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

Studies Development Plan

Environmental research proposed to begin in FY2024 or FY2025 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 | 50 YEARS ESP ENVIRONMENTAL STUDIES PROGRAM

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List of Acronyms

AMAPPS	Atlantic Marine Assessment Program for Protected Species
BOEM	Bureau of Ocean Energy Management
CMA	Center for Marine Acoustics
CMI	Coastal Marine Institutes
COP	Construction and Operations Plans
DOC	Department of Commerce
DOE	Department of Energy
DOI	Department of the Interior
DOT	Department of Transportation
EEZ	exclusive economic zone
EFH	essential fish habitat
EJ	environmental justice
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESP	Environmental Studies Program
FEK	fisherman's ecological knowledge
FY	fiscal year
G&G	geological and geophysical
GCCESU	Gulf Coast Cooperative Ecosystem Studies Unit
GOM	Gulf of Mexico
GOMMAPPS	Gulf of Mexico Marine Assessment Program for Protected Species
GOMR	Gulf of Mexico Region
IWG	interagency working group
IWG-OEC	Interagency Working Group on Ocean Exploration and Characterization
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
NCCOS	National Centers for Coastal Ocean Science
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOMEC Strategy	National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone
NOPP	National Oceanographic Partnership Program

NOSB	National Ocean Sciences Bowl
NSL	National Studies List
OCAP	Ocean Climate Action Plan
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
UA	University of Alaska
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) manages 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. The Environmental Studies Program (ESP) helps provide BOEM 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, 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 may impact the environment (both physical and human) and how those impacts may 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 environmental quality and productivity, and the causes of these changes.

ESP and environmental assessment form the foundation of BOEM's environmental program and ensure that environmental protection is a foremost concern and an indispensable requirement in BOEM's decision-making. Administratively, the Office of Environmental Programs (OEP) at BOEM headquarters oversees ESP, 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 possible research program 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 ($138.7 million over the past 5 years). Average annual planned funding for ESP is currently $30 million, though the expenditure level has varied over the years. ESP funds currently are dispersed for defined projects through three vehicles: interagency agreements with Federal agencies; cooperative agreements with state, local, and nonprofit institutions, including Native American Tribal communities; and competitive contracts. ESP manages the funds to deliver the most-needed and highest quality research at the best value to the government. **Figure 1** shows how ESP allocated funding by both vendor and discipline between fiscal years (FYs) 2019 and 2023.

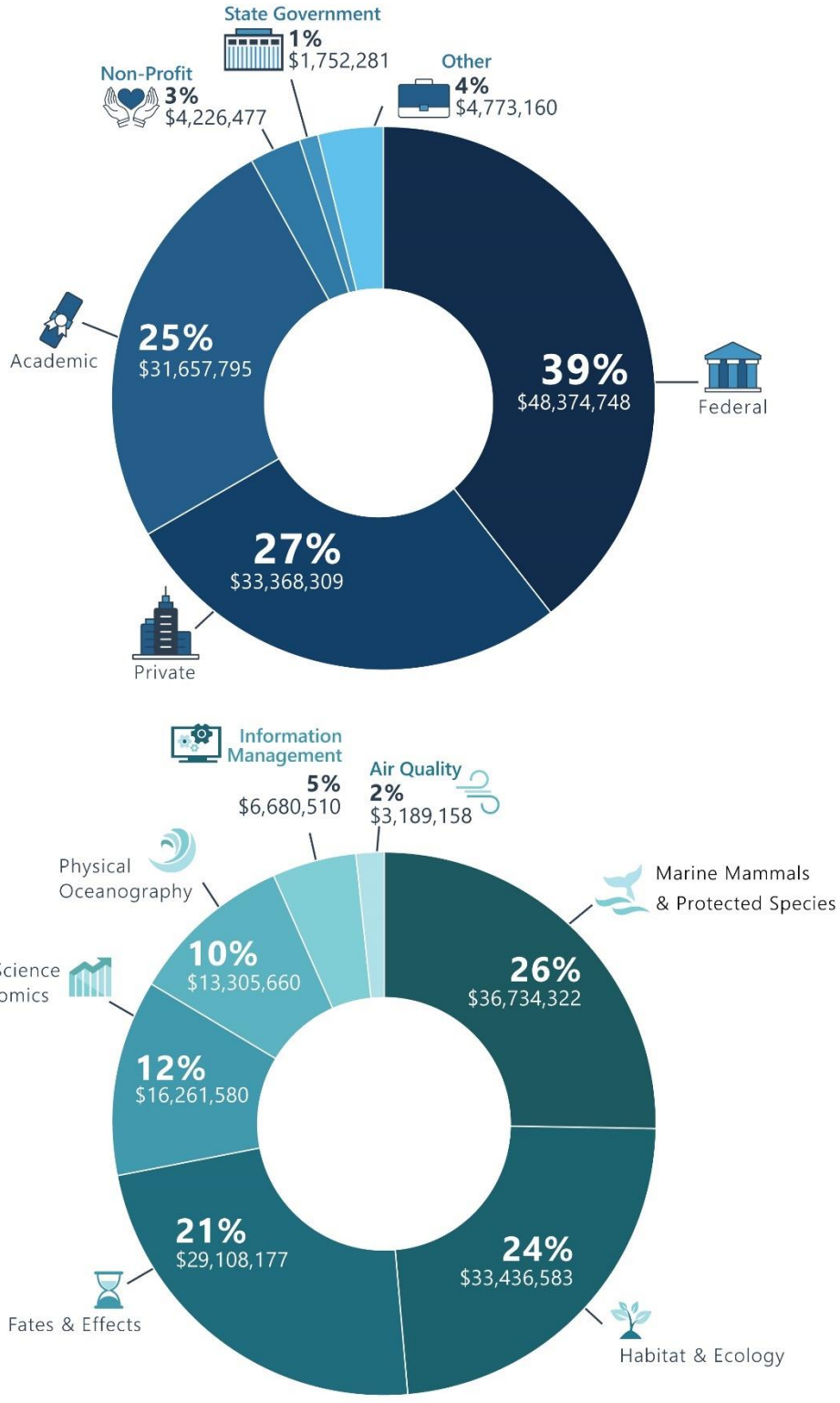


Figure 1. Cumulative ESP expenditures for FY 2019–2023 by vendor type and discipline

1.1.4 ESP Priorities

The following four priority areas ESP identified last year remain in place for the FY 2024–2025 cycle. In developing study ideas, BOEM subject matter experts (SMEs) are 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 is 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 impact BOEM's work, and, to adequately prepare for those impacts, ESP needs to view the environment through a climate change lens.

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

Tribal: 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 knowledge 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 2024–2025.

Environmental Justice (EJ): EJ cuts across all the priority areas. ESP recognizes the inter-relationships between climate change and vulnerable communities, such as low-income fishing, minority, 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 EJ 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 and low-income populations (59 FR 7629). BOEM seeks to apply effective and consistent consideration of EJ in the National Environmental Policy Act (NEPA) process by applying best practices and best available scientific information when assessing potential impacts on EJ communities from BOEM-authorized activities. To do this, BOEM must understand how offshore energy activities may impact vulnerable communities to determine whether Federal activity may have a disproportionately high and adverse impact on a community. Specifically, BOEM needs to understand the many environmental, social, and cultural current and future baselines and cumulative impacts, including effects of climate change, and historical land or resource use.

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. Scientific research that is use-inspired is designed to both provide answers to specific questions needed for management decisions and advance broader fundamental knowledge. 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; and utilize scientific and scholarly information in making agency policy, management, or regulatory decisions. Further, the policy applies to all who assist with developing or applying the results of scientific and scholarly activities, including contractors, cooperators, partners, permittees, and volunteers.

