection and post-injection for CCUTS projects in each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska)?
4. What information and data are currently available regarding potential environmental impacts and associated monitoring methods from CCUTS activities in the onshore environment that can be translated to the offshore environment?
5. What are the gaps in understanding potential environmental impacts from CCUTS activities on the human and marine environment?
6. What are the gaps in understanding that may affect the efficacy of monitoring protocols and methods for the CO_2 plume and pressure front as well as the environmental resources of the OCS?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

[IEA] International Energy Agency. 2021. Net zero by 2050: a roadmap for the global energy sector. Paris (FR): International Energy Agency. https://www.iea.org/reports/net-zero-by-2050.

[IPCC] Intergovernmental Panel on Climate Change. 2005. Carbon dioxide capture and storage. Cambridge (UK): Cambridge University Press. 431 p. https://ipcc.ch/report/carbon-dioxide-capture-and-storage/

[NAS] National Academies of Sciences, Engineering, and Medicine. 2019. Negative emissions technologies and reliable sequestration: a research agenda. Washington (DC): The National Academies Press. https://doi.org/10.17226/25259.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Fugitive CO_2 Emissions Analyses from Carbon Capture, Utilization, Transportation, and Storage (CCUTS) Activities on the Outer Continental Shelf (OCS)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Melissa Batum (Melissa.Batum@boem.gov), Eric Wolvovsky (Eric.Wolvovsky@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 14, 2022
PICOC Summary	
Problem	BOEM has new authority, under the 2021 Bipartisan Infrastructure Law, to oversee carbon dioxide (CO_2) capture, utilization, and sub-seabed sequestration (storage) on the OCS. Information on potential impacts of these activities on the human and marine environment is needed to inform leasing and management decisions.
Intervention	Determine the most probable fugitive CO_2 emissions scenario from CCUTS activities for each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska). Include potential region-specific threats for fugitive CO_2 emissions. Perform a literature review and synthesis of potential fugitive CO_2 emissions pathways, mechanisms, and volumes from CCUTS activities over the lifetime of the projected buildout scenario (cumulative) for each OCS Region. Identify information needs that will guide future environmental studies.
Comparison	BOEM needs more information about the potential environmental impacts of CCUTS activities for each OCS Region, in particular, how these activities may serve as climate change mitigation that aims to reduce the concentration of greenhouse gases (GHGs) in the atmosphere.
Outcome	The fugitive CO_2 emissions analyses will aid BOEM's ongoing rulemaking efforts and future operational needs (National Environmental Policy Act [NEPA] analyses, consultations, etc.). These analyses can be incorporated (directly or by reference) into programmatic and site-specific NEPA analyses at the national and regional levels. In addition, they may be referenced for rulemaking analyses (cost-benefit, etc.). Identified information gaps will provide direction for future studies to include field and/or laboratory analyses.
Context	Negative emissions technologies such as CO_2 storage will be an important part of the United States' efforts to mitigate the climate change crisis and reach its net-zero emissions goal by 2050. The focus of this study is at the national level (all OCS Regions, including Atlantic, Gulf of Mexico [GOM], Pacific, Alaska).

BOEM Information Need(s): Carbon dioxide (CO_2) capture and removal is an essential part of current climate mitigation models (IPCC 2005, NAS 2019, IEA 2021) and thus a strong component of the United States' goal to mitigate the climate crisis and reach net-zero carbon emissions by 2050. Congress and the current Administration have advanced on numerous fronts to promote the capture, utilization, and

storage (CCUS) of CO_2 on the OCS. Namely, BOEM was given new authority, under the Bipartisan Infrastructure Law, which amended the Outer Continental Shelf Lands Act (OCSLA), to authorize and manage the capture, utilization, and storage of CO_2 in the sub-seabed of the OCS. To support this new authority, information on environmental impacts of these activities is needed to inform rulemaking and leasing and management decisions.

In addition, Council on Environmental Quality (CEQ) recently issued a memorandum in the Federal Register to relevant Federal agencies to provide guidance on the facilitation of reviews associated with the deployment of CCUS projects and CO_2 pipelines, and to support the efficient, orderly, and responsible deployment of CCUS projects and CO_2 pipelines. "To facilitate the deployment of CCUS in the United States in line with the Administration's climate and economic goals, agencies should consider developing programmatic environmental reviews, such as tiered documents or programmatic environmental impact statements (PEISs) under NEPA, or programmatic biological opinions under the ESA [Endangered Species Act], where such analyses can facilitate more efficient and effective environmental reviews of multiple projects while maintaining strong community engagement" (87 FR 8808).

To support BOEM's new authority and rulemaking, inform leasing and management decisions, facilitate reviews associated with the deployment of CCUS projects, environmental studies and analyses will be needed to comply with the NEPA. Under NEPA, analyses are required to determine potential impacts on the human and marine environment over the lifetime of the projected buildout for each OCS Region (Atlantic, GOM, Pacific, Alaska). These cumulative analyses can be incorporated (directly or by reference) into programmatic and site-specific NEPA analyses at the national and regional levels. In addition, they may be referenced for rulemaking analyses (e.g., cost-benefit analysis).

BOEM's current study "Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico (GOM)" (GM-22-01) is conducting sampling to determine methane leakage volumes from abandoned wells in the GOM to evaluate potential water and air quality impacts. The results of this study can inform the proposed study in this profile by characterizing the integrity of abandoned wells in the GOM and quantifying the rate of methane leakage, which may also correlate to the rate of fugitive CO_2 emissions from abandoned wells.

Background: The INVEST in America Act (i.e., Bipartisan Infrastructure Law) of 2021 amended OCSLA's leasing provisions to authorize the Department of Interior to grant leases, easements, and rights-of-way on the OCS for the purpose of carbon sequestration. (See 43 U.S.C. § 1337(p)(1)), granting BOEM management authority over carbon sequestration in subsea reservoirs on the OCS. Rulemaking efforts are currently under way to create the regulations for CO_2 capture, utilization, transportation, and sequestration (CCUTS) leasing and associated reporting/information requirements.

The CEQ delivered the *Report to Congress on Carbon Capture, Utilization, and Sequestration* (CEQ 2021). CEQ also issued a memorandum in the Federal Register to relevant Federal agencies to provide guidance on the facilitation of reviews associated with the deployment of CCUS projects and CO_2 pipelines, and to support the efficient, orderly, and responsible deployment of CCUS projects and CO_2 pipelines.

Objectives: To produce analyses of potential fugitive CO_2 emissions from CCUTS projects that can be used in programmatic and regional level environmental analyses assessing the potential impacts of these activities on the marine and human environment. These analyses will also aid the current

rulemaking effort. This effort will also guide development of future environmental studies that would include field and/or laboratory analyses in the priority areas identified in this report.

Methods: The study will compile existing knowledge of potential fugitive CO_2 emissions from OCS CCUTS activities via literature review and synthesis, over the lifetime of the projected buildout scenario (cumulative) for each OCS Region (Atlantic, GOM, Pacific, Alaska). Potential fugitive emission sources include wells, riser pipes, geologic formations, pipelines, vessels, etc. Knowledge gaps that are relevant to the BOEM environmental program will be identified from the literature review and modeling analyses. Future BOEM studies to address these information needs may include field, laboratory, or modeling analyses.

Specific Research Question(s):

1. What information and data are currently available regarding potential fugitive CO_2 emissions from CCUTS activities in the offshore environment?
2. What existing information and data are currently available regarding potential fugitive CO_2 emissions from CCUTS activities in the onshore environment that can be translated to the offshore environment?
3. What are all the potential sources of fugitive CO_2 emissions from CCUTS activities on the OCS (for example, wells, riser pipes, geologic formations, pipelines, vessels, etc.)?
4. What are all the potential mechanisms that may cause fugitive CO_2 emissions from CCUTS activities on the OCS (i.e., leakage from wells, geologic formations, pipelines, riser pipes, etc. due to overpressuring, seismic activity, weather events, human error, etc.).
5. What are the most effective monitoring techniques that can be used to measure fugitive emissions from CCUTS activities on the OCS?
6. What is the potential contribution to ocean acidification of underwater CO_2 fugitive emissions from CCUTS activities?
7. What is the most probable fugitive CO_2 emissions scenario (cumulative) from the buildout of CCUTS activities in each OCS Region (Atlantic, GOM, Pacific, Alaska)?
8. What are the gaps in understanding the full scale of fugitive CO_2 emissions from CCUTS activities on the OCS?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

[IEA] International Energy Agency. 2021. Net zero by 2050: a roadmap for the global energy sector. Paris (FR): International Energy Agency. https://www.iea.org/reports/net-zero-by-2050.

[IPCC] Intergovernmental Panel on Climate Change. 2005. Carbon dioxide capture and storage. Cambridge (UK): Cambridge University Press. 431 p. https://ipcc.ch/report/carbon-dioxide-capture-and-storage/

[NAS] National Academies of Sciences, Engineering, and Medicine. 2019. Negative emissions technologies and reliable sequestration: a research agenda. Washington (DC): The National Academies Press. https://doi.org/10.17226/25259.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Mobilization of Chemical Contaminants Associated with Offshore Wind Farms
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Ursula Howson (ursula.howson@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	-
Problem	Offshore wind (OSW) facilities may inadvertently release chemical contaminants into the environment and may remobilize previously deposited contaminants in the sediment.
Intervention	Through field sampling in OSW lease areas, this study will establish a pre-construction baseline for chemical contaminants in sediments and then conduct construction and post-construction monitoring surveys on sediments.
Comparison	The pre-construction study would serve as the baseline to compare with construction and post-construction. Comparison could also be made between sites with historic contamination and presumed pristine sites.
Outcome	To understand the baseline level of contamination in OSW lease areas and resultant contamination or remobilization of contaminants by OSW facilities
Context	Permitted OSW facilities in the New York Bight that have established construction timelines

BOEM Information Need(s): Chemical contaminants could be released from OSW facilities or could be mobilized from the sediment during construction activities. Those contaminants could affect the health and sustainability of marine organisms as well as terrestrial organisms that feed on them (e.g., seabirds). Although remobilization of contaminants in sediments may not be an issue for some OSW facilities that are far offshore, some facilities closer to shore near urban areas (e.g., the New York Bight region) are in locations near where contaminants were dumped offshore or were transported through the ecosystem from leaking onshore sources or may install export cables inshore where contamination could have occurred previously (Gottholm 1993, Mecray et al. 2013).

Background: Installation, operation, and decommissioning of OSW energy facilities can result in the introduction of toxic chemicals that can negatively impact the health and sustainability of marine organisms and seabirds. Cable and foundation installation and dredging associated with OSW energy facilities have the potential to resuspend sediment which may contain contaminants (Latimer et al. 1999, Torres et al. 2009), and as many contaminants adhere to fine grain organic material which would likely remain in suspension longer than coarse-grained inorganic material such as sand, cable installation in soft sediments such as silt may pose a higher risk of remobilization. Additionally, scour of sediment may occur at the base of a turbine foundation and could also result in resuspension of sediment and remobilization of contaminants. The chemical contaminants that can be potentially released from

offshore wind energy facilities include aluminum, copper, zinc, iron, bisphenol A, algaecides, herbicides, petroleum hydrocarbons, silicone fluids, and protective coatings. The operations of the offshore wind energy facilities can also remobilize deposited contaminants in the sediments. It is noteworthy that the lack of a baseline study of contaminants was an impediment to mitigation of oil spills, e.g., in the Gulf of Mexico.

Objectives: The goal of the multi-year study idea is to develop a monitoring program to determine the role of offshore wind energy facilities in the modification of the ecological condition of the environment. Pre-construction monitoring will establish a baseline level of contaminants, while monitoring during and after construction will examine the introduction of new contaminants and the remobilization of existing contaminants due to offshore wind activities.

Methods: Through the use of a Before/After/Control/Impact (BACI) design, pre-construction (Before) sampling would occur to determine baseline levels of contaminants in sediment and biota in active OSW lease areas and cable corridors where turbines and/or cables would be installed. Sampling (After) would also occur during and after construction. Although most benthic monitoring for OSW projects is non-extractive, if sediment samples were collected by developers, those samples could be leveraged for chemical analysis for this study. One study site (including Control and Impact sampling sites) would be in a location with no known or suspected contamination ((“uncontaminated”, e.g., an OSW lease/cable corridor offshore of southern New Jersey), to be compared with a second site (including Control and Impact sampling sites) with known or suspected contamination (“contaminated”, e.g., an OSW lease area/cable corridor outside of New York Harbor). Control sites would be identified outside of both the uncontaminated and contaminated lease areas/cable corridors. Impact sites would be identified inside the lease area/ cable corridor at sites of turbine and/or cable installation. As naturally occurring trace metals occur on the seafloor, a desktop study would be conducted during selection of study sites to locate hot spots of contamination where there may be a measurable difference between background and contaminant levels which would raise a concern about contamination of marine life. Sources of baseline data on background contamination levels could include the US Geological Survey (USGS) usSEABED Database (USGS 2020), and US Army Corps of Engineers and USGS records on regional disposal activities (USACE undated, USGS undated). Examples of chemical contaminants to be monitored include petroleum hydrocarbons, PCBs, PBDE flame retardants, organochlorine pesticides, mercury, tributyl tins, and microplastics, as well as chemicals used in OSW facilities, such as aluminum, copper, zinc, iron, and silicone fluids. The design of the monitoring program would be analogous to the National Oceanic and Atmospheric Administration’s National Status and Trends Long-Term Monitoring Program (NOAA NCCOS 2017).

Specific Research Question(s):

1. What are the baseline (pre-construction) chemical contaminants and contaminant concentrations in the sediments and biota within an OSW lease area?
2. What are the chemical contaminants and contaminant concentrations in the sediments and biota of an OSW lease area during construction and post-construction (operations) phases?
3. Do activities related to the construction and operation of an OSW facility result in remobilization of previously deposited sediment contaminants?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Gottholm BW. 1993. Assessment of chemical contaminants in the Hudson-Raritan Estuary and coastal New Jersey area. National Ocean Service, Office of Ocean Resources Conservation and Assessment.

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

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
Final Report Due	TBD
Date Revised	February 18, 2022
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 is 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 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): Research, develop, and test the public's sense for aesthetic appeal for innovative measures for visually mitigating offshore wind energy facilities using photorealistic representations and public engagement methods. Relatively little is known about the variables that affect the degree of perceived visual impact from offshore development. While 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 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 could 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 critical 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 build awareness in BOEM when negotiating mitigation options with the 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
- Mitigation treatments will also consider flight safety

Objectives: 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?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Accounting for Scale Bias in Marine Minerals Studies
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.hansen@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	-
Problem	The scale of Marine Minerals Program (MMP) studies affects the interpretation of results and understanding of impacts (Grothues et al. 2021). The scale of the research footprint may not match the scale of habitat and species' scales. This can lead to mischaracterizing species distributions or habitat associations that are necessary to assess dredge impacts.
Intervention	Existing data from prior studies and dredge-related monitoring should be analyzed at various scales to find the best correlative fit.
Comparison	Habitat and species distribution relative to BOEM activities should be compared at different scales (e.g., gradually coarser) to better understand "scale bias."
Outcome	Applying the appropriate scale to study and monitoring results will improve the accuracy of previous study interpretation, while informing the design of future MMP studies resulting in data sets that may better inform environmental analyses and leasing decisions.
Context	Atlantic and Gulf of Mexico Outer Continental Shelf to 50-m depths.

BOEM Information Need(s): BOEM has invested over $1 billion in studies since beginning in 1973. These data and results have informed BOEM decisions and driven additional research. To maximize these results and apply them more accurately, BOEM must understand how the scale of research and activities matches (or mismatches) the scale of habitats and species distributions (Grothues et al. 2021). The importance of this study was echoed by Dr. Kevin Stokesbury at a Committee on Offshore Science and Assessment meeting in fall 2021. The outcome of this study could improve the methodological approach for studying the potential impacts of MMP authorized actions resulting in new data sets and approaches to assessing the environmental implications of MMP leasing decisions.

Background: Scale can be both temporal and spatial. Temporal scale can vary between short-term (0–5 years), intermediate term (5–10 years), and long-term (10–25+ years); spatial scale from near (10s of meters), mid (10s of kilometers), to far (100s of kilometers) (B. Jensen, pers. comm.). Within a habitat, animals often fluctuate between scales depending on habitat use (e.g., large spatial scale for migrations but small spatial scale for reproduction). "Scale bias" is the extent to which the temporal or spatial scale that an experiment or survey is conducted, which influences the results (Levin 1992; Mashintonio et al. 2014, cited in Grothues et al. 2021). Scale affects how we analyze results (e.g., power analysis) and

interpret study results (Knorr 2017). It also impacts how we interpret effects from a disruption, like dredging. See figure below for a diagrammatic representation.

In several BOEM-funded literature syntheses (Michel et al. 2013, Rutecki et al. 2015, Grothues et al. 2021), findings reveal a variety of fish-habitat associations over the last 30+ years that are relevant when evaluating the potential impacts associated with dredging activities. Though this comprehensive literature base exists, not all studies have tested various scales in the study design or during results interpretation. Correlations might have been calculated at a fine-scale resolution (e.g., species distribution to a specific sand feature in one season) but not tested further at other scales (e.g., a species guild in a larger area over years). The finest scale may still have the best correlation, but the strength of that fit is unknown until "zooming out." There may also be significant species-habitat associations at both small and regional scales, though they mean different things ecologically (Mashintonio et al. 2014). Furthermore, under current sea level rise projections, the size, scale, and frequency of dredging efforts required to support future coastal resiliency initiatives is changing so future research must adapt to changes in dredging.

The proposed study will address this "scale" data gap and could implicate future assessments and studies by leading to more accurate applications of BOEM research findings. This study could also serve as a pilot effort to inform a follow-on study reviewing scale bias in BOEM's renewable energy and oil and gas programs.

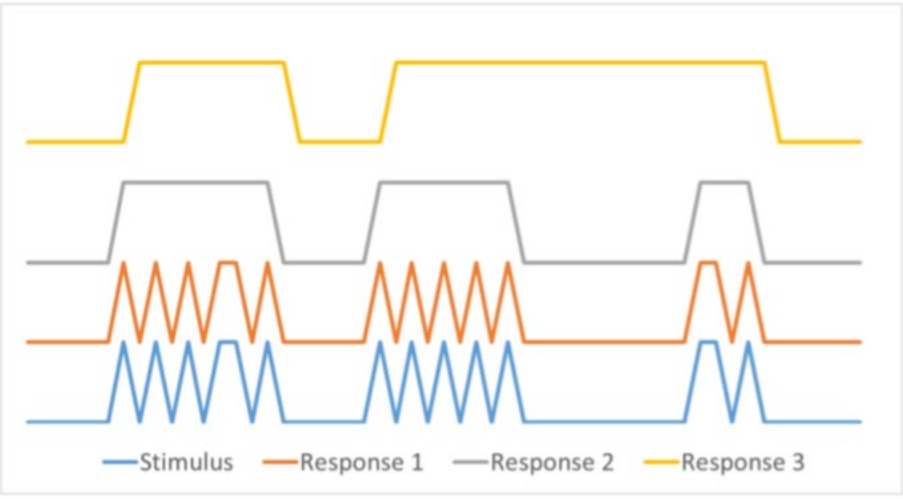

Figure 21. Diagrammatic representation scaled response
In the figure above, a hypothetical perturbation (e.g., storm, dredging, trawling) is represented as an oscillating state (lower blue line, up is disturbance, down is no disturbance) along a time line (x-axis). Three possible response patterns (upper three curves) show the effect of scale in eliciting or detecting a response. The uppermost hypothetical response is least correlated to the stimulus unless the stimulus signal is resampled to a lower resolution and also lagged, but remains plausible as a response, for instance if fish evacuate an area on the basis of frequent disturbance, rather than in response to just one event. The same pattern holds true if the x-axis is understood to depict a spatial measurement (e.g., meters). In that case, fish may vacate a wide area that has a high density of habitat disruptions even if they do not avoid any individually disturbed area. The conceptual figure also holds for attractor stimuli (e.g., concentration of shell hash), in which case the response is positive.

Figure from Grothues et al. 2021

Objectives: Identify how well the spatial and temporal scales of MMP research and authorized activities match (or mismatch) the scales of habitat and fish distribution. Provide recommendations and propose existing or new methods that consider relevant scales for future MMP research.

Methods:

- A Methods Paper would first outline data requirements and proposed execution of how to identify scale bias in MMP studies. This paper will also identify the spatial and temporal scale(s) of potential impact from BOEM-authorized dredging activities.
- Based on these recommendations, existing datasets on fish and habitat from relevant BOEM studies, plus data from partners like USACE or local communities, would be reviewed for data richness. Potential BOEM studies include fish-habitat associations researched off New England (MM-17-05), New York Bight (BOEM 2021-036), eastern Florida (BOEM 2019-043), and Louisiana (GM-14-03-10).
- Of these, a qualifying subset would go through an iterative process to identify the effects of scale. As described in Section 6.4 of Grothues et al. 2021, habitat variables like bathymetry, sediment, and infauna would be described at the finest scale possible. Overlaid on this is fish species distribution, again at the finest scale possible. Correlations between habitat and species distribution are then measured. From here, the resolution is downgraded, or made coarser, and correlations recalculated (Mashintonio et al. 2014). The best fit indicates the appropriate scale.

Specific Research Question(s):

1. How does scale affect MMP's research results? What are the appropriate scales among various studies?
2. How can the appropriate sampling and statistical methods be determined in order to detect change at the appropriate scale (or different scales)? How can BOEM determine the sufficiency of study footprints to answer objectives?
3. What temporal and spatial ranges best reflect MMP activities, and the habitats and species potentially impacted?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Evaluating Sediment Mobility on the Gulf of Mexico Outer Continental Shelf (OCS)
Administered by	Marine Minerals Program
BOEM Contact(s)	Ana Rice (ana.rice@boem.gov), Jennifer Steele (Jennifer.steele@boem.gov), and Jessica Mallindine (Jessica.mallindine@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 14, 2022
PICOC Summary	
Problem	Incomplete understanding of sediment mobility across the OCS affects the ability of BOEM to adequately manage and preserve resources and provide effective environmental oversight. A comprehensive climatological analysis to evaluate the potential for seafloor sediment mobility across the Gulf of Mexico (GOM) OCS to the shelf break (200-m isobath) is needed to inform decisions on management and preservation of critical assets, such as infrastructure (i.e., pipelines, platforms) and cultural resources.
Intervention	Develop a regional modeling predictive tool that incorporates atmospheric (winds), hydrodynamic (ocean waves and currents), morphologic (bathymetry), and geologic (sediment type and distribution) parameters to characterize the probabilities of seafloor sediment mobility across the GOM OCS over the last 20 years
Comparison	A predictive tool in development at the NRL that currently estimates sediment mobility globally at the resolution of the Navy's operational wave and current (order 4 km), will be adapted to a regional higher resolution (order 1 km) wave and current model in the GOM. The GOM tool will additionally incorporate measured bathymetric and geological parameters (e.g., grain size distribution) to further refine its predictive skill. The tool will be used to compare probabilities of sediment mobility on the GOM OCS.
Outcome	A regional climatological analysis over the last 20 years of the seabed state across the GOM OCS that identifies regions and periods of high, moderate, and low sediment mobility probabilities. The analysis will primarily be used to inform management decisions on critical assets, particularly infrastructure and cultural resources, while also supporting planning needs across all three program areas.
Context	GOM OCS to the shelf break (200-m isobath). The seabed state predictive tool could be adapted for use in Atlantic and Pacific OCS Regions.

BOEM Information Need(s): BOEM needs to identify areas of increased sediment mobility to manage and preserve resources and provide effective environmental oversight. This comprehensive knowledge will aid in the evaluation of the physical and environmental impacts to critical assets, such as existing infrastructure and cultural resources (e.g., displacement/damage of pipelines and platforms, shipwrecks and telecommunication cables, and pipeline leakage vulnerabilities); in the placement of future

infrastructure, such as wind energy transmission lines and oil and gas pipelines; and dredging buffers around them, which sequester potential sediment resources. This information would also directly support infrastructure removal recommendations, particularly in vulnerable high-risk areas where sediment mobility can cause either exposure or excess burial of assets.

Background: While pipeline burial of 3 ft. (30 CFR 250 Subpart J) is required by the Bureau of Safety and Environmental Enforcement, pipeline exposure and displacement under extreme storm-driven or chronic sediment transport has been reported in various areas of the GOM OCS (personal communication with NOAA; Gearhart et al. 2011; Hooper and Suhayda 2005), indicating areas of increased sediment mobility may be widespread. That information is however anecdotal and not systematic. Several past and present BOEM-funded studies (e.g., BOEM 2016-038, GM-21-01, Harris et al. 2020) focused on understanding the factors that trigger sediment fluxes in the shelf during extreme events, such as during storms and hurricanes, and during high-energy gravity flow events in the Mississippi River Delta Front in the northern GOM. However, comprehensive knowledge of sediment mobility across the GOM OCS is still needed, particularly where and when dynamic seafloor areas may arise due to atmospheric, hydrodynamic, and geological factors. Evidence of increased sediment mobility and thus low seabed stability is of concern because it is unknown how these zones influence the structural integrity of surrounding infrastructure and resources. A strong storm event, for example, may alter an excavated dredge pit and thus potentially impact adjacent infrastructure and cultural resources if adequate buffers (Narin et al. 2005) are not in place that take into consideration the area being prone to sediment mobilization. Conversely, sediment resources otherwise unavailable within existing buffers may be freed for use in generally stable and less dynamic areas.

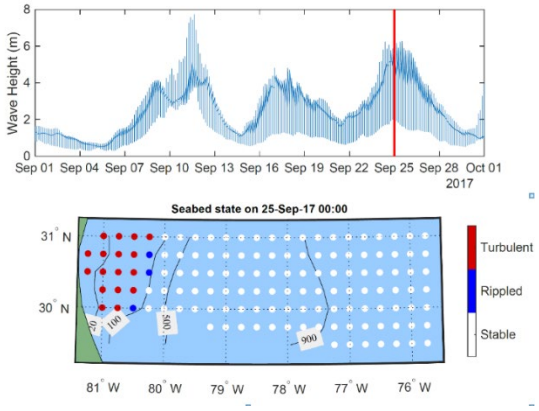

Figure 1: Top: WaveWatch III predicted significant wave heights for all locations in the Kings Bay, GA domain in 09/2017; Bottom: Preliminary output (wave-generated mobility only) from NRL's prototype seabed state predictive tool for 9/25/2017, showing regions of high (turbulent) and moderate to low (rippled) sediment mobility to the 100 m isobath, and no mobility (stable) offshore. Grid resolution is 4 km.

The U.S. Naval Research Laboratory at Stennis Space Center, MS, is currently developing a tool as part of an NRL Base Program funded project titled "Developing a shallow water environmental database for nearshore operations" that ingests reanalysis model data of globally simulated ocean waves and currents to predict the spatial and temporal mobilization of seafloor sediment over a given hindcasted time period. The tool currently assumes a homogeneous seabed composed of coarse quartz sand with a single estimated median grain size (Figure 1). The development of algorithms that consider additional geological parameters (e.g., sediment type and distribution) as well as the ability to ingest higher

resolution regional hydrodynamic data is necessary for developing a comprehensive and skilled analysis of the potential for seafloor sediment mobility in the GOM.

Objectives:

1. Set-up, run, and validate a regional (order 1-km resolution) GOM OCS coupled ocean hydrodynamic and seafloor sediment mobility simulation to hindcast temporal and spatial sediment mobilization in the GOM OCS over the last 20 years.
2. Generate and compare sediment mobility output from a simulation with a single grain size (median grain size quartz sand) in (1) to a simulation with spatially varying geologic parameters in a subset area domain (e.g., Louisiana).
3. Use model output to identify potential areas of increased sediment mobility on the GOM OCS.
4. Recommend best practices or strategy for management and preservation of resources around infrastructure and cultural resources based on seabed state and sediment mobility in the GOM.

Methods: Adapt NRL's seabed state predictive tool to function over regional scales (from 4 km to order 1-km grid resolution) using the Delft3D-Flexible Mesh hydrodynamic model in the GOM OCS (State Water line to the 200-m isobath). Perform a climatological analysis over the last 20 years to identify areas of high, moderate, and low sediment mobility probabilities in the GOM OCS. Characterize multi-scale physical processes (i.e., cyclic wave loading) and determine major modes of wind, circulation, and wave events at multiple (inter-annual, seasonal, synoptic) temporal scales that cause strong bottom shear episodes leading to sediment mobilization. Develop algorithms to allow incorporation of geological data into the model in the form of interpreted sediment type and distribution maps. Validate the model using NRL's repository of hydrodynamic and sediment observations in the GOM (Penko et al. 2017, Lim and Calantoni 2020). Ingest available sediment distribution maps for Louisiana (https://cims.coastal.louisiana.gov/Viewer/Map.aspx?guid=f8ec2690-bbb1-4879-ac30-aa44f5878b7f) into the model and assess effects of geological factors on sediment mobility at regional scales.

Specific Research Question(s):

1. What is the contribution of each of the primary atmospheric, hydrodynamic, morphological, and geological factors controlling sediment mobilization across the GOM OCS?
2. Where and during what conditions are regions of the GOM OCS at high, moderate, or low risk for sediment mobilization?
3. Which specific factors are most crucial for informing and improving future seafloor mobility assessments for identifying high-risk sediment instability areas at regional scales?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Minerals and Ecosystems of the Remote Pacific
Administered by	Marine Minerals Program (MMP) and Pacific Outer Continental Shelf (OCS) Region
BOEM Contact(s)	Jennifer Le (jennifer.le@boem.gov), Jeremy Potter (jeremy.potter@boem.gov), Mark Leung (mark.leung@boem.gov), Paul Knorr (paul.knorr@boem.gov), Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	Intra-agency Agreement; Cooperative Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	March 31, 2022
PICOC Summary	
Problem	Baseline environmental data are required to support BOEM analyses and decision-making as the marine critical minerals industry develops. For example, there is interest in mining polymetallic nodules on the abyssal plain south of the Hawaiian Islands, an area for which very limited environmental data exist.
Intervention	The MMP and Pacific OCS Region are funding USGS to evaluate critical mineral resources. There is opportunity to leverage this partnership for baseline environmental data collection, using a boxcore and potentially an autonomous underwater vehicle (AUV).
Comparison	This study will provide necessary baseline environmental data in areas for which industry interest in critical minerals is anticipated Exclusive Economic Zone (EEZ), south of the Hawaiian Islands.
Outcome	These data will provide essential information on the benthic habitats associated with critical mineral deposits to support BOEM analyses and decision-making, as well as USGS critical minerals prospectivity models.
Context	U.S. EEZ south of the Hawaiian Islands, other areas in the U.S. EEZ anticipated to have high critical mineral resource potential

BOEM Information Need(s): BOEM needs baseline environmental data in areas of anticipated seabed mining industry interest to inform required analyses under regulations such as the National Environmental Protection Act and the Magnuson-Stevens Fishery Conservation and Management Act (i.e., Essential Fish Habitat). Results from this study will provide initial characterization of benthic habitats associated with critical mineral deposits and significantly add to our knowledge base of potentially targeted areas. Specifically, geological, physical, chemical, and biological information will be collected at a polymetallic nodule field south of the Hawaiian Islands, as well as other areas of opportunity anticipated to have high resource potential for critical minerals. These data are crucial to assess the potential impacts of critical mineral mining on the marine environment. Additionally, resulting information will inform USGS prospectivity models to better predict critical mineral deposits and support sustainable development of the OCS in other areas.

Background: MMP and Pacific OCS Region are co-funding a USGS-led resource evaluation expedition to evaluate critical minerals resource potential for areas in the Pacific. In addition to resource evaluation,

BOEM needs baseline environmental data for its analyses and regulatory requirements. This profile is intended to complement the BOEM-funded resource evaluation effort and provide funding for an environmental component designed to leverage the high cost of deep-water expeditions.

Polymetallic nodule fields lie on abyssal plains (4,000–6,000-m water depth) underneath oligotrophic waters with extremely slow sedimentation rates that allow for nodule formation (Dutkiewicz et al. 2020). The Clarion-Clipperton Zone is a 4.5 million km^2 abyssal plain in close proximity to the southern Hawaiian OCS which contains trillions of nodules. Polymetallic nodules contain high amounts of Ni, Cu, Co, Mo, Zr, Li, Y, and rare-earth elements that are valuable for technology and energy applications (Hein et al. 2013). These vast nodule fields play an important role in global ocean health (e.g., the marine carbon cycle; Smith et al. 2008), host a diverse community of organisms (Amon et al. 2016; Laroche et al. 2020), and provide a myriad of ecosystem services (Armstrong et al. 2012). Benthic habitats associated with polymetallic nodules have shown limited capacity to recover from disturbance within several decades (Simon-Lledó et al. 2019; Vonnahme et al. 2020; see Investigation of an Historic Seabed Mining Site on the Blake Plateau). Although many studies have been conducted in the Hawaiian Islands area, studies have been limited to the upper 2,000-m water depth, which is much shallower than where nodule mining would occur.

Objectives: This study will inform BOEM environmental analyses and USGS models to better evaluate potential impacts of the critical minerals industry in the U.S. EEZ. It leverages existing planned cruises and targets multiple high-priority areas of interest for critical minerals. This specific funding will contribute to the following environmental objectives:

1. Measure environmental parameters (e.g., dissolved oxygen, turbidity, nutrients) to assess the oceanographic regime associated with critical mineral occurrences (i.e., funded cruise to HI, additional opportunistic cruises TBD).
2. Characterize the diversity and distribution of biological communities, including any sensitive or important habitats, in relation to critical mineral occurrences.

Methods: BOEM is partnering with USGS and academic institutions to conduct resource evaluation and environmental investigations, respectively. These combined cruises will use a boxcore and AUV (on the Hawaii expedition, potentially on opportunistic cruises as well) to collect measurements and samples at areas of mutual interest to BOEM and USGS. BOEM has a general area of interest and USGS is working to refine their models to predict where, within that general area, has the highest probability of nodule resources. The AUV will be deployed close to the seafloor to collect multibeam echosounder and backscatter data for high-resolution bathymetry maps, as well as imagery (e.g., megafauna diversity and abundance, lebenspurren) and baseline oceanographic measurements (e.g., dissolved oxygen, turbidity) to characterize the near-bottom environment. Based on remote-sensing surveys, the boxcore will be deployed at areas with highest mineral resource potential to obtain physical sediment samples for geological (e.g., nodules, sediment composition, grain size) and biological (e.g., epifaunal and infaunal diversity, abundance, distribution, meiofauna, genetic) analyses. By collecting baseline environmental data in tandem with resource evaluation, BOEM can begin to characterize habitats associated with critical mineral deposits, which will be essential to analyzing potential impacts from resource recovery. A potential National Oceanic and Atmospheric Administration multibeam effort to map the area in advance of this resource evaluation cruise is being explored. These data would be used to help inform deployment of the AUV and boxcore.

Specific Research Question(s):

1. What seafloor and sub-seafloor features exist throughout the nodule field, or other critical mineral occurrence?
2. What environmental structures and processes are characteristic of the prospective nodule area?
3. What are the diversity, abundance, and distribution of the benthic biological community, including infauna? Are there indicator taxa and/or sensitive habitat, e.g., corals, sponges?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Modeling Benthic Recovery with Variable Dredge Conditions
Administered by	Marine Minerals Program (MMP)
BOEM Contact(s)	Deena Hansen (Deena.hansen@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	-
Problem	Dredging activities directly remove the benthos from the immediate dredge cut area, which may also have productivity and indirect food web effects. The type of dredge, the frequency of dredging events, time of year, and environmental setting affects the rate of benthic community recovery. Field work at every site and for every dredge event is not feasible, so a model will allow for quantified estimates of recovery in the absence of monitoring. Current impact assessments infer recovery patterns without the ability to make more accurate conclusions based on project-specific conditions.
Intervention	If we better quantify the rate of recovery relative to dredging conditions (considering natural fluctuations), we can improve our impact assessments and make better decisions on future dredge events.
Comparison	This study aims to model benthic recovery relative to different dredge frequencies and environmental conditions.
Outcome	We expect a model to create a formula that would allow BOEM to input project parameters to estimate, including uncertainty, the rate of benthic recovery for different dredge conditions.
Context	Atlantic and Gulf of Mexico Outer Continental Shelf (OCS) waters up to 50-m depths.

BOEM Information Need(s): To inform assessments and decisions for dredge events in all MMP regions, BOEM needs to quantitatively estimate how different dredge activities impact benthic recovery when site-specific data are not available. In the process of excavating sediment, dredges can remove, bury, or otherwise potentially harm benthic invertebrates, a source of biomass that is important prey to higher trophic animals. Many benthic invertebrates recolonize within months to years depending on operational and environmental factors, including the frequency (i.e., time between events), depth of dredging (i.e., “cuts”), and ecosystem characteristics. While many site-specific studies have quantified post-dredging recovery, benthic monitoring of every project site (from undisturbed baseline to recovered or modified system) is inconsistent due to project timing, inherent system variability in physically-dominated settings, etc. relative to duration and funding of monitoring. An empirical model to quantify estimated recovery rates will improve benthic impact assessments, including cumulative impacts, for all potential dredging projects (Atlantic and Gulf of Mexico OCS).

Background: Various studies have investigated the recovery of benthic communities following a disruption like trawling or dredging (e.g., Crowe et al. 2016; see Michel et al. 2013 for a review). Most studies have focused on how physical and environmental conditions impact the recovery to a pre-disruption state. In addition to this, the frequency and intensity of dredge events may also affect how the benthos recolonizes. Because benthic recolonization occurs in several successional stages, recovery should be considered in two major respects: a return to pre-dredge biomass, and to pre-dredge biodiversity. Hiddink et al. (2017) found that the depletion, and subsequent recovery, of seabed macroinvertebrates was correlated to the depth of disruption by different bottom trawls. We hypothesize that more frequent dredging would also lead to greater depletion of benthic invertebrates and longer recovery times. We also hypothesize that there will be a correlation, so that estimates of benthic recovery would vary in a predictable way with dredge frequency and season. The results of a BOEM-funded study to characterize the intensity of site-specific dredging (OCS Study BOEM 2018-019, "Using Dredge Plant Operational Data to Measure Cumulative Use and Cumulative Impacts") could also be incorporated when characterizing dredging operations.

Objectives: The study will model the recovery of benthic invertebrates based on different dredge depth and frequency for the many potential dredge areas that do not conduct site-specific benthic monitoring. As feasible, the model will include covariates to account for environmental and seasonal fluctuations. The preferred outcome would be a multivariate, empirical formula such that a BOEM analyst could input different dredging activity, characterized by frequency and season (independent variables, x), and receive an estimate (plus uncertainty) of time to benthic recovery (dependent variable, y). These estimates from the model could be applied before dredging, then validated after dredging with actual values (if available from site-specific monitoring). At sites with repeat dredge events, these recovery rates could then be used to better characterize cumulative impact or system response (e.g., longer recovery rate if dredge events have a higher frequency). BOEM could potentially use these estimates to determine areas and timing of leasing.

Methods: This model will investigate how benthic recovery is related to dredge depth and frequency using at least 20 existing data from dredge projects or studies (e.g., "Natural Habitat Associations And The Effects Of Dredging On Fish At The Canaveral Shoals, East-Central Florida" and "Ecological Function And Recovery Of Biological Communities Within Sand Shoal Habitats Within The Gulf Of Mexico"). No new data or field work will be executed as part of this study. The study would start with a data synthesis of known recovery rates and processes, related to dredge frequency when possible. Relevant data include benthic grabs, invertebrate composition (e.g., species size, biomass, and richness), sediment profile imaging, grain size analysis, dredging activity, bathymetry, other seafloor profiling, and a variety of environmental variables like season and hydrodynamics. These data to inform the model are expected to be mined from BOEM-funded studies, the U.S. Army Corps of Engineers, academia, and state resource managers, among others. These recovery data will be analyzed to determine how dredge depth and frequency, with environmental covariates (e.g., season, latitude, and any site-specific conditions), influence benthic recovery rates.

In addition to the data synthesis, the final product will be a logistic regression model that represents how benthic recovery varies with dredge depth and dredge frequency, including measures of uncertainty. It will be validated using several "set aside" datasets, as well as ground-truthed with future projects. It will also be compared to the model developed for post-trawling recovery (Hiddink et al. 2017) to see how recovery differs among the two general activities. This model will support a user interface where a BOEM user may input project parameters for a benthic recovery estimate. The final

formula will provide the ability to estimate recovery rates of dredge activity before and after dredging occurs at sites that lack site-specific benthic monitoring.

Specific Research Question(s):

1. How does dredge depth and frequency (i.e., timing between events) affect benthic recovery?
2. What are the quantitative estimates of benthic recovery for different dredge depths and frequencies?
3. How might dredge activity have cumulative effects on the benthic environment?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	BOEM-MARINe (Multi-Agency Rocky Intertidal Network)
Administered by	Pacific OCS Regional Office
BOEM Contact(s)	Lisa Gilbane (lisa.gilbane@boem.gov), Susan Zaleski (susan.zaleski@boem.gov), Abigail Ryder (abigail.ryder@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2023–2028 (funding requested for FY 2023–2027)
Final Report Due	June 30, 2028
Date Revised	April 29, 2022
PICOC Summary	
Problem	Active offshore oil and gas operations can significantly impact sensitive rocky intertidal habitats, which are home to a diversity of species, including the endangered black abalone. Monitoring rocky shores annually is the only way to determine if there are impacts from Outer Continental Shelf (OCS) operations and to be able to understand the cumulative impacts to this sensitive habitat.
Intervention	These funds will support ongoing monitoring studies which date back to 1975. Statistical analyses of repeated species abundance and size-structure data are a powerful way to detect change over time. Additional site-wide protocols are conducted to understand changes among sites and differentiate between OCS oil and gas-related activities and other anthropogenic effects.
Comparison	The MARINe program makes regional comparisons by relying on monitoring outside of OCS activity areas, which is done with identical methods and funded by 40 universities and agency partners in the program. These data have also been utilized in Before/After/Control/Impact- (BACI-) based analyses of non-OCS oil spills, water pollution, and Marine Protected Area assessments.
Outcome	Trends impacting rocky shore species—such as human trampling, disease, and climate change—are expected to intensify. In addition, potential offshore renewable energy activities along with continued oil and gas production may impact rocky intertidal habitats and communities. Comparing community metrics inside and outside of potential OCS-related impact areas enables us to differentiate impacts from OCS activities versus changing environmental conditions. The public engagement with this program will continue to be strong, and results will directly inform National Environmental Policy Act and Endangered Species Act (ESA) consultations as well as significantly benefit state partners.
Context	California, Oregon, Washington, Alaska This program proposes expansion along the U.S. West Coast in areas of the OCS that are actively planning for renewable energy leasing.

BOEM Information Need(s): Current and planned OCS operations are a strong public concern because of previous oil spills along the Pacific coastline. As required by the OCS Lands Act, BOEM needs to regularly monitor vulnerable and sensitive resources adjacent to ongoing OCS activities. Rocky shore communities were chosen 20 years ago as key resources to monitor because they are rare and unique to ocean-

upwelling regions in the world. Also, multiple species are long lived and an important resource to many fishes, birds, and mammals.

BOEM and U.S. West Coast partner States need rocky shore community metric data for evaluating oil spill impacts, water quality discharges, and adjacent Marine Protected Areas. We anticipate this type of information will continue to be needed to inform decisions relating to oil and gas decommissioning and renewable energy leasing. In particular, BOEM has a specific continual need for black abalone count and size data as well as abalone habitat quality assessments for ESA consultations. This is the only source of data available for the endangered black abalone on the mainland of California and in the past, these data were utilized for the listing and establishment of critical habitat for black abalone (Miner et al. 2006).

Background: BOEM's support for the MARINe program provides funding to monitor 32 rocky shore sites of interest to BOEM, of which 24 sites are adjacent to OCS operations in California and 8 sites are off the Oregon coast, where an OCS offshore wave energy facility is planned. MARINe also collects data at sites in Washington and Alaska with funds from partners such as the National Park Service. MARINe was formally established in 1997 after the Exxon Valdez oil spill and the realization that oil spill impacts can only be assessed when baseline data are available. MARINe needs to continue to facilitate detection of new trends in a regional context across the U.S. West Coast over time, such as sea-level rise (Kaplanis et al. 2020), tracking decline in ochre stars (Miner et al. 2018; Moritsch and Raimondi 2018), and recording current conditions as baseline data prior to the inception of offshore renewable energy installations.

MARINe is a cost-effective program that heavily relies on leveraged funds shared across partners including the States of California and Oregon, the U.S. Navy, and five National Park Service units (Gilbane et al. 2021). Although BOEM specifically supports monitoring in areas adjacent to OCS activities, BOEM uses data collected from other sites for use as comparative reference condition. BOEM supports approximately one-third of the overall database and website costs. MARINe's shared methods and database are valuable to state agencies and are used as a model for other ecological programs. Analyses are not limited by access to data or constraints of joining separate methods. This structure also enables a framework for resource-limited groups such as Tribal Nations, local municipalities, or local environmental groups to get involved in rocky reef monitoring, fostering positive interactions, and facilitating learning opportunities with the public. MARINe jointly publishes 1–3 papers in scientific journals per year, averages 25–35 data requests per year, and averages 2,000 hits per month on its website, https://marine.ucsc.edu/.

Objectives: This study provides for the continued monitoring of 32 rocky intertidal sites on the mainland shore immediately adjacent to OCS oil and gas facilities offshore southern California and a potential OCS wave energy facility offshore Oregon. The following objectives are necessary to meet this goal:

- Determine spatial and temporal trends for selected species and communities at 32 sites along the U.S. West Coast.
- Determine species diversity and other community metrics and compare among sites, in particular between OCS and non-OCS sites.
- Measure size-structure (as a proxy for age class) of black abalone, owl limpets, and sea stars change over time and in response to punctuated impacts.

- Proactively engage with Native American Tribal Nations by providing resources such as a salary for part-time coordination, facilitated meetings, and funding to Tribes to better understand their practices of coastal harvest. Provide funding sources for Tribes fosters engagement with capacity-limited communities. Multiple Tribal Nations are known to have current or ancestral ties to coastal areas and possess multi-generational knowledge of these habitats.

Methods: MARINe employs standardized field protocols, a shared database, and a website (www.rockyintertidal.org). Sites are monitored by four teams of field biologists, including the BOEM Pacific Regional Investigations Survey and Monitoring (PRISM) team. The long-term protocol determines the percent cover and count of selected species within fixed plots, including barnacles, mussels, sea stars, black abalone, and surfgrass. This protocol is implemented each fall and provides a high confidence for detecting small changes in abundances of targeted species. A second biodiversity protocol is implemented each spring. The biodiversity protocol allows BOEM to extrapolate beyond the spatial constraints of the core monitoring program and evaluate species changes across the site, identify rare species, and provide clues to movement of species in relation to changes in the physical environment. Biodiversity is the more time-consuming protocol, so the four teams combine to sample four sites per year, completing all the sites within a five-year rotation. Temperature is recorded at 10-minute intervals at all sites. Data are placed in a common database and are accessible through graphing, downloads, and map visualizations, as well as through specific requests to the database manager.

Improving public data access is a goal. Improved access is linked to data assurance measures; database management includes quality control measures for data entry such as updates to web and app-based forms and scripts to detect errors. To ensure that future groups know which species MARINe sampled, data collectors archived representative species from each field group with the Smithsonian. This vouchering and archival effort will be continued at the remaining unsampled sites and species in California and in Oregon in coordination with partners pursuing eDNA library development primarily through a collaboration with Channel Islands National Park personnel. To make our data more accessible to the public and involve citizen science programs, we will produce identification guides and improve our online photo database. Improved quality assurance and control of this long-term program will also include better and public documentation of field and database protocols.

Specific Research Question(s):

1. What is the trend over time (in percent cover or counts sampled once a year) for selected species and communities in fixed plots at 32 sites along the U.S. West Coast?
2. What is the species diversity at a site and how do community metrics vary among sites?
3. How does the size-structure (as a proxy for age class) of black abalone, owl limpets, and sea stars change over time and in response to an impact?
4. How does proximity to OCS activities in California and Oregon affect communities and selected species?

Current Status: N/A

Publications Completed:

See https://marine.ucsc.edu/explore-the-data/publications/index.html.

Affiliated WWW Sites:

https://marinecadastre.gov/espis/#/search/study/100267

https://www.pacificrockyintertidal.org

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Characterization of the Distribution, Movements, and Foraging Habitat of Endangered Leatherback Turtles in Designated Critical Habitat off the U.S. West Coast
Administered by	Pacific OCS Regional Office
BOEM Contact(s)	Desray Reeb (desray.reeb@boem.gov), Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	Phase I: FY 2023–2026 (June 2023–October 2025) Phase II: FY 2026–2028 (June 2026–June 2028)
Final Report Due	TBD
Date Revised	April 29, 2022
PICOC Summary	
Problem	The occurrence and habitat use for leatherback sea turtles that occur offshore Oregon and Washington is currently unknown. The absence of these data makes it extremely challenging to accurately assess potential impacts to this species from offshore renewable energy development.
Intervention	Systematic aerial surveys and telemetry tagging of leatherback sea turtles in Oregon and Washington waters will be conducted to understand their abundance, distribution, and habitat use in this region, and compare with existing data for offshore central California.
Comparison	The data will form the baseline of comparison to understand potential impacts from offshore renewable energy development offshore Oregon and Washington, as well as any BOEM-related activities that may occur in these areas.
Outcome	The combined data will 1) fill a key data gap on leatherback distribution, abundance, and habitat use off northern California, Oregon, and Washington, and 2) provide a more robust sample size to assess leatherback use of the central California marine ecosystem.
Context	Northern California, Oregon, and Washington

BOEM information need(s) to be addressed: This project will provide BOEM and NMFS with information essential for evaluating and conducting environmental reviews (Endangered Species Act [ESA] and National Environmental Policy Act) of proposed BOEM-permitted activities, including renewable energy activities, and for mitigating potential impacts on endangered leatherbacks and their prey. These data will fill a key data gap on leatherback distribution, abundance, and habitat use offshore northern California, Oregon, and Washington.

Background: Pacific leatherback turtles, *Dermochelys coriacea*, are federally listed as endangered under the ESA and are recognized as being under threat of extirpation within the Pacific Ocean. Leatherbacks that nest at beaches in the tropical western Pacific migrate across the Pacific to forage on seasonally abundant sea nettles, *Chrysaora fuscescens*, in two known areas off the U.S. West Coast: central California and Oregon-Washington (OR-WA) between June and November. Both areas are designated as

Leatherback Critical Habitat (77 FR 4169, 27 February 2012). Since 2000, integrated aerial survey, telemetry, and in-water sampling have been successfully conducted off central California to characterize leatherback distribution, movements, abundance, habitat use, foraging behavior, and health. Some information on leatherback occurrence is available off OR-WA, but no estimate of leatherback abundance is available for that region. Previous studies were very limited seasonally, and had limited sample sizes. NOAA aerial surveys designed to document leatherback occurrence off OR-WA during 2010, 2011, 2014, and 2021 and telemetry tracks of three leatherback turtles tagged at western Pacific nesting beaches that foraged off OR-WA have revealed that leatherback use of this area is highly variable, patchy, and—at present—spatially unpredictable (Benson et al. 2011, 2020; NMFS and USFWS 2020). This study would significantly expand the dataset.

Objectives: Characterize the distribution, movements, and foraging habitat of endangered leatherback turtles in designated Critical Habitat offshore northern California, Oregon, and Washington.

Methods: This is a two-phase study in which Phase I will inform the feasibility of Phase II.

Phase I: Leatherback occurrence in the study area is largely unknown; therefore, this first phase will focus on three years of replicated aerial surveys to document distribution and estimate abundance via line transect methodology. If leatherbacks are routinely sighted in the first two years, the third year of aerial surveys will support satellite and acoustic telemetry efforts to identify movements, following at-sea capture of leatherbacks, using a specially designed leatherback capture vessel complemented by vessel-based telemetry. The plane will guide the boat to surfacing leatherbacks. Sampling will be conducted from early June to early October during leatherback foraging season, targeting waters offshore northern California, including the Humboldt Wind Energy Area, Oregon, and Washington.

Phase II: Following successful detection of leatherback sea turtles for Phase I, Phase II proposes two additional years of satellite and acoustic telemetry to identify movements following at-sea capture of leatherbacks using a specially designed leatherback capture vessel, with plane support to guide the boat to surfacing leatherbacks and suction-cup attached VHF/camera tags with time-depth recorders for fine-scale foraging and behavior studies, also using leatherback capture techniques described above for satellite telemetry.

Specific Research Question(s): The following research questions address leatherback ecology, demography, and status along the U.S. West Coast and will be considered in an environmental context, especially relating to climate change:

Phase I:

1. What are the key areas of aggregation and/or high use for leatherbacks foraging within the poorly-understood ESA-designated Critical Habitat off northern California, Oregon, and Washington?
2. When do leatherback turtles occur in the Pacific Northwest (i.e., Oregon and Washington)? Does this vary between California and Pacific Northwest foraging grounds?

Phase II:

3. When compared to existing central California data, do leatherbacks move between California and Pacific Northwest foraging grounds, or are the foraging populations discrete?

4. Does the occurrence of leatherbacks offshore Oregon and Washington inform the status of the population?
5. How do foraging leatherbacks use vertical and horizontal habitat, and what prey species are being consumed, in neritic waters off the U.S. West Coast? Does this vary regionally and temporally?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Benson SR, Eguchi T, Foley DG, Forney KA, Bailey H, Hitipeuw C, Samber BP, Tapilatu RF, Rei V, Ramohia P, Pita J, Dutton PH. 2011. Large-scale movements and high-use areas of western Pacific leatherback turtles, *Dermochelys coriacea*. Ecosphere. 2(7):art84. doi:10.1890/ES11-00053.1

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[NMFS and USFWS] National Marine Fisheries Service, U.S. Fish and Wildlife Service. 2020. Endangered Species Act status review of the leatherback turtle (*Dermochelys coriacea*). Report to the National Marine Fisheries Service Office of Protected Resources and U.S. Fish and Wildlife Service.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Evaluating Hawaiian Fisheries and Potential Impacts of Offshore Wind Energy Development
Administered by	Pacific OCS Regional Office
BOEM Contact(s)	Linette Makua (linette.makua@boem.gov), Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	Contract or Competitive Cooperative Agreement
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 29, 2022
PICOC Summary	
Problem	Given the ubiquity of fishing activities in virtually every part of the ocean, offshore wind energy proposals often face strong opposition from fishing stakeholders, and successful outreach to these stakeholders is often inhibited by incomplete information.
Intervention	Discussions between BOEM and stakeholders, site visits
Comparison	Characteristics of different ports/harbors and fishing sectors unique to Hawai'i and their vulnerability to prospective offshore wind energy development
Outcome	Human dimension data, both qualitative and quantitative, on Hawaiian fisheries in an exportable database format, and an analysis of fisheries vulnerabilities and stakeholders' attitudes toward offshore wind energy projects
Context	Hawai'i OCS

BOEM Information Need(s): To reach common understanding between fishing and offshore wind energy on the OCS, BOEM needs to understand and seek input from all potentially impacted fishing sectors. Obtaining information to ensure orderly OCS development offshore Hawai'i is hampered by the lack of information necessary to conduct outreach activities and impact analyses. The State of Hawai'i has a bold energy agenda to achieve 100 percent clean energy by the year 2045 (H.B. 623[1]). This will make Hawai'i the first state to set a 100 percent renewable portfolio standard for the electricity sector.

Background: Hawaiian fisheries are uniquely integrated into the local traditions, culture, and economy of the State. These include subsistence fishermen operating strictly from shore as well as long-range, commercial-scale fisheries, and their participants' motivation includes, in many cases, a complex blend of cultural, subsistence, and economic drivers. Some of these fisheries take place in waters far from the main Hawaiian Islands (Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui, Hawai'i), but most depend on access to areas within a few tens of miles from their home port, including areas under consideration for installation of offshore wind farms. The Western Pacific Regional Fishery Management Council (2002) notes that 1) fishing and related services and industries are important to all of Hawai'i's inhabited islands, 2) the social and economic cohesion of fishery participants is particularly strong at the island

[1] HB623_CD1_.pdf (hawaii.gov)

level, and 3) fishing communities are best not distinguished according to fishery or gear type. Critically, there is often no clear distinction between subsistence, cultural, recreational, and commercial fisheries.

Given the importance and the lack of up-to-date, general knowledge of the human dimensions of Hawaiian fisheries, BOEM needs to support a study to collect social, economic, and logistical fisheries data, especially those of the Native Hawaiian Communities, and evaluate the potential impacts to social and economic attributes of local fisheries. BOEM will recognize Indigenous Traditional Ecological Knowledge—a form of Indigenous Knowledge (IK)—as one of the important bodies of knowledge contributing to the scientific, technical, social, and economic advancements of the United States and to our collective understanding of the natural world.[2] For Native Hawaiians, cultural heritage and the natural world are valued as one. After working with our Indigenous partners in other states for many years, BOEM has found that it is best to treat IK and science as independent but comparable knowledge systems. Consulting early with local IK holders may not only help in better designing scientific activities but also in developing more accurate and culturally rich stories. BOEM seeks to connect with entities (TBD) within the Native Hawaiian Community. This study will complement the BOEM-funded study, *Maritime Cultural Resources Site Assessment in the Main Hawaiian Islands*, and will complement the effort described in one of three reports from that study, *A Guidance Document for Characterizing Native Hawaiian Cultural Landscapes* (Van Tilburg et al. 2017).

Objectives: The purpose of this study is to collect information on Hawai'i's fisheries to enable early and effective outreach, and to inform impact analyses (National Environmental Policy Act [NEPA] and Coastal Zone Management Act).

Methods: Several alternative approaches to evaluating similar fisheries attributes have been used in comparable circumstances: Fuller et al. (2017) quantified social-ecological connectivity among California-Oregon-Washington fisheries using the infoMap community detection algorithm (Rosvall and Bergstrom 2008) to construct "participation networks". They used the strength of these networks to assess fisheries' sensitivity to social and economic disturbance. Fuller et al.'s (2017) approach relies on generally available fisheries data (landings time series, accessed from PacFIN); but these data may be limited to fisheries with a more substantial commercial role, excluding those that are primarily recreational or subsistence, and the metadata (particularly home port information) may not accurately reflect the location of capture. Pitcher (1999; see also Pitcher et al. 1998) developed a rapid assessment tool called RAPFISH based on a multivariate approach for comparing the sustainability of multiple fisheries. RAPFISH has been adapted for use in comparing alternative offshore marine renewable energy technologies (Kramer et al. 2010). The flexibility of this method and the option to include qualitative, as well as quantitative, data on social, economic, and ecological aspects of diverse fisheries made it the technique of choice for prioritizing management options for Hawaiian fisheries (Nelson and Kramer 2017). A combination of these methods may be used for this study, or other appropriate techniques that may be proposed by the recipient.

Studies of the potential social and economic effects of the installation and operation of offshore renewable energy technologies in the main Hawaiian Islands will be useful to BOEM. Such studies might involve:

[2] Executive Office of the President, MEMORANDUM FOR THE HEADS OF DEPARTMENTS AND AGENCIES (2021, November 15) 111521-ostp-ceq-itek-memo.Pdf (whitehouse.Gov)

1. Gathering and synthesizing existing economic and port infrastructure data for potentially affected fisheries
2. Conducting structured discussions with key participants (including Native Hawaiian communities) in Hawaiian fisheries and with resource agency representatives
3. Analyzing these data to identify opportunities for public outreach
4. Comparing alternative scenarios for offshore wind energy lease plans
5. Complying with NEPA including Environmental Justice reviews
6. Improving the likelihood of public support and the successful development of offshore wind energy resources in Hawai'i

The costs and complexity of collecting human dimensions data will be minimized by engaging knowledgeable and respected local fisheries representatives, and limiting formal engagement to community leaders, including leaders of Indigenous, minority, and low-income communities, and resource managers (Nelson and Kramer 2017; Kittinger et al. 2012). Some measure of engagement to community leaders s also expected to improve cooperation and data quality (Crane et al. 2017). To gain a basic understanding of existing fishing infrastructure and sense of place, site visits to ports and harbors will precede guided discussions. Such leaders will help BOEM identify individuals who possess traditional knowledge and incorporate traditional knowledge into the evaluation.

The timing of this effort is critical: collecting these data substantially (five years) before any project is established enables BOEM and project proponents the best opportunity to understand the human environment in Hawai'i and respond appropriately.

Specific Research Question(s):

1. What human dimension aspects (including Traditional Ecological Knowledge) are important in characterizing Hawaiian fisheries in O'ahu and outer islands?
2. What existing port infrastructure supports Hawaiian fisheries and how can this infrastructure be protected or improved?
3. How can existing frameworks of understanding and mitigating potential impacts from offshore wind energy development be adapted to the unique fishing culture of Hawai'i?
4. How can outreach activities and impact analyses be sensitive to the foundational Hawaiian cultural strengths of ʻohana (extended family and social groups), moʻomeheu (culture), and ʻāina (land and sea)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Facilitating Resilience and Adaptation in Commercial Fisheries in Response to Offshore Renewable Energy Development and Climate Change
Administered by	Pacific OCS Regional Office
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	Inter-agency Agreement and/or Cooperative Agreement
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	April 29, 2022
PICOC Summary	
Problem	Although the public and decision-makers may be aware of the general debate regarding climate change, there is a lack of understanding as to how expected changes can be addressed at the local or project scale.
Intervention	A series of analyses that will encompass the offshore causal-change progression (climate-oceanographic-biological-socioeconomic) will be developed for Pacific Region fisheries in areas currently prospective for offshore renewable energy development.
Comparison	Oceanographic, biological, and socio-economic outcomes will be compared across various climate change scenarios.
Outcome	Study products will be useful for stakeholder outreach, National Environmental Policy Act (NEPA) analyses, and evaluation of construction and operation plans for offshore energy development.
Context	The spatial scope of the project will be the Pacific OCS Region, with initial analyses focusing on the Southern California and Northern California Planning Areas.

BOEM Information Need(s): Most commercial fishery sectors will be precluded from OCS leases when development of floating wind or marine hydrokinetic energy occurs. The potential consequences of these restrictions represent a challenge to understand, predict and mitigate due to a variety of factors, including how climate change may interact with potential effects of a proposed offshore energy project.

Impact analyses for commercial fishing often focus on short-term negative effects and neglect to elucidate the long-term and frequently beneficial aspects of offshore renewable energy development. Although the public and decision-makers may be aware of the general debate regarding climate change, there is a lack of understanding as to how expected changes can be addressed at the local or project scale. Enhancing the predictive capacity of managers to determine the scope of potential impacts from offshore energy in the context of climate change scenarios will have widespread utility, and aid BOEM in developing complete impact analyses for NEPA documents, reviewing construction and operation plans for appropriate mitigation measures, and communicating with stakeholders, including affected State governments and renewable energy task forces.

Background: Given the ubiquity of fishing activity on the OCS, any site selected for offshore energy development will overlap with areas currently used by one or more commercial fishing sectors. Thus, to

reduce conflicts among industries, a detailed understanding of potential short- and long-term impacts is necessary to develop a successful mitigation strategy.

An additional consideration to the above challenge is that it will have to be met at a time when the effects of climate change will be increasingly prominent. Climate change is expected to heavily impact the marine life and productivity of oceans (Pinsky et al. 2013; Free et al. 2019; Lotze et al. 2019), and these changes will propagate to marine fisheries (Young et al. 2019; Fisher et al. 2021). Observable changes are already occurring along the West Coast of the U.S. (Chavez et al. 2017) and elsewhere (Barange et al. 2018), but linking theoretical impacts to local communities so that specific mitigative actions can be developed and implemented has rarely been attempted (Mason et al. 2022).

This study will analyze how potential impacts from offshore energy development and climate change may interact. It will build upon two ongoing BOEM-funded studies (BOEM 2021a, 2021b) and past work detailing potential mitigation measures for the commercial fishing industry (IE 2012; EEI 2014).

Objectives: The objective of this study is to select a range of potential climate change scenarios and conduct a series of analyses that examines the offshore causal-change progression (climate-oceanography-biology-socioeconomics) for Pacific Region fisheries and (1) describes potential changes, (2) describes how these changes may interact with changes expected from offshore energy development, and (3) offers potential mitigation strategies that will increase the resilience or adaptability of the commercial fishing industry.

Methods: Researchers will first review the available evidence and possible scenarios of climate change, and then synthetize this information into a final framework useful for commercial fisheries within the Pacific Region. This impact framework will be used alongside models detailing the changes expected in oceanographic parameters and species distributions for a range of climate change scenarios. Next, information on existing commercial fisheries and the status of their harvested populations near prospective offshore energy development will be used to construct coupled social-ecological systems to understand potential responses to climate change scenarios. Finally, potential impacts from offshore energy projects will be added to the system, and a comprehensive resilience framework will be developed to examine how conflicts can be avoided, minimized, or compensated.