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

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

ESP evaluates each project 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 provides 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. 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 nine Coastal Ecosystem Studies Unit networks (Alaska, Californian, Chesapeake Watershed, Gulf Coast, Hawaii-Pacific Islands, North Atlantic Coast, Pacific Northwest, Piedmont-South Atlantic Coast, and South Florida-Caribbean); these connections enable 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 highly successful, collaborative program that facilitates partnerships between Federal agencies, academia, industry, and Tribal communities to advance ocean science research and education. Through this collaboration, Federal agencies with overlapping mission priorities can better leverage their limited resources to accomplish objectives that would otherwise be too large for any single agency to achieve acting on its own. 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 renewable energy. 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 ongoing and completed ESP studies is available the BOEM website.[2] 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. The GovInfo BOEM repository houses all final reports from ESP-funded studies.[3] The newly launched ESP Hub[4] also provides additional information for many studies completed in the last 20 years, including technical summaries, final reports, and associated publications.

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*[5] and quarterly *Science Notes* newsletters.[6]

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 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. Over the past two years, BOEM has hosted a number of John A. Knauss Marine Policy fellows in both OEP and 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

[2] https://www.boem.gov/environment/environmental-studies/environmental-studies-information
[3] https://www.govinfo.gov/collection/boem
[4] https://esp-boem.hub.arcgis.com
[5] https://www.boem.gov/Ocean-Science
[6] https://www.boem.gov/Science-Notes

links to the pre-college community and allow students to be aware of career opportunities in the marine sciences and in the Federal Government. 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 Bureau uses the SDP internally to outline ESP'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. This document is also a critical communication tool for the scientific community and other external stakeholders and partners.

All studies proposed in this SDP are subject to the availability of funds. Proposed studies within the SDP are peer reviewed by selected BOEM SMEs. Study needs may be adjusted after the release of this document to respond to shifting priorities, emerging information needs, and the ESP budget.

The SDP also serves as a foundation for the annual National Studies List (NSL), which identifies ESP studies approved for funding.

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 the following:
    - 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 the following:
    - 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 biota
- Presence and nature of shipwrecks, submerged cultural landscapes, and other cultural and historic sites
- 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 to propose and fund.

1. **Need for Information in BOEM Decision-Making:** All studies must contribute to BOEM's information needs 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) over broader studies providing insights that 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 expenditures for both specific research questions and "infrastructure" (such as maintenance of museum collections and ocean observing systems) to 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. This criterion assist in priority setting and in providing 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 also are considered core components of this criterion.
4. **Cost-Effectiveness:** Studies must be cost-effective, and the expense of a study is relevant in comparing its value with other study opportunities. However, costly studies are still considered if the expense is necessary for important knowledge or leveraged with other funders.
5. **Leveraging Funds:** Study proposals should explore opportunities for shared funding. Leveraging 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. Proposals also 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 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

OEP's Division of Environmental Sciences provides overall coordination for the SDP development process. The proposals in this SDP are developed by BOEM's regions and programs through internal and, in certain cases, external review. Research proposals 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 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 the 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. In addition to these three program areas, the Bureau

recently launched the Center for Marine Acoustics to better understand the complexity of ocean sound—specifically the impacts of man-made sound on marine life. Furthermore, new activities and initiatives relating to BOEM's mission include carbon sequestration, energy and mineral development offshore of the U.S. Territories, offshore hydrogen production, and the recently released Ocean Climate Action Plan.

1.4.1 Conventional Energy

OCSLA (43 U.S.C. §1344) requires DOI to prepare a National OCS Oil and Gas Leasing Program with a proposed lease sale schedule on the size, timing, and location of areas for leasing. DOI ensures that the U.S. Government receives fair market value for acreage made available for leasing and that oil and gas activities conserve resources, operate safely, and the environment. A new National 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. As of May 2023, approximately 11.5 million OCS acres are actively leased by BOEM for conventional energy development. Currently OCS conventional energy development provides for approximately 2% of the Nation's natural gas production and about 15% of domestic oil production.

1.4.2 Renewable Energy

The Energy Policy Act of 2005 (EPAct; P.L. 109-58) amended OCSLA to add renewable energy to DOI's (and BOEM's) development and environmental protection responsibilities. There 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, a Record of Decision was signed to approve Vineyard Wind—the Nation's first commercial scale wind project. Vineyard Wind is scheduled to bring new energy to homes beginning in 2023. Next, BOEM issued a Record of Decision for South Fork Wind Farm off Rhode Island on November 24, 2021. Installation of the turbines is expected during the summer of 2023.

In March 2021, the White House released details of its plan to boost the offshore wind energy industry.[7] DOI and the Departments of 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, 13 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 held lease sales in the New York Bight (an area of shallow water between Long Island and

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

the New Jersey coast) that will serve the largest metropolitan center in the country and off North Carolina (February 2022 and May 2022, respectively). Additional lease sales are planned for the Central Atlantic and Gulf of Maine.

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 66 negotiated agreements and conveyed rights to approximately 185 million cubic yards of sand and sediment for coastal restoration projects along the coastline of eight different Atlantic and Gulf of Mexico (GOM) states (statistics updated through February 2023). Along almost 450 miles of the Nation's coastline, these projects have protected billions of dollars of infrastructure, as well as important ecological habitats.

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 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-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. The 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. The CMA will continue to evolve as

[8] https://www.boem.gov/sites/default/files/documents/about-boem/MOU-NOAA-BOEM.pdf

marine acoustics issues have increased in national and international significance. The CMA science priorities for FY 2024–2025 are the following:

- Enhance and sustain Passive Acoustic Monitoring in the Atlantic, in conjunction with other ocean observing systems
- Understand temporary threshold shift and auditory recovery in marine mammals after exposure to complex sounds
- Observe sea turtles' behavior and physiology in response to anthropogenic sound sources
- Determine the optimal design for a sound exposure apparatus for fishes and invertebrates
- Examine behavioral and masking effects of marine vibroseis on marine mammals

1.4.5 Upcoming Activities

The INVEST in America Act (also referred to as the Bipartisan Infrastructure Law) of 2021 amended OCSLA's leasing provisions to authorize DOI to grant leases, easements, and rights-of-way on the OCS for the purpose of carbon sequestration. The act granted BOEM management authority over carbon sequestration in sub-seabed reservoirs, and rulemaking efforts currently are under way to establish regulations to implement a nationwide OCS carbon sequestration program. To support this new authority and the breadth of this new program, BOEM needs environmental information to inform its rulemaking, program development, and policy decisions.

BOEM's geographic responsibility increased substantially with the passage of the Inflation Reduction Act of 2022, which gave BOEM authority for energy and mineral development in five permanently inhabited territories, as well as other territories and possessions of the United States. BOEM's initial focus will be on Puerto Rico, but, over the next few years, the Bureau will also need to consider implications of mineral and energy development in the other U.S. Territories.

There is also significant Federal interest in the generation of hydrogen as an alternative fuel. The above-mentioned Bipartisan Infrastructure Law provided $7 billion to the Department of Energy to establish 6 to 10 regional clean hydrogen hubs across America. Given this focus on hydrogen, BOEM will need to consider the implications of offshore hydrogen development. There is interest from industry in the generation of both "blue" (produced by methane) and "green" (produced by renewable energy) hydrogen. Both blue and green hydrogen could result in "combo" activities, whereby a hydrogen generation facility is co-located with an oil/gas rig or an offshore wind facility, respectively. As with BOEM's other programs, the Bureau will look to ESP to provide the science needed for informed decision-making in this area.