Specific Research Question(s):

1. Using a range of climate change scenarios foreseeable within the next 20 to 50 years, what are the potential impacts to U.S. commercial fisheries and are there patterns emerging according to gear and harvested species categories?
2. Using the climate change scenarios described in question 1, what is the expected local manifestation of *biological changes* in areas prospective for offshore energy development in the Pacific Region, focusing on harvested, keystone, and protected species?
3. Using species distribution and biological productivity models developed in question 2, what is the expected local manifestation of *changes to fisheries* in areas prospective for offshore energy development, focusing on fisheries most likely to be impacted from offshore energy activities?
4. Using the analyses developed in question 3, what potential mitigation measures would be useful to avoid, minimize, compensate, or enhance local fisheries in areas prospective for offshore energy development?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Pacific Marine Assessment Partnership for Protected Species (PacMAPPS) II
Administered by	Pacific OCS Regional Office
BOEM Contact(s)	Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	Inter-agency Agreements
Performance Period	FY 2023–2026
Final Report Due	Hawaiian Archipelago: June 30, 2025 California Current: June 30, 2026 Winter Hawaiian Archipelago: September 30, 2026
Date Revised	April 29, 2022
PICOC Summary	
Problem	Up-to-date density estimates for protected species are needed to ensure that environmental assessments are accurate. Prior to PacMAPPS I, these data were several years old.
Intervention	Collaborate with ongoing NMFS efforts to continue to conduct multiple biological surveys to estimate population densities of endangered or threatened marine species and continue to fill spatial and temporal gaps in current survey efforts
Comparison	Comparisons between the older existing data sets and this new species density and distribution data will inform trends or changes in environmental variables and/or species densities and distributions.
Outcome	Up-to-date assessments, including spatial and temporal distribution, of protected species in areas of the Pacific that are of special interest to BOEM
Context	Southern California, Central California, Northern California, Washington, Oregon, Hawaii

BOEM Information Need(s): BOEM Pacific Region continues to assess environmental effects of existing oil and gas development activities and proposed renewable energy facilities using the best available information. For marine mammals, we often rely on stock assessment reports prepared annually by NMFS. Although these reports are prepared annually, the underlying data supporting these reports may be several years old and NMFS' Science Center cruise schedules in the Pacific (Southwest, Northwest, and Pacific Islands Fisheries Science Centers) are not necessarily coordinated across species distributions. Likewise, there is limited information on offshore distribution and use of the Outer Continental Shelf (OCS) by other protected species including seabirds and sea turtles. This study supports a Pacific-wide strategic plan for coordinated protected species assessment surveys and derived site-specific analyses relevant to BOEM's areas of interest.

Background: In 2011, BOEM and NMFS signed a memorandum of understanding whereby both agencies agreed to cooperate and coordinate environmental studies and analyses. Collection and analysis of protected species (marine mammals, seabirds, and sea turtles) data are fundamental needs for both agencies. In 2013, the Marine Mammal Commission recommended that BOEM Pacific Region partner with other state and federal resource agencies, academic institutions, and private researchers to

support broad-scale, multi-year, seasonal wildlife surveys. BOEM met with NMFS, U.S. Navy (Navy), and U.S. Fish and Wildlife Service (FWS) representatives from West Coast and Pacific Islands Science Centers and regional offices on March 18, 2016. The objective was to develop a multi-year strategic plan for protected species assessment surveys across the Pacific that would address each agency's information needs. BOEM, Navy, FWS, and NMFS all agreed that the U.S. West Coast (California Current ecosystem) and Hawaiian Archipelago were high-priority areas for protected species survey effort. A white paper arising from the 2016 workshop (https://www.fisheries.noaa.gov/west-coast/science-data/pacmapps-pacific-marine-assessment-program-protected-species) described the resulting partnership between our agencies (BOEM, Navy, NMFS) and included a plan (schedule and funding needs) to conduct protected species surveys throughout the North Pacific between 2017 and 2022 and to conduct analyses of these data. That first round of PacMAPPS generated valuable data products (see BOEM 2021; Moore 2021a, 2021b; Oleson 2021a, 2021b). The goal now is to maintain the successful partnership established between our agencies and regions under PacMAPPS, so that we can continue to support ongoing information needs pertaining to accelerating wind energy development planning across the Pacific. To this end, it is time to initiate a new round of protected species surveys and analysis. BOEM's contribution to this effort will help update knowledge about protected species distributions and densities, help fill spatial and temporal gaps from prior survey efforts, and provide important baseline information for eventually evaluating the potential impacts of offshore wind energy development to protected species taxa in the study area.

Objectives: The purpose of this study is to provide up-to-date assessments, including spatial and temporal distribution, of protected species in areas of the Pacific that are of special interest to BOEM. Specific objectives include:

1. Provide updated estimates of population size and maps of animal density, particularly for marine mammal species.
2. Identify oceanographic conditions that influence protected species distribution.
3. Describe how protected species distribution in the Pacific may shift with changing environmental conditions.
4. Identify geographic features that are associated or interact with key life history elements (e.g., feeding, migration, breeding, and birthing).
5. Evaluate the relative importance of protected species habitat on a scale useful for the evaluation of offshore energy projects in the Pacific.
6. Archive survey data in a system that will allow current data to be compared with past and future efforts.

Collection of data across the range of species' distribution provides context for environmental review of offshore projects. A clear understanding of what drives species' use of marine habitats allows us to describe the relative intensity of interactions between protected species and offshore human activities. Both context and intensity are critical components of National Environmental Policy Act reviews.

Methods: NOAA vessels will conduct long-range visual and acoustic line-transect surveys for protected species and collected oceanographic data in the Hawaiian Archipelago ecosystem in Calendar Year (CY) 2023 (circa Aug–Dec). Another survey effort in the California Current ecosystem (Washington through California) will be conducted in CY 2024 (Aug–Nov/Dec). And a third survey effort will be conducted in

the Hawaiian Archipelago again, but in winter (to describe animal ecology at that time of year) in CY 2025 (Jan–Mar). The resulting data will be used to support up-to-date stock assessments and derived protected species use and distribution products for areas of interest to BOEM (currently portions of Oregon, central and southern California, and the Main Hawaiian Islands).

Specific Research Question(s):

1. Where do marine mammals live in the Pacific?
2. Why do they live there?
3. What factors can we look at to predict future distribution?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Oleson EM. 2021a. Final report of the Hawaiian Islands Cetacean and Ecosystem Assessment Study (HICEAS) 2017 and 2020: a PacMAPPS study. Camarillo (CA): US Department of the Interior, Bureau of Ocean Energy Management. 313 p. Report No.: OCS Study BOEM 2021-042. https://espis.boem.gov/final%20reports/BOEM_2021-042.pdf

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Archaeology and Coast in Crisis: Traditional Cultural Properties at Risk, Part 1
Administered by	Gulf of Mexico Regional Office
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov), Doug Jones (douglas.jones@boem.gov), Dustin Reuther (dustin.reuther@boem.gov)
Procurement Type(s)	Cooperative Agreement through Gulf Coast Cooperative Ecosystem Studies Unit (GCCESU)
Performance Period	FY 2023–2028
Final Report Due	TBD
Date Revised	April 25, 2022
PICOC Summary	
Problem	Due to coastal land loss and nearshore development activities, archaeological sites and traditional cultural properties (TCPs) are rapidly transitioning from a terrestrial to a submerged context. It is not fully understood how this has affected coastal communities, Tribes, and their relationships with these cultural resources nor how best to incorporate these communities into consultation and mitigation processes for actions which may affect these sites.
Intervention	This study will work with coastal communities and Tribes to proactively understand their perspectives of submerging and submerged archaeological sites and TCPs, including their preferences for how state and Federal agencies manage, document and/or mitigate these resources.
Comparison	Some local community perspectives may champion continued ecological change and development, others may bring a different perspective based on their unique experiences. Refining areas of concern and communities that wish to engage will better target for meaningful National Environmental Policy Act (NEPA) and consultation work, especially considering forthcoming wind energy development in the Gulf.
Outcome	A Submerged Sites Management Plan will be prepared that utilizes collaboratively collected data to facilitate their involvement in state and Federal NEPA processes.
Context	Central GOM

BOEM Information Need(s): Under the Outer Continental Shelf (OCS) Lands Act, BOEM has a responsibility to address the needs expressed by states that may be affected by BOEM's OCS programs. The State of Louisiana has expressed concerns about the loss of coastal archaeological sites due to erosion, subsidence, and sea-level rise, and the effects of their loss from the Native American perspective. The state has repeatedly expressed the critical need to document archaeological sites threatened by sea-level rise and coastal erosion as well as document how Louisiana's communities (modern, descendant, and Tribal) are affected by the loss of archaeological sites and their TCPs. The Choctaw Nation of Oklahoma voiced similar concerns during previous consultations under Section 106 of the National Historic Preservation Act, as part of a separate BOEM study, when they requested studies that identified the spiritual impacts of archaeological site loss in addition to the physical impacts. State concerns include offshore infrastructure (e.g., pipelines and transmission lines) and activities such

as increased vessel traffic that pass through state lands and may affect submerged archaeological sites, some of which are known to contain human remains. The proposed study will provide important information to the State of Louisiana and affected communities for cultural resource management purposes as well as inform BOEM's NEPA analyses related to the effects of OCS oil- and gas-related activities on coastal archaeological sites. Additionally, as the potential impacts of offshore renewable energies on the cultural resources in coastal Louisiana are yet to be fully realized, this study would provide much-needed baseline data for future NEPA analyses of these projects. This study proposes to develop strategies for managing at-risk archaeological sites and TCPs along Louisiana's coast, incorporating Tribal community involvement, and to recommend how BOEM should incorporate these considerations into its consultations and NEPA analyses. The U.S. National Park Service initiated similar land-loss planning both within their parks, as well as across coastal Louisiana, and BOEM will similarly need to address land loss within states affected by BOEM's OCS-related activities (NCPTT 2020; Rockman 2015).

Background: The State of Louisiana contains 40% of the nation's wetlands and experiences 90% of the land loss in the lower 48 states, equivalent to approximately 25 to 35 square miles per year (LA DNR 2015). The rapid loss of Louisiana's coastline is not only an environmental crisis, but a resource management crisis as well. The loss of critical archaeological information will hamper the state's efforts to document, manage, and protect its non-renewable cultural resources. According to Louisiana's Office of Cultural Development Historic Preservation Plan, "One of the greatest challenges…is the task of simply identifying significant historic properties before they are altered or destroyed. This is particularly true for the less tangible properties such as cultural landscapes or traditional cultural properties…" (LA OCD 2011).

This study will support BOEM's assessments and consultations by identifying the effects of coastal erosion and archaeological site loss on local communities, descendant communities, and Tribes, and provide BOEM with the requisite data to make informed decisions about its future programmatic activities. The study will provide background information (baselines) on specific groups identified as having been affected by archaeological and TCP site loss and will provide insight into how each group and their sites have been affected in the past and how these sites may be affected in the future by ongoing coastal erosion and future development from BOEM and Bureau of Safety and Environmental Enforcement (BSEE) program activities. As erosion progresses, new and future OCS-related infrastructure (e.g., wind development and associated transmission lines, oil and gas pipelines, or sand and gravel extraction and beach renourishment activities) could pass through undetected submerged archaeological sites, causing irreparable damage and loss of archaeological information. Under E.O. 13175 and S.O. 3317, Federal agencies are required to consult with affected Tribes on actions that have Tribal implications. This study will provide an opportunity to identify affected Tribes and begin a dialogue to determine actions that require consultation. The information and analyses will be incorporated into Tribal consultations, consultations with affected Gulf States, NEPA documents, Environmental Justice analyses, and OCS-related programmatic reviews.

Ethnographic research and partnerships with descendant communities and Tribes can provide critical information on the history and cultural significance of sites that are now threatened by erosion and land loss. By taking a combined archaeological data-recovery and anthropological approach to understanding the importance of these sites, BOEM is assisting the State of Louisiana and Tribal communities with obtaining the information needed for their respective purposes (Sorset 2013).

Objectives:

- Document perspectives of descendant communities and Tribal groups on investigations of archaeological sites and TCPs endangered by coastal erosion, subsidence, and sea-level rise.
- Create a social history and geography of coastal Louisiana's terrestrial and submerged sites by surveying the coast with locals, descendant communities, and Tribes, and recording their respective histories (Citizen Science).

Methods: (1) Ethnographers, anthropologists, and/or archaeologists will collect information and perspectives from modern, descendant, and Tribal communities on the loss and potential loss of archaeological sites and TCPs due to sea-level rise, erosion, and subsidence. (2) They will seek input into how submerged sites should be managed, documented, and/or mitigated by state or Federal agencies. (3) They will request information pertaining to the effects of subsidence and erosion on the spiritual significance of TCPs. (4) The study will result in a Final Report and a Submerged Sites Management Plan. This study is recommended for funding through a cooperative agreement and the GCCESU.

Specific Research Question(s):

1. How has land loss, energy and resource development, and BOEM and BSEE program activities affected how coastal communities and Tribes relate to impacted archaeological sites and TCPs?
2. How does a retreating shoreline affect local perspectives on how best to balance development, ecological protections, and preservation of archaeological sites and/or TCPs?
3. How do coastal communities and Tribes want state and Federal agencies to manage, document and/or mitigate submerged sites and TCPs?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Assessing Avian Collision-Risk for Offshore Wind Development in the Gulf of Mexico: A Remote Sensing Approach
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Timothy White (timothy.white@boem.gov), Jeri Wisman (jeri.wisman@boem.gov), Tershara Matthews (tershara.matthews@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2028
Final Report Due	TBD
Date Revised	February 7, 2022
PICOC Summary	
Problem	Approximately two billion birds migrate through the northern GOM region, where offshore wind energy development on the OCS is expected. Additionally, two Endangered Species Act- (ESA-) listed and one ESA-proposed species use airspace in these same areas during much of the year. High uncertainty on the distributions and altitudes of birds offshore could create conflict between wind operations and environmental regulations.
Intervention	The study will apply remote sensing methods (portable radar and passive acoustics) offshore to understand the seasonal height, distribution, abundance, and phenology of birds over open GOM waters. These data will inform siting and management recommendations and/or mitigation measures to minimize turbine-related mortality (incidental take) and other adverse effects of birds within the GOM.
Comparison	The study will conduct comparisons across seasons and sampling locations in bird abundance and altitudinal distribution will capture temporal and geographic structure that may be important in siting decisions. Data collection will be replicated across several successive years to address interannual variation. This information would also complement existing BOEM-funded efforts (e.g., the Gulf of Mexico Marine Assessment Program for Protected Species) by providing hard-to-gather information on flight altitudes over open water.
Outcome	Provide important information to inform BOEM, USFWS, and Bureau of Safety & Environmental Enforcement regulatory needs. This includes 1) the number of birds typically expected within the rotor-swept zone, 2) environmental covariates related to flight altitude, and 3) collision risk assessment across space and time.
Context	Industrial energy activities in GOM Region

BOEM Information Need(s): Additional information is needed to assess the potential for reducing avian mortality due to collisions with offshore wind turbines in the Gulf of Mexico (GOM), particularly during spring and fall bird migration (e.g., Cohen et al. 2017, Horton et al. 2019, Clipp et al. 2021). Data on the height, distribution, abundance, and phenology of avian movement patterns are needed to inform offshore wind energy development planning decisions given that each spring and fall billions of birds migrate across the GOM as part of their annual life cycle (Horton et al. 2019). This is in addition to the

federally listed Piping Plover and Red Knot, and the proposed listed Black-capped Petrel, all of which regularly use the airspace over the open Gulf.

Background: Over two billion birds representing some five-hundred species use GOM habitats each year (Fourneir et al. 2019). Included among these species are the federally listed Piping Plover and Red Knot, as well as the proposed listed Black-capped Petrel (Jodice et al. 2021), all of which occupy airspaces over the open Gulf. The peak abundance of birds occurs during the spring and fall migration seasons, but the two ESA-listed and one ESA-proposed species in the Gulf typically occur during the fall-winter and spring-fall months, respectively. Understanding when, where, and at what height birds are moving over the Gulf throughout the year can inform wind development siting and other mitigation measures.

Collision-related bird mortality in the GOM has precedent. Russell (2005) estimated 200,000 avian deaths per year over the entire oil and gas (O&G) platform archipelago in the GOM. Collisions accounted for 34% and 48% of the mortality observed in spring and fall, respectively. Russell (2005) likely underestimated avian mortality given limits to carcass detection. Mortality of trans-Gulf migrants associated with offshore wind energy may considerably add to and even exceed those already attributed to O&G platforms, given potential build-out of wind energy in the Gulf and the increasing size of turbine rotor-swept zones. Additionally, these threats may impact the two ESA-listed and one ESA-proposed species utilizing airspace over Gulf waters. This suggests exposure risk to wind energy development may be consequential for most of the calendar year for a variety of species under conservation concern. Considering bird abundance in North America declined by 29% over the last 50 years (Rosenberg et al. 2019), wind development in the GOM would be another source of additive mortality increasing the number of anthropogenic threats known to negatively impact avian populations.

Since the emergence of utility-scale wind energy production, efforts to understand and mitigate collision risk between flying animals and turbines have been challenged by the biological and technological complexities of the problem. Birds and bats vary widely in their habits and flight behavior, yet Federal and state regulatory agencies are mandated to respond to legal protections for flying animals (e.g., ESA, Migratory Bird Treaty Act, National Environmental Policy Act). This challenge is compounded by forecasted growth in terrestrial and offshore wind energy production of 435% between 2020 and 2051; this in addition to offshore wind accounting for a record 10% of new wind installations in 2020. The growing interest in offshore wind development poses a potential hazard to birds that is unremitting, since these developments have an operational life span of 25–30 years. Measuring impact of offshore wind facilities is especially challenging considering the difficulties of post-construction fatality detection and high uncertainty in offshore bird distributions and flight altitudes.

Radar is one of the few remote sensing technologies that can capture data on the passage rates and vertical distributions of flying animals throughout the day and night. The use of portable radar in the offshore environment to assess seasonal height, distribution, abundance, and phenology of birds better ensures data collection at geographic areas and altitudes specific to offshore wind energy development. Acoustics will aid in determining the species composition of the bird scatterers detected by the radar systems. In this way, the proposed research complements an existing study on the National Studies List that proposes to examine bird movements using data from weather radar continuously over fine and broad scales to monitor bird movements at medium and high altitudes. Portable radar has the potential to address uncertainty at the local level at the scale of a specific wind turbine. Whereas weather radar can extract bird-like scattering over much larger distances and higher altitudes. Developing a multi-modal framework by combining data streams from these systems at multiple vertical and horizontal

scales can address uncertainties concerning potential local and cumulative migratory bird interactions across the GOM in association with wind energy development.

Objectives: The proposed study will determine:

- Spatial and temporal patterns in avian abundance and distribution throughout the year in areas slated for offshore wind development.
- The flight altitudes of birds, bats and potential species composition in the airspace over the open ocean.

Methods: Deployment of multiple acoustic sensors and X-band radars modified for biological data collection to measure altitude stratification, geographic distribution, passage rates, species identification, abundance, and phenology from vessels, O&G platforms, and other suitable offshore testing platforms. Timeline of project envisioned as multi-season to capture baseline spring and fall migration, and multi-year to quantify interannual variability. Multiple sampling locations are required to calibrate a geographic baseline gradient of migration intensity. The use of vessels allows greater spatial coverage around the GOM, whereas platform deployment will be prioritized in areas slated for wind development or suitable for testing purposes. On vessels, motion compensation, sea clutter mitigation, and advanced methods of target discrimination (Schmaljohann et al. 2008) will be integrated into a single radar platform suitable for the offshore environment. Human observers will supplement and corroborate radar observations with taxon-specific information on distribution and behavior. Radars deployed on O&G platforms are freed from the complications of platform motion and complement vessel-based observation by enabling long-duration (months to years with occasional service), cost-effective data collection. he proposed deployment of portable radar units is highly scalable depending on the level of support. The collected data will allow us to compare bird abundance and altitudinal distribution across space and time, which will capture temporal and geographic structure that may be important in siting decisions, including mitigations such as potential seasonal curtailment. Additionally, this study will calculate the proportion of birds within the rotor-swept zone over space and time as well as determine associations between flight height and environmental covariables.

Specific Research Question(s):

1. What are the spatiotemporal patterns of birds and possibly bats in areas slated for offshore wind development across the annual cycle?
2. What altitudes are birds utilizing when flying over open water?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites:

https://gomamn.org/

https://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/Birds_Strategic_Framework_06.23.17.pdf

https://gomamn.org/wp-content/uploads/2020/02/GoMAMN.pdf

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Census of Decommissioned-in-Place (DIP) Pipelines and Appurtenances Approved for DIP under 30 CFR 250 Subpart Q
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Sarah Vaughn (sarah.vaughn@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	January 28, 2022
PICOC Summary	
Problem	Pipelines and appurtenances are DIP on the seafloor with little to no understanding of the overall impact to the marine environment.
Intervention	Literature synthesis of the biological, economical, ecological, archaeological, chemical, and physical impacts of DIP practices
Comparison	Comparison of the impacts of leaving DIP infrastructure on the seafloor versus health and safety, economical, and environmental justifications against removing the infrastructure
Outcome	Greater understanding of the environmental impacts incurred by leaving DIP infrastructure on the seafloor
Context	Central and Western GOM

BOEM Information Need(s): BOEM needs to better understand the environmental ramifications of allowing operators to DIP pipelines and appurtenances on the seafloor under 30 CFR 250.1750 versus any environmental, economic, or health and safety consequences incurred with complete removal.

Background: Offshore operators routinely request a variance or departure from complete removal of end of active use pipelines and appurtenances with the justification that removal would constitute greater safety and environmental hazards when compared to DIP. A report prepared in 2004 for a study authorized by the former Minerals Management Service and the Department of Transportation found only minor environmental risk associated with pipelines DIP; however, the study assumed all pipelines were properly cleaned and decommissioned. In addition, the focus of the 2004 study was primarily personnel safety and risk associated of DIP pipelines versus removal, with less emphasis on environmental impact and cost factors (Scandpower Risk Management, Inc. 2004).

The 2021 Government Accountability Office (GAO) report on Offshore Oil and Gas determined that the Bureau of Safety and Environmental Enforcement (BSEE) needed to formulate and finalize updates to pipeline regulations to address safety and environmental risks and that without updated regulations, BSEE will continue to lack enforceable standards for pipeline decommissioning (GAO 2021). The GAO report noted that since the 1960s, approximately 97% of pipelines that had reached the end of active use, estimated at around 18,000 miles in length, were authorized to be DIP on the seafloor and concluded that safety and environmental risks were not thoroughly evaluated during applications

submitted by offshore operators for pipeline decommissioning and abandonment (GAO 2021). Furthermore, the GAO report found that there is no assurance that operators meet the decommissioning standards in accordance with 30 CFR 250.1751, and the condition and locations of DIP pipelines are not monitored. This lack of oversight limits the capacity to mitigate long term risks.

Pipelines that are DIP incorrectly are at risk for exposure, movement, and corrosion. Exposed DIP pipelines and appurtenances can pose potential hazard to commercial fishing activities and become navigational obstructions; DIP pipelines that have moved may threaten culturally or archaeologically sensitive resources or Essential Fish Habitat; and DIP pipelines that have begun corroding may lack the structural integrity for future removal, leak hydrocarbons or other chemicals, and contaminate surface mineral deposits (GAO 2021).

In addition to pipelines DIP, BSEE allows for appurtenances such as umbilicals to be DIP without existing regulation authorizing the practice and little to no information on the potential environmental impact. Umbilicals may contain lines for electric or hydraulic power or chemicals which may not be practicable to flush. BSEE Notice to Lessees (NTL) 2015-G03, *Marine Trash and Debris Awareness and Elimination* under BSEE's Pollution Prevention Regulations at 250.300, educates offshore workers about the environmental threat of trash and debris discarded at the sea surface that may sink or float. The NTL does not apply to DIP pipelines and appurtenances.

Objectives:

- Assess the environmental impacts (including biological, ecological, archaeological, chemical, and physical aspects) of decommissioning pipelines and appurtenances and abandoning on the seafloor.
- Assess the environmental impacts (including biological, ecological, archaeological, chemical, and physical aspects) of pipelines and appurtenances removal and onshore disposal.
- Identify data gaps that may require further study.
- Compare the environmental benefits and detriments of DIP on the seafloor to removal and onshore disposal.
- Review the health and safety risks associated with leaving pipelines and appurtenances on the seafloor versus risks encountered through removal and disposal activities.
- Review the economic benefits attributed to DIP compared to costs incurred by DIP pipeline exposure, movement, corrosion, interference with commercial fishing, or navigational obstructions.
- Analyze records of post-hurricane pipeline inspections for impacts to DIP pipelines and umbilicals.

Methods: The study would involve a thorough literature review of relevant research; a database query of records for background DIP pipeline or umbilical information such depth, installation date, DIP date, and other relevant details as available; a query and review for DIP pipeline inspection records; and a comparative analysis of findings.

Specific Research Question(s):

1. What are the environmental benefits and detriments to DIP pipelines and appurtenances compared to removal?
2. What are the health and safety risks associated with DIP and with removal?
3. What are the economic benefits of pipeline and appurtenance DIP?
4. What data gaps remain with respect to DIP pipelines and umbilicals versus removal and offshore disposal?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Characterization of BOEM and BSEE Oil- and Gas-Related Vessel Traffic in the Gulf of Mexico
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Hayley Karrigan (hayley.karrigan@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 20, 2022
PICOC Summary	
Problem	GOM is lacking detailed data and assessment of oil and gas (O&G) related vessel traffic. This information is needed for all GOM Planning Areas to meet specific Terms and Conditions of the 2020 National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) and to inform Endangered Species Act (ESA) and Marine Mammal Protection Act consultations.
Intervention	BOEM must determine the level of OCS O&G vessel activity over time, ports used, the type of vessels being utilized by industry, and percent of each vessel type specifically dedicated to GOM OCS O&G related activities.
Comparison	BOEM must determine changes in OCS O&G vessel activity over time, with multiple types of vessels, and currently, no baseline exists. This is used to determine the accuracy of "take" estimations; take exceedance could cause ESA consultation re-initiation and an additional expenditure of staff resources, and delay in current efforts.
Outcome	Study results will enable BOEM and BSEE to establish the utility of Automatic Identification System (AIS) data (currently presented in the 2020 NMFS BiOp) with respect to OCS O&G vessel traffic and identify other potential data sources for vessel traffic estimates.
Context	All GOM Planning Areas

BOEM Information Need(s): The 2020 NMFS BiOp on the Federally Regulated Oil and Gas Program Activities in the Gulf of Mexico includes a Term and Condition, as amended in 2021, related to gathering and understanding actual annual O&G related vessel traffic in the GOM OCS. Section 15.3.3 Term and Condition #3 Subsection 15.3.3.1 Bureau of Ocean Energy Management Reporting F states, "BOEM, in conjunction with BSEE, shall annually report to NMFS summarized vessel data associated with all O&G activities. Reporting shall include: vessel type (barge, tow, tanker, supply, etc.), vessel tracks vessel size/draft, vessel type/purpose, port name, number of annual port calls for that vessel, outgoing vessel offshore destination (e.g., block area name and water depth), highest travelling vessel speed capability, and other relevant information as identified through annual review process. Vessel captains typically keep vessel logs and know the specifications of their vessels, and therefore this information should be readily available to oil and gas companies."

BOEM and BSEE need more specific information on GOM vessel traffic information to comply with the 2020 NMFS BiOp and further validate NMFS assumptions in the BiOp related to vessel interactions and takes of ESA-listed marine mammals and sea turtles. Current assumptions may be overly conservative or uncharacteristic of vessel activity specific only to oil- and gas-related activities in the OCS. BOEM and BSEE need to know how to monitor/account for the number of vessel trips in a year to determine the accuracy of take estimation and ground truth NMFS assumptions. Otherwise, take estimates could erroneously be exceeded, potentially causing the re-initiation of ESA Section 7 consultation, which would incur a significant amount of staff time and efforts, in addition to delays on ongoing efforts. In addition, this vessel traffic information could be used to develop more informed vessel strike and noise impact analyses, and vessel traffic characterization in National Environmental Policy Act documents.

Background: Worldwide, the ocean has become a noisy habitat for marine animals as ambient noise levels rise as a result of anthropogenic activities from various sources (Tyack 2008). Cetaceans rely on sound as a primary sense for vital life functions and increased noise levels may mask important sounds, including con-specific vocalizations, as well as cause direct harm (Richardson et al. 1995; Erbe et al. 2019). Beyond noise from service vessels, vessel interactions or strikes are a major concern for marine mammals (Laist et al. 2001). Marine mammals and sea turtles in the GOM inhabit a highly industrialized environment with multiple anthropogenic inputs including shipping, O&G activities, and military operations (Estabrook et al. 2016).

In the 2020 BiOp, NMFS identified the use of vessel traffic or vessel trips (e.g., line miles) as a surrogate for vessel strike and trash and debris takes. Surrogate is defined as a species or environmental parameter used to estimate take when it is difficult to detect for a specific species. NMFS currently estimates take based on historic AIS vessel data (via https://www.marinetraffic.com/) overlapped with species distribution data in the GOM. At this time, AIS data is the most extensive information on vessel traffic in the GOM OCS. The concern with just using the AIS data is that vessels are used for other purposes beyond OCS oil- and gas-related activities, so the extent to which a vessel is used solely for BOEM-managed activities is not clear, certain, or easily validated. This method may overestimate actual O&G vessel traffic since certain vessels may have other purposes and also be used for other unrelated activities during a trip. Therefore, estimated takes may be overestimated as well, which is a potential re-initiation trigger for the ESA consultation. This would result in a notable increase in staff time and efforts, as well as delays in current efforts.

Objectives:

- The study will be phased and initially would establish the utility of the AIS data. If the utility of the data can be validated, the study will establish a baseline for BOEM oil- and gas-related vessel activity throughout the GOM OCS (including ports) against which to judge potential past, present, and future vessel interactions/strikes as well as characterize potential impacts per specific vessel and percent usage.
- If the utility of the AIS data cannot be validated, other characterization options should be investigated. This includes a search for other databases and/or models.
- If existing databases or sources are not identified, evaluate potential for direct data acquisition from industry.

Methods: This study would have multiple phases.

Phase 1: Assess AIS data and utility and validate vessel types utilized within the entire O&G industry (e.g., percent usage and time/area). Provide curated list of vessels by type that are appropriate for this type of analysis. Provide recommendation for other vessel data sources that could be used in lieu of the AIS data.

Phase 2: If a curated AIS list is possible or other vessel data source is identified in Phase 1, then move forward with a thorough synthesis of vessel traffic across the entire Northern GOM. Determine if AIS provides vessel speeds or if there is another database/modeling with a more accurate approach to vessel characterization.

Phase 3: If earlier evaluation from Phase 1 or 2 suggests that a curated list would not provide accurate information, then develop industry data requirements and prepare the economic review (e.g., complete required forms over the length of the process) as required by the Paperwork Reduction Act (PRA) regulations.

Specific Research Question(s):

1. Does AIS data provide an accurate representation of GOM OCS O&G vessel traffic?
2. Are there alternative data sets that would better represent GOM OCS O&G vessel traffic compared to AIS data?
3. Is vessel traffic data collection directly from Operators before, during, and after permitted BOEM activities feasible within the limits of the PRA?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Climate Migration and Dynamic Environmental Justice Considerations
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Dustin Reuther (dustin.reuther@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2023–2027
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	-
Problem	Coastal communities in Louisiana, many of which are integral considerations for BOEM's Environmental Justice (EJ) analyses, are experiencing intensifying and ongoing climate-related migrations away from the coastline. It is currently unknown how offshore energy activities, and their onshore components are impacted by, or potentially themselves impact, this dynamic demographic process.
Intervention	This study will use mixed methods to characterize ongoing out-migration across coastal Louisiana, as it relates to EJ communities, and investigate this demographic shift in the context of OCS energy activity.
Comparison	EJ communities in coastal Louisiana (especially Native American communities) have been disproportionately affected by oil and gas activities and are also the most at risk to experience the worsening effects of climate change and anthropogenic environmental alterations in the coastal region. This current situation is also the baseline condition for any future renewable energy developments in the Gulf of Mexico (GOM).
Outcome	This study would assist BOEM in understanding ongoing trends and resident decision-making processes to better assess and predict demographic trends as they relate to the onshore components of offshore energy infrastructure and BOEM's EJ and National Environmental Policy Act (NEPA) processes.
Context	Central GOM

BOEM Information Need(s): Continued out-migration from Louisiana's coastal region adds complexity to EJ considerations as they relate to historically under-served communities and potential for disproportionate effects from OCS energy and mineral development activities. BOEM requires a clearer and more thorough understanding of these demographic shifts to better inform Bureau decision makers as mandated by NEPA and the OCS Lands Act. This data would represent a baseline for all future analyses, and for offshore energy this information is a crucial component in appreciating the cumulative effects of BOEM-regulated activities. BOEM needs a comprehensive characterization of this migration process as it relates to both offshore energy and EJ concerns.

Background: Migration away from Louisiana's coastal region (sometimes also referred to as "retreat" or "climate-change migration" in contemporary literature) has been an ongoing process for more than 100 years (due to coastal land loss, extreme weather events, and economic opportunity). Although it originally affected primarily Native American and other marginalized communities, continued land loss

in coastal Louisiana has exacerbated the impacts of hurricanes and other manmade and natural disasters for all coastal populations. Still, many of these coastal populations are members of EJ communities who have been shown to be "increasingly disproportionately impacted by the development of the offshore oil and gas industry," and thus represent a pressing informational need for BOEM's EJ analysis (Hemmerling et al. 2021, 134). This increased impact stems from the fact that these populations (increasingly, members of Native American communities) are sited around upstream and downstream oil and gas infrastructure and participate in oil and gas-related economic activities (Hemmerling et al. 2021; Laska et al. 2005). As future renewable energy development in the area could utilize and build from the established oil and gas infrastructure and workforce, many of these communities will also be included in future NEPA and EJ analyses for renewable energy.

Currently, migrations away from the coastal region appear to be happening at an accelerated rate, as each new out-migration contributes to the fraying of social networks in communities and disincentivizes pull factors which keep residents in these communities (Peterson 2020; Simms 2021). Further, many of these migrations may be happening in a less geographically incremental manner than is traditional to coastal Louisiana (such as moving within parishes or to nearby parishes), with coastal Louisiana residents now increasingly moving out of state to join pioneering migrant family members in other locales, especially Texas. This trend is expected to place coastal Louisiana as the second highest region in the United States for out-migration due to sea level rise by 2100 (Hauer 2017). This has led the Louisiana Office of Community Development (2019), for example, to advocate for the State of Louisiana to prioritize relocation programs over structural coastal protection and restoration strategies. While some independent work has been undertaken to better understand how coastal residents conceptualize a sense of place and some decision-making processes related to specific precipitating events (e.g., Simms 2021), exactly how this dynamic population process relates to BOEM concerns in the region is not currently well developed.

A study looking at the modeled effects of a 100-year storm on demographics in Louisiana's coastal region showed that the effects would be felt disproportionately among Asian and Hispanic populations overall and among particular community clusters of African Americans and Native Americans within the region; further, much of the affected Native American population will not receive the same level of protection from the state's ongoing plans for coastal protection and restoration (Dalbom et al. 2014). Oil and gas spills, such as the onshore Murphy Oil refinery spill following Hurricane Katrina or the offshore *Deepwater Horizon* disaster, have negatively affected many of these communities, contributing further to out-migrations, potentially affecting them in the future. With increasingly worsening hurricanes, this has further EJ implications; for example, following Hurricane Ida there were over 1,500 reports of pollution incidents in Louisiana and the OCS, and the National Oceanic and Atmospheric Administration identified 55 spills (Migliozzi and Tabuchi 2021; US Coast Guard 2021). The hurricane also likely prompted another wave of out-migration from coastal Louisiana.

Objectives: The objectives of this study are to

- Characterize ongoing out-migration from coastal Louisiana
- Relate this out-migration to ongoing and future oil and gas operations and future renewable energy development
- Better understand how this migration process should be accurately accounted for in EJ analyses and environmental impact assessments, including cumulative effects

- Explore the ways in which this process can be described, measured, and applied to ongoing and future EJ and NEPA work undertaken by BOEM

Methods: This mixed-methods study will combine analyses of data from publicly available sources, such as the US Census, with ethnographic methods, such as semistructured and/or unstructured interviews, and situate these through Geographic information system (GIS) analysis, to provide insights into and knowledge of the process of out-migration. GIS and demographic data will capture general regional trends and relations to wider socioeconomic factors and identify the physical, place-based components of migration and its relation to the infrastructure of offshore energy. Communities where ethnographic research should be undertaken will be identified through the preliminary analysis of demographic and GIS data. Augmenting this, BOEM is currently establishing internal methodology for EJ analysis in NEPA documents, and the results of these efforts could be applied to demographics data during this stage (also reducing workload for these efforts in future NEPA analyses). Ethnographic research between different EJ out-migration and receiver communities will better articulate the similarities and differences between community-specific trends to inform both community-specific and regionally applicable processes. Interviews will capture personal decision-making processes and better articulate the context-specific data surrounding migration. For example, ethnographic decision modeling could be used to understand the applicability of individual migration decisions at the community scale, and if consistency is found, out-migration as an impact factor could be more accurately analyzed in potential NEPA scenarios.

Specific Research Question(s):

1. Which demographics are staying, and which are leaving? Could this change EJ criteria for coastal communities?
2. Where are migrants going (as these could potentially be current or future areas of EJ and/or NEPA concern)?
3. How does coastal out-migration relate to the current and anticipated infrastructure of offshore energy activities (both petroleum and renewable)?
4. Can precipitating events and decision-making processes be understood enough to predict the future impact of coastal out-migration (e.g., ethnographic decision modeling)?
5. How best can the cumulative and potential future effects of out-migration be characterized in relation to community cohesion, EJ and NEPA considerations, or energy infrastructure?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Geodatabase of Benthic Community Habitat in the Gulf of Mexico
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Jeri Wisman (Jeri.Wisman@boem.gov), Alicia Caporaso (Alicia.Caporaso@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	April 14, 2022
PICOC Summary	
Problem	Spatial geographic information systems (GIS) and other mapped benthic community habitat feature data/information is curated within BOEM's Gulf of Mexico Region (GOMR) in disparate formats, within several databases, with non-uniform quality control, and maintained by several different offices within the region. There is no standardized procedure for reporting and/or recording newly discovered features or updating spatial resolution of features.
Intervention	Develop a public-facing geodatabase for all benthic habitat feature classes in the GOM and standardized procedures for reporting and recording features and associated data, quality assurance, maintenance, and publishing
Comparison	BOEM GOMR does not maintain a comprehensive geospatial or other database for reporting or recording benthic community habitat features.
Outcome	The creation of a comprehensive geodatabase of benthic community habitat feature
Context	Northern Gulf of Mexico (GOM)

BOEM Information Need(s): BOEM requires accurate information about the seafloor to appropriately mitigate impacts to sensitive, benthic habitats. Currently, BOEM uses an inefficient process to document and review relevant benthic community habitat features, including presence or absence of feature(s), feature type, vertical relief, confirmed organisms, etc. BOEM subject matter experts (SMEs) currently use a practice of "start at the beginning" for review and analysis, meaning that previously documented data and information on proposed activity areas are not easily accessible for SMEs to compile or review. This can lead to duplication of efforts by SMEs when conducting reviews, as well as duplication of efforts to identify and document seafloor features by regional offices of environment, resource evaluation, and mapping. This presents a need for a geospatial tool as well as a streamlined, standardized process for recording and accessing spatial data associated with benthic community habitat to reduce waste of valuable resources (e.g., time, effort, Environmental Studies Program [ESP] funding) and increase quality assurance and control. For example, this geospatial tool could be used to geospatially represent the results of completed or ongoing ESP efforts as well as archive the data for studies such as "Identifying Sensitive Hardbottom Habitat in Shallow Federal Waters of the Gulf of Mexico (GM-21-x05) (CSA Ocean Sciences Inc. 2021)." Additionally, having the spatial data in this format would allow for larger scale

analyses, such as monitoring changes to benthic communities from regional, long-term impacts (e.g., climate change).

The geospatial tool would be made publicly available for use by other Federal agencies and stakeholders as well as operators in the GOM OCS. Users could identify and avoid known benthic features covered by BOEM lease stipulations and other Notice to Lessees guidance and subsequently reduce Requests for Information in, for example, the post-lease benthic review process.

Background: BOEM SMEs reference digital spatial data and mapping products depicting benthic community habitat features to inform several mission critical activities, including programmatic National Environmental Policy Act (NEPA) analyses, Post-Lease NEPA analyses, geohazard and risk mitigation, information needs analyses, Essential Fish Habitat and Endangered Species Act interagency consultation, etc. Currently, spatial GIS and other mapped benthic community habitat feature data and associated information is curated within BOEM's GOMR in disparate formats, within several databases, with non-uniform quality control, and are maintained by several different offices within the region. Additionally, there is no standardized procedure for reporting and/or recording new or legacy (i.e., stored in paper or Technical Information Management System PDF documents) features, updating the spatial resolution and associated data of features, conducting quality assurance and control, or releasing timely spatial mapping information to BOEM, other governmental agencies and stakeholders, or the public. In addition, there is no tool for quickly identifying a lease block as containing no benthic community features. For example, in the above-mentioned study, GM-21-x05, of the 237 lease block high-resolution geophysical surveys reviewed for the presence of hard bottom benthic features, approximately 50% of the lease blocks had no benthic features present. A centralized geodatabase would quickly allow reviewers to note that no benthic features are in the proposed activity area, thus reducing time and resources duplicating effort.

Objectives:

- Create a publishable, working geodatabase of benthic community habitat features identified on the seafloor surface through high-resolution geophysical survey or other ground-truthing methods (e.g., remotely operated vehicle surveys) currently stored in disparate digital formats and databases in BOEM GOMR.
- Review and consolidate existing BOEM GOMR mapping features, layers, shapefiles, etc. (e.g., topographic features, pinnacles, etc.) into the geodatabase.
- Standardize tabulated data and metadata for all feature class layers.
- Develop standardized procedures for feature addition, revision, or removal to/from the geodatabase.
- Develop a public interface for visualization, access, and use (e.g., through Marine Cadastre [https://marinecadastre.gov/], boem.gov, Ocean Reports, etc.).

Methods:

- Review BOEM's existing databases and libraries to identify spatially referenced benthic community habitat features (e.g., EORS.gdb, BOEM Water Bottom Anomalies, study findings, etc.).

- Create a blueprint for the benthic community habitat feature geodatabase, as well as a draft Standard Operating Procedures (SOP) for reporting and recording updates to the database.
- Develop an inclusive benthic community habitat feature geodatabase using the identified BOEM benthic community habitat features and associated data/information and update SOP(s) as necessary.
- Provide a tutorial and training session for BOEM SMEs for how to use and incorporate the new benthic community habitat feature geodatabase into BOEM processes (e.g., post-lease benthic reviews).

Specific Research Question(s): N/A

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

CSA Ocean Sciences Inc. 2021. Identifying sensitive, hardbottom habitat in shallow, Federal waters of the Gulf of Mexico: final report. New Orleans (LA): US Department of the Interior, Bureau of Ocean Energy Management. 135 p. Report No.: BOEM 2021–069.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Impacts of Offshore Carbon Sequestration on the Marine Environment: Literature Review and Synthesis for Management
Administered by	TBD
BOEM Contact(s)	Thomas Kilpatrick (thomas.kilpatrick@boem.gov), Mark Mueller (mark.mueller@boem.gov), Melissa Batum (melissa.batum@boem.gov), Jennifer Le (jennifer.le@boem.gov)
Procurement Type(s)	TBD (likely Contract or Cooperative Agreement)
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	Month Day, Year
PICOC Summary	
Problem	BOEM has new authority, under the 2021 Bipartisan Infrastructure Law, to oversee carbon dioxide (CO_2) capture, utilization, transportation, and sub-seabed sequestration (storage) on the Outer Continental Shelf (OCS). Information on potential impacts of these activities on the human and marine environment is needed to inform leasing and management decisions.
Intervention	Perform a literature review and synthesis of the impacts of subsea CO_2 sequestration on the marine and coastal environment at the national level for each OCS Region (Atlantic, Gulf of Mexico, Pacific, Alaska) with a focus on directly informing BOEM and US Government-wide management needs. Identify information needs that will guide future environmental studies.
Comparison	BOEM needs more information about the potential environmental impacts of subsea CO_2 sequestration, in particular how CO_2 leaking from sequestration reservoirs may affect OCS resources, the marine and coastal environment, and atmosphere. sediments, benthic biota, and the water column.
Outcome	The literature review will aid BOEM's ongoing rulemaking efforts and future operational needs (National Environmental Policy Act (NEPA) analysis, consultations, etc.). These analyses can inform programmatic and site-specific NEPA analyses at the national and regional levels. In addition, the results may inform lease stipulations and/or terms and conditions of plan approvals. The results may also aid in the development of rulemaking requirements. Identified information needs will provide direction for future studies to include field and/or laboratory analyses.
Context	Negative emissions methodologies such as CO_2 sequestration will be an important part of the United States' efforts to mitigate the climate change crisis and reach net-zero emissions by 2050. Special focus will be given to the Gulf of Mexico due to ongoing resource assessment efforts there and relatively higher likelihood of activity there, but the information is needed and will apply in all regions.

BOEM Information Need(s): CO_2 capture and removal is an essential component of current climate mitigation models; and therefore, likely to be an essential part of the United States' goals to mitigate the climate change crisis and reach net-zero carbon emissions by 2050 (IPCC 2005, NAS 2019, NAS 2021, The

White House 2021). The only prior BOEM-funded study on the topic (Smyth and Hovorka 2018) detailed recommendations for best management practices for CO_2 sequestration in subsea reservoirs, with a focus on geological considerations like reservoir selection and pipeline transmission. That report did not provide sufficient detail on potential environmental impacts including direct, indirect, and cumulative effects that will be needed to accurately inform NEPA and other environmental analyses. There remains a need to identify potential impacts to the marine environment to guide appropriate pre- and post-activity management and monitoring. This need is made all the more urgent by BOEM's newfound authority over carbon sequestration in subsea reservoirs over the OCS. A couple of European countries and Australia have developed similar offshore sequestration regulations but so far only a couple of projects are actually underway. A literature review and synthesis at the national level but with unique context given for each of BOEM's OCS regions will help focus future environmental efforts, such as impacts from CO_2 leaking from reservoirs (including possible air quality impacts), seismicity, and pipelines and transport.

Background: The INVEST in America Act (i.e., bipartisan infrastructure bill) of 2021 amended the OCS Lands Act's leasing provisions to authorize the Department of Interior to grant leases, easements, and rights-of-way on the OCS for the purpose of carbon sequestration (see 43 U.S.C. § 1337(p)(1)), granting BOEM management authority over carbon sequestration in OCS subsea reservoirs. Rulemaking efforts are currently under way to create the regulations for CO_2 sequestration leasing and associated reporting/information requirements.

A newly awarded BOEM study, Impact of Abandoned Oil and Gas Wells on Air and Water Quality in the Gulf of Mexico (GM-22-01), will inform and be coordinated with this study. The Gulf field study will measure the amount of CO_2 and methane leaking from a small (~10 sites) sample of abandoned oil and gas wells in the Gulf of Mexico. Such leaks have been identified in the past, but it is unknown how many leaks exist and what are the immediate and cumulative environmental impacts.

Leaks from subsea CO_2 reservoirs could cause localized acidification of seawater, with potential negative impacts on benthic and pelagic ecosystems (Rastelli et al. 2015). For example, ocean acidification (and shifting zones of aragonite saturation state) can have negative effects on organisms across a range of depths (Lunden et al. 2014, Hennige et al. 2020). CO_2 that leaks into the water column could escape to the atmosphere via air-sea fluxes, which would be relevant to BOEM efforts to regulate greenhouse gas emissions over the OCS.

For monitoring of CO_2 sequestration projects, BOEM information needs include (NAS 2019): how to identify leaks; the threshold at which a leak would require mitigation efforts (Smyth and Hovorka 2018); how to adapt monitoring for changing needs and conditions over time; and to what extent monitoring of CO_2 plumes in the geological reservoir is necessary, and what are the optimal monitoring methods to do so (seismic, subsea pressure, etc.)

Objectives: To conduct a focused literature review and synthesis of the impacts of subsea CO_2 sequestration on the marine environment to directly inform BOEM assessment/analysis needs for both pre- and post-lease. This effort will potentially guide development of future environmental studies that would include field and/or laboratory analyses in the priority areas identified in this report. The prior BOEM study (Smyth and Hovorka 2018) focused more on the geological aspects of subsea CO_2 sequestration and best management practices; it provides a solid foundation to build on but this study will provide needed focus and detail about the potential impacts to the benthic and pelagic marine environments and also potentially surface air quality.

Methods: The study will compile existing knowledge on carbon sequestration impacts on the marine environment, via review and synthesis of literature and other public information (workshop reports, etc.). Subsea CO_2 sequestration has already taken place off Norway and Australia, so BOEM does not have to start from a blank slate. Information needs that are relevant to the BOEM environmental program will be identified from the literature review. The study deliverables would include specific recommendations for future BOEM studies to address, including field, laboratory, or modeling analyses.

Specific Research Question(s):

1. What information and data are currently available on the impacts of leakage from subsea CO_2 sequestration reservoirs on the marine environment? What is the threshold at which a leak would require mitigation efforts? Are there any known impacts of this CO_2 leakage on air quality?
2. What are the known or potentially likely impacts of subsea CO_2 sequestration to seismicity, benthic biota, and other components of the marine environment?
3. To what extent can BOEM use the same regulatory framework as for oil and gas operations, and where might there be novel Impact Producing Factors?
4. What are the optimal monitoring methods for identifying leaks? How to adapt monitoring of each CO_2 sequestration site for changing needs and conditions over time?
5. To what extent is it beneficial and/or necessary to monitor CO_2 plumes in the subsea geological reservoir, and what are the optimal monitoring methods to do so (seismic, subsea pressure, etc.)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Smyth RC, Hovorka SD. 2018. Best management practices for offshore transportation and sub-seabed geologic storage of carbon dioxide. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. 259 p. OCS Study BOEM 2018-004. https://marinecadastre.gov/espis/#/search/study/27007

The White House. 2021. The long-term strategy of the United States: pathways to net-zero greenhouse gas emissions by 2050. Washington (DC): U.S. State Department and Executive Office of the President. 65 p. https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Offshore Wind Energy Data Collection for the Gulf of Mexico Region for Economic Impact Analysis
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Doleswar Bhandari (doleswar.bhandari@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	February 7, 2022
PICOC Summary	
Problem	In order to conduct a robust economic impact analysis of the first offshore wind energy development project under these circumstances, BOEM requires project-level data on the type, cost, and origin of the material, services, and labor. Such data will support BOEM's modeling of economic and demographic effects and the monitoring of a rapidly evolving industry.
Intervention	Systematic project-level data collection will significantly improve BOEM's capacity to conduct National Environmental Policy Act (NEPA) analysis for socioeconomic impacts of proposed future wind projects. To achieve this goal, the data must be sufficient for BOEM's needs and must be collectible—that is, a reasonable burden on industry. This study will identify these data and the forms in which to collect them.
Comparison	Offshore wind energy development in the GOM region is new, and it would be useful to compare with offshore wind developments in Europe, specifically how data is collected from developers.
Outcome	Systematic project-level data collection will help BOEM gain information and analysis necessary for the economic impact analysis of offshore wind energy projects. Once developed for the Gulf, the findings should be applicable to other regions.
Context	Offshore wind energy development in the Gulf of Mexico (GOM) Region

BOEM Information Need(s): Wind energy development in the GOM Region is new. While BOEM has a considerable base of oil and gas-related socioeconomic information for the GOM, it lacks similar wind energy-related information. Also, since offshore renewable energy is a new industry to the GOM, many areas of impact are yet to be developed and discovered. At this initial stage, the potential windfarm development, transmission, and distribution areas in the GOM Region can only be vaguely understood. Therefore, it is important to develop and initiate a systematic project-level wind energy data collection from different phases (i.e., Site Assessment Plan, Construction and Operations Plan, Facility Design Report, Fabrication and Installation Report, project construction, and commencement of operations) that will provide standard, regularized, and reliable measures of this industry that will support socioeconomic impact assessment (including Environmental Justice assessments), robust economic modeling and estimations, annual monitoring, and the analysis of cumulative effects. The last two of these are particularly

important since the industry is new and rapidly evolving. This methodology can be developed under the renewable energy regulation 30 CFR 585.611 and 585.627 data submission requirements. A mindful definition of these requirements will maximize their usefulness. Additionally, President Biden signed Executive Order (EO) 14008, "Tackling the Climate Crisis at Home and Abroad," which created a government-wide Justice40 Initiative to deliver 40 percent of the overall benefits of relevant federal investments to disadvantaged communities. Knowing more about wind energy-related workers supports the Justice40 initiative in wind energy projects. This project will focus on the first wind project in the GOM region, and other subsequent wind projects can also learn from the first project.

Background: Descriptive information for assessing economic and labor demand falls into three categories based on considerations of their procurement and records keeping. Wind energy-related technical information includes turbine size, turbine holding structure, nacelle size and quality, distance from the main transmission line, distance to the population center, size of the wind farm as well as location of sources of manufacturing of these components. Much of this is early-stage information, but some are not since repairs and upgrades occur during a project's life. This is the easiest information to collect but, depending on how far up- and downstream the analysis goes, it is not necessarily easy. The second is such human resources information as numbers of particular job categories, conditions of employment, and compensation systems. The variation of this information by project phase (e.g., construction vs. maintenance) is often critical to impact assessment. Because of its proprietary nature, the collection of this information is more challenging than it is for the technical, and difficulties are compounded by subcontracting and other labor-management issues if one moves up or downstream. Finally, to assess the onshore effects of offshore employment, one needs information on the onshore distribution of that employment, at minimum information on employee job categories and compensation. Obtaining such information is particularly challenging and must come stripped of personally identifiable information. A sound system must use multiple approaches to collect the required information. To deliver information usable to BOEM, it must be collected in ways that are not onerous to participant companies and are in alignment with 30 CFR 585.113 regarding BOEM's commitment to preserve proprietary information internally and not release same to the public.

Objectives: This project aims to develop the first systematic project-level wind energy data collection in the GOM regions by defining 30 CFR 585.627 data submission requirements and establish a systematic and efficient system by which companies can provide these data. These data will provide critical support for BOEM environmental impact assessments, socioeconomic modeling, and monitoring of OCS wind energy developments.

Methods: This research aims to develop the first systematic project-level wind energy data collection for the GOM region, although once developed, it may be applicable elsewhere. This study will rest on expertise from BOEM and from the renewable energy industry as well as draw on existing data and literature. The question a systematic approach must address is, on one side, what data does BOEM want or need for regional/local analyses and, on the other, what data might it get and how might it get it? There are different types of data and different costs to acquiring them. Part of the solution will be BOEMs, and part calls for BOEM/industry interaction. For example, the acquisition of important data may be regularized through the CFR 585.611 and 585.627 data submission requirements for companies using OCS waters for wind energy development. Working closely with BOEM and with advice from industry and other experts, the project will identify the data to be collected and the methods and instruments by which these data will be collected. The

project will then use this information to obtain two years of systematic data. The project aims at the following:

- Bridge the data gap in offshore wind energy projects by collecting wind energy-related technical and human resource data. As Jobs and Economic Development Impact Model (JEDI[1]) lists, the technical data include plant characteristics (i.e. plant capacity, number of turbines, row spacing, turbine spacing, etc), turbine design (i.e. turbine rating, rotor diameter, hub height, rated wind speed, blade mass, blade deck space, blade length, nacelle mass, tower mass), site characteristics (i.e. site depth, mean wind speed, distance from port to the site, distance from the site to an offshore substation, distance from offshore substation to landfall, distance from landfall to interconnection, landfall trench length) substructure design (i.e. foundation type, scour protection), electrical infrastructure (i.e. alternating current resistance, capacitance, conductor size, current capacity, inductance, linear density, rated voltage, cost/km, redundant export cable), port characteristics (i.e. port name, port rate/month, # of cranes), and vessel deployment. Human resource data include the number of workers in each job category across the wind energy construction, operations, and maintenance phases.
- Collect wind energy construction costs data including turbine component costs (Nacelle/nrivetrain, blade, tower materials and labor costs), the balance of system costs (substructure and foundation, electrical infrastructure components, assembly, and installation, ports and staging, development, and other project costs, engineering, and management -materials and labor costs) and soft costs (commissioning, construction finance, insurance, contingency, decommissioning, and such).
- Collect operations and maintenance cost data (offshore maintenance; onshore maintenance, operation, management, and general administration; environmental health and safety monitoring; materials and labor; insurance; and fees).
- Identify the list of wind energy-related jobs across the wind energy development phases and obtain or estimate individual compensation by place of residence and place of work.

Specific Research Question(s):

1. What socioeconomic impacts are offshore wind energy projects expected to produce?
2. What are the capital expenditure costs of offshore wind projects?
3. What are the operation and maintenance costs of offshore wind projects?
4. Who are the people who work for wind energy projects? Where do they live, and where do they work?
5. What kind of data is needed for annual socioeconomic impact monitoring?

[1] The JEDI Offshore Wind model is a publicly available model used to estimate economic impacts of utility-scale offshore wind energy projects. The model was developed by NREL. It is a free tool and available for download. For more information on the full suite of JEDI models or to download the JEDI Offshore Wind model see: https://www.nrel.gov/analysis/jedi/wind.html

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References: N/A

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Onshore Infrastructure Utilization, Development, and Potential Scenarios Related to Gulf of Mexico Outer Continental Shelf Wind Energy Projects
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Sindey Chaky (Sindey.Chaky@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	February 7, 2022
PICOC Summary	
Problem	BOEM needs to understand how potential offshore wind energy projects may develop using existing coastal infrastructure, what new onshore infrastructure may be required, and how Gulf Coast communities and business that may potentially provide support for offshore wind energy projects could be affected.
Intervention	This study will conduct a coherent and thorough assessment within the context of a range of scenarios regarding existing and potential new onshore support infrastructure that may develop as offshore wind energy projects develop in the GOM.
Comparison	Comparative to wind energy development in the North Sea where, like the GOM, oil and gas activities have been ongoing for decades
Outcome	BOEM decision-makers and various stakeholders will gain a better understanding of how wind energy projects may develop in the GOM and the potential social, economic, industrial, and community-level effects that may occur.
Context	GOM Region

BOEM Information Need(s): BOEM requires specific, detailed information about the various types of onshore coastal infrastructure that may be utilized to provide upstream and downstream support for the development of wind energy projects on the GOM OCS. Of particular interest is how existing onshore coastal infrastructure may interact with offshore wind energy development and what new types of onshore infrastructure may be required to support this frontier industry (e.g., ports, shipyards, fabrication yards, support services, electric grid). This information is critical for developing scenario projections that will inform BOEM's environmental impact analyses across all resources and will ultimately inform BOEM decision-makers in their oversight and management of OCS resources as mandated by the OCS Lands Act.

Background: While seasoned over many decades with petroleum industry activities, the GOM OCS is a frontier area regarding offshore wind energy. Not only is the offshore wind industry new to the GOM, but it is also relatively new to the U.S. and is rapidly developing both technologically and organizationally. The relationship of its offshore component to its upstream support (e.g., the fabrication of wind turbines and necessary support vessels, along with the existing supply chain), and its relationship to its downstream component (how it will fit into the larger electric grid and the economics

driving the grid in the Gulf Coast states) are true unknowns. BOEM funded two exploratory studies broadly focused on how renewable energy activities may develop in the GOM, the first looking at what resources exist in the GOM for renewables activities (Musial et al. 2019) and the second conducting economic modeling and site analyses for areas in the GOM that may hold promise for wind energy development (Musial et al. 2020). Both studies found that more detailed infrastructure information would be needed in the future if wind energy were to become a reality in the GOM.

While much of the limited information available on wind energy development in the U.S. comes from the Atlantic Region, the GOM Region is fundamentally different from the Atlantic in numerous ways, from population density and shoreline development to the socioeconomic standing of coastal populations and the fragility of a coastal topography battered by issues of land loss, subsidence, and climate change. The areas of the GOM OCS best suited for wind farms with the best wind resources for wind energy development are sparsely settled, poorer and face more issues related to climate change, land loss, and difficult access to markets (Texas and Louisiana). Also unique to the GOM is the expansive onshore coastal infrastructure and support services network that has developed in response to offshore oil and gas industry activities for many decades and has been described extensively in numerous BOEM studies (The Louis Berger Group, Inc. 2004, Dismukes 2010, Dismukes 2011, Kaplan et al. 2011). The potential future interaction between wind and petroleum industries and synergies among onshore infrastructure types and transferability across labor skills need to be further explored.

Furthermore, the GOM Region faces the unique situation of potentially hosting dual offshore energy producing industries where one well-developed offshore energy producing industry upon which states have relied for employment and economic development (i.e., oil and gas), is faced with a newly emerging wind energy industry in this frontier area and its potential relationships with the uses of the ocean that currently exist. Many of the labor skills used in the oil and gas industry will be transferable to the emerging renewables industry in the GOM. This synergistic interaction across industries needs to be explored and better understood to inform decision making.

Objectives: BOEM seeks increased understanding of onshore coastal infrastructure needs for wind energy development in the GOM and potential scenarios that can inform environmental impact assessments across resources and with attention to potential socioeconomic impacts on coastal communities.

1. Gather insights into how frontier GOM wind energy activities will affect and interact with existing onshore energy infrastructure, the regional labor market, and energy market in the GOM Region.
2. Better understand how potential changes in land use and coastal infrastructure to support offshore wind projects may have social and economic consequences in coastal areas, particularly in vulnerable communities with environmental justice concerns.

Methods: Anticipated methods may include but are not limited to focused literature review; some limited, guided discussions with a range of subject matter experts; and analytical research of the latest information regarding offshore wind projects' infrastructure needs. Methods may also include a comparative analysis of how offshore wind in the GOM may evolve similarly or differently from wind development in the North Sea where oil and gas activities were already well-established over many years with particular attention to onshore support infrastructure and effects to communities at a local level.

This is a new field and offerors must provide a coherent approach to this unusual problem—frontier development of wind projects within a mature offshore petroleum environment. This will not be a modeling project. Its objective is a thoughtful consideration of possible scenarios or directions that offshore wind energy development might take in the GOM Region.

Specific Research Question(s):

1. How will the offshore wind energy industry develop on the GOM OCS regarding onshore coastal infrastructure and land use?
2. What currently existing specific coastal infrastructure in GOM coastal states will be able to provide support for offshore wind projects? (e.g., fabrication yards, shipbuilding, ports, etc.)
3. What new onshore support infrastructure may need to be constructed in the coastal GOM states as a result of offshore wind develop in the GOM?
4. How will this new frontier industry affect coastal communities regarding land use, coastal infrastructure, and supply chain support?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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

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

The Louis Berger Group, Inc. 2004. OCS-related infrastructure in the Gulf of Mexico fact book. New Orleans (LA): U.S. Department of the Interior, Minerals Management Service. 234 p. Report No.: OCS Study MMS 2004-027.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Study of Plastic Pollution from Abandoned Umbilicals in the Gulf of Mexico (GOM)
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov), Sarah Vaughn (sarah.vaughn@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	March 28, 2022
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. Materials present in umbilicals could include nylon, rubber, thermoplastic hose, fiber optics, steel, and copper. These umbilicals are frequently abandoned in the GOM and consist of an external polymer layer (Frazer et al. 2015). Over time the polymer weakens and releases plastic into the environment (Cárdenas et al. 2007). High density polyethylene is likely the most common external layer of an umbilical. The degradation of these plastic materials in the GOM 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 GOM. Microplastics are known to have impacts to the environmental health. (NASEM 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 GOM 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?
6. What is the fate of the degrading plastic?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	The Top-Down Air Emission Method: A New Approach to Upgrade Pollutant Emission Inventories in the Gulf of Mexico
Administered by	Gulf of Mexico OCS Regional Office
BOEM Contact(s)	Jose Hernandez (Jose.hernandez@boem.gov)
Procurement Type(s)	Contract, Inter-agency Agreement
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	February 7, 2022
PICOC Summary	
Problem	For about two decades, BOEM has performed air emission inventories in the Gulf of Mexico (GOM) based on Environmental Protection Agency (EPA) statistically sampled emission factors (bottom-up approach) that have been reported a high degree of uncertainty. Such uncertainty creates at least three central problems for air quality management: 1) lack of confidence of the amount of a pollutant entering in the atmosphere, 2) higher lack of confidence in results from air quality models that rely on such emissions as inputs to evaluate impacts onshore and in National Environmental Policy Act (NEPA) cumulative analysis, and 3) the fact that there are no other estimates in the region to validate this traditional approach adopted by BOEM.
Intervention	An alternative to estimate emissions inventories is the top-down emission approach. This method combines improved air quality models and the ability to calibrate results with observations while simulations are in progress.
Comparison	Comparing bottom-up and top-down air emission inventories offers the possibility to determine pollutant sources overlooked or overestimated from methods under review. Such comparison also allows to diagnose corrections, and since top-down are based on higher spatial resolution, it can identify better dominant sources from local to regional scales.This comparison also allows a better understanding of impact assessments from air quality models and, later, a better interpretation of NEPA cumulative analysis.
Outcome	Three outcomes: 1) improvements in pollutant emission estimates from sources in the GOM region, 2) validation of results from different emission estimates, and 3) upgrades in estimates of air quality impacts from air quality models, and upgrades in NEPA cumulative analysis.
Context	Central and Western GOM

BOEM Information Need(s): Under the Outer Continental Shelf Lands Act (OCSLA), BOEM is required to comply with the National Ambient Air Quality Standards (NAAQS) to the extent that offshore oil and gas industry activities do not significantly affect the air quality of any state in the BOEM jurisdiction, eastward of longitude 87°30'W in the GOM. The Clean Air Act Amendments of 1990 specifically mandate BOEM to conduct studies to assess the potential for onshore and cumulative impacts of certain pollutant emissions from those activities. For about two decades, BOEM has performed air emission inventories in

the GOM using a bottom-up method based on the U.S. EPA AP-42 statistically sampled emission factors; however, USEPA has recognized that such factors need improvements and have a high uncertainty (USEPA 2013). Concerns on high uncertainty of results from air quality modeling in the GOM using traditional BOEM emissions are addressed in chapter 6 of a study from Wilson et al. (2019a), while an independent technical review from the National Academy of Science, Engineering and Medicine (2019), found overarching issues in the assessment of uncertainties in air quality modeling and associated cumulative impact in that study. Emission inventories are fundamental to appropriately set baseline conditions and impact analysis, which are fundamental in air quality management, properly set mitigations, more accurately perform NEPA analysis. All support BOEM's decisions with complying environmental laws. This profile study targets the need to improve air emission estimates in the GOM as a tool for BOEM to accomplish mission goals in air quality.