Lastly, in March 2023, the Ocean Policy Committee release the Ocean Climate Action Plan (OCAP).[9] The OCAP represents a whole-of-government focus on ocean-based climate solutions needed to mitigate and adapt to the impacts of climate change. Containing over 70 actions, the plan is structured around three broad goals (create a carbon-neutral future; accelerate nature-based solutions; and enhance community resilience to ocean change) and informed by six cross-cutting principles (ocean health and

[9] https://www.whitehouse.gov/wp-content/uploads/2023/03/Ocean-Climate-Action-Plan_Final.pdf

stewardship; EJ; engage with Tribal Nations and Indigenous Peoples; outreach and engagement; science, evidence, and knowledge; and interagency coordination). BOEM will play a significant role in the implementation of the plan due to its authority over offshore wind deployment and over sub-seabed geologic sequestration of carbon dioxide. ESP's environmental research, monitoring, and observations are important for many OCAP actions, and the plan further strengthens the case for ESP to develop innovative monitoring solutions that can be incorporated into a sustained, long-term monitoring program to better assess impacts to ocean ecosystems from BOEM-authorized activities and the effect of climate change on BOEM-authorized activities and resources.

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.[10] 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.[11] The withdrawal is in effect from July 1, 2022, through June 30, 2032. The withdrawn areas extend along the Atlantic from off the coast of North Carolina to Florida. While under this moratorium, BOEM will not be conducting baseline studies in support of oil and gas on the Atlantic OCS.

Appendix A includes the tables of proposed studies for FY 2024–2025. **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 2024–2025.

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.

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

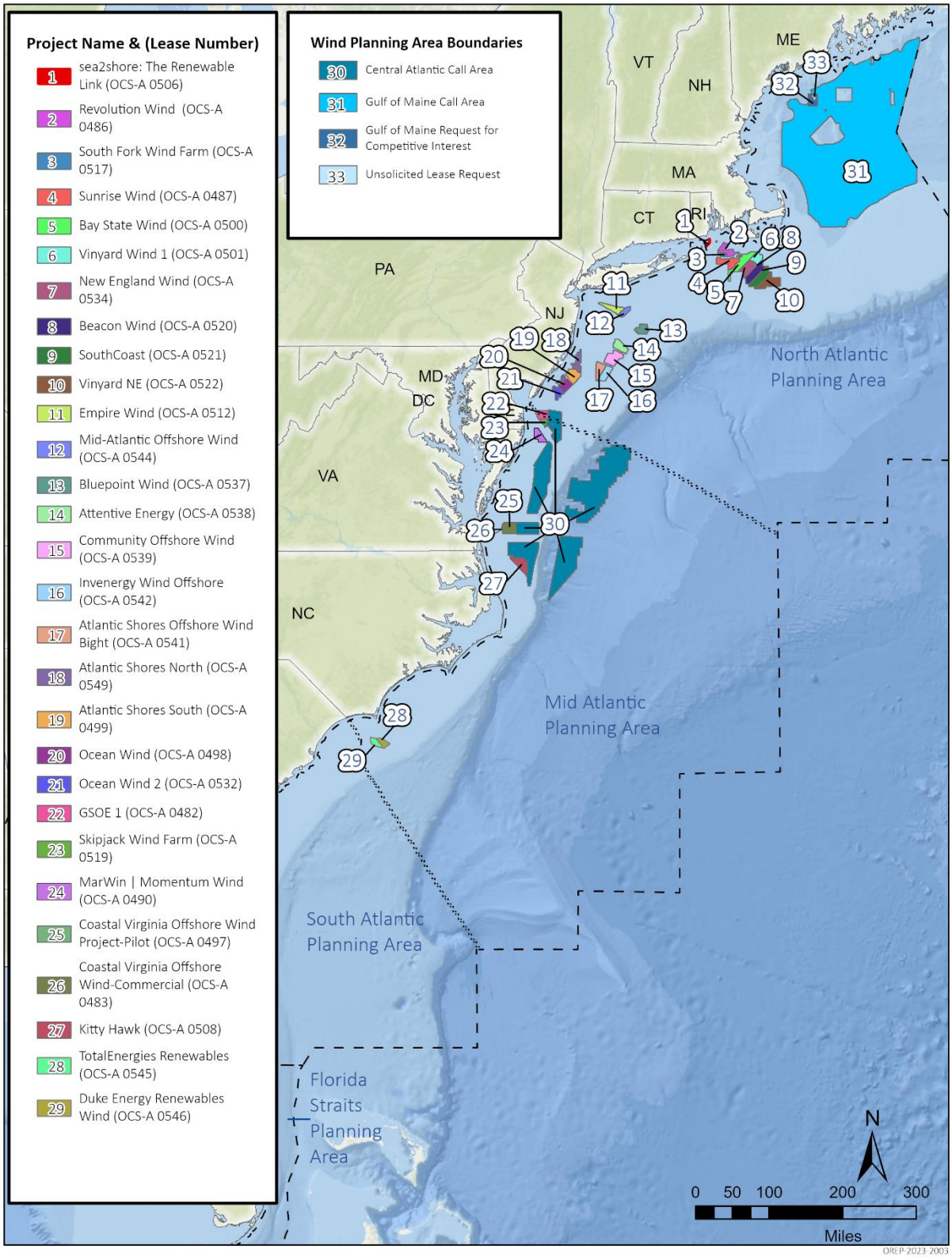


Figure 2. Atlantic Region OCS planning areas for renewable energy and Renewable Energy Areas

2.1.2 Renewable Energy Activities

BOEM's Office of Renewable Energy Programs (OREP) manages the offshore renewable energy development on the Atlantic OCS; 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 28 active commercial leases along the Atlantic Coast extending from Massachusetts to North Carolina. 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 13 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. BOEM initiated the leasing process in the Gulf of Maine.

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.

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), 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 on 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. Although 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 (EFH), 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. In addition, a study has been proposed to initiate an analysis of the potential effects of critical mineral activities on the environment.

2.3 Alignment With SSQs

2.3.1 Renewable Energy Activities

With the goal to approve 16 COPs by the end of 2024, the focus is on information needed to evaluate these plans and begin post-construction monitoring. Key issues of concern raised by the public include air quality, benthic habitats, protected species, visual impacts to coastal communities, and use of fisher's ecological knowledge (FEK).

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. BOEM has worked with NOAA to conduct surveys along the Atlantic through the Atlantic Marine Assessment Program for Protected Species (AMAPPS). The third five-year agreement is coming to an end, and BOEM is proposing to continue this effort through a fourth agreement. This funding to NOAA would support seasonal surveys of protected species from Maine to Florida and out to the EEZ. Acoustics are often used to track marine species, and BOEM has an opportunity to partner with the National Science Foundation by augmenting measurements taken by the Pioneer Array. The Pioneer Array will be relocated to an area off of North Carolina, and BOEM is proposing to deploy additional acoustic measuring devices in the vicinity of the array to further expand movement monitoring, particularly of the North Atlantic right whale.

Habitat

In 2022, BOEM conducted the Carolina Long Bay lease auction, resulting in two executed leases offshore of southeastern North Carolina. NOAA Fisheries' Southeast Regional Office expressed concerns to BOEM regarding the presence of sand, low-relief "pavement," and high-relief hardbottom (e.g., ledges) EFH within the lease areas and potential transmission corridor. Building off BOEM-supported work conducted 2014–2016 by NOAA's National Centers for Coastal Ocean Science (NCCOS), a proposed study would support NCCOS to refine field survey and data processing methods to better map habitats of concern within Carolina Long Bay in support of avoiding, minimizing impacts, and guiding mitigation measures to protect EFH. These improved methods would be directly applicable towards upcoming survey work in, and EFH consultations for, Carolina Long Bay, and broadly applicable for future lease development activities in the South Atlantic, GOM, and U.S. territorial regions that share similar marine habitats.