Background: Traditionally, in the U.S. and other countries, air emission inventory bottom-up approaches (for instance, Crippa et. al. 2018) are based on statistically sampled emission factors that are assumed to be representative of long-term averages for all facilities in the source category of air pollution; however, uncertainty of its estimates poses a main challenge (Miller et. al. 2018). Important progress has been made in air quality modeling and technology in the last decades, with significant improvements in the quality of measurements, while the number of data available today (from surface fixed monitors, mobile devices, aircraft and remote sensing) have increased substantially. The top-down methods, offers the possibility to evaluate bottom-up emissions to determine, for instance, those pollutant emission sources overlooked or overestimated and better understanding of emissions from local to regional scales (Elguindi et. al. 2020).

Top-down approach utilize a combination of air quality models (with improved dispersion and chemical processes computational representation) and available observations to minimize errors while simulations are in progress (Cui et al. 2017). This profile will propose a top-down method adapted to BOEM needs using state of science and technology in modeling and up to date available observations to enhance the analysis of pollutant emissions assessment in the GOM region.

Objectives:

- Estimate pollutant emission inventories from sources in the GOM Region using top-down approach.
- Validate traditional BOEM bottom-up estimates with top-down approach emission estimates.
- Determine statistics metric (biases and errors) at different areas of interests (local to regional) where uncertainty has been a challenge in previous air quality modeling studies.

Methods: The most recent air pollutant emission inventory (Wilson et al. 2019b) will be a proxy to define locations of oil and gas platforms and activities in the GOM. To investigate emissions from these sources, a combination of an advance photochemical model (with enhanced physical and chemical representations) and measurements is needed. For the modeling part, the project needs to determine from existing models the one that offer better options (chemical transformations and transport) for the top-down approach that can be suitable to estimate emissions from the surface to the atmospheric boundary layer and from local (fine resolution) to regional scales. For measurements the project will use any available data (from offshore and onshore fixed or mobile stations and remote sensing) of pollutants like NAAQS criteria pollutants and greenhouse gases (methane and carbon dioxide). Such pollutant observations should match pollutants from modeling predictions. To enhance model performance

(temporal and spatial) at the atmosphere (model vs observed concentrations), several flights with a research aircraft are needed. This aircraft equipped with air quality monitoring systems (from agencies like National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, or contractors) will perform campaigns to measure concentrations and estimate surface pollutant emissions.

Specific Research Question(s):

1. What are the main sources of uncertainty in the traditional GOM emission inventories?
2. Are there specific pollutants over or underestimated in the traditional GOM emission inventories?
3. Are there specific geographical areas over or underestimated in the traditional GOM emission inventories?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References

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Wilson D, Billings R, Chang R, Do B, Enoch S, Perez H, Sellers J. 2019b. Year 2017 emissions inventory study. New Orleans (LA): US Department of the Interior, Bureau of Ocean Energy Management. 231 p. Report No.: OCS Study BOEM 2019-072.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Cook Inlet Area-wide Recreation and Tourism Inventory
Administered by	Alaska Regional Office
BOEM Contact(s)	Jeffrey Brooks (jeffrey.brooks@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	April 26, 2022
PICOC Summary	-
Problem	BOEM-authorized activities could affect ocean-dependent and ocean-enhanced recreation and tourism resources of Cook Inlet. Information on the characteristics, location, and timing of recreation and tourism for the Cook Inlet area are dated, which could result in inaccurate baselines and imprecise effects analyses.
Intervention	This study would develop information on the recreation and tourism resources of the Cook Inlet area.
Comparison	Study outcomes would be compared to results of similar studies conducted in other planning regions.
Outcome	Information would be used to describe the affected environment and potential effects, develop and implement mitigation of effects, and inform consultations.
Context	Cook Inlet Planning Area and adjacent coastal areas

BOEM Information Need(s): Understanding how recreation and tourism may be affected by Cook Inlet Outer Continental Shelf (OCS) energy development is important for assessing potential impacts. BOEM needs a baseline study regarding the relative importance of ocean-dependent and ocean-enhanced recreation and tourism for residents and visitors of the area and how these amenities could be affected by future OCS lease sales, exploration, and development. Results would be useful for describing the affected environment, analyzing potential impacts, developing and implementing mitigation measures, and informing consultations and public involvement.

Background: The Cook Inlet Planning Area and adjacent coastal areas encompass portions of three Alaska boroughs, Kenai Peninsula Borough (KPB), the Lake and Peninsula Borough, and the Kodiak Borough. Tourism and recreation are key sectors of the region's economy. Previously viewed as a mature industry with large positive impacts but modest or negative overall growth, it is now seen as a fast-growing sector as visitor's and resident's interests and local opportunities continue to grow and evolve (Kenai Peninsula Borough 2019). Much of the emerging recreation and tourism is taking place on public lands such as the Chugach National Forest, Kenai Fiords National Park, Katmai National Park and Preserve, the Kenai National Wildlife Refuge, and the Lake Clark National Park and Preserve.

The upper Cook Inlet area hosts a mature offshore energy sector in state waters. After a two-decade hiatus (no OCS lease sales were held from 1996 to 2017), recent industry interest and investment has focused on the state and OCS waters of the lower Cook Inlet. This renewed activity raised concerns for

the potential effects of OCS development on the region's recreation and tourism sector, especially those ocean-dependent and ocean-enhanced activities. A few studies have been conducted on the effects of OCS development on recreation and tourism in Alaska, but these have been limited to specific sectors (*e.g.*, Kenai Peninsula sportfishing) (Criddle, *et al.* 1998) or have focused on the effects of catastrophic events, such as the *Exxon Valdez* oil spill (Fall 2001). The baseline information in these studies needs to be updated to capture changes that have occurred to the sector in the last 20 years.

Research in the Atlantic (Parsons and Firestone 2018; Smythe *et al.* 2018.), Gulf of Mexico (Eastern Research Group, Inc. 2014), and Pacific Regions (Hoelting and Burkardt 2017) has led to new insights on how routine OCS conventional, renewable energy projects, and technological disasters in all OCS regions could affect recreation and tourism (Industrial Economics, Inc. 2014). Baseline information has routinely been developed on this sector in these areas. This information, including geographic information in the Marine Cadastre, has been important in marine spatial planning to prevent and reduce conflicts. Developing similar information for Alaska-specific conditions would contribute to comprehensive OCS-wide data on this sector.

Objectives:

- Establish a baseline of ocean-dependent and ocean-enhanced recreation and tourism activities, amenities, and associated expenditures (*e.g.*, those that are dependent on or sensitive to coastal and marine resources).
- Identify the preferences that visitors and residents consider to be of value when making recreational choices and how these preferences might differ based on geographic location within the study area or between residents and non-residents.
- Document trends to better understand how the recreation and tourism industry has responded to Cook Inlet offshore energy infrastructure projects.
- Provide a framework for monitoring the spatial and temporal aspects of recreation and tourism.

Methods: BOEM anticipates a three-year study. In year one, researchers would assemble baseline data on the dimensions of ocean-dependent and ocean-enhanced recreation and tourism (i.e., activity, location, timing, level of participation, past expenditures) and the portion of recreation and tourism that would be sensitive to OCS activities. For year one, the synthesis of existing information and secondary data would be compiled using literature reviews, archival research, and examination of publicly available data. In years two and three, primary data would be collected using a combination of focus groups, surveys, interviews, and community workshops, which would require travel to hub cities and smaller communities; these methods would be used to measure current preferences, values, and expenditures of residents and visitors. Researchers would seek an Office of Management and Budget approval number for primary data collection efforts to comply with the Paperwork Reduction Act. Other methods could be adapted from studies in other regions (e.g., Garcia *et al.* 2012; Smythe *et al.* 2018).

Specific Research Question(s):

1. How could routine OCS activities and industrial accidents affect recreation and tourism in the Cook Inlet area?
2. What are the specific recreation and tourism resources, activities, and expenditures in the Cook Inlet area and when and where do these occur?

3. What measures could be used to monitor and mitigate effects to recreation and tourism?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Smythe T, Smith H, Moore A, Bidwell D, McCann J. 2018. Methodology for analyzing the effects of Block Island Wind Farm on Rhode Island recreation and tourism activities. 300 p. Report No.: OCS Study BOEM 2018-068.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

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 2023–2025
Final Report Due	TBD
Date Revised	April 26, 2022
PICOC Summary	-
Problem	Information about pipeline gas release frequency and release scenarios is dispersed throughout peer reviewed and gray literature, and modeled scenarios specific to the Alaska Outer Continental Shelf (OCS) are unavailable. Impacts of natural gas releases 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 and models.
Comparison	The results will support gas release scenarios used in National Environmental Policy Act (NEPA) assessments by modeling gas release, ignition, and explosion frequencies, spatial footprint of hazards using Alaska OCS relevant data, and documented impacts to resources.
Outcome	The project will produce a synthesis report on historic onshore and offshore gas pipeline releases including documentation of impacts to the environment. This synthesis will include quantitative gas release information, such as release frequencies or explosion footprints derived from modeling, for use in gas release scenarios in Alaska OCS NEPA documents.
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 readily available 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 low. 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 onshore and offshore continental U.S.
- Utilize specific pipeline release scenarios and a software system to model the behavior, dispersion, 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 U.S. onshore or offshore OCS pipeline natural gas release or rupture and subsequent fire and or explosion (e.g., MMS 2009; Stephens *et al*. 2002). Using three to six pipeline scenarios provided by BOEM, Alaska Regional Office the researchers will 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, documented 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 modeled or calculated gas release parameters provide quantitative information to assess impacts from a natural gas release or rupture, ignition, and/or explosion from an onshore or offshore pipeline?
4. What are the documented impacts of natural gas releases or subsequent fire or explosion to resources?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Sea Ice Climatology within Cook Inlet, Alaska
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 2023–2026
Final Report Due	TBD
Date Revised	April 26, 2022
PICOC Summary	-
Problem	Synthesized sea ice data for Cook Inlet is quite dated, and conditions have changed rapidly in recent years. Updated information about sea ice geographic coverage and duration is needed to validate coupled ice-ocean models used in BOEM's Oil Spill Risk Analysis (OSRA), improve tidal energy resource characterization for renewable energy applications, and inform environmental reviews and decision-making on Outer Continental Shelf (OCS) activities.
Intervention	This study will analyze interpreted sea ice data (*e.g.*, National Weather Service [NWS] and the National Ice Center [NIC]) for Cook Inlet to produce improved estimates of sea ice geographic coverage over time. Remotely sensed imagery, observations, and contributions of physical forcing mechanisms will be evaluated to gain new insights into changes in sea ice.
Comparison	The results will document geographic coverage and changes in sea ice cover for almost a quarter of a century.
Outcome	The analysis will document the role of physical forcing mechanisms on sea ice areal coverage and duration, offer information for validation of coupled ice-ocean circulation and tidal resource characterization models, and improve understanding of the existing environment to support National Environmental Policy Act analyses.
Context	Cook Inlet Planning Area

BOEM Information Need(s): Improved modern understanding of changes in sea ice type, geographic extent, and persistence is needed to provide context for interpretation of changing ecosystem patterns and inform environmental reviews and decision-making regarding oil and gas exploration and development plans. In addition, BOEM needs updated information about sea ice, including the type and geographic extent of sea ice coverage over time, to validate coupled ice-ocean circulation models used to support OSRA and to evaluate tidal resource characterization for renewable energy.

Background: During winter, sea ice that forms in upper Cook Inlet and areas of lower Cook Inlet (Nelson and Whitney 1995, 1996) can substantially impact human activities (Parker and Jacobs 2018), the ecosystem (Laidre *et al*. 2017), and tidal resource characterization (Wang and Yang 2020). Ice types include pack ice, shorefast or beach ice, stamukhi (layered ice-cakes), and estuarine river ice. Ongoing environmental change in the subarctic has potentially altered the type, geographic coverage, and seasonality of the sea ice in and along the Cook Inlet coast. The sea ice geographic coverage along the

Cook Inlet coast was last quantified bimonthly by Mulherin *et al*. (2001), but these data are more than two decades old. Understanding of the geographic coverage, shorefast ice persistence, and seasonality of sea ice is important for understanding the fate of spilled oil and for accurate tidal energy resource characterization. Sea ice persistence affects the fate of oil as sea ice acts as a barrier to oil penetrating the shoreline. Updated information is needed to facilitate modeling, planning, and decision-making for either oil and gas or renewable energy and enable understanding of where sea ice occurs for oil and gas or renewable activities.

Objectives:

- Assess and document the sea ice type, geographic coverage, and persistence in Cook Inlet at a higher temporal resolution than historical studies and evaluate if it has changed over time.
- Evaluate how changes in sea ice relate to local and regional changes in physical parameters (*e.g.*, temperature, pressure, freshwater influx or major storms), as well as to global climate shifts.

Methods: Researchers will compile a time-series of interpreted sea ice data (*e.g.*, NWS Alaska Sea Ice Program and the NIC) for Cook Inlet from 2000 through 2022. Results will be analyzed to produce a climatology that includes, minimum, mean, median, and maximum sea ice geographic extent and to evaluate the changes in sea ice over time. Researchers will synthesize available historical observations and information on sea ice type in Cook Inlet. Researchers will document and conduct observations of the sea ice type, growth, and melt along a portion of the shoreline adjacent to the southcentral Alaska road system during one seasonal cycle. Researchers will compile a time-series of physical parameters to evaluate any correlations between ice extent, ice type, and physical parameters.

Specific Research Question(s):

1. How has sea ice type, geographic extent, concentration, or persistence in Cook Inlet changed over time?
2. How has the sea ice in Cook Inlet been altered in recent decades and what can be inferred about ecosystem changes and oil and gas exploration and development or renewable energy activities in relation to these changes?
3. What is the best sea ice metric for use in OSRA model validation or accurate tidal energy resource characterization?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Tidal Flow Characteristics and Associated Biological Use of Cook Inlet
Administered by	Alaska Regional Office
BOEM Contact(s)	Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 26, 2022
PICOC Summary	-
Problem	BOEM needs an improved understanding of the potential renewable tidal energy areas within the Cook Inlet Outer Continental Shelf (OCS) to inform planning decisions for potential tidal renewable and conventional energy development, facilitate engineering design, and provide baseline information about biophysical interactions to support environmental analyses.
Intervention	This study will synthesize and make existing information accessible, identify information needs, and sample up to four identified tidal renewable energy sites in the Cook Inlet OCS and State of Alaska waters.
Comparison	The study would assess the potential for tidal renewable energy and resource use in the Cook Inlet OCS compared to existing historical and modeled information.
Outcome	This study would characterize tidal flow, tidal energy, biological use and productivity, and design parameters at up to four areas in Cook Inlet to identify potential renewable energy sites, potential impacts, and design parameters.
Context	Cook Inlet Planning Area and adjacent State of Alaska waters in upper Cook Inlet

BOEM Information Need(s): Information is needed to understand renewable tidal energy potential within the Cook Inlet OCS to inform decisions for planning, support environmental analyses for potential tidal renewable as well as conventional energy development, and facilitate appropriate engineering design. Information from the study could inform a future Request for Interest, aid in site selection, and provide information about biological vulnerabilities to tidal energy technologies to help guide mitigation during the National Environmental Policy Act (NEPA) process.

Background: There is growing interest from utilities in potential tidal renewable energy development in Cook Inlet. Tidal renewable energy systems are designed to extract the kinetic or potential energy flow and convert it into electricity. Cook Inlet has the highest tidal renewable energy potential in the United States and has a theoretical resource of 160 terawatt hours per year (TWh/yr) (Kilcher *et al.* 2021). Semidiurnal tidal currents in Cook Inlet create strong frontal convergence zones known as rips (Haley 2000). Current velocities within the rips exceed 8 knots (Nelson and Whitney 1996). These tidally induced rips could produce tidal energy but also serve as migratory pathways for salmon returning to their spawning streams, forage sites for sea birds, and areas for diverse fish catch by fishers (Moulton 1996; Okkonen 2005). Very little information has been published to-date regarding the characterization of tidal current energy in Cook Inlet. However, U.S. Department of Energy laboratories have recently

been investigating the renewable energy potential of Cook Inlet, Alaska, though further work is needed (Branch *et al*. 2021; NREL 2021). In addition, BOEM initiated the *Feasibility Study for Renewable Energy Technologies in Alaska Offshore Waters* (AK-21-x07) in 2021. The goal of that effort is to identify areas of high potential for developing renewable energy across Alaska, which will help to inform selection of study sites for this project focused on Cook Inlet.

Objectives:

- Collate and synthesize available data on the physical qualities and quantities of the tidal energy and flow in Cook Inlet, Alaska, as well as the biological use and productivity of tidal renewable energy areas of interest, including the nearby current rips.
- Collect detailed physical oceanography data necessary to characterize the tidal flow, energy, and design criteria parameters throughout the water column at designated sites in Cook Inlet, Alaska.
- Evaluate design parameters for large-scale hydrokinetic energy potential specific to Cook Inlet, Alaska.
- Inform modeling refinements of Cook Inlet tidal energy to validate large-scale renewable energy potential.

Methods: Researchers will identify and gather existing, relevant, and readily available physical oceanographic and biological datasets and information for up to four potential tidal renewable energy site locations. The datasets will be organized into a common framework for review, synthesis, and identification of specific information needs to guide development of field plans and inform modeling needs, following the approach outlined by Kilcher *et al*. (2016). Researchers will conduct a field campaign to collect measurements needed to characterize tidal flow, tidal energy, design parameters, and biological resource use and productivity of up to four tidal renewable energy sites.

Specific Research Question(s):

1. What are the tidal flow, energy dynamics, and biological observations throughout the water column?
2. What is the biological use or productivity of the selected sites and of current rips in the proximity?
3. What are the design parameters for large-scale renewable energy components and structure?
4. How can current models be enhanced to characterize renewable tidal energy?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

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
Final Report Due	TBD
Date Revised	April 28, 2022
PICOC Summary	-
Problem	Updated information on locations, species composition, and sizes of seabird colonies in Lower Cook Inlet (LCI) and associated regions is important to guide prudent development of oil and gas resources. Colony surveys provide information needed to mitigate disturbance and other potential effects on seabird populations from oil and gas activities, vessel traffic, and oil spills. Large fluctuations in seabird breeding distribution and abundance are occurring at multiple colonies, likely due to drastic environmental perturbations in the Gulf of Alaska (GOA) in recent decades (Piatt *et al*. 2020). A comprehensive review of seabird colonies in the region is necessary to understand the extent of these fluctuations.
Intervention	Information on seabird colony locations, species, and abundance will be collected for LCI. Census efforts will prioritize information about colony size and species of concern within the outflow of LCI, including Shelikof Strait, the Kodiak Archipelago, and the Kenai Peninsula.
Comparison	To compare and quantify numbers of breeding seabirds at colonies in the LCI region, the study will use traditional boat-based census counts, population estimates using emerging technology, photographic counts with machine learning software, and indices derived from marine-band radar. 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.
Context	LCI and Shelikof Strait

BOEM Information Need(s): A better understanding of ongoing seabird population fluctuations in LCI 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 inform the effects of climate change and improve the assessment of impacts from industry activities and 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. The study will provide information about ongoing trends related to

climate change effects on seabirds, help evaluate potential impacts from industry activities, and identify possible mitigation measures.

Background: Seabirds are long-lived, conspicuous, and feed near the top of marine food web. These characteristics, coupled with their tendency to nest in large colonies, allow seabirds to be counted and monitored relatively easily. By studying seabirds, scientists can detect variability in their prey abundance and diversity and environmental changes that affect seabirds. The LCI and outflow (Shelikof Strait, northern Kodiak Archipelago, Kenai Peninsula) supports approximately 325 seabird colonies totaling over half a million breeding birds. 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. Funding for surveys has been sporadic over the years, however. In the 1970s and 1980s, the USFWS led marine bird surveys in the LCI as part of the Outer Continental Shelf Environmental Assessment Program (OCSEAP) to provide information needed for decisions regarding offshore oil and gas development. Following OCSEAP, survey efforts were reduced and 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, the USFWS investigated marine bird populations in the spill-affected area, but survey efforts again tapered off due to lack of funding. 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. Efforts to fully assess the impacts of these events are once again hampered by the lack of updated baseline information.

Objectives:

- Establish current population estimates at seabird colonies and species composition to update baseline estimates for breeding distribution, abundance, and species composition in LCI.
- Document any changes in seabird distribution, abundance, and trends over the past 40–50 years.
- Evaluate the extent of fluctuations in seabird breeding distribution and abundance that have been seen at multiple colonies in LCI.
- 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.*, ledge vs burrow/crevice nesting) and colony accessibility. Researchers at USFWS will collaborate with U.S. Geological Survey (USGS) to develop and apply emerging technology protocols for determining abundance estimates of ledge nesting breeding seabirds (*e.g.*, murres, kittiwakes). 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 and to minimize potential undercounting. Working with partners at the Alaska Maritime National Wildlife Refuge and 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 40–50 years?
3. Do new technologies for quantifying seabird distribution and abundance provide robust measures (*i.e.*, repeatable and defensible during oil spill mitigation)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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. In: Rice S, Spies R, Wolfe D, Wright B, editors. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18. p. 684–711.

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.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Linking Summer and Winter Foraging Areas to Diet and Annual Survival of Seabirds from Colonies in the Lower Cook Inlet Area
Administered by	Alaska Regional Office
BOEM Contact(s)	Rick Raymond (richard.raymond@boem.gov)
Procurement Type(s)	Intra-agency Agreement
Performance Period	FY 2024-2028
Final Report Due	TBD
Date Revised	April 26, 2022
PICOC Summary	
Problem	Seabird breeding populations in lower Cook Inlet (LCI) have declined dramatically since baseline studies in the 1990s, and reproductive success has been severely curtailed since the 2014–2016 North Pacific marine heat wave. Mechanisms of this decline and outlook for recovery are uncertain.
Intervention	Recent studies (conducted 2016–2021) have included population counts and estimates of breeding success, but basic ecological (diet composition, overwintering areas) and demographic (annual survival) parameters are required to better understand recent population changes or predict recovery potential. Future population statuses have not been measured.
Comparison	These fundamental parameters were measured in the 1990s, when baseline data on seabird population ecology in LCI were gathered after the *Exxon Valdez* oil spill. Findings on current populations will be compared from those earlier studies.
Outcome	The rate of recovery of seabirds from the heatwave is unknown but could be modeled after a better understanding of foraging limitations and adult survival rates. This increased understanding would provide information on the status and trends of seabird populations to address future concerns about disturbance in LCI from oil and gas operations.
Context	LCI

BOEM Information Need(s): Understanding natural and anthropogenic risks to seabirds in potential oil and gas lease areas has been a BOEM priority for decades, both to mitigate impacts of offshore oil development, drilling, and shipping, and to assess the impact of potential oil spills. Recent ecological events in the LCI region have altered the fundamental demography of seabird populations. The information collected in this study will update baseline data to support environmental analyses for future lease sales and exploration, development, and production activities in Cook Inlet and provide information to support an analysis of the potential cumulative effects of climate change and oil and gas activities.

Background: The USGS has been studying seabirds and forage fish in LCI intermittently since 1995, both before (1995–2001) and after (2016–2021) the prolonged marine heat wave of 2014–2016. In 2015–2016, as much as one-quarter of the common murre population in the Gulf of Alaska and Bering Sea died from starvation, and they failed to produce offspring at multiple colonies throughout the North

Pacific. Likewise, in LCI, poor food supplies led to population declines and breeding failures in both common murres and black-legged kittiwakes; effects have persisted into 2021. Impacts of the heatwave will continue to be felt for several more years—even if food supplies and productivity return to normal—because of the huge loss of recruitment from recent breeding failures. To date, there is no obvious explanation for all these aberrant observations, but its occurrence makes clear the need to track the recovery (or failure) of these populations and to research possible mechanisms of change. We hypothesize that poor foraging conditions, acute population declines, and multi-year recruitment failures have modified the age composition and future growth potential of current populations.

Objectives: This study will identify the mechanisms that may account for breeding failures, increased adult mortality, and failure to secure food, with the following specific objectives:

- Track post-breeding migration and identify overwinter foraging areas of adult murres and kittiwakes.
- Quantify diets of adult murres and kittiwakes.
- Assess adult survival in murres and kittiwakes.

Methods: To discover overwintering habitats, the post-breeding migration of kittiwakes and murres will be tracked with geolocator (GLT) tags before they leave their colonies. Researchers will recapture the birds when they return to the colony the following spring, and data stored on the tags will be downloaded. To quantify diets of adults and chicks, fecal DNA sampling will be conducted using next-generation sequencing (NGC) during the breeding season. This will eliminate lethal sampling that has been used historically and will provide more comprehensive prey information compared to bill-load and regurgitation sampling alone. To measure annual survival of kittiwakes and murres, traditional mark-recapture methods will be used. Adult breeding birds will be captured, marked, and re-sighted using a unique combination of colored plastic leg bands to determine “recapture” rates and estimate survival rates. At least 4–5 years of tagging and re-sighting effort are needed to obtain enough data to estimate annual survival with recapture models.

Specific Research Question(s):

1. What is the likelihood that seabirds can recover from the die-off and breeding failures?
2. Where are the important foraging areas for murres and kittiwakes during summer and winter?
3. How have diet composition, quality of prey, and adult survival changed since baseline studies were conducted in the 1990s?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References: N/A

Environmental Studies Program: Studies Development Plan | FY 2023–2024

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 2024–2027
Final Report Due	TBD
Date Revised	April 26, 2022
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 National Environmental Policy Act (NEPA) 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 with funding from BOEM 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 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-1990's (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: This study will 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 1995–2001 years of colony work for BOEM, 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?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Piatt JF, editor. 2002. Response of seabirds to fluctuations in forage fish density. *Exxon Valdez* Oil Spill restoration project final report. Anchorage (AK): U.S. Department of the Interior, Minerals Management Service. 406 p. Report No.: OCS Study MMS 2002-068.

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.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

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 2024–2026
Final Report Due	TBD
Date Revised	April 26, 2022
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 may 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 and 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): As part of the National Environmental Policy Act (NEPA) process for Federal regulated activities, BOEM needs to accurately describe the marine ecosystem to assess potential effects from those activities. It can be difficult to know when regime shifts have occurred, and updated descriptions of marine ecosystems are warranted. Forage fish are a key component to ecosystem function and stability and long-term monitoring of forage fish populations, and their relation to predators can provide insight into ecosystem changes. This study will develop a cost-effective tool to help monitor potential ecosystem level changes; to provide insight to when new research is needed to update existing baseline descriptions; and to 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, issuing permits, and Development and Production Plans by helping to ensure BOEM uses data that accurately reflects the current marine ecosystem when describing the biological environment during its regulatory process.

Background: Time series data are necessary to better understand the influence of environmental variation on populations of marine organisms. Time series data focused on assessing the spatial and

temporal variability of lower trophic species (*e.g.*, forage fish) can enhance understanding of upper trophic level changes in fish, seabird, and marine mammal populations (Arimitsu *et al*. 2021; Piatt *et al*. 2020). Better data for forage fish species variability—especially forage fish like capelin, sand lance, and herring—are needed to more effectively link the lower trophic patterns to changes in fish, marine bird, and marine mammal populations. Though this study will focus on fish and seabird diet observations to obtain seasonal and interannual information on variability of forage species in Cook Inlet, the results may also shed light on drivers of change for other marine biota. This study will extend and complement recent and ongoing BOEM-supported efforts assessing seabird and forage fish status, trends, and ecology in lower Cook Inlet (AK-16-09, AK-20-10, and AK-22-01).

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. This study is intended as a long-term monitoring program to provide maximum value as a data source. Once the study is established following the completion of this award, future efforts will seek other sources of funding for subsequent years of data collection.

Predator Fish Diets: 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 will 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. Analysis of eDNA will also be considered to describe stomach contents. 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.

Seabird Diets: 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 representative study species, having a circumpolar distribution, 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 two to three 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, 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) and 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)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Addressing Key Information Gaps in Acoustic Ecology of North Atlantic Right Whales
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	May 13, 2022
PICOC Summary	
Problem	Passive acoustic monitoring (PAM) is a highly effective tool for identifying the near real-time presence of acoustically active species. However: 1) information on availability bias (i.e., how often we expect to detect them) is lacking for North Atlantic right whale (NARW) in the mid-Atlantic, leading to uncertainty in species density estimations; and 2) the lack of data on the behavioral ecology (i.e., what they are doing when they are making particular vocalizations) of this species limits our ability to comprehensively analyze PAM data.
Intervention	Gather biologging data on the acoustic behavior of the NARW in the Mid-Atlantic.
Comparison	The results of this study will allow researchers to better assess potential impacts to NARW from human activities than would have been possible before.
Outcome	The data will: 1) improve abundance estimates; 2) increase the value of existing PAM data; 3) inform the assessment of the effectiveness of PAM as a mitigation strategy for these priority ESA-listed species; and 4) provide, short term habitat usage and movements of these species to assist in identifying currently unknown potentially important biological areas.
Context	Mid-Atlantic

BOEM Information Need(s): BOEM requires robust, current information on NARW to: 1) fully analyze and disclose the potential for impacts to this endangered species from Outer Continental Shelf (OCS) activities at the programmatic and site-specific level; 2) help ensure that a species is not jeopardized by activity or that critical habitat is not adversely modified by that activity pursuant to the Endangered Species Act (ESA); 3) minimize incidental take of marine mammals resulting from BOEM-permitted activities, thus meeting not only the small numbers and negligible impact requirement under the Marine Mammal Protection Act (MMPA) but also making every effort to maintain the health and stability of marine mammals and their ecosystem; and 4) fulfill Federal assessment and consultation responsibilities. Additionally, BOEM is required to design and implement mitigation measures to reduce or eliminate impacts from regulated activities on protected and managed species.

Background: The lack of information about acoustic behavior of the critically endangered NARW creates a high degree of variability in their detection probabilities and the analysis of data from passive acoustic monitoring, which is one of BOEM's primary mitigation and monitoring tools. BOEM relies on density and abundance data (Roberts et al., 2016) to assess the potential impacts on protected species from

BOEM-permitted activities. However, acoustic behaviors of the NARW in the mid-Atlantic, particularly call rates, is poorly understood. For example, NARW have dramatically different acoustic behavior in the southeast versus northeast extent of their range, but their acoustic behavior in the Mid-Atlantic, where we now know they are located year-round, has never been studied. This adds tremendous uncertainty into the density and abundance models that are generated from acoustic data.

Traditional survey methods for cetaceans include shipboard or aerial surveys. However, these surveys provide a snapshot of cetacean occurrence in any given area and these data are spatially and temporally restricted since it can only be obtained under appropriate survey conditions (e.g., good visibility). Therefore, although aerial and broadscale vessel-based survey data provide much-needed regional data, they are of limited use to infer specific behavioral patterns in fine spatial and temporal scales.

Establishing cue rates (how often a whale vocalizes) for NARW in diverse behavioral states and habitats also allows for PAM data collected previously through BOEM studies to be reanalyzed and be more useful. This information will provide much-needed species-specific behavioral data (for example, dive durations) to feed into population-level impact modeling analyses – an emphasized need identified by The National Academies of Sciences Committee (NASEM, 2016).

The data collected during this study will assist in improving the analytical robustness and biological meaningfulness of acoustic data collected during BOEM-funded studies as well as the credibility of passive acoustic monitoring, a critical mitigation prescribed by BOEM. It will also improve comparability of PAM data collected in different geographic regions. Additionally, implementing this study would provide BOEM with a means of validating BOEM's current PAM practices for endangered species impact mitigation.

Objectives:

- Observe and describe acoustic ecology of NARW across geographies and life histories where significant data gaps in call rates exist.
- Verify and/or establish cue rates combined with visual observation to inform accurate density modeling of data deficient marine mammal species applicable to renewable energy for impact analysis.
- Inform potential overlap of biologically important areas for NARW with BOEM's areas of interest.

Methods: This project will utilize validated and available techniques and technologies:

1. Mobile 3-D passive acoustic monitoring: vessel and/or automated underwater vehicle-based PAM will provide ground truthing and guidance for existing stationary PAM.
2. Biologging: electronic tags such as 3-D digital accelerometer/acoustic tags will be used to augment remote study to provide an understanding of habitat use and movement in relation to acoustic behavior.
3. Vessel based eDNA and biopsy sample collection will provide additional information on stock structure and distribution.

Specific Research Question(s):

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

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Assessing Climate Change Risk and Information Gaps in Habitats of Concern on the Outer Continental Shelf
Administered by	Office of Environmental Programs
BOEM Contact(s)	Stephanie Sharuga (stephanie.sharuga@boem.gov), Mark Mueller (mark.mueller@boem.gov), Christina Bonsell (christina.bonsell@boem.gov), John Schiff (john.schiff@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	April 1, 2022
PICOC Summary	
Problem	Climate change is altering abiotic conditions in Outer Continental Shelf (OCS) environments, potentially negatively impacting habitats and species of interest. Most marine climate change research to date has focused on shallow and/or coastal environments, and there is a need for better understanding of the research that has been done in deeper waters of the OCS.
Intervention	This study will compile and evaluate information on climate change in OCS environments, particularly associated with sensitive species and other habitats of interest where BOEM-managed activities occur. The study will investigate the extent and effects of climate change-related changes, such as ocean acidification, deoxygenation, temperature, and influences on ocean circulation.
Comparison	Without this study, there would be a continued lack of easily accessible and relevant resources related to climate change in OCS environments that would hinder BOEM's ability to understand and evaluate the multiple related impacts and impact levels to adequately inform future decision making.
Outcome	This study will expand knowledge and fill in information and data gaps related to climate change in OCS environments. Information will be synthesized to create deliverables that will serve as resources to be used for decision making and planning of future potential research needs.
Context	The scope and results of this study span all BOEM regions and will be applicable to all BOEM-managed activities in deep-sea OCS environments.

BOEM Information Need(s): Climate change has far-reaching impacts that can have a variety of consequences for marine environments, especially when compounded with additional stressors resulting from human activities. Information on climate change is needed to inform BOEM's assessments and evaluations of impacts to habitats in areas of BOEM-managed activities and for sensitive habitats of interest such as cold-water corals. The study will focus primarily on deeper waters of the OCS and directly address areas and resources of concern for BOEM. This desktop literature synthesis study's deliverables will contribute to more effective assessments and consultations, also helping to address current information gaps and inform best management practices (BMPs) and future research needs. The information collected and synthesized will allow for more informed resource-

management decisions related to marine minerals, oil and gas, and renewable energy activities throughout the OCS. It will inform numerous national and/or programmatic efforts (e.g., National OCS Oil and Gas Leasing Program), a variety of National Environmental Policy Act sections (e.g., Affected Environment, Routine and Accidental Impacts, and Cumulative Impacts), and Coastal Zone Management Act consistency determinations. The information synthesized will also contribute to BOEM's ability to meet federal agency responsibilities under the Federal Ocean Acidification Research and Monitoring Act (FOARAM 2009) and President Biden's Executive Order 14008 ("Executive Order on Tackling the Climate Crisis at Home and Abroad"). As climate change effects are expected to magnify over time, the information will be of particular importance for accurately and more precisely estimating the cumulative effects of BOEM-managed activities on the OCS. Species-, population-, and habitat-level magnitude of climate changes needs to be better understood for BOEM analyses to accurately assign impact levels in Environmental Impact Statements or other assessments and to inform future operational management decisions (e.g., necessary mitigation measures to protect affected species and habitats).

Background: Climate change and its effects are a growing concern for marine environments, and such effects are increasingly being observed in the deep ocean (Sweetman et al. 2017), i.e., waters deeper than the photic zone. Despite this, until recent years there has been relatively limited research into characterizing climate change-related effects such as ocean acidification, deoxygenation, temperature changes, ocean circulation changes, and other parameters in deeper waters and associated habitats. Key climate change documents such as the IPCC Sixth Assessment Report (IPCC 2021) and UN World Ocean Assessment II (United Nations 2021) do not focus on or adequately address climate change in deeper waters (Levin 2021). Information that does exist is located across disparate sources and often not specifically focused on BOEM's areas of activities or resources of interest, with much of the current knowledge specific to relatively shallow marine habitats such as tropical coral reefs.

Climate change can have both direct and indirect impacts on fauna and sensitive habitats, with non-negligible effects on individual species populations and wider ecosystem integrity and connectivity. One example of this is observed strengthening and shoaling of the oxygen minimum zone due to warming waters off the California coast (Bograd et al. 2008, Stramma et al. 2020). This can lead to habitat compression and loss for both benthic and pelagic species, including those that are commercially important (Netburn & Koslow 2015, Gallo & Levin 2016). Climate change can also disproportionately affect certain marine species (i.e., calcifying organisms) and habitats such as those dominated by fauna like cold-water corals. Cold-water coral habitats are being increasingly exposed to acidified conditions due to climate change-related shifts of the aragonite saturation horizon (Zheng and Cao 2014, Perez et al. 2018), with live corals showing reduced calcification and coral skeletons becoming severely eroded (Maier et al. 2008, Lunden et al. 2014, Hennige et al. 2020). Within the century, most current cold-water coral habitats could be beneath the aragonite saturation horizon (Guinotte et al. 2008); scleractinian coral communities below the aragonite saturation horizon have already been observed in the North Pacific (Baco et al. 2017). Additionally, regional- or global-scale climate change impacts on foundational and habitat-forming species can potentially have even further reaching effects on the other benthic and pelagic species that are dependent on them.

Objectives: The objectives of this study are the following:

- Identify types and extent of potential climate change impacts in deeper water OCS environments and for sensitive habitats based on the current state of knowledge.
- Compile and synthesize information on climate change effects in areas of BOEM-managed activities and for associated sensitive habitats to create resources for BOEM SMEs.

- Determine BOEM management-focused data and information gaps related to climate change that need addressing, also aiming towards building future interagency and non-federal partnerships to collectively coordinate and conduct field-based focused data collection studies.
- Determine recommendations for future study needs and BMPs related to climate change in deeper OCS waters within the specific context of BOEM-managed activities.

Methods: This study will enable a better understanding of the data and information that are available related to climate change effects in areas of the OCS where BOEM-managed activities occur, as well as potential impacts to ecosystems (especially sensitive/vulnerable habitats and fauna). Potential aspects of climate change that may impact deeper OCS waters, such as ocean acidification, temperature changes, deoxygenation, and changes to ocean circulation, will be considered. Emphasis will be placed on waters deeper than the photic zone and/or depths of ≥ 200 m, with exceptions made, where applicable, to accommodate region-specific sensitive habitat variations. For example, in Alaska, many typically deep-sea coral species may be found at depths shallower than typical for other regions. Such exceptions will be made in consultation with BOEM SMEs based on agency needs. This study will include multiple parts:

- Part 1: Compile a scientific literature review and accompanying literature database about climate change drivers and effects in deeper OCS environments where BOEM-managed activities occur and for associated sensitive habitats (e.g., cold-water corals). The study will focus on compiling existing information and data. Examples of information include types of potential climate change effects and related geochemical or biological parameters; impacts of climate change on different OCS habitats; approaches for measuring parameters and effects; best practices for collecting climate change data; and more. The scope will be guided by BOEM SMEs, potentially with input from other federal SMEs (e.g., National Oceanic and Atmospheric Administration, U.S. Geological Survey).
- Part 2: Identify information and data gaps related to climate change in OCS environments that warrant further investigation by BOEM and its partners.
- Part 3: Develop recommendations for future research that is needed to better understand climate change in deeper water OCS environments, including what should be researched and approaches that should be used. This may include recommendations for topics and geographies for future field-based studies to conduct that would include new sampling and analysis needed to address identified data gaps.
- Part 4: Develop a set of BMPs that will be used later to help BOEM integrate the produced climate change impacts information into appropriate assessment documents and processes.

Specific Research Question(s):

1. What information and data are currently available about climate change effects in areas of the OCS where BOEM-managed activities occur?
2. What are the potentially affected habitats, organisms, and associated resources of concern and potential short- and long-term effects on them?
3. Are specific species/habitats (e.g., scleractinian corals) likely to be disproportionally affected by specific climate change-driven factors (e.g., change in aragonite levels) and how?
4. How can BOEM and others address identified information/data gaps regarding climate change in deep-sea environments (e.g., specific recommended future field work and BMPs)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Behavioral and Physiological Responses of Sea Turtles to Sound
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Hilary Kates Varghese (hilary.katesvarghese@boem.gov)
Procurement Type(s)	Cooperative Agreement, Contract
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	December 29, 2021
PICOC Summary	
Problem	Sounds produced by BOEM-authorized projects may impact sea turtles; a current lack of knowledge about the behavioral and physiological impacts of sound may lead to inaccurate assessment of impact on sea turtles.
Intervention	Gather behavioral and physiological data on the impacts of sound exposure data on targeted species to better inform Endangered Species Act (ESA) consultations
Comparison	Without additional data, estimates of acoustic impacts on sea turtles will continue to be derived from limited data or surrogates, leading to potentially incorrect estimates of the amount and degree of impact.
Outcome	The outcome of this study would lead to a better understanding of the behavioral and physiological impacts of sound on sea turtles for more accurate impact assessments.
Context	Atlantic, Pacific, and the Gulf of Mexico

BOEM Information Need(s): In 2021, BOEM convened a workshop to develop a methodological framework for sea turtle behavioral and physiological (stress/hormone) response to sound studies as BOEM is required to estimate potential acoustic impacts from industry sources. The effects of noise produced by BOEM permitted activities on endangered sea turtles are poorly understood. As such, an incomplete understanding of physiological and behavioral impacts of sound across species and life stages may lead to incorrect estimates or assumptions about the magnitude of impacts from BOEM permitted activities. Results from behavioral response studies (BRS) and physiological response studies can be used to directly quantify the impact of noise on a target species.

Background: The impact of sound-generating events is a substantial factor that needs to be considered in addressing environmental impacts of offshore energy activities. However, limited data are available to accurately assess these impacts for sea turtles. Currently employed auditory thresholds are derived from fish, which have very different ear anatomy, and behavioral response thresholds are derived from the responses of two individuals to approaching airguns (Department of Navy 2017, McCauly et al. 2000). No data are available to assess impacts of sound on physiological (stress) responses. In a draft biological opinion on G&G permitting in the Gulf of Mexico, NMFS identified a critical data gap regarding our knowledge of the impacts of sound: “Although all sea turtle species studied exhibit the ability to detect

low-frequency sound, the potential effects of exposure to loud sounds on sea turtle biology remain largely unknown" (Nelms et al. 2016).

In October 2021, through a cooperative agreement with North Carolina State University, BOEM convened a workshop to develop methods to examine behavioral and physiological (stress/hormonal) responses of sea turtles to sound. This workshop synthesized the current state of knowledge on sea turtle behavior, physiology, and hearing and prioritized future research (*in prep.*). Workshop participants concluded that many important knowledge gaps exist, particularly with respect to physiological responses and long-term fitness consequences of noise disturbance in sea turtles. A pressing need exists for increased investment in research to start to fill those gaps, particularly given the recent and ongoing increase in offshore energy development in areas that overlap the habitat of vulnerable populations of sea turtles in US waters.

Six ESA-listed species of sea turtles travel widely throughout the waters of the North Atlantic Ocean, Gulf of Mexico, Pacific Ocean, and the Caribbean Sea and may be exposed to BOEM activities in multiple planning areas or in other countries. High-intensity sounds can cause behavioral changes, physiological trauma, and even death in some vertebrate species (Richardson et al. 1995). Therefore, sounds from activities such as pile driving, seismic surveys, and drilling could have impacts on these turtles. Sea turtles may use sound for navigation, locating prey or preferred habitat, predator avoidance, and environmental awareness (Piniak et al. 2016). They occupy different ecological niches throughout their life cycle, each characterized by unique acoustic conditions - yet there is extremely limited data on how their behavior and physiology are impacted by anthropogenic sounds.

Previous studies on hearing in several species of sea turtles have demonstrated that they are most sensitive to low-frequency (< 1,000 Hz) acoustic and/or vibratory stimuli in air and underwater (Lavender et al. 2014, Martin et al. 2012 Piniak et al. 2016). This range of maximum sensitivity overlaps with several low-frequency anthropogenic sound sources such as: seismic airguns, offshore drilling, pile driving, and vessel traffic (Hildebrand 2009). Variation in threshold levels and frequencies of maximum sensitivity between species and age classes exist. In addition, behavioral and physiological responses to anthropogenic sounds may vary throughout a turtle's lifetime, so it is important to examine the impacts of sound on several species and life stages. For example, breeding adult females may experience a lower stress response, as female loggerhead, hawksbill, and green turtles appear to have a physiological mechanism to reduce hormonal response to stress in order to maintain reproductive capacity at least during their breeding season, a mechanism apparently not shared with males (Jessop et al. 2004). BOEM has already invested in addressing data gaps in turtle hearing;[1] however, substantial data gaps remain in our understanding of the impacts of detectable sounds for various species and life stages. This proposal aims to further invest in filling those gaps.

Little data exist on either the behavioral or physiological (stress/hormone) responses of sea turtles to sound. While several studies have examined physiological responses of sea turtles to stressful events (e.g., incidental or directed capture in fishing nets, cold stunning, handling, transport, etc.), to our knowledge no studies have examined physiological (stress) responses of sea turtles to sound. Of the few behavioral studies that exist, mixed responses have been elicited. (O'Hara and Wilcox 1990, Moein et al. 1995, McCauley et al. 2000, Weir 2007, DeRuiter and Larbi Doukara 2012). For example, McCauley et al. (2000) observed that one green turtle and one loggerhead sea turtle in an open water pen increased

[1] OCS Study BOEM 2012-01156. Underwater hearing sensitivity of the leatherback sea turtle (*Dermochelys coriacea*): assessing the potential effect of anthropogenic noise.

swimming behaviors in response to a single seismic airgun at received levels of 166 dB re 1µPa and exhibited erratic behavior at received levels greater than 175 dB re 1µPa. DeRuiter and Doukara (2012) observed that 57% of loggerhead turtles exhibited a diving response after seismic airgun array firing at received levels between 175 and 191 dB re 1µPa. However, Weir (2007) did not observe the significant behavioral responses to airgun array but did observe responses to the presence of large seismic vessels and Hazel et al. found sea turtle avoidance to small vessels was impacted by vessel speed (Hazel et al. 2007) . O'Hara and Wilcox (1990) observed differing and erratic behaviors from loggerhead sea turtles. Studies conducted have largely focused on loggerhead sea turtles, and those that observed responses are often based on very few individuals. BOEM is currently investing in a project to examine behavioral responses to impulsive sounds in adult leatherback sea turtles, however additional controlled studies are needed to better determine the sound pressure levels predicted to cause behavioral responses in a variety species and age classes of sea turtles.

Objectives: Use new data gathered from hearing sensitivity tests and behavioral studies to determine which sounds (frequency and sound pressure level) may elicit behavioral and physiological (stress) responses in sea turtles.

Methods: Sea turtle behavioral and physiological responses to a variety of acoustic stimuli and simulated sources of anthropogenic sounds (e.g., airguns, pile driving, drilling, vessel noise etc.) will be examined by monitoring sea turtle behavior (visually and/or with biologging tools) and physiological metrics (hormonal e.g., fecal samples; cardiac e.g., heart rate; hematology e.g., blood samples; etc.) before, during, and after sound exposure. Study design should be guided by the priorities identified (e.g., acute sources, species and age classes, etc.) and methodological recommendations (e.g., use of controlled exposure experimental designs, types of data that can be collected through captive vs. field-based experiments, etc.) identified in the 2021 workshop report (*in prep.*). For example, while controlled exposure experiments to examine physiological impacts may be efficiently and effectively conducted in captivity, BRS are best conducted with freely swimming turtles in the field. Real sources are preferred, however if they cannot be obtained due to access or cost, the use of simulated sources is preferred.

Specific Research Question(s):

1. What are the received levels of low-frequency anthropogenic sound that elicit behavioral responses in sea turtles?
2. What are the received levels of low-frequency anthropogenic sound that elicit physiological responses in sea turtles?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Building an Integrated, Sustained, Marine-life-observing Capability for U.S. Territorial Waters
Administered by	Office of Environmental Programs
BOEM Contact(s)	James M. Price (james.price@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2027
Final Report Due	TBD
Date Revised	February 11, 2022
PICOC Summary	
Problem	Increasingly greater climate variability is occurring at a global scale within the atmosphere and oceans, in conjunction with the direct effects of human activities, necessitating long-term observations of population impacts for more comprehensive impact analyses. Also, cumulative effects on populations can be significant and not readily observed with short-duration studies of the type more commonly done by BOEM and collaborators. Finally, there is a need to observe variability within whole ecosystems to assess more realistically the impacts from offshore energy development.
Intervention	This study seeks the innovative integration of these existing observational programs: the Animal Telemetry Network (ATN); the Marine Biodiversity Observation Network (MBON); and the Regional Associations of the IOOS for longer-term, ecosystem-focused monitoring.
Comparison	Most past and current BOEM-funded (and co-funded) studies have been greatly informative but of short duration and limited geographic extent and focused only on a few species or populations.
Outcome	This study will enhance the capability to observe longer-term variability (e.g., decadal-scale climate change) over greater geographic extent for a more complete assessment of possible adverse environmental impact and an improved capability to differentiate natural variability over anthropogenic impacts.
Context	All U. S. territorial waters; all species (microbes to whales); ecosystem focused

BOEM Information Need(s): Whereas BOEM has done an excellent job making use of the best available science to inform managerial decisions and to comply with National Environmental Policy Act, Endangered Species Act, Marine Mammal Protection Act, etc. requirements, spatial and temporal coverage of most of BOEM's studies have been somewhat limited to fully resolve the variability in the natural environment. The focus of these studies has been on one or a few species or populations. This has been necessary in some cases. However, the cumulative effects from long-term or broad-scale exposures to stressors and the downstream consequences to ecosystems are being missed. A more comprehensive assessment of possible adverse impacts requires an expanded, multi-agency observational capability.

Background: Over the past dozen years, BOEM has invested considerably in establishing collaborative partnerships for ocean monitoring, in particular the ATN and MBON. They in turn have established working relationships with the regional associations of the interagency IOOS and their university affiliates, GEO BON, the International Association for Biological Oceanography (IABO), the International Ocean Biodiversity Information System (OBIS), and its U.S. node, the Canadian-initiated, International Ocean Tracking Network, and the Smithsonian Institution's Tennenbaum Marine Observatories Network.

A main purpose of these networking efforts is to develop the capability to pool observational resources to be able to make sustained, long-term, wide-spatial-scale (whole-ecosystem-scale) observations of a changing ocean and do it economically. The MBON and ATN in partnership have gone a long way to achieving this goal with programs like BIOTRACK and, with NOAA CoastWatch, the Seascapes products and an established data archive for animal tagging observations.

This study is BOEM's contribution to the next major push to develop an integrated, sustained, marine-life-observing capability. NOAA's IOOS Program, in partnership with BOEM, NASA, and the Office of Naval Research, has initiated a call for research proposals via the National Oceanographic Partnership Program to 1) build upon the foundation established by the MBON, the ATN, and the U. S. IOOS regional associations to work across sectors and disciplines towards an integrated, sustained, marine-life-observing capability for U. S. waters, inclusive of estuaries and the deep ocean; 2) advance the state of technology for efficient and/or automated collection of species and associated habitat observations; 3) enable open access to biodiversity data and information; and 4) utilize these observations, technological developments, and data to address place-based (e.g., sanctuaries, reserves, protected areas, offshore energy development areas, etc.) managerial, conservation, and restoration needs.

Objectives: The objective of this study is to fund or co-fund one or a few of the most highly rated proposals on scientific merit that, additionally, address(es) a BOEM informational need or needs.

Methods: BOEM personnel oversaw the review process and had access to all the submitted proposals. The sponsors' review panel was conducted on February 22–24, 2022, before the conclusion of the first BOEM Science and Technical Review (STR) team review period. This gave the STR team an opportunity to review the proposals that were both among the more highly rated on scientific merit and that had value to BOEM. If there were any worthy of funding, the STR team recommended adoption on the FY 2023 National Studies List.

Specific Research Question(s): N/A

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References: N/A

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Carbon Mapper and Air Measurements in the Gulf of Mexico (GOM)
Administered by	Office of Environmental Programs
BOEM Contact(s)	Holli Wecht (Holli.Wecht@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	February 9, 2022
PICOC Summary	-
Problem	BOEM has been tasked with reducing greenhouse gas emissions, including methane (CH_4) and carbon dioxide (CO_2), from its authorized offshore energy activities. BOEM needs to identify facilities and emissions sources to target for potential rulemaking and reduction. BOEM has CH_4 and CO_2 emissions estimates in our emissions inventories, however these monthly emissions estimates are not based on measurement data, but on emissions factors (some based on information from the 1990s) and operational data. Having measured data, along with the emissions inventory data, will strengthen BOEM's justification for potential rulemaking. In addition, all measurement data (methane and other pollutants) will be used for offshore satellite validation and to improve BOEM's emissions inventory.
Intervention	Conduct several Carbon Mapper measurement flight campaigns in the GOM to obtain CH_4 and CO_2 data, conduct several flight campaigns measuring column NO_2 with the GCAS and continuous vertical profiles of ozone and aerosols with the High Spectral Resolution Lidar-2 (HSRL2), plus provide a general analysis of the data (which facilities and sources are the highest emitters based on the measurement data and comparison to satellite data and emissions inventory)
Comparison	All measurement data can be compared with BOEM's satellite and emissions inventory data.
Outcome	Datasets with analysis showing the top facility and source emitters and comparisons to the satellite and emissions inventory
Context	GOM

BOEM Information Need(s): The main need is pollutant measurement data in the GOM. The Carbon Mapper instrument deployed on aircraft will provide BOEM measured CH_4 and CO_2 data for the GOM, which can increase BOEM's knowledge for future rulemaking and will also improve BOEM's bottom-up emissions inventory. The GCAS measurements deployed on aircraft will provide BOEM measured column NO_2 (CO_2 and NO_2 are co-emitted pollutants) data for the GOM, which can be used to evaluate the utility of the Tropospheric Emissions: Monitoring of Pollution (TEMPO) satellite instrument (launching in January 2023) for continued measured emissions assessments and improvement of the emissions inventory, which is shared with the U.S. Environmental Protection Agency (EPA) for the National Emissions Inventory.

Background: BOEM has been tasked with reducing greenhouse gas emissions, including CH_4 and CO_2, in Executive Orders 14008 ("Tackling the Climate Crisis at Home and Abroad") issued January 27, 2021 and Secretary's Order 3399 ("Department-Wide Approach to the Climate Crisis and Restoring Transparency and Integrity to the Decision-Making Process") issued April 16, 2021. BOEM needs to identify facilities and emissions sources to target for potential rulemaking and reduction. BOEM has emissions estimates in our emissions inventories (Gulfwide Offshore Activity Data System and OCS AQS) however these monthly emissions estimates are not based on measurement data but on emissions factors and operational data. Having measured data, along with the emissions inventory estimates, will only strengthen BOEM's justification for potential rulemaking as well as using the measurement data for making improvements to the emissions inventories.

The Carbon Mapper instrument, using advanced remote sensing technology, deployed on aircraft will measure CH_4 and CO_2 data (https://carbonmapper.org/). Carbon Mapper is both a nonprofit organization and a program to monitor and help accelerate reductions in global CH_4 and CO_2 emissions. Infrared imaging spectroscopy offers the ability to pinpoint, quantify and track high-emission CH_4 and CO_2 point sources at the scale of individual facilities.

The NASA TEMPO satellite will take hourly measurements of atmospheric gases — including ozone, nitrogen dioxide and formaldehyde as well as aerosols — across North America and provide air quality products that will be made publicly available and help improve air quality forecasting. It is scheduled to be launched in early 2023. There are several campaigns to validate the satellite onshore, but no scheduled offshore studies. NASA will conduct airflights in the GOM with their Johnson Space Center Gulfstream-V (GV) aircraft to measure column nitrogen dioxide (NO_2) with the GEOCAPE Airborne Simulator (GCAS) and continuous vertical profiles of ozone and aerosols with the High Spectral Resolution Lidar-2 (HSRL2). This opportunity would leverage the airborne payload of NASA's Synergistic TEMPO Air Quality Science mission in summer 2023. This data can be utilized to validate the TEMPO satellite data, improve BOEM's emissions inventories, and evaluate methods for using TEMPO data to monitor offshore emissions beyond the timeline of this study.

In addition, all measurement campaigns should be coordinated temporally with the BOEM study's NASA SCOAPE II cruise (2023), after the TEMPO satellite launch (early 2023) so that BOEM will have a valuable emission (CH_4, column NO_2, etc.) dataset of both aircraft and vessel measurement data and satellite data. Lastly, BOEM will also seek volunteer coordination with the Offshore Operators Committee to get hourly operational data of the facilities sampled so that there can be a direct comparison of all the CH_4 and CO_2 datasets. Additionally, temporally-coordinated aircraft measurements of CO_2 and NO_2 can be used to estimate emissions factors from facilities, enabling estimates of CO_2 emissions from TEMPO NO_2 data, as NO_2 is measured from satellite far more frequently and at better spatial resolution than CO_2. These datasets will be used for proposed rulemaking and in the proposed FY24 Improving BOEM's Bottom-Up (BU) Emissions Inventory study profile to improve the current BU emissions inventory.

This study would tie-into the proposed study profile mentioned above and the Department of Energy Argonne IAA and would utilize the FY22 NASA IAA as a vehicle to purchase the Carbon Mapper and measurement data (as a separate order under the over-arching IAA).

Objectives:

- Collect measured CH_4 and CO_2 data in the GOM to identify top facility and source emitters. These sources may fall under BOEM, BSEE, EPA/USCG, or Department of Transportation regulatory authority.

- Collect measured column NO_2 data in the GOM to improve the emissions inventory data and validate TEMPO satellite data.

Methods:

1. Conduct Carbon Mapper flight campaigns in the GOM in coordination with NASA's SCOAPE II cruise, satellite data and BOEM's voluntary efforts with operators (if possible).
2. Conduct flight campaigns in the GOM in coordination with the NASA's SCOAPE II cruise with their Johnson Space Center Gulfstream-V (GV) aircraft to measure column NO_2 with the GEOCAPE Airborne Simulator (GCAS) and continuous vertical profiles of ozone and aerosols with the High Spectral Resolution Lidar-2 (HSRL2).
3. Conduct basic analysis of the Carbon Mapper data identifying top facility and source emitters.
4. Conduct analysis of the column NO_2 data comparing with the TEMPO satellite and identifying top facility and source emitters and suggestions for improvement of the emissions inventory.

Specific Research Question(s):

1. Based on the Carbon Mapper data, what are the top facility and source emitters for CH_4 and CO_2?
2. Do the top facility and source emitters from the measured CH_4 and CO_2 data match the emissions inventory top facility and source emitters?
3. Are there commonalities among the emitters, such as age or production volume?
4. How does the offshore column NO_2 data compare with the newly launched TEMPO satellite data?
5. Do CO_2 and NO_2, which are co-emitted by combustion processes, compare well enough for satellite NO_2 data to expand emissions studies beyond airborne measurements?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: https://carbonmapper.org/

References:

Nowlan C, Liu X, Janz S, Kowalewski M, Chance K, Follette-Cook MB, Fried A, Abad GG, Herman JR, Judd L, et al. 2018. Nitrogen dioxide and formaldehyde measurements from the GEOstationary Coastal and Air Pollution Events (GEO-CAPE) airborne simulator over Houston, Texas. Atmos. Meas. Tech. 11:5941–5964. doi:10.5194/amt-11-5941-2018.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Feel the Vibrations: Behavioral Response by Fish and Invertebrates to Particle Motion/Substrate Vibration from Pile-Driving
Administered by	Office of Environmental Programs
BOEM Contact(s)	Erica Staaterman (erica.staaterman@boem.gov), Hilary Kates Varghese (hilary.katesvarghese@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	2/3/2022
PICOC Summary	
Problem	Pile-driving activity associated with offshore construction introduces substantial energy into the substrate, which has the potential to negatively impact marine life that spend their lives on, in, or near the seafloor. Very few studies exist on the potential behavioral effects of substrate-borne vibration on marine life.
Intervention	The proposed study would provide strategic insight into the magnitude and scope of the potential behavioral effects of substrate-borne vibration on susceptible species by examining 1) multiple fish and invertebrate species, 2) a suite of behavioral responses—acute, chronic, and/or biologically meaningful, and 3) behavioral responses in a realistic pile-driving scenario.
Comparison	There are few studies that have examined impacts of water-borne particle motion on demersal species, and even fewer studies focusing on substrate-borne particle motion. A selection of species representing a range of sensory and/or mobility abilities will be tested in order to broaden the applicability of the results of this work.
Outcome	The knowledge gained from this study will be used by several BOEM program and regional offices in assessing impacts of BOEM activities. The Center for Marine Acoustics (CMA) will use the results to help inform their 1) acoustic impact model, 2) technical papers provided to regional offices on acoustic issues, and 3) recommendations made to regulators on acoustic issues. The results will also be used in specific BOEM regulatory documents, such as environmental impact statements and Construction and Operations Plans. This study will directly address widespread concern raised by the fishing community that BOEM does not understand the effects of sound on commercially important fish and invertebrate species.
Context	Nation-wide relevance for activities involving marine construction but focused on species found in New England given timing of proposed wind farm construction

BOEM Information Need(s): Offshore construction activities routinely involve sound and vibration-generating activities, such as pile-driving. Little is known about the effects of substrate-borne vibroacoustic disturbances on marine life living on or in the substrate. The behavioral response information expected from this proposed study will be used by BOEM to make more informed assessments of the impacts of its activities, which will include species of ecological and commercial

importance. The results will directly inform the animal behavior component of the CMA's acoustic impact model, as well as technical papers the CMA writes on acoustic issues, made available to other offices within BOEM to better inform environmental impact assessments, biological assessments, and inform decisions related to the National Environmental Policy Act and Endangered Species Act processes. Finally, the information will be used by the CMA to make recommendations to regulators responsible for updating acoustic impact thresholds with the best available science.

Background: Offshore construction activities, particularly impact pile-driving, produce significant energy that is transmitted into the water column and through the substrate. Substantial progress has been made in understanding the extent and magnitude of the effect that acoustic pressure waves in the water column have on marine life, especially on marine mammals. Acoustic energy is also coupled into the seafloor as substrate vibration that is well-described by directional particle motion (Hawkins *et al.* 2021). The scientific community has become increasingly aware that most fish and invertebrates sense sound through particle motion (Hawkins *et al.* 2021). Several studies, including ongoing BOEM-funded studies (AT 20-01/M20AC10009), have begun to explore study designs for assessing behavioral response in free-swimming fish (Spiga *et al.* 2017) and squid (Jones *et al.* 2020a, 2020b) to acoustic exposure that include measurements of particle motion. . But there are many species of fish and invertebrates that live at or within the substrate. Very little research has focused on behavioral responses of these species to the vibroacoustic disturbances in the substrate. Therefore, there is an explicit need for a study of demersal fish and invertebrate species to particle motion and substrate-borne vibration to fill this knowledge gap. In fact, at the 2020 workshop on the state of the science related to wildlife and offshore wind energy development, the expert working group identified behavioral response studies of priority taxa to particle motion and substrate vibration as a key research priority for the next five years (Popper *et al.* 2022). The fishing community has also raised concerns on this topic.

The proposed study builds on recent BOEM investments, like Real-Time Opportunity for Development of Environmental Observations (RODEO), which included preliminary but limited physical measurements of particle motion, during construction of the Block Island Wind Farm (Amaral *et al.* 2018, OCS Study BOEM 2018-029). It also builds on an ongoing BOEM study (AT-20-01) of behavioral effects of offshore construction sound on freely swimming black sea bass and squid. Neither of these studies were explicitly focused on the behavioral effects of demersal species to substrate-borne vibration and particle motion and so these questions remain unanswered. However, the methodological approaches—i.e., sound field measurement equipment, behavioral response study design—developed in these respective studies could be leveraged to address these outstanding research questions, thus capitalizing on the expertise and knowledge gained through those studies.