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. BOEM is looking to produce a suite of innovative and pragmatic mitigation measures to reduce visual impact from offshore wind energy facilities. Also, FEK needs to be incorporated into BOEM's decision-making process. With leasing in the Gulf of Maine planned for the summer of 2024, development will follow in the coming years. FEK may be used to inform decisions concerning the development of floating offshore wind.

Fates and Effects

Though offshore wind provides electricity without the emission of gases (including carbon dioxide), the vessels used for construction and operations do have emissions. These must be accounted for during environmental reviews. BOEM developed an emissions calculator that needs to be updated. In addition, as more wind energy projects are approved, the cumulative impacts from the multiple projects needs to be evaluated.

2.3.2 Marine Minerals Activities

Table 2 shows MMP studies proposed for this SDP: three studies are more programmatic and span multiple regions; two studies focus on the Atlantic Region; and a sixth on the GOM Region.

The first study would identify the benthic habitat units specifically required for EFH consultations and developing a Coastal and Marine Ecological Classification Standard-based protocol to enable BOEM and its stakeholders to provide consistent and comparable geospatial information to inform offshore wind energy, mineral leasing, and dredging events. Clearly identifying habitat type is critical to appropriately analyze potential individual project and cumulative impacts (SSQs 1, 4, and 9). For example, BOEM and other agencies need to use the same habitat identifiers when consulting with other agencies to ensure we are on the same page when discussing impacts and potential mitigation and minimization measures.

The second study would develop 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 a dredge cut area and may impact productivity and, indirectly, the food web (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 (SSQs 1 and 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.

The third study would address information that is needed to evaluate the potential effects of critical mineral activities. A similar project, funded by the MMP, is currently underway to generate a series of references covering critical mineral resource evaluation, including prospecting, mining, and the novel and complex extraction technologies used to execute these operations. The study proposed for this SDP would develop similar references focused on environmental assessment. This study would inform environmental analyses and focus on identifying information gaps, recommending future critical mineral studies to address gaps, and reviewing processes to ensure high-quality critical mineral environmental assessments (SSQs 1 and 4). These reviews would document the mineral resources, associated environment, and economic guidance needed to evaluate critical mineral activity requests and would assist analysts as they provide information for decision-makers.

The fourth study focuses on needed information with respect to critical minerals use assessments. The study proposed for the SDP would continue interagency analysis of an historic deep-sea mining test site at approximately 800 m depth on the Blake Plateau in the U.S. Atlantic Ocean (MM-21-03). BOEM, USGS, and NOAA have been collaborating to learn more about this site and planning for this joint study.

On June 29, 2019, NOAA Ship *Okeanos Explorer* performed a systematic multibeam survey surrounding the "Deepsea Ventures Site." This initial mapping enabled a return visit by the *Okeanos Explorer* on November 11, 2019, to conduct an 8-hour exploratory ROV (remotely operated vehicle) dive guided by USGS and BOEM input.[12] The dive documented evidence of past activities, including a "patio block" marker installed by the USGS and apparent seafloor disturbances from equipment consistent with the types of seafloor mining equipment thought to have been used in the 1960s. The purpose of the new second phase of work is to conduct a second research cruise to implement the in situ collection of geological and biological samples at several locations in both the disturbed areas and control areas. Leveraging unusual access to a historically impacted site, the analysis of these samples would provide needed information for future NEPA assessments by evaluating the potential environmental impacts from seafloor mineral extraction, including to any endemic fauna, to better inform understanding of disturbance recovery (SSQs 1, 4, and 9).

The final study MMP proposes for this SDP would utilize ecosystem modeling to examine the disruption to primary producers and/or primary consumers from dredging (SSQs 1 and 4). This study would leverage existing ecosystem studies funded by BOEM (i.e., Ship Shoal (MM-19-01) and Canaveral Shoals (NT-14-x14)). The results from this study could be used by both BOEM analysts in NEPA and EFH documents, as well as by resource management agencies when assessing potential impacts from dredging.

Tables 1 and 2 show how Atlantic Region studies focused on renewable energy address the SSQs.

[12] https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/nov7/nov7.html

Table 1. Alignment of proposed FY 2024 OREP studies with BOEM programs and SSQs

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 Offshore Wind Energy Facility Emission Estimating Tool Version 3.0		✓						✓				
2	Improving Methods and Identifying Best Practices for Defining and Delineating Low-Relief Hardbottom Essential Fish Habitat in Wind Energy Areas – Case Study in Carolina Long Bay		✓	✓				✓				✓	
3	Ocean Environmental Monitoring and Sound Propagation Study at Mid-Atlantic Shelfbreak Offshore Wind Area		✓	✓		✓						✓	✓
4	Offshore Landscape, Seascape, and Visual Impact Mitigation Study		✓								✓	✓	
5	Cumulative Air Quality Impacts Modeling Analysis		✓								✓		
6	Atlantic Marine Assessment Program for Protected Species (AMAPPS)	✓	✓	✓	✓			✓	✓				✓
7	Collecting Fisher's Ecological Knowledge (FEK) for Use in Gulf of Maine Offshore Wind		✓					✓			✓		

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 MMP studies with BOEM programs and SSQs

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	Developing a Critical Minerals Environmental Assessment Framework (CMEAF) for Critical Minerals Activities	-	-	✓	✓	-	-	✓	-	-	-	-	-
2	Coastal Marine and Ecological Classification Standard Application: Offshore Energy and Minerals Development	-	✓	✓	✓	-	-	✓	-	-	-	-	✓
3	In Situ Sampling at a Historic Equipment Test Site on the Blake Plateau	-	-	✓	✓	-	-	✓	-	-	-	-	✓
4	Extrapolating Benthic Recovery Estimates Beyond Single-project Constraints	-	-	✓	✓	-	-	✓	-	-	-	-	✓
5	Baseline Characterization of Communities on Sand Shoals and Nearby Habitats in the Gulf of Mexico	-	✓	✓	✓	-	-	✓	-	-	-	-	✓
6	Modeling Food Web Effects from Dredging	-	-	✓	✓	-	-	✓	-	-	-	-	✓

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 50-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) 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 2024–2025 SDP, the Pacific Region received and considered 94 study ideas from stakeholders, including Federal and state agencies, Tribal organizations, universities and other research institutions, nonprofit organizations, stakeholder alliances, and private companies. Additionally, 9 BOEM staff proposed 12 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. The final list for this SDP comprises the proposals that are also manageable based on potential workload.

Appendix A includes the tables of proposed studies for FY 2024–2025. **Appendix B** provides the profiles for the proposed studies.

3.1.1 Conventional Energy Activities

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, 2022, cumulative production was 1.4 billion barrels of oil and 1.9 trillion cubic feet of gas; annual production was 2.6 million barrels of oil and 2.4 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; 4) the shut-in of Platforms Hogan and Houchin starting in October 2019; 5) the October 2021 break and shut-in of the San Pedro Bay Pipeline (affecting Platforms Edith, Ellen, and Eureka); and 6) the December 2022 shut-in of Platform Irene and closure of the Phillips 66 Santa Maria refinery.

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 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.