Objectives: The goal of this study is to provide insight about the potential effects of substrate-borne vibration from pile-driving activity on demersal fish and invertebrates through a dedicated empirical behavioral response study. The results will provide sufficient empirical evidence—by considering a range of behaviors that are acute, chronic, and/or biologically significant. Insight will also be gained on the relationship between changes in the vibroacoustic field and behavioral responses.

Methods: The proposed study is for a behavioral assessment of demersal fish and/or invertebrates during actual pile-driving (preferred) or simulated pile-driving activity (acceptable) and will include a control to assess baseline behavior without pile-driving activity. Measurements will be made of the vibroacoustic field (must include particle motion), using appropriate tools for each type of vibroacoustic wave. The study output will provide appropriate context for assessing the cause of any observed changes in behavior by including measurements and/or documentation of other relevant disturbances

and environmental factors. The objectives may be achieved through one or a combination of field or laboratory studies, with the intention of examining a vibroacoustic field that is representative of offshore construction pile-driving.

Potential field methods to observe animals near pile-driving may include, but are not limited to the following:

- Animal-mounted sensors (e.g., accelerometers) to measure fine-scale movements (e.g., startle responses, lateral movements, feeding behaviors).
- An acoustic telemetry array to monitor larger-scale movements (e.g., habitat-displacement).
- *In situ* cages equipped with video cameras and/or tagged animals.
- Simulated pile-driving or playback experiments* in a small bay or saltwater pond where animals can easily be observed and/or recaptured if tagged.

Potential laboratory methods may include, but are not limited to:

- Simulated pile-driving or playback experiments* under similar conditions to actual offshore wind vibroacoustic activity, conducted in large, acoustically isolated tanks equipped with video cameras and/or tagged animals to observe animal behavior (individuals or in groups).
- An approach where particle motion can be tested, and perceived pressure can be controlled for (in the case of species that are also pressure sensitive).

Potential species may include (listed by approximate priority, preference to include multiple species):

- Flatfish (e.g., common sole, winter flounder)
- Bivalves (e.g., scallop, clam, mussels)
- Crustaceans (e.g., American lobster, crabs)
- If multiple species are examined, species should represent a range of life history strategies, mobility, and hearing abilities, and preference to species with commercial/conservation importance (Popper *et al.* 2022).

*Approach will need to ensure the simulated vibroacoustic field has similar characteristics to actual pile-driving.

Specific Research Question(s):

Depending on the study design, possible research questions may include:

1. Does the activity elicit short-term behavioral response in the species (e.g., flee, startle, freeze)?
2. Does the activity interfere with reproductive behaviors (e.g., spawning, egg-guarding)?
3. Does the activity interfere with food finding behaviors (e.g., foraging, filtering, scavenging)?
4. Does the activity cause sustained behavioral shifts (e.g., habitat-abandoning)?
5. What is the threshold for behavioral response, is it behavior-specific?
6. Do individuals adapt, acclimate, or become sensitized to exposure and what are the characteristics that define those processes (e.g., onset, duration, etc.)?
7. Do changes in behavior correlate with changes in the vibroacoustic sound field?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Amaral JL, Beard R, Barham RJ, Collett AG, Elliot J, Frankel AS, Gallien D, Hager C, Khan AA, Lin Y, et al. 2018. Field observations during wind turbine foundation installation at the Block Island Wind Farm, Rhode Island. 191 p. Report No.: OCS Study BOEM 2018-029.

Hawkins AD, Popper AN. 2016. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES J Mar Sci. 74(3):635–651.

Hawkins AD, Hazelwood RA, Popper AN, Macey PC. 2021. Substrate vibrations and their potential effects upon fishes and invertebrates. J Acoustic Soc Am. 149(4):2782–2790.

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Popper AN, Hice-Dunton L, Jenkins E, Higgs DM, Krebs J, Mooney A, Rice A, Roberts L, Thomsen F, Vigness-Raposa K, et al. 2022. Offshore wind energy development: research priorities for sound and vibration effects on fishes and aquatic invertebrates. J Acoustic Soc Am. 151(1):205‑215.

Spiga I, Aldred N, Caldwell GS. 2017. Anthropogenic noise compromises the anti-predator behaviour of the European seabass, *Dicentrarchus labrax* (L.). Mar Poll Bull 122(1-2):297–305.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Investigating Shoreline Fumigation Algorithms in Offshore and Coastal Dispersion Model for AERMOD – Part 2 of the U.S. Environmental Protection Agency's Inter-agency Agreement to Improve AERMOD for Overwater Applications
Administered by	Office of Environmental Programs
BOEM Contact(s)	Holli Wecht (Holli.Wecht@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	January 13, 2022
PICOC Summary	
Problem	BOEM needs to replace Offshore and Coastal Dispersion (OCD) with AERMOD, USEPA's preferred dispersion model for overland. However, AERMOD does not have the necessary platform downwash and shoreline fumigation algorithms. Modeling is one approach that BOEM uses to determine possible air quality impacts caused by Outer Continental Shelf (OCS) oil and gas activities, as required under the National Environmental Policy Act (NEPA) and the Outer Continental Shelf Lands Act (OCSLA). BOEM needs to continue current work to incorporate a platform downwash algorithm into AERMOD and add necessary shoreline fumigation algorithms to achieve this goal.
Intervention	The older offshore dispersion model, OCD, has aspects that are outdated. An effort to integrate the platform downwash algorithm from OCD into AERMOD has been ongoing with results currently preliminary and additional refinements being needed. A scoping study to identify and assess existing shoreline fumigation formulations and algorithms is currently ongoing and includes a review of the shoreline fumigation algorithms in OCD. The results of the scoping study need review with a determination of a path forward to add shoreline fumigation to AERMOD. This path of integrating shoreline fumigation from OCD would also require AERMOD to be re-coded to include two meteorological streams (overland and overwater) and include a mechanism for identifying the location of the shoreline relative to the source.
Comparison	Current wind tunnel studies funded by BOEM are being used to test, evaluate, and refine platform downwash algorithms and integrate modern technology results in AERMOD. Though there are limited field study databases to fully evaluate the updated model, intercomparisons of OCD and AERMOD, with platform downwash added, would be run post-installation of shoreline fumigation which could be a method to validate the shoreline fumigation. However, other methods of validation and data availability will need to be explored.
Outcome	Having the necessary platform downwash and shoreline fumigation algorithms in AERMOD are steps that are necessary for the USEPA to replace OCD with AERMOD through regulatory action for use in BOEM applications. In 30 CFR 550, operators are required to use USEPA's *Guideline on Air Quality Models* (published as Appendix W to 40 CFR Part 51), thus BOEM needs to support USEPA's efforts to complete the steps required to replace OCD with AERMOD.

Context	Gulf of Mexico

BOEM Information Need(s): The USEPA has listed AERMOD as a preferred overland dispersion model in its *Guideline on Air Quality Models* (published as Appendix W to 40 CFR Part 51). AERMOD does not have the necessary platform downwash and shoreline fumigation algorithms required for overwater applications. The older OCD dispersion model treats both platform downwash and shoreline fumigation, which are scientifically sound, but other aspects of OCD are outdated such the inability to use current operating systems, outdated post-processing routines that do not conform with current National Ambient Air Quality Standards (NAAQS) averaging times, and limits on the number of sources and receptors that can be represented in a single model run. BOEM needs to continue current work to incorporate a platform downwash algorithm into AERMOD and add necessary shoreline fumigation algorithms into AERMOD to achieve this goal. A possible path of integrating shoreline fumigation from OCD would also require AERMOD to be re-coded to include two meteorological streams (overland and overwater) and include a mechanism for identifying the location of the shoreline relative to the source.

Background: The 1990 Clean Air Act Amendments requires the USEPA to set the NAAQS for widespread pollutants from numerous and diverse sources considered harmful to public health and the environment. OCSLA states that OCS oil and gas exploration, development, and production activities cannot significantly impact the NAAQS compliance of any state. Modeling is one application that BOEM determines possible air quality impacts caused by OCS oil and gas activities as required under NEPA and OCSLA. BOEM's regulations at 30 CFR 550 require that modeling must be conducted according to the guidelines of the USEPA's Appendix W. Having necessary shoreline fumigation algorithms in AERMOD is one step BOEM needs to replace the outdated OCD, according to the USEPA through discussions of IWAQM-Overwater and the USEPA's White Paper (USEPA 2022).

Shoreline fumigation is the condition when offshore emissions intersect the thermal internal boundary layer that forms onshore; mixing within this layer may cause ground level concentrations increase.

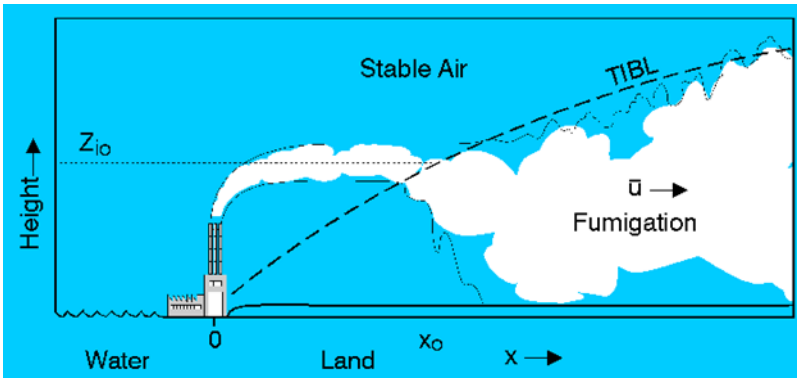

Figure 1. Shoreline fumigation (CSIRO 2008).

The current offshore dispersion model, OCD, has both platform downwash and shoreline fumigation algorithms, which are of sound science, but OCD has not been updated in 20 years. BOEM needs to replace OCD with AERMOD, USEPA's preferred dispersion model for overland. However, AERMOD does not have the necessary platform downwash and shoreline fumigation algorithms. An effort to integrate the platform downwash algorithm from OCD into AERMOD has been ongoing with results currently preliminary and additional refinements being needed. A scoping study to identify and assess existing

shoreline fumigation formulations and algorithms is currently ongoing and includes a review of the shoreline fumigation algorithms in OCD. The results of the scoping study need review with a determination of a path forward to add shoreline fumigation to AERMOD. This path of integrating shoreline fumigation from OCD would also require AERMOD to be re-coded to include two meteorological streams (overland and overwater) and include a mechanism for identifying the location of the shoreline relative to the source.

This study would tie into the ongoing BOEM IAA with USEPA, IAA Number M19PG00019 (GM-19-X05), which started the necessary improvements needed in AERMOD for offshore applications (to replace OCD) by incorporating the OCD platform downwash algorithms into AERMOD. This study would be a continuation of this effort (and USEPA IAA) by now studying the OCD shoreline fumigation algorithms.

Objectives: The objectives of the study are to refine and further evaluate the OCD platform downwash algorithm that has been installed into AERMOD and add shoreline fumigation algorithms into AERMOD.

Methods: This study would consist of:

1) Further evaluation of the platform downwash algorithm and to make refinements as needed to meet the criteria of Appendix W as a preferred model.
2) Review of the ongoing IAA's shoreline fumigation scoping study.
3) Determine the best fit path forward to incorporate shoreline fumigation into AERMOD (USEPA has determined there are multiple potential paths forward).
4) Draft and finalize shoreline fumigation coding into AERMOD (including the incorporation of two meteorological streams).
5) Complete model intercomparisons and model evaluations.

Specific Research Question(s):

1. What is the best approach to incorporate shoreline fumigation into AERMOD?
2. For the more appropriate solution, what are the meteorological data needs and what updates will need to be made to AERMET and/or AERMOD?
3. How does the newly formed shoreline fumigation algorithm in AERMOD compare to OCD shoreline fumigation algorithm?
4. Are there limitations in the applicability of fumigation algorithms not previously seen in scientific literature?

Current Status: The platform downwash algorithm from OCD has been integrated into a version of AERMOD under a current IAA. USEPA with plans to release the current integration as an alpha option in AERMOD in the late spring of 2022. Preliminary results indicate under prediction when evaluated against recent wind tunnel studies performed by CPP Wind Engineering & Air Quality Consultants under contract with BOEM. Additional evaluation is needed with refinements to the implementation. A scoping study on shoreline fumigation is ongoing under the current IA.

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

[CSIRO] Commonwealth Scientific and Industrial Research Organisation. 2008. The Kwinana coastal fumigation study. Canberra (Australia): Commonwealth Scientific and Industrial Research Organisation; [accessed 2022 May 4]. http://www.cmar.csiro.au/e-print/open/sawford_1997a.html

[USEPA] U.S. Environmental Protection Agency. 2022. AERMOD modeling system updates related to overwater modeling applications. Washington (DC): U.S. Environmental Protection Agency; [accessed 2022 May 4]. https://www.epa.gov/sites/default/files/2021-01/documents/overwater_white_paper.pdf

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Marine Environmental Data Internet Access and Environmental Study Capability Ecosystem (MEDIASCapE) Phase I
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jonathan Blythe (jonathan.blythe@boem.gov), Erica Staaterman (erica.staaterman@boem.gov), Gregory Fulling (gregory.fulling@boem.gov)
Procurement Type(s)	Inter-agency Agreement
Performance Period	FY 2022–2025 (Phase I); FY 2022 – 2027 overall
Final Report Due	April 5, 2025
Date Revised	April 5, 2022
PICOC Summary	
Problem	There is a need for greater accessibility of BOEM environmental studies data.
Intervention	Develop or procure a service for taking custody of studies data to enable review and acceptance of environmental studies data deliverables and facilitate the transfer of environmental studies data to corporate systems or long-term repositories. Phase I will focus on Passive Acoustic Monitoring (PAM) and Protected Species Observer (PSO) data collected by BOEM to support Renewable Energy Development in the Atlantic.
Comparison	N/A
Outcome	Improved retention and broader dissemination of environmental studies data
Context	Open by default, non-sensitive and non-proprietary environmental studies data

BOEM Information Need(s): Data are the material products of every environmental study, as they are required to collect or create them. Further, data collected by the US government must be made available using open formats, so that it is possible to read and use the data without paying for software or decoding tools to access and reanalyze the data. This study will provide a data service to help Environmental Studies Program (ESP) data comply with Open Government Data Act requirements to facilitate open access and engagement over studies data with Federal agencies, academia, the private sector, industry, and the public.

Phase I of this study will enable more informed interagency consultations on renewable energy construction projects and serve to preserve the data for long-term assessments of BOEM's environmental policy regarding renewable energy leasing in the Atlantic.

Background: ESP-funded environmental studies are typically conducted by leading experts from the ocean sciences research community. Through ESP, BOEM has a broad reach to engage with research entities from other Federal ocean agencies, academia, the private sector, industry, and the public. Most of these groups operate completely outside of BOEM's IT operational environment, often making environmental study data access and sharing difficult. Inconsistent practices between ESP-funded studies regarding the delivery mechanism, open format, and data stewardship is a critical data management issue that needs to be addressed and standardized at a national level.

Under most circumstances, the "rights in data" clause of the Federal Acquisition Regulations entitles the government to unlimited rights to access and use data that ESP collects under its extramural research activities, and ESP stipulates the "right in data" clause in contracts and agreements, however this may not occur in all cases. Although the government may assert the rights in data from studies, unless the studies data are captured as a requirement under a contract and the government retains a copy of the data deliverable from a study, the government's rights in data is extremely difficult to enforce, and there have been recent concrete examples of the problems this can cause.

Renewable Energy Development in the Atlantic will produce voluminous environmental compliance data that BOEM will need to review in order to ensure that mitigation measures to protect marine mammals such as the North Atlantic Right Whale are effective and sufficient. Without access to environmental compliance data, the bureau is flying blind and cannot fulfil its environmental protection mission. This is an urgent need that ESP can fill by providing a mechanism for submitting, reviewing, analyzing, and archiving these important datasets. While BOEM is not responsible for environmental compliance data that industry collects, it is in BOEM's interests to stipulate to industry how to contribute these data to a shared repository that BOEM can access to review and use for its assessment and consultation activities. Although BOEM's legal mechanisms to require industry data are different from the studies authorities under the Federal Acquisition Regulations, the same guidance and mechanisms that we establish for our studies data can provide a guidance, a community standard, and a viable data pathway that other Federal agencies and sectors could use.

Objectives: This study profile addresses some of the core challenges in managing ESP data.

- The service will be made available to all studies Principal Investigators to provide a mechanism for delivery of interim and final studies data and facilitate evaluation of its compliance with relevant community standards for open formats.
- ESP data submitted to BOEM using this service will come free and clear of any licenses or restrictions and be made available in the public domain.
- Custodianship can also enforce a moratorium period when the data will be held behind a log in but may still be subject to FOIA.
- Once data from studies are in the public domain, data will be disseminated in open formats following community standards. This way it will be easier for BOEM analysts to access and reuse study data for the purpose for which they were collected (the original government requirement), and it will also enable others to reuse the data free of any restrictions or concerns about their license or terms of use.
- Phase I in this study will address the data pathways for Passive Acoustic Monitoring recordings and Protected Species Observer datasets delivered from environmental studies, to ensure that they are readily available for reuse by other Federal ocean agencies, academia, the private sector, industry, and the public.

Methods: The service will include tools for the Principal Investigators to load data and for BOEM regional staff and HQ ESP representatives to review and accept research results, using tools like the Alaska Ocean Observing System's Research Workspace (Turner and Gill 2018).

ESP can procure R&D services to improve ESP data management from any one of several companies that currently provide these services to other Federal agencies. These companies leverage technologies that support open formats and have expertise in using open source software that were developed to support

the Federal research enterprise, such as the National Ocean and Atmospheric Administration's Environmental Research Division's Data Access Program (ERRDAP) solution developed by NOAA (Mendelssohn and Simons 2008), which can work directly with other Federal agencies' instances of ERRDAP, and it can automate submission of Archival information packages to their designated repositories. Other examples of open data tools include the MD Toolkit developed by the U.S. Geological Survey and U.S. Fish and Wildlife Service (Bradley 2020), and the Open Data Registry available from Amazon Web Services (https://registry.opendata.aws/).

Data will be accessible through web links for data download or data services that are available to the general public, and BOEM staff will be able to access these data securely just like BOEM staff can currently download data from other Federal repositories accessible through the web. The security environment must maintain these statutory requirements. Despite being an external web environment, it will serve as an intermediate step for bringing study data into government owned and operated IT systems.

Phase I of this study will focus on Archiving of Passive Acoustic Monitoring recordings and visual observations from Protected Species Observers, which are complementary methods used to detect the presence of marine mammals. Both datasets are typically collected by environmental studies to address BOEM information needs and industry to address environmental compliance requirements. Data from various sources can be combined to help understanding marine mammal distributions and potential impacts from BOEM's Outer Continental Shelf activities. This study will recommend a common data pathway to guide the data collection, processing, analysis, and Archival. Archiving will entail a centralized database, processed to a standard of data quality that is acceptable to the community, using common tools. National Centers for Environmental Information is the designated long-term repository for PAM and PSO data, and this study will research and document the capacity and tools needed to liaise with industry and lead the interagency to implement scientific data stewardship of these datasets.

Specific Research Question(s): What services or products can ESP best use to support the submission, review, acceptance, and dissemination of BOEM required data to staff scientists and analysts, the public and other Federal partners? How can free and open distribution of PAM and PSO data to the public help BOEM to realize better environmental protection and a better return on its research investments.

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Bradley J. 2020. Alaska Data Integration Working Group; working on methods to efficiently integrate and share data. [accessed 2022 Jan 14]. https://github.com/adiwg.

Mendelssohn R, Simons RA. 2008. ERDDAP - an easier way for diverse clients to access scientific data from diverse sources. American Geophysical Union Fall Meeting; 2008 Dec 15–19; San Francisco, CA. https://ui.adsabs.harvard.edu/abs/2008AGUFMIN52A..09M/abstract

Turner C, Gill I. 2018. Developing a data management platform for the ocean science community. Marine Technology Society Journal. 52(3):28–32. doi: 10.4031/MTSJ.52.3.8

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Marine Mammal Hearing Temporary Threshold Shift from Complex Noise Exposure
Administered by	Office of Environmental Programs
BOEM Contact(s)	Shane Guan (shane.guan@boem.gov), Erica Staaterman (erica.staaterman@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	May 19, 2022
PICOC Summary	
Problem	Current noise impact assessments on marine mammal hearing threshold shift (TS) from noise exposure uses a binary approach by classifying the noise sources into two mutually exclusive categories: impulsive and non-impulsive. However, in real-world situations, animals are often exposed to complex noise that includes both impulsive and non-impulsive components. Studies on human psychoacoustics show that exposure to complex noise is more likely to induce TS than to purely non-impulsive noise, given the same acoustic energy. However, currently there is no research on marine mammal TS from complex noise exposure. Therefore, it is often difficult for BOEM to accurately assess the effects of marine mammal noise exposure from a project that generates both impulsive and non-impulsive noises simultaneously.
Intervention	This study proposes to conduct temporary threshold shift (TTS) studies on captive marine mammal species that are exposed to complex noise with different impulsiveness using either behavioral or auditory evoked potential approach.
Comparison	The results of the study would be used to compare the existing marine mammal TTS noise exposure criteria and be used to update or revise the current categorization of noise types to provide more realistic impact assessment in the future.
Outcome	The study would provide TTS thresholds on select marine mammal species when exposed to complex noise from anthropogenic sounds.
Context	Nation-wide relevance for activities involving offshore wind construction, seismic exploration, subsea drilling and dredging, etc.)

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. Currently, there is no information on auditory thresholds of marine mammals when exposed to complex noise (noise that contains both impulsive and non-impulsive structures). Without this information, it would be impossible to accurately assess the effects of this type of sound from BOEM regulated activities on marine species and their environment. This issue is also raised by the Marine Mammal Commission in its letter to BOEM regarding suggestions for consideration in the Studies Development Plan for FY 2023–2024.

Background: Marine engineering activities (e.g., offshore wind project construction and operation, seismic exploration, subsea drilling and dredging, and structure removal) often generate intense and/or long-lasting noises that are known to impact marine life. Currently, a binary approach is used to assess the effects of marine mammal noise exposure by classifying the noise sources into two mutually exclusive categories: impulsive and non-impulsive. Two different noise-induced threshold shift (NITS) criteria are used to assess marine mammal auditory affects.

However, under real-world situations, animals are often exposed to both types of noises simultaneously from a wide range of activities. For example, during impact pile driving for wind turbine installation, the noise sources in the vicinity include impact hammer noise (impulsive) and construction vessel noise (non-impulsive). The noise field that contains both impulsive and non-impulsive structures are referred to as complex noise in human psychoacoustic research (Ahroon et al. 1993). It has been shown in human and terrestrial animal studies that exposure to complex noise is more detrimental than non-impulsive steady-state noise given the same cumulated exposure energy, and that the characteristics of "impulsiveness" can be an important factor that determines the TTS thresholds from exposure (Hamernik et al. 2003; Qiu et al. 2007; Hamernik et al. 2007; Zhao et al. 2010; Qiu et al. 2013; Xie et al. 2016). However, there is no existing study on NITS of marine mammals (or any marine species) when exposed to complex noise (Guan and Brookens 2021). This proposed study would contribute to knowledge on marine mammal auditory effects from exposure to a noise field that is more likely to be encountered in a real-world situation. The information obtained from this study would greatly assist BOEM decision-making using scientific knowledge that is first in class. Furthermore, the results from this work could eventually lead to a paradigm shift in the way we regulate underwater noise, if the results indicate that marine mammals exhibit different NITS to complex noise exposure.

Objectives:

- Obtaining NITS on selected marine mammal species (i.e., different functional hearing groups and/or species with TTS data available from previous studies) that are exposed to complex noise at different impulsiveness setting,
- Establishing appropriate standards for classifying noise types based on metrics of impulsiveness from different noise sources under general operating conditions, and
- Recommendations for updating or revising current marine mammal noise exposure criteria as needed based on study results.

Methods: The study would conduct noise exposure experiment on select marine mammal species using behavioral or auditory evoked potential procedures to obtain NITS thresholds under different intensity and impulsiveness. Based on the resultant criteria, the researchers would develop appropriate metrics to characterize impulsiveness of the noise sources, which, in turn, would lead to updated or revised marine mammal noise exposure criteria recommendations.

Specific Research Question(s):

1. Do marine mammals exhibit different NITS thresholds when exposed to complex noise vs. pure impulsive or non-impulsive noises that have the same exposure energy?
2. Do marine mammals exhibit different NITS thresholds when exposed to complex noise that have different impulsiveness but the same exposure energy?

3. What is/are the appropriate standard(s) to classify and characterize noise types and their potential to cause TS based on metrics of impulsiveness?
4. Do current NITS thresholds, based on pure impulsive and non-impulsive noise exposure, provide adequate protection of marine mammals in BOEM decision-making in a real-world scenario with complex noise field?
5. Do current NITS thresholds based on pure impulsive and non-impulsive noise exposure need to be updated or revised for BOEM's environmental assessment?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Ahroon WA, Hamernik RP, Davis RI. 1993. Complex noise exposures: an energy analysis. J Acoust Soc Am. 93:997–1006.

Guan S, Brookens T. 2021. The use of psychoacoustics in marine mammal conservation in the United States: from science to management and policy. J Mar Sci Eng. 9:507.

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Xie H, Qiu W, Heyer NJ, Zhang M, Zhang P, Zhao Y, Hamernik RP. 2016. The use of the kurtosis-adjusted cumulative noise exposure metric in evaluating the hearing loss risk for complex noise. Ear Hear. 37:312–323.

Zhao Y, Qiu W, Zeng L, Chen S, Cheng X, Davis RI, Hamernik RP. 2010. Application of the kurtosis statistic to the evaluation of the risk of hearing loss in workers exposed to high-level complex noise. Ear Hear. 31:527–532.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Next Generation of Animal Telemetry: Year II
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Inter-agency Agreement, Contract
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	January 11, 2022
PICOC Summary	-
Problem	Spatial and temporal coverage limitation of telemetry receiving stations lead to data loss and cost ineffectiveness for animal movement studies upon which BOEM and other agencies depend heavily for understanding impacts of activities as well as distribution changes resulting from a changing climate.
Intervention	Leverage growing small-satellite industry, anticipated to be as many as 18,000 orbiting by 2028, to augment current limitations.
Comparison	Change is measured by increased location accuracy and bandwidth available to telemetry needs for an open-source tracking receiver (software-defined radio or global positioning system) that can be included on future small satellites, such as those from academia, government, and industry (Planet, Starlink, etc.).
Outcome	Improved data quality with reduced costs for animal telemetry needs
Context	Global

BOEM Information Need(s): This study implements BOEM's Outer Continental Shelf (OCS) Lands Act mandate to monitor the marine environment adjacent to U.S. OCS operations as well as support for understanding species distributions of commercial value and changes occurring as a result of climate change. Understanding animal movement in the OCS is required for nearly everything under BOEM's purview. Telemetry is an important tool to support animal movement and behavior studies to supplement survey efforts. Additionally, animal telemetry can be used to infer movements related to activities in the OCS, such as geophysical surveys, platform construction and demolition. Animal telemetry can provide relevant information for environmental analysis and consultations across program areas such as wind and hydrokinetic placement locations, oil/gas leasing, and even be used in monitoring impacts of climate change. A need for improved data on animal movement, behavioral, and foraging ecologies have routinely been identified in public comments related to energy development and marine mineral extraction.

Background: This study proposes the development of a supplemental/alternative method of OCS marine animal tracking by leveraging NASA's expertise with small satellites and space technologies and using NASA's CubeSat Launch Initiative (CSLI) network and Flight Opportunities Program.

Animal movement studies face several technological factors due to proprietary technology, limited radio transmission range, overhead satellite time limitations, and most importantly, cost. Cumulatively, these

factors limit the opportunity to gather information on animal movements throughout the U.S. Exclusive Economic Zone. Tracking of highly mobile marine megafauna is typically accomplished by the ARGOS satellite. An open-source receiving network, which does not depend on the ARGOS satellite system significantly lowers costs by enabling the use of a constellation of low-cost, open-source data relay small satellites.

The small-satellite community can be leveraged to invest in a CubeSat alternative to the current ARGOS system. CubeSats are a class of small research-class spacecraft built on an open standard and measuring 10-cm square. NASA's CubeSat Launch Initiative (CSLI) provides opportunities for small-satellite payloads to hitch-hike on rockets planned for upcoming launches. This program engages engineering schools across the United States to develop low-cost microsatellite experiments that have been developing and launching CubeSats from around the world annually. Additional tracking sensors can be placed easily on the future CubeSats, as well as autonomous underwater vehicles, ocean-going vessels, aircraft, and existing buoys to create a truly wireless ocean.

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

This is a continuation of an FY17 study to determine the feasibility of leveraging small satellites for animal telemetry. During that study, a global crowdsourcing ideation challenge took place, as well as tests of commercial off-the-shelf tracking equipment on high-altitude balloons. Workshops were also conducted with the SmallSat and biologging communities. In 2021, we started year 1 of the project. The focus of year 1 was developing the payload sensor package and further iterating to mature the design through testing.

The next step in the project is to continue iterating on the design to complete payload integration. This will be accomplished through prototype testing using high-altitude balloons to characterize functionality and performance. This will support the design of the sensor that will be tested onboard the International Space Station (ISS) and eventually, a constellation of small satellites. The planned activities will also include conducting workshops with the SmallSat and biologging communities.

Through the implementation of this project, BOEM achieves improved tools for OCS monitoring; engaging scientific, engineering, and technology partners in an innovative program; and developing a tech-savvy workforce while filling in information gaps in OCS data cost-effectively.

Objectives:

- Leverage SmallSats and open-source tracking technology to develop and demonstrate an OCS tracking/monitoring network suitable for geographically and taxonomically diverse marine megafauna.
- Demonstrate ability to track and transmit tag data using the SmallSat network.
- Describe feasibility of tracking pelagic megafaunal movements outside the range of existing surveys.

Methods: Leveraging NASA's expertise with small satellites and space technologies for required tracking instruments and using NASA's CSLI network and Flight Opportunities Program, we will utilize space-based transceivers aboard CubeSats and the ISS as well as ocean and terrestrial-based transceivers to demonstrate the feasibility of tracking various marine megafauna.

The aforementioned will support the overall goals of the project:

1. Conduct technology demonstrations as "proof of concept" exercises using commercial hardware on a high-altitude balloon, on the external rack of the ISS, and a small constellation of small satellites.
2. Conduct open-source hardware, software, telemetry, data management systems architecture, and communication protocol workshops with the community of experts as well as ocean telemetry engineering experts to establish a standardized communication platform for low orbital small-satellites.
3. Convene a workshop of the CubeSat community as well as ocean telemetry engineering experts to establish a standardized communication platform for low orbital pico-satellite.
4. Convene a public competition to create a coding algorithm for managing big data associated with visualizing movements accurately.

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

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Levenson JJ, Martinez A, Uribe E, Ben-Maor S, Cortez J, Contreras J, Thaler A, Bosyk J. 2021. Developing the next generation of animal telemetry. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 113 p. Report No.: OCS Study BOEM 2021-060.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Piloting an Approach to Community-Informed Characterization of Environmental Justice (EJ) Communities Potentially Impacted by BOEM-Authorized Activities
Administered by	Office of Environmental Programs
BOEM Contact(s)	Laura Mansfield (laura.mansfield@boem.gov), Meghan Cornelison (meghan.cornelison@boem.gov), Kimberly Sullivan (kimberly.sullivan@boem.gov)
Procurement Type(s)	Contract, Inter-agency Agreement, Cooperative Agreement
Performance Period	FY 2022–2025
Final Report Due	Spring 2025
Date Revised	March 31, 2021
PICOC Summary	
Problem	Environmental analyses at BOEM could provide better support for decision-making with more specific information on the EJ communities that may be affected by BOEM-authorized activities. Sections within National Environmental Policy Act (NEPA) documents currently discuss potential EJ impacts in a general sense. To present analysis on potential impacts on communities, it is critical to first characterize communities so that impacts can be analyzed within local contexts, and ideally with local input.
Intervention	Develop and conduct a pilot application of an approach to utilize existing data in conjunction with community-provided input to produce short community characterization summaries.
Comparison	Without community characterizations, NEPA assessments will likely continue to describe communities generally and may fail to acknowledge local contexts and impacts to EJ communities, including overlooking impact nuances between communities.
Outcome	A collection of brief EJ community characterization summaries for approximately 10 communities within three chosen study areas, a subset of which would include targeted community input.
Context	A pilot study of selected areas representing various stages of BOEM's energy-related processes

BOEM Information Need(s): Various Federal statutes, including NEPA, require BOEM to examine the social and economic impacts of BOEM-authorized activities at the community level. Additionally, policy and guidance related to environmental justice calls for meaningful engagement and access to decision-making processes for EJ communities (E.O. 12898, E.O. 13985, E.O. 14008, U.S. EPA 2016). BOEM's planning and engagement efforts, and NEPA documents, could be improved with more detailed information about EJ communities. Sections on EJ in some environmental impact statements speak broadly about entire regions or discuss generalized impacts, rarely including information linked to a specific community context. Baseline information to support community characterization is available but has not been effectively applied in analyses to identify local contexts. With short summaries readily accessible, BOEM analysts could better understand the affected environment and potential impacts and could include select language from summaries or incorporate by reference into environmental analyses.