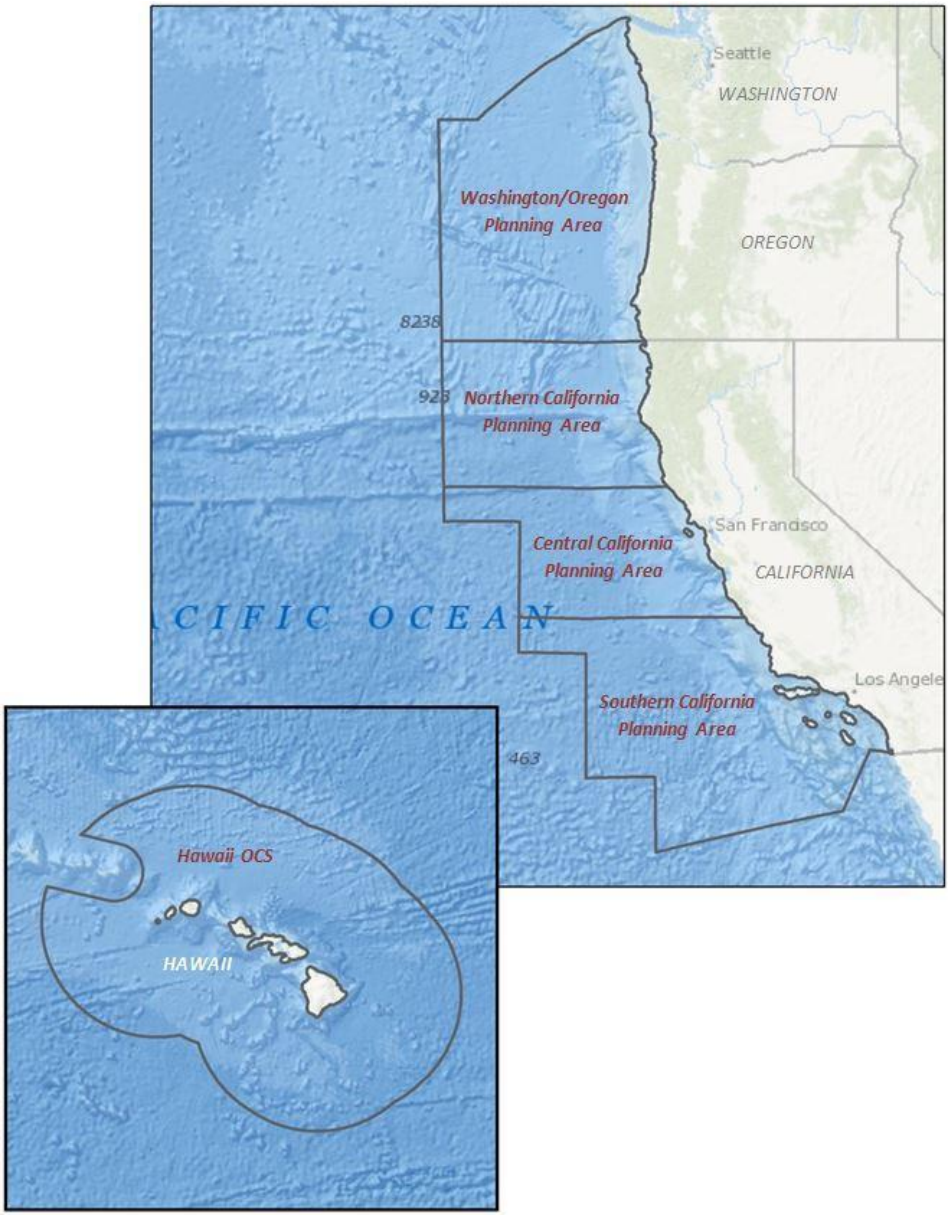


Figure 4. Pacific Region OCS planning areas

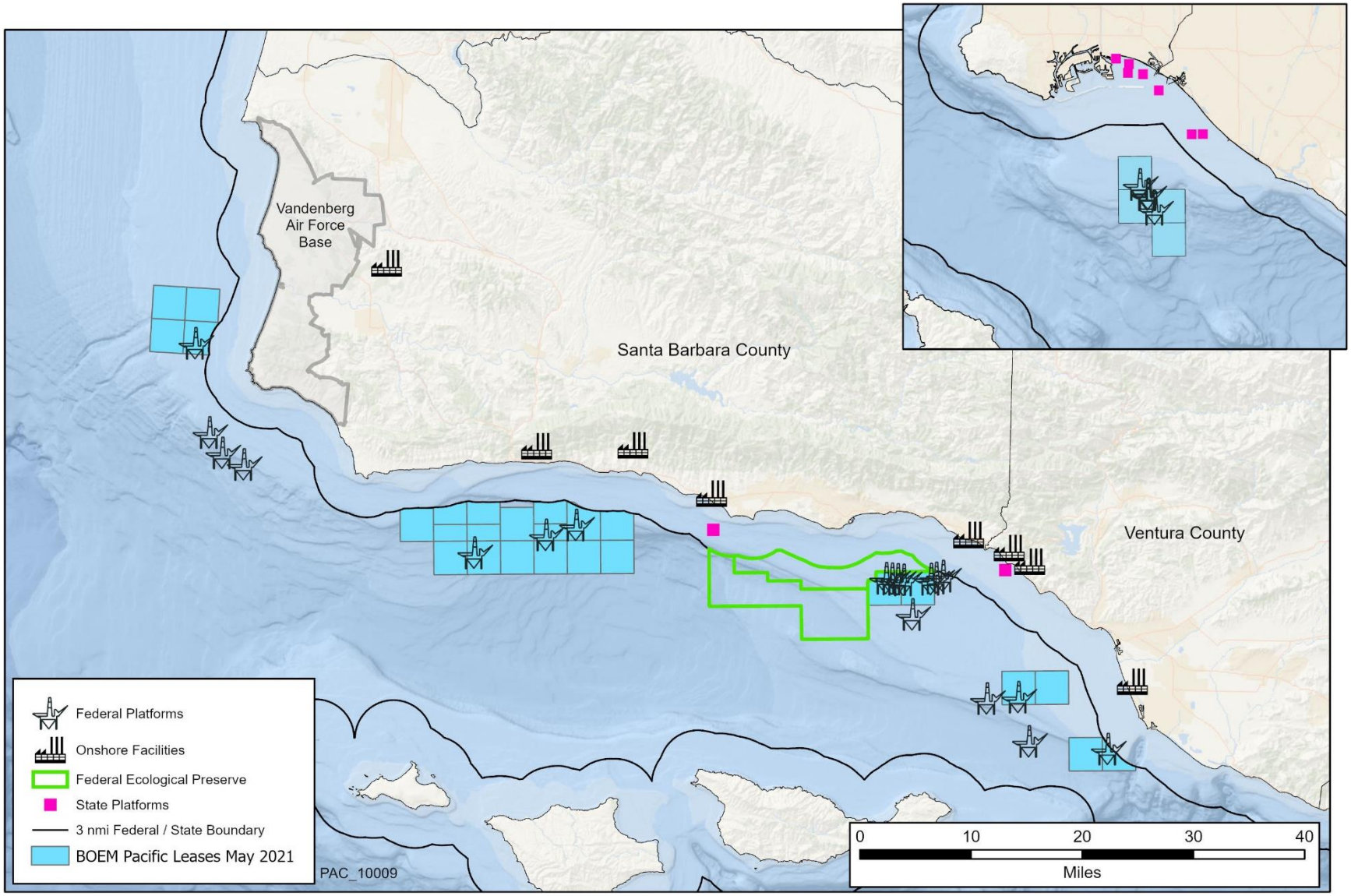


Figure 5. Oil and gas leases and facilities in the Pacific Region

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; the PacWave South project, a proposed open ocean wave energy test center, will located approximately six nautical miles off Newport, Oregon. Planning for potential development of wind energy offshore California, Oregon, and Hawaii (**Figure 6**) is actively underway. BOEM held a wind energy lease sale—the first-ever offered along the West Coast—in December 2022 for five leases offshore Central and Northern California; the lease areas have the potential to produce over 4.6 gigawatts of offshore wind energy, enough to power over 1.5 million homes. BOEM requested public comment on draft Call Areas offshore Oregon in early spring 2022 and is continuing to evaluate the Call Areas to identify Draft Wind Energy Areas. The potential for wind energy offshore Hawaii has been under consideration since 2016. BOEM received two unsolicited lease requests for areas off the Washington coast, prompting the Bureau to begin informational discussions with the State of Washington and Tribes about potential offshore wind energy development.

Ongoing and proposed studies would 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.

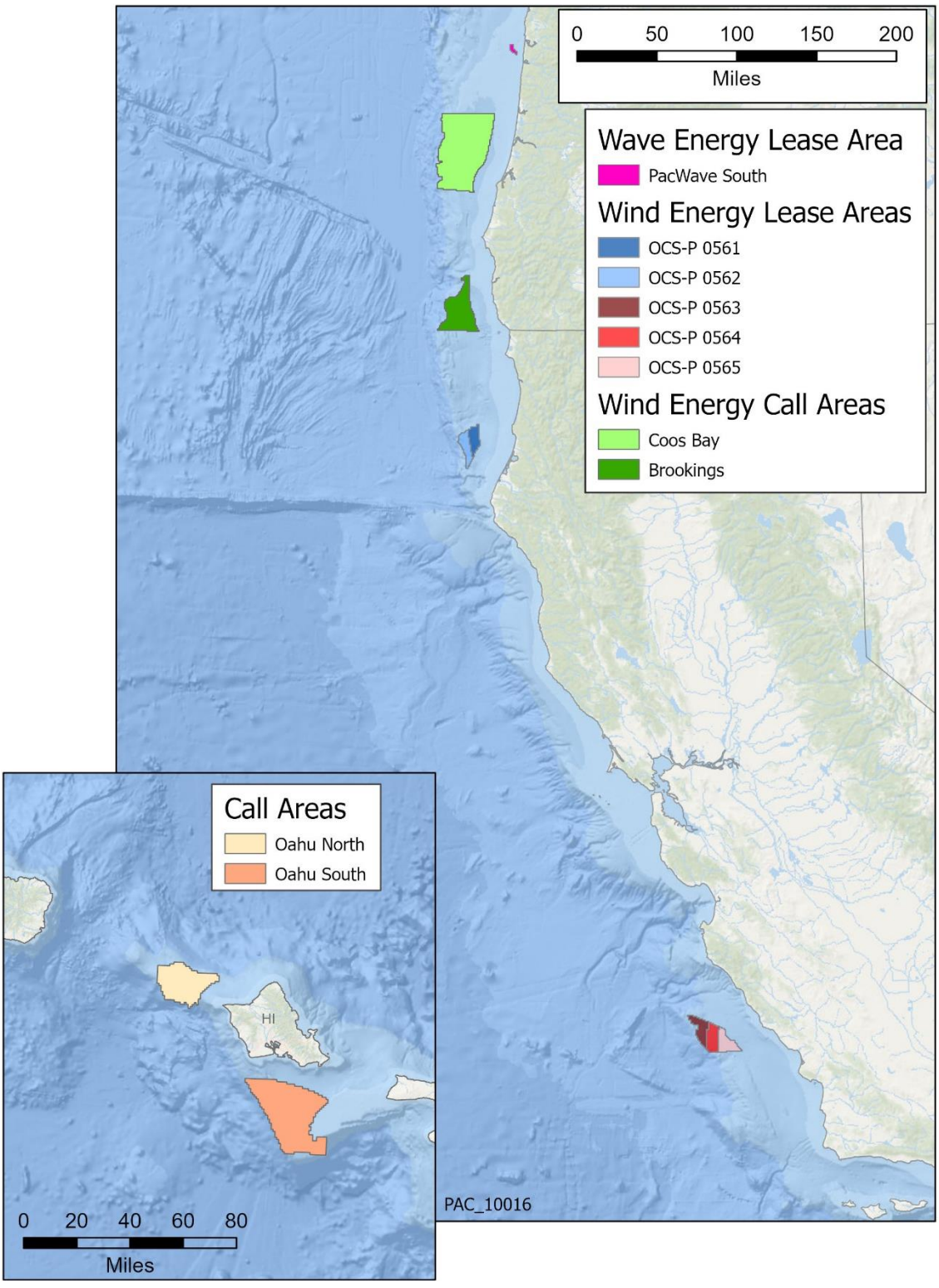


Figure 6. Areas of interest for renewable energy in the Pacific OCS, including Call Areas for wind energy offshore Oregon and Hawaii, wind energy leases offshore California, and a wave energy research lease offshore Oregon

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.

BOEM is considering environmental studies and resource evaluation efforts to inform potential future industry interest in critical marine minerals. The MMP and Pacific Region currently are co-funding several critical marine mineral resource evaluation efforts in partnership with USGS's Pacific Coastal and Marine Science Center. This effort includes two scientific research expeditions in 2023 and 2024 to investigate potential polymetallic nodule resources and the surrounding ecosystems in the OCS south of the island of Hawaii, additional USGS laboratory support to assess archived polymetallic nodules from the Blake Plateau (mid-Atlantic), and a recently completed cruise in the Escanaba Trough.

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.

Although marine minerals are found throughout 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 areas 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 co-funded a USGS-led effort that identified 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 pairing 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 scheduled to begin in FY 2023.

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 six Pacific Region studies proposed for FY 2024, one would inform conventional energy, six would inform renewable energy, and one would inform marine minerals. Of the proposed studies, two would have potential applicability to more than one program (**Table 3**).

As shown in **Table 3**, each proposed study addresses one or more of BOEM's SSQs (themes), including the following areas:

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

Table 3. Alignment of proposed FY 2024 Pacific studies with BOEM programs and SSQs

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	Port Infrastructure Needs of Commercial and Recreational Fisheries Along the U.S. West Coast	-	✓	-	-	-	-	-	-	-	✓	-	-
2	Traditional Native Hawaiian Voyaging and Cultural Fishing and Boating Practices on the OCS	-	✓	-	✓	-	-	✓	-	✓	✓	-	-
3	Understanding Cetacean Ecology in the California Wind Energy Lease Areas (and Related to Floating Offshore Wind) Through Acoustic Analysis	-	✓	-	✓	✓	-	✓	-	-	-	✓	✓
4	Characterization of Water Column Habitats to Understand Potential Impacts from Deepwater Energy and Mineral Development	-	✓	✓	-	-	-	✓	-	-	-	-	-
5	Pre-development Distribution and Behavior of Key Coastal Cetacean Species Near the Morro Bay Wind Energy Lease Area	-	✓	-	✓	✓	-	✓	-	-	-	✓	✓
6	Developing a Next Generation Tag Technology for Sea Otters (*Enhydra lutris*)	✓	✓	-	-	-	-	-	-	-	-	✓	-

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 by creating a wind energy taskforce, completing a draft Regional Environmental Assessment for an offshore lease event and related activities, and announcing and publishing a proposed sale notice for an offshore wind sale in the GOM.

GOMR environmental studies 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 partnered 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 in biological research. USGS, through their Ecosystems Mission Area, has procured and conducted several studies for GOMR, 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.