Furthermore, conducting community-informed research could advance earlier community awareness of BOEM activities and support building foundational and trusted relationships. Gaining first-hand information will help "ground-truth" some of the existing information that would be collated into the community characterization summaries. Considering the scale and pace at which energy planning, leasing, and development (especially offshore wind) is expected to occur over the next decade, BOEM may be well served to explore efficient yet meaningful approaches to understanding and describing EJ communities that can be implemented as needed.

Background: There is a substantial amount of data currently available and accessible to inform the EJ community characterization summaries, including indicators on poverty, population composition, and personal disruption. National Oceanic and Atmospheric Administration (NOAA) Fisheries maintains the Community Social Vulnerability Indicators (CSVIs), which is a national effort to develop indicators to uniquely characterize community well-being and evaluate vulnerability and resilience of coastal communities to disturbances (regulations, sea level rise, etc.). Other related information includes climate change indicators (sea level rise risk, storm surge risk), economic indicators (labor force structure, housing characteristics), and gentrification pressure (housing disruption, retiree migration, urban sprawl). Efforts to create EJ community characterization summaries would build upon all existing data or information on communities. However, community characterization summaries would focus on issues and concerns directly related to BOEM-authorized activities, particularly offshore wind, and engagement efforts with communities in collaboration with other agencies such as, but not limited to, the U.S. Department of Energy's Wind Energy Technologies Office, NOAA, and Sea Grant. This effort will also look at what indicators or other considerations should be expanded to better address new information needs or to meet the evolving guidance on EJ or best practices for assessing impacts and engaging with EJ communities. NOAA Fisheries and BOEM both recognize overlapping elements between equity and EJ and will work closely to shape this research to fully consider intersections with energy justice and other types of justice. NOAA Fisheries' subject matter experts have provided support to BOEM in identifying EJ research needs and will continue to work with BOEM to shape this research, recognizing the importance of a collaborative study to gain knowledge and fill knowledge gaps about EJ communities. NOAA Fisheries is working to update their fishing community profiles and can reference and use the information collected in BOEM's study to better characterize EJ concerns. This pilot study can also inform approaches for future data collections important to fulfilling both BOEM and NOAA Fisheries goals of understanding equity and EJ concerns.

Objectives:

- Characterize EJ communities, using existing information, to expand BOEM's knowledge of communities and populations that may potentially be affected by BOEM-authorized activities and associated onshore infrastructure.
- Pilot an approach to developing locally informed summaries that will highlight unique contexts and concerns of EJ communities around offshore energy planning and activities.
- Improve early engagement with EJ communities in offshore wind planning and incorporation of community information and data into environmental analyses.
- Record preliminary ideas on additional information, data, or decision tools needed in the future to more fully evaluate potential impacts on EJ communities.

Methods: This study would pilot an approach to develop community characterizations. These characterizations would involve several components, beginning with a discussion between the principal

investigator and BOEM to select 3 areas and identify approximately 10 communities in each area in which to conduct pilot community characterizations, for a total of approximately 30 community characterizations. The study would consolidate, review, and analyze the representation of existing data from multiple sources into a readily available format. BOEM and the principal investigator would then identify a small subset of communities, approximately three to five communities total, to collect primary information. The principal investigator would contact community leaders, key informants, and community organizations to request review of and local input into the characterizations of their community.

An important source of data will likely be NOAA Fisheries' CSVI Toolbox. NOAA Fisheries would provide support on best practices for using this data. Other data sources to consider include EPA's EJScreen, the Economics: National Ocean Watch (ENOW) data set, the U.S. Census Bureau, Bureau of Labor Statistics, and other sources of relevant information (including qualitative, written, or oral information). For primary research on the small subset of communities, the contractor shall fund and facilitate stipends to compensate community organization leaders or other selected key informants for their participation, modeled after contracts for BOEM's tribal engagement efforts. This research will identify specific vulnerabilities (e.g., displacement, gentrification), needs (e.g., resources to engage), preferences (e.g., desire to change jobs, cultural values), adaptive capacities (e.g., job training), barriers to engagement (e.g., languages, accessibility), or any other information deemed relevant through study planning or preliminary discussions. After conducting primary research, the community information would be coded and analyzed to develop a thematic analysis and identify where views aligned or were different.

Community summaries will highlight characteristics that identify vulnerabilities, themes, issues, or concerns of each community. Each community summary would include relevant history, demographics, economics, coastal and marine resource use, coastal land use including existing facilities, outreach approaches that are locally appropriate for that specific EJ community, identification of key community leaders and organizations, and other baseline conditions that will enable BOEM analysts to better incorporate specific community interests into environmental reviews and the decision-making process. These summaries would be accompanied by a methodology document describing summary objectives, methods, data sources, definitions, and other relevant information.

Specific Research Question(s):

1. What are the social, economic, and cultural characteristics of each identified EJ community, as reflected in available secondary data?
2. What additional insights and characteristics can be gained through community-provided information?
3. When is the best time within the planning, leasing, or development process to conduct community summaries for BOEM use?
4. Based on knowledge gained during this research, what are some additional data gathering efforts or decision tool developments that could be useful to develop in the future for assessing impacts on EJ communities?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites:

Webtool: https://www.st.nmfs.noaa.gov/data-and-tools/social-indicators/

Methodology: https://www.fisheries.noaa.gov/national/socioeconomics/social-indicator-supporting-information

References:

NOAA Fisheries Office of Science and Technology. 2019. NOAA Fisheries Community Social Vulnerability Indicators (CSVIs). Version 3. Silver Spring (MD): National Oceanic and Atmospheric Administration, Office of Science of Technology; [updated 2020 Dec 21]. https://www.fisheries.noaa.gov/national/socioeconomics/social-indicators-coastal-communities

U.S. Environmental Protection Agency. 2016. Promising practices for EJ methodologies in NEPA reviews; report of the Federal Interagency Working Group on Environmental Justice and NEPA Committee. Washington (DC): U.S. Environmental Protection Agency. 56 p.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Qualitative Risk Assessment Approach Refining Acoustic Processes and to Explore the Inclusion of Cumulative Effect Analysis for Offshore Windfarm Construction and Operations
Administered by	Office of Environmental Programs
BOEM Contact(s)	Stanley Labak (Stanley.labak@boem.gov), Erica Staaterman (erica.staaterman@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	May 4, 2022
PICOC Summary	
Problem	Offshore renewable energy development produces high levels of intermittent, impulsive noise and persistent noise due to vessel use and turbine operations. Current numerical approaches typically look at discrete examples of acoustic stressor impacts alone. These analyses have not been able to quantitatively assess and integrate the overall impact of acoustic and non-acoustic stressors. This integration is needed for qualitatively assessing cumulative effects.
Intervention	This proposed study would provide valuable insights on refining the fidelity and robustness of the current acoustic risk assessment approaches and identify potential methodologies to expand these approaches to also include non-acoustic stressors. This is all with a goal of quantitatively addressing cumulative effects for offshore windfarm activities.
Comparison	There are two BOEM-funded studies that have produced reports that use a risk assessment framework to quantify the aggregate acoustic risk for seismic and windfarm activities in the Gulf of Mexico (GOM) and off New England (BOEM reports BOEM-2021-022 and BOEM 2021-081, respectively). These studies were proof of concept evaluations for the risk assessment approach for specific acoustic sources. This study is the next natural step to refinement of those efforts and to expand them beyond just acoustic stressors.
Outcome	The study would establish methodologies and tools for beginning to quantify the cumulative effects of risk from multiple stressors using expert elicitation and allow comparisons of various alternatives and mitigation factors in National Environmental Policy Act (NEPA) documents and in regional activity planning.
Context	Nationwide relevance for developing a quantitative tool to assess cumulative effect, specifically for offshore wind farms but theoretically for all BOEM-regulated activities

BOEM Information Need(s): BOEM NEPA and Endangered Species Act (ESA) consultation documents (including environmental impact statements [EISs], Construction and Operations Plans, etc.) analyze the impacts of offshore energy and construction activities, including installation of large wind turbine structures. Part of the requirements of NEPA and ESA regulatory documents include analyses of the cumulative effects of the proposed activity, which up to now has been primarily qualitative. However,

with the ever-increasing complexity of the knowledge and quantification of the various stressors (both acoustic and non-acoustic) it has become obvious there is a growing need to quantitatively examine the cumulative effects of BOEM activities. Additionally, this work will potentially facilitate the evaluation of the various options available to BOEM, other regulators, and project planners and managers.

Background: In 2013, an expert working group (EWG) consisting of biologists, engineers, and underwater acousticians began working together (with the support of BP and Shell) on a systematic framework to evaluate potential effects of specific acoustic exposures on marine mammals. The objective was to develop a structured process that included logical elements of previous assessment methods that applied noise exposure predictions to estimate potential effects on hearing and behavior, but increasingly integrated relevant biological and ecological variables in predicting the probability of such potential effects and interpreting their significance. The framework was deliberately structured in a stepwise manner including elements (*e.g.*, level A and B takes) consistent with current U.S. regulatory assessment methods, but with additional stages that explicitly included biologically and ecologically meaningful contexts by which to interpret potential responses and that at least began to consider chronic influences. Notable aspects of the resulting framework included:

- Inclusion of ecologically relevant methods for predicting animal distribution.
- Incorporation of variance in animal density estimates.
- Integration of behavioral aversion in animal movement models.
- Integration of population consequences of disturbance (PCOD) approaches to evaluate potential effects relative to exposure magnitude and duration.
- Development of risk assessment methods that include biologically and environmentally relevant aspects of the context of exposure.

The original scope was intentionally narrow, focusing on relatively short-term, small-scale potential effects of discrete exposures (acute) on marine mammals from seismic airgun surveys in the GOM. The EWG framework built on a sequence of advances made in noise exposure criteria, PCOD modeling/framework, and environmental assessment and represented a significant step in evolving from relatively simplistic assessment methods to more sophisticated approaches that consider biological, environmental, and contextual covariates. However, the need to move beyond this acute paradigm to address aggregate exposures from multiple similar seismic activities and long-term, large-scale potential effects of chronic noise (e.g., masking effects) was identified as a critical evolution. Also, the utilization of expert elicitation was identified as a method of circumventing the obstacles that Population Consequences of Acoustic Disturbance (PCAD) and PCoD (National Academies 2005, 2017; Pirotta 2018) approaches required scientific input from numerous, diverse, complex, and slowly funded and executed scientific studies that may not be available in the near future.

With BOEM and National Marine Fisheries Service (NMFS) funding, this work continued and a risk assessment framework for seismic activities was developed for aggregate activities and also for chronic activities in the GOM (report BOEM 2021-022). Additionally, the framework was adapted to examine offshore wind farm activities for multiple projects in both their construction and operational phases. This work will concentrate on offshore wind projects for this study, but in general, the techniques and approaches could be applied to other impact sources. This study enabled the user to understand and manage many of the temporal and spatial variables involved, enabling decisionmakers to minimize their potential impacts. Two variations of the risk framework were used in the Gulf geological and geophysical EIS process. NMFS sponsored a specific study to examine the masking of marine mammal activities by

seismic surveys. This was not directly included in the EIS, but it facilitated NMFSs decisions on it. The second application introduced the concept and approach to the larger audience, and it was included in the EIS. As a new technique, it was not strictly relied on in the decision process, but it was used to assist the NMFS decision process.

Objectives: The objectives of this study are to:

- Expand the capabilities of the current windfarm risk framework by implementing improved temporal, spatial and environmental layering used in the framework (e.g., allowing expansion beyond the existing layers to items like prey species data or non-acoustic environmental factors), implement means to quantify the uncertainty and data gaps of critical local parameters (e.g., upwelling, runoff, etc.), and identify operational methods to allow the comparisons of results (initially, this will be used to examine results from multiple scenarios for an acoustic stressor, but it will also be expanded in the next bullet to include multiple stressor results),
- Expand the current aggregate acoustic framework to incorporate non-acoustic stressors into the current framework to quantify the cumulative effects for BOEM-regulated activities, and
- Develop a tool that is both useable and tunable for determining cumulative effects for BOEM-regulated activities.

Methods: The study would convene a team of experts in acoustics, marine biology, acoustic impact analysis, acoustic modeling, statistics, oceanography and the equivalent types of experts in other appropriate fields to first review what approaches and risk assessment framework developments are already available, and then refine and expand those approaches to meet the objectives. Integral to this effort is the building of the necessary databases and models/algorithms to examine, test, and evaluate the approaches identified and ultimately to build a tool, which is capable of assisting non-expert users to evaluate the risk for their specific scenario(s).

Specific Research Question(s):

- Identify and evaluate the numerous variables necessary to improve the acoustic risk assessment process and their volatility. What are they and how sensitive is a risk assessment framework to them?
- Identify the most important potential contributors to both acoustic and combined acoustic/non-acoustic cumulative effects. What are these contributors, how should they be “weighted,” and what gaps exist in trying to incorporate them into a combined risk assessment framework?
- Identify an approach to building a tool that can assist the regulator in assessing cumulative risk. Then build the tool. What is the technical basis for this tool and what does an operator need to be aware of to use it effectively?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Substrate-Borne Vibroacoustic Disturbances from Offshore Wind Construction: Measurements, Physical Characteristics, and Propagation
Administered by	Office of Environmental Programs
BOEM Contact(s)	Shane Guan (shane.guan@boem.gov), Hilary Kates Varghese (Hilary.Katesvarghese@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2023–2026
Final Report Due	TBD
Date Revised	May 19, 2022
PICOC Summary	
Problem	Offshore construction activities, such as installation of large wind turbine structures, generate high levels of vibration on the seabed and in the substrate, in addition to intense water-borne sound, that could impact aquatic organisms and their environment. While there have been numerous studies on characterization and propagation of water-borne noise from these activities, there is virtually no dedicated research on characterization and propagation of substrate-borne vibroacoustic waves. Without the understanding of physical characteristics and propagation of substrate-borne vibrations, BOEM will not be able to address the potential effects of these disturbances on marine life, especially the benthic ecological communities, from offshore wind construction.
Intervention	This proposed study would gain valuable insights on the physical characteristics and propagation of various substrate-borne vibroacoustic disturbances through field measurements and numerical modeling during wind turbine pile driving.
Comparison	Currently, there are almost no studies investigating substrate-borne vibration and its potential environmental effects. BOEM has funded a study to analyze some of the sediment-borne vibroacoustic data that were collected during pile driving for the Real-time Opportunity for Development Environmental Observations [RODEO]) and Coastal Virginia Offshore Wind (CVOW) projects (AT-2022-08). However, those datasets were limited and focused on water-borne particle motion measurements. This study would focus on substrate-borne vibration using sensors dedicated to collect such data.
Outcome	The study would establish methodologies for substrate-borne vibroacoustic disturbance data collection and provide physical characteristics of these mechanical waves. The knowledge gained from the study is needed to accurately assess potential impacts on benthic organisms and their environment from wind project construction.
Context	Nation-wide relevance for activities involving wind turbine pile driving, and potentially for other marine engineering activities that cause disturbances to the seabed

BOEM Information Need(s): Offshore construction activities, including installation of large wind turbine structure during in-water pile driving, generate intense vibroacoustic disturbances that propagate both

through the water column and in the substrate. While there have been numerous studies addressing water-borne acoustic disturbances and particle motion, there is essentially no information on the types and characteristics of these substrate-borne vibroacoustic disturbances. Without such knowledge, it would be difficult for BOEM to accurately assess potential impacts on marine life due to exposure to these disturbances, in particular the benthic organisms, many of which are commercially important species. The results will directly feed into the Center for Marine Acoustics impact models, as well as being used for impact assessments. Therefore, this information will benefit multiple BOEM programs for required decision-making related to National Environmental Policy Act and Endangered Species Act processes and in Office of Renewable Program's Construction and Operations Plan development.

Background: Pile driving for offshore wind farm construction generates various substrate-borne vibroacoustic disturbances, including compressional and shear waves that propagate within the sediment, as well as interface (Scholte) waves along the seabed (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 increasing realization that fishes and marine invertebrates primarily sense sound as a form of particle motion (Popper and Hawkins 2018; Hawkins et al. 2021). 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).

Currently there is limited information on the physical characteristics and propagation of substrate-borne mechanical waves, and there is no dedicated and systematic study to address these topics (e.g., Miller et al. 2016; Hazelwood and Macey 2016; Hazelwood et al. 2018; Potty 2020). Results from the recent BOEM-funded Block Island Wind Farm study showed that at ranges of 500 m and 1,500 m, particle acceleration levels measured on the seabed were well above the behavioral sensitivity for the Atlantic salmon, plaice, dab, and Atlantic cod up to a frequency of approximately 300 Hz (HDR 2019). In FY 2022, BOEM is funding another study to conduct in-depth substrate-borne mechanical wave measurements during RODEO and CVOW projects (AT-2022-08). However, data collection from these studies are mainly focused on water-borne acoustic pressure and particle motion, with substrate-borne data only available from one geosled and one Ocean Bottom Recorder (OBX) at limited distances between 725 and 1,150 m. Without additional data collected at a wide range of distances, it is impossible to gain enough insight of wave propagation to be able to sufficiently model this complex phenomenon accurately.

This proposed study would contribute to knowledge on substrate-borne mechanical waves from marine engineering activities, including offshore wind construction. The information obtained from this study would greatly assist BOEM decision-making using scientific knowledge that is first in class. In addition, this study would explore additional data collection methods and identify the most appropriate geoacoustic sensor(s) to obtain substrate-borne vibroacoustic signals at different ranges and layers of the sediment.

Objectives: The objectives of this study are to

- Establish appropriate methodologies to collect and analyze substrate-borne vibroacoustic disturbances from offshore wind construction activities that could potentially affect benthic ecological communities, and
- Obtain critical knowledge on the characteristics and propagation of different types of substrate-borne mechanical waves at various source ranges and at various sediment depths for impact assessment modeling.

Methods: The study would first develop an appropriate methodology for the collection and analysis of substrate-borne vibroacoustic disturbances based on preliminary study results from a currently BOEM-funded project (AT-2022-08). Then, using that methodology, additional substrate-borne mechanical wave measurements would be made on at least one newly approved offshore wind project (e.g., Vineyard Wind and/or South Fork Wind) during construction activities. Vibroacoustic data would be collected at various distances from the source and sediment depths using appropriate geoacoustic sensors. For field data collection, vessel(s) will be needed to deploy and retrieve acoustic sensors and recording equipment. Finally, the data will be analyzed to in a way that propagation models can be developed in the future for impact assessments.

Specific Research Question(s):

1. What are the appropriate methods to collect substrate-borne vibroacoustic disturbance data from an offshore wind construction project that are relevant to environmental impact assessment (including the suitable geoacoustic sensors, signal processing, and acoustic metrices)?
2. What are the types of substrate-borne vibroacoustic disturbances from offshore wind construction activities and how are they related (e.g., compressional, shear, and interface waves)?
3. What are the physical characteristics of substrate-borne mechanical waves from offshore wind construction activities (i.e., amplitude, frequency, directivity, propagation speed, duty cycle, etc.)?
4. What are the propagation characteristics of substrate-borne mechanical waves from offshore wind construction activities and how they relate to different types of sediments (i.e., decay rate over distance and depth, frequency-dependent propagation, etc.)?
5. How can substrate-borne mechanical waves be modeled for their physical characteristics and propagation so ranges to effects can be predicted for impact assessment?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Understanding Potential Health Impacts of Outer Continental Shelf (OCS) Energy Activities on Environmental Justice (EJ) Populations
Administered by	Office of Environmental Programs
BOEM Contact(s)	Laura Mansfield (laura.mansfield@boem.gov), Stephanie Sharuga (stephanie.sharuga@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	March 31, 2022
PICOC Summary	
Problem	Many of BOEM's National Environmental Policy Act (NEPA) documents, including the National Programmatic environmental impact statement (EIS) and the Office of Renewable Energy Program's EISs do not describe potential health impacts of OCS energy related activities. Consideration of potential health impacts on EJ communities is required by Executive Orders (E.O.) 12898.
Intervention	This study proposes to conduct a literature review and synthesis to provide BOEM with information to use in EJ sections of NEPA documents. The synthesis will highlight potential health impacts relevant to EJ communities located in coastal areas near OCS energy activities.
Comparison	Without this study, potential human health impacts related to OCS energy activities will continue to be inadequately considered in environmental assessments.
Outcome	This study will help BOEM better identify, assess, and communicate potential human health impacts related to OCS energy activities. The synthesis of existing information will improve BOEM's understanding and communication of how offshore energy activities could potentially affect the health of residents in potentially affected EJ communities. Furthermore, this study will allow for identification of specific data gaps and facilitate better prioritization of human health information needs.
Context	This study will be carried out at national level and will include data and other information collected from all regions. Deliverables are applicable at both a national and regional level.

BOEM Information Need(s): National-level assessments can be improved with more information about how OCS energy activities could potentially affect the health of residents in EJ communities. Understanding linkages between these activities and potential health impacts would enable BOEM to make more equitable and environmentally-just decisions. It would also help BOEM to meet E.O. 14008, E.O. 12898, E.O. 13985, and E.O. 13990. Synthesized information would offer NEPA document authors a common knowledge base to advance consistency across the bureau.

Background: Current information on potential linkages between OCS activities and human health and well-being is spread across a variety of sources. Much of the available information typically evaluates impacts from environmental disasters, such as oil spills, rather than with respect to routine activities. While some activities or factors have been explored in relatively good detail, it is necessary to synthesize information specifically for BOEM's context to better understand the impact of OCS activities on human health. There is limited research specifically on the health of residents of EJ communities.

Objectives: Improve BOEM's ability to understand the affected environment of EJ communities, including the health and potential vulnerabilities of residents, and assess potential health impacts related to BOEM-authorized activities.

- Determine what information is available on EJ community health useful for the BOEM context.
- Identify types of potential environmental impacts created by BOEM-authorized activities that could possibly create health impacts on residents of EJ communities.
- Identify potential pathways that could expose residents of EJ communities to health impacts.
- Identify the types of potential health impacts on residents of EJ communities from OCS energy activities.
- Identify data gaps and future research needs related to human health impacts from OCS energy activities.

Methods: This study will compile relevant existing literature and data available on potential health impacts on EJ communities. The scope will cover OCS energy activities, including both offshore components and onshore support infrastructure. Sources will include existing peer-reviewed literature, models, databases, Subject Matter Expert (SME) input (where applicable and available), and other data sources. The literature review will focus on public health information. The review will highlight information that could help BOEM assess types and levels of human health impacts for activities. There will be coordination with BOEM SMEs throughout the process to ensure the deliverables maximize usefulness to the agency's needs and identify future information needs.

A comprehensive list of potentially impacting activities and factors will be compiled from the literature review and those already considered by BOEM in its EISs and national program analyses (e.g., noise, lighting, traffic, routine discharges, air quality, water quality, bottom/land disturbance, fisheries, visible infrastructure, space/use conflicts). Possible pathways through which humans may be exposed to potential health impacts from those activities and factors will be determined. Information on all potential human health effects of those activities or factors will be compiled. Conceptual models will also be created to visualize potential human health impacts and will include the following: "source" (i.e., potentially impacting activity or factor), pathways (i.e., how the impacts are transferred to the receptor, or potentially affected communities), and "sink" (i.e., specific potential human health impacts). Additionally, data gaps and future research needs related to OCS energy activities potential impacts on human health will be identified. All information collected will be synthesized to create a set of resources for SMEs consisting of an information database (i.e., collection of relevant literature and/or data), conceptual model(s), and synthesis summary report. The information database will build upon resources in the EJ Methodologies database related to health and will be provided in a format that can be integrated into that database.

Specific Research Question(s):

1. Can potential human health impacts be identified and, if so, what are the ways they are being identified and measured?
2. What are the OCS energy activities and factors that can have potential human health impacts on residents in EJ communities and what are those health effects?
3. Can available literature provide insights into what may contribute to potential health impacts being different in one area versus another?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References: N/A

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Updating BOEM's Environmental Sensitivity Methods and Models to Support Oil, Gas, and Wind Energy Development
Administered by	Office of Environmental Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	January 12, 2022
PICOC Summary	
Problem	Niedoroda et al. (2014) developed a method for evaluating the relative environmental sensitivity and marine productivity of the Outer Continental Shelf (OCS) that requires an update to account for the exponential growth of BOEM's activities and new databases produced by BOEM's studies. The current interface and scripts will also require updating to facilitate a wider userbase at BOEM.
Intervention	The products proposed are largely quantitative and rigorous methods for evaluating the relative environmental sensitivity of broad OCS regions to future BOEM-regulated activities.
Comparison	This tool will allow us to compare the relative environmental sensitivity of BOEM's 26 OCS Planning Areas and aggregated ecoregions.
Outcome	The outcome of this product will inform BOEM's National and Renewable Energy Programs with updated models of environmental sensitivity to BOEM's activities.
Context	All BOEM regions

BOEM Information Need(s): Models and methods developed by OCS BOEM Study 2014-16, *A Method for the Evaluation of the Relative Environmental Sensitivity and Marine Productivity of the Outer Continental Shelf* (Niedoroda et al. 2014) require updating to account for expanded lease areas, new databases, and for wider use within BOEM.

Background: Relative environmental sensitivity incorporates both the vulnerability and resilience of an OCS region's ecological components (i.e., habitats and biota) to the potential impacts of OCS oil and gas and offshore renewable energy activities in the context of existing conditions (e.g., climate change forecast, regulatory status, productivity). Section 18(2)(G) of the Outer Continental Shelf Lands Act of 1953, as amended (OCSLA; 43 U.S.C. § 1331) states that decisions regarding exploration and development will be in part based on consideration of "the relative environmental sensitivity and marine productivity of different areas of the Outer Continental Shelf" (Niedoroda et al. 2014).

Objectives:

- Evaluate information sources for and approaches to estimating relative environmental sensitivity.

- Develop and recommend options for replacing or supplementing previous BOEM methodologies.
- Be scalable, or easily expanded to allow the addition of new information and additional data.
- Conduct the relative environmental sensitivity of the 26 OCS Planning Areas using the approach identified and selected by BOEM.
- Be scientifically valid, transparent (e.g., methods and inputs used to derive results are made available), and repeatable by other scientists.

Methods: evaluate the existing methods for estimating relative environmental sensitivity and marine productivity, including:

- Previous and current BOEM environmental sensitivity analysis methodologies.
- Peer-reviewed literature of case studies, metrics, and data types used in similar environmental sensitivity analyses.
- Other information.

Specific Research Question(s):

1) How should model scale affect our decision process (e.g., some methods are “micro scale” which would need to be combined to reach the OCS planning area scale; others are large scale and more easily adaptable to OCS planning areas)?

References:

Niedoroda A, Davis S, Bowen M, Nestler E, Rowe J, Balouskus R, Schroeder M, Gallaway B, Fechhelm R. 2014. A method for the evaluation of the relative environmental sensitivity and marine productivity of the Outer Continental Shelf. Herndon (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 80 p. + appendices. Report No.: OCS Study BOEM 2014-616.

Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Integrating Dimethyl Sulfide (DMS) Gradients into Dynamic Management to Predict North Atlantic Right Whale Occurrence in Cape Cod Bay
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2023–2025
Final Report Due	TBD
Date Revised	May 13, 2022
PICOC Summary	
Problem	BOEM planning and mitigation currently relies on scientifically validated methodologies to detect and/or anticipate the occurrence of North Atlantic right whales (NARW) in order to minimize impacts to these species. However, these methodologies do not afford the ability to do short timescale forecasting of when these critically endangered large whales are likely to occur in Cape Cod Bay. This is especially vital for NARW mother-calf pairs who exhibit acoustic crypsis and are the most vulnerable to being missed by current offshore wind passive acoustic mitigation.
Intervention	Investigate the threshold response of right and sei whales to DMS gradients relative to species movements and aggregation and develop the ability to detect such DMS concentrations via remote sensing, thereby providing a dynamic, predictive tool to be used by management.
Comparison	The results from this research can be compared with aerial survey and passive acoustic monitoring (PAM) results to develop an integrated approach to help improve our understanding and predictive capabilities.
Outcome	Integrating DMS gradient to predict NARW occurrence will provide a dynamic, predictive tool that could be relative to all Endangered Species Act large whale species.
Context	Cape Cod Bay, MA

BOEM Information Need(s): BOEM requires robust information on the occurrence of endangered species to minimize incidental take of marine mammals resulting from BOEM-permitted activities, thus meeting requirements under the Marine Mammal Protection Act but also making every effort to maintain the health and stability of critically endangered marine mammals, like the NARW. Additionally, BOEM is required to design and implement mitigation measures to reduce or eliminate impacts from regulated activities on protected species. These needs can be met most efficiently if BOEM can support the development a method to predict when and where NARW aggregations will occur on very short timescales. This tool would add to and advance current mitigation options and result in a more robust and comprehensive mitigation strategy.

Background: BOEM relies heavily on PAM as a key mitigation tool for the protection of endangered species, such as the NARW. However, NARWs are known to be less voluble than other large whale

species, and mother-calf pairs, the population segment most susceptible to vessel collisions, maintain acoustic crypsis (Nielsen et al 2019, Cusano 2019, Parks et al 2019). As such, additional tools are needed to support more comprehensive and effective mitigation strategies.

Dimethylsulfide (DMS) is a compound used by phytoplankton to balance internal osmotic pressure (among other functions). When zooplankton consume phytoplankton, DMS is released in concentrations relative to the degree of grazing and DMS is a well-established infochemical in the marine environment (Savoca and Nevitt 2014). DMS is a potential additional tool for predicting site occupancy, residency and vacancy for species that feed on zooplankton such as copepods or euphausiids (krill) but may not otherwise be acoustically active. Species known to feed on zooplankton, or have been shown to be sensitive to DMS concentrations, and for which DMS could potentially function as a predictive tool include NARWs (Baumgartner et al. 2011), sei whales (Baumgartner et al. 2011), blue whales (Goldbogen et al. 2011), humpback whales (Bouchard et al. 2019), loggerhead turtles (Enders and Lohhmann 2012), and harbor seals (Kowalewsky et al. 2006).

The ability to dynamically identify the presence of protected species and predict when they are likely to aggregate in time and space is a significant advantage to ensuring effective management of protected species. Developing the ability to remotely identify and monitor DMS concentrations would enable mitigation for these acoustically cryptic individuals. Beyond NARW, this study has applicability to other species and geographies, such as Rice's whale in the Gulf of Mexico, and sei and blue whales in the U.S. Atlantic and Pacific, all species that also target zooplankton.

The DMS tool can be used by managers to: 1) target temporal and spatial site-specific monitoring via PAM or aerial surveys, thereby reducing costs relative to chronic monitoring requirements; and 2) provide stakeholders with advanced warning relative to the possibility of upcoming management actions, thereby eliminating costly emergency response actions created by the sudden appearance of species of concern.

BOEM's mission would be greatly enhanced by developing a predictive tool that could be used to identify where and when aggregations of key species, like the NARW, would occur and when such aggregations would likely dissipate.

Objectives:

- Demonstrate the ability to make real-time shipboard/autonomous measurements of DMS at relevant temporal and spatial scales.
- Correlate DMS values with concurrent observations of Calanus and NARW abundance.
- Identify DMS thresholds that predict right whale occupancy of CCBCH.
- Develop satellite capability to remotely sense and identify DMS concentrations at scales relevant to management.
- Combine threshold results and remote sensing capabilities to predict the occurrence, occupancy and vacancy of NARWs at sites of interest to BOEM.

Methods: This project will utilize validated and available techniques and technologies such as conducting measurements of DMS in seawater using a sequential vapor generation chemiluminescence instrument (Okane *et al*. 2019, Owen *et al.* 2020) sampled in the immediate path of a focal NARW. Data collection will be augmented by autonomous vessel using standardized transects for DMS February to

May; designed to capture low-high-low DMS concentrations; data combined with aerial surveys conducted by the Center for Coastal Studies during this same period.

Specific Research Question(s): What are the thresholds of DMS concentrations which can inform predictability of the presence of NARWs?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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