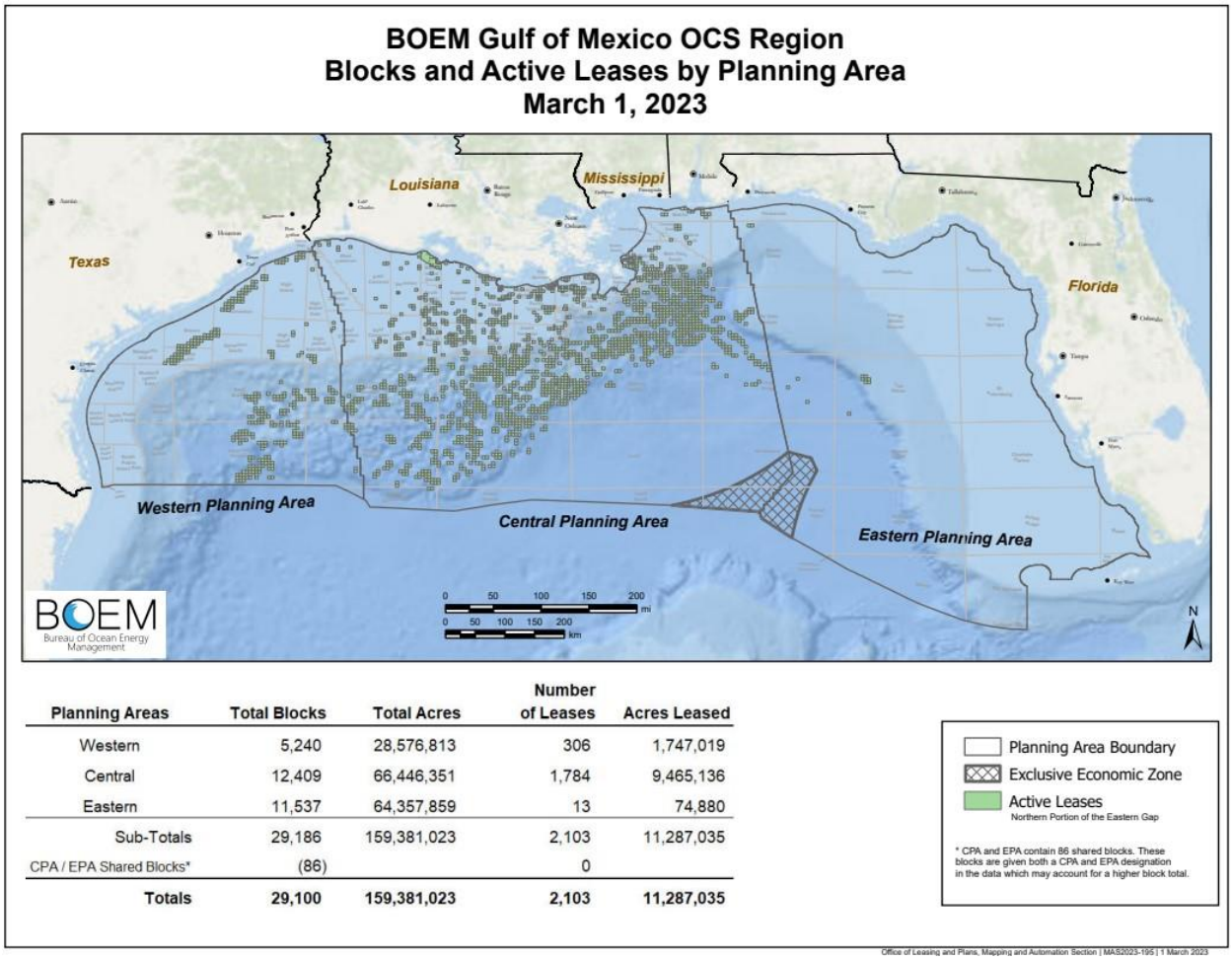
The INVEST in America Act of 2021 granted BOEM the authority to manage carbon sequestration and storage in subsea oil and gas reservoirs of the OCS. BOEM currently is developing the new program and proposed rules. Much attention is focusing on the potential for offshore carbon storage in the GOM and the need to acquire scientific information to better understand the potential environmental impacts.

Appendix A includes the tables of proposed studies for FY 2024–2025. **Appendix B** provides the profiles for the proposed studies.

4.1.1 Conventional Energy Activities

As of March 1, 2023, there are a little over 2,100 active oil and gas leases on the GOM OCS (**Figure 7**). Within active leases, there are more than 1,550 platforms making substantial contributions to the Nation's energy supply. GOMR currently provides approximately 15% of U.S. domestic oil production and 2% of U.S. domestic gas production. Energy exploration and production activities include leasing,

exploration, development, removal of platforms, and installation of pipelines. For more information on GOMR, please visit the region's web page.[13]



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	306	1,747,019
Central	12,409	66,446,351	1,784	9,465,136
Eastern	11,537	64,357,859	13	74,880
Sub-Totals	29,186	159,381,023	2,103	11,287,035
CPA / EPA Shared Blocks*	(86)		0	
Totals	**29,100**	**159,381,023**	**2,103**	**11,287,035**

Figure 7. GOM OCS Region planning areas and active oil and gas leases (March 1, 2023)

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

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

challenges are becoming more complex and deserving of rigorous and integrated environmental study, monitoring, and management.

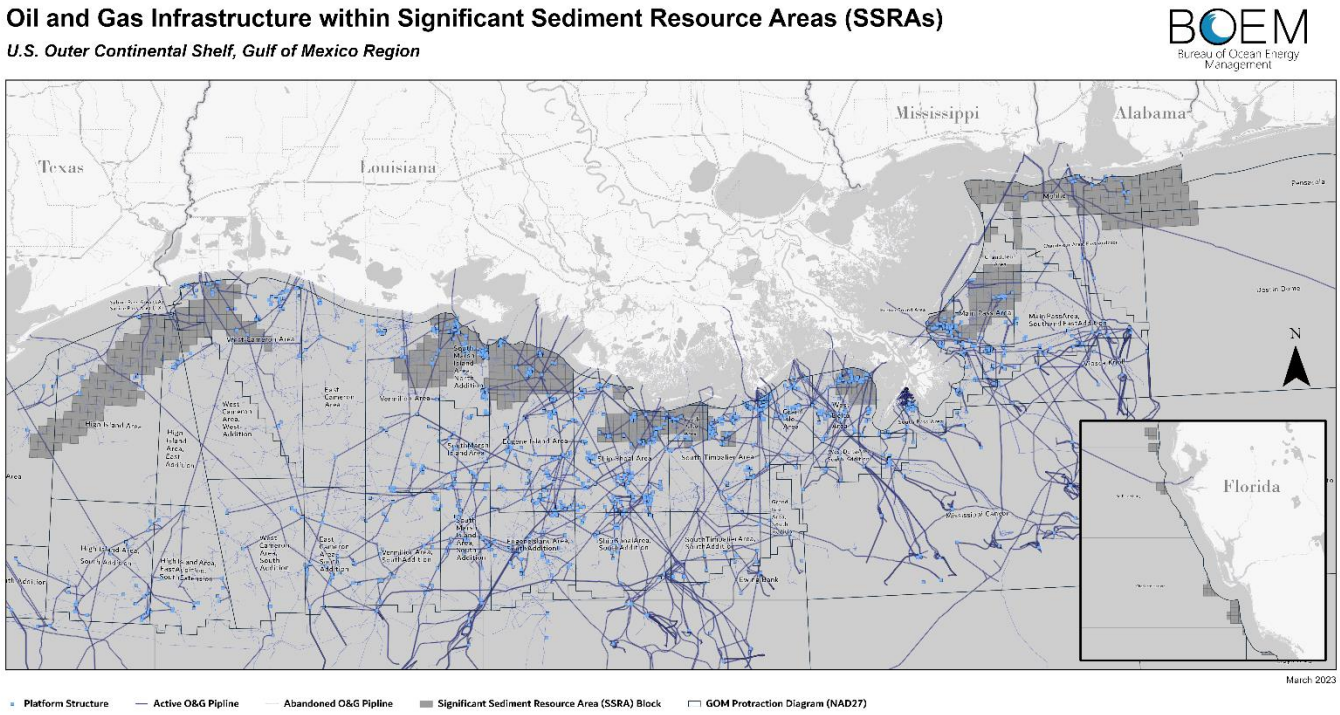


Figure 8. Complex, competing-use challenges in the GOM (updated in March 2023)

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 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, and a third on July 27, 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. BOEM published the draft Environment Assessment was published on July 20, 2022; the final Wind Energy Areas on October 31, 2022; and the *Proposed Sale Notice for Commercial Leasing for Wind Power Development on the Outer Continental Shelf in the Gulf of Mexico* in the Federal Register on February 24, 2023. **Figure 9** shows the renewable energy planning areas in the GOM.

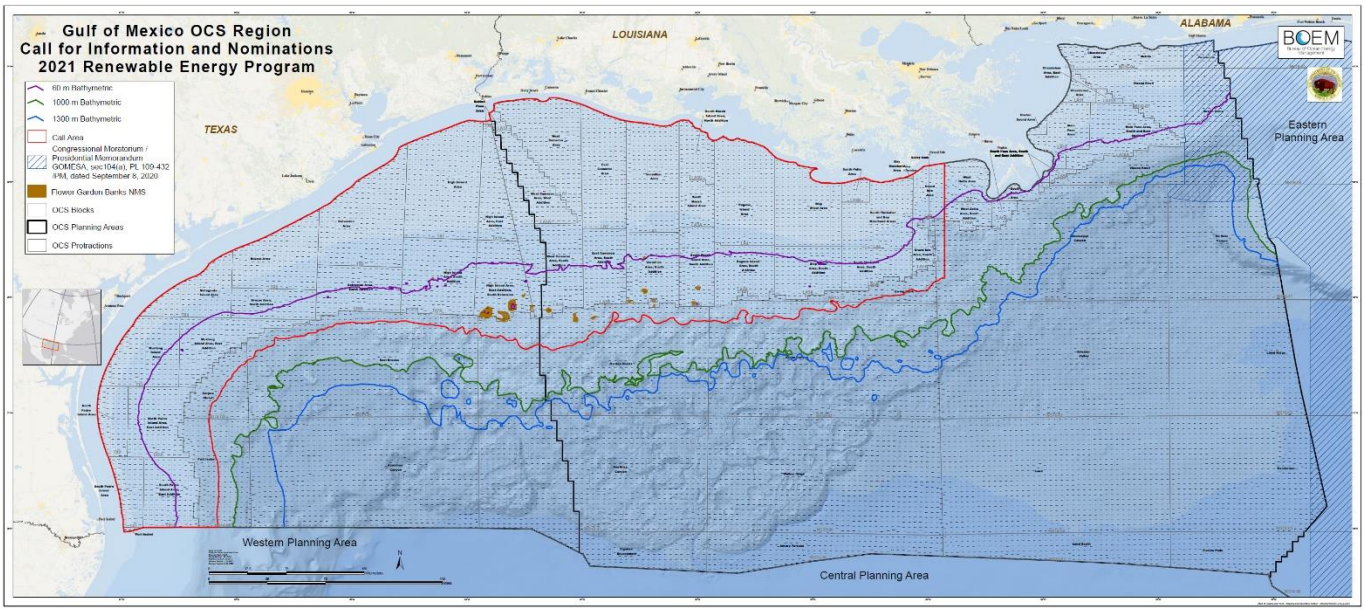


Figure 9. GOM renewable energy planning areas

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 identify potential resources that could be affected by BOEM decision-making. With the momentum moving forward on renewable energy development and captured carbon sequestration in the Gulf, new information needs have been identified to help inform the development and management of these programs. One study proposal for FY 2024 is the continuation of the Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPS). This follow-up study would focus on gathering seabird, cetacean, and sea turtle distribution, abundance, and habitat use data in Wind Energy Areas in the GOM.

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 various sources. The studies listed in **Table 4** would provide the information needed to better understand the effects of BOEM's programs on the human, coastal, and marine environments per OCSLA, NEPA, the NHPA, and other laws. GOM staff would work closely with OEP staff on a study to track vessel and helicopter activity and incorporate this data into BOEM's emissions inventory tool (listed in **Table 6**). Information provided by these studies would enable BOEM to conduct more comprehensive and informed environmental impact assessments, associated NEPA analyses, and Tribal/EJ consultations. For example, a newly proposed inventory of submerged historic aircraft would inform BOEM's NHPA obligations and efforts to identify submerged cultural resources that could be impacted by BOEM's various programs.

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 would inform cumulative impacts and other NEPA analyses, environmental and Tribal consultations, and assessment of the effectiveness of existing mitigations and survey guidelines. Most of the studies proposed for FY 2024 would inform both cumulative impacts analyses and long-term monitoring efforts. In addition, studies related to marine minerals extraction would 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 would 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 nine study profiles for the FY 2024 NSL and no profiles for FY 2025 and beyond. All profiles address at least one national SSQ, while several of the profiles address two or more questions (**Table 4**). Six of the nine studies would inform the conventional energy program, seven would inform the renewable energy program and/or carbon sequestration in the GOM, and three would additionally inform the MMP. Out of the nine studies proposed, three would inform all program areas in the GOM.

One profile proposes to measure and monitor criteria air pollutant concentrations and their precursors at selected locations to determine if their levels are above or below the NAAQS and to inform NEPA and cumulative impact analyses. Another profile would assess the effectiveness and compliance levels of current seismic mitigation measures for protected species by examining protected species observer data collected between 2016 and 2023.

4.3.2 Marine Minerals Activities

MMP has one new study profile proposed in the GOM for FY 2024 (**Table 2**). This proposal addresses three SSQs and focuses on investigating predator and food web relationships between species on sand shoals and non-shoal areas to determine if species abundance is influencing predator abundance and behavior on these sediment-rich areas (SSQs 1, 4, 9). Understanding predator and food web relationships on sand shoals is needed to make informed management decisions on dredging operations and may also be helpful for improving mitigation strategies to reduce the effects of dredging on sea turtles, blue crab, and other species. In addition, outcomes from this proposed field study would be useful for conducting NEPA for sediment dredging and renewable energy structures. Although this proposed study would be conducted in the GOM, the findings could be applied across the OCS for marine minerals and renewable energy activities, especially the East Coast off the Carolinas, Virginia, and Maryland.

4.3.3 Renewable Energy Activities

GOMR is proposing several seven studies that would inform wind energy development in the Gulf. Four studies focus on social science topics: 1) developing an inventory of submerged historic aircraft inventory (mentioned above), 2) developing geospatial data to inform assessments and mitigation measures for potential impacts to fishing communities that utilize WEAs, 3) collecting baseline datasets along Gulf coastal communities that may be impacted by wind energy development and carbon sequestration activities, and 4) identifying and characterizing EJ communities to develop an EJ-focused Fact Book, which also would inform BOEM's conventional and marine minerals programs. Another study proposes to model and simulate hydrodynamic conditions prior to installation of wind turbines and determine how these conditions change after installation to inform mitigation development, consultations, impact assessments. The continuation of the GOMMAPPS study would inform all BOEM's programs, including renewable energy. Finally, one study proposes to identify use areas and movement patterns of Black-capped Petrels, a species of bird currently being considered for listing as threatened under ESA.

Table 4. Alignment of proposed FY 2024 GOM studies with BOEM programs and SSQs

Priority Rank	Study Title	Conventional Energy	Renewable Energy	Marine Minerals	SSQ 1: **Cumulative Effects**	SSQ 2: **Sound**	SSQ 3: **Exposure to Chemicals**	SSQ 4: **Habitat or Landscape Alteration**	SSQ 5: **Air Emissions**	SSQ 6: **Future Ocean Conditions**	SSQ 7: **Social Sciences**	SSQ 8: **Existing or Emerging Technology**	SSQ 9: **Long-term Monitoring**
TBD	A Data Inventory and Assessment of Submerged Aircraft Loss Records on the OCS	✓	✓	✓		-	-	-	-	-	✓	-	-
TBD	Evaluating the Social Vulnerability of Fishing Communities when Siting Offshore Wind Energy Developments in the Gulf of Mexico	-	✓	-	✓	-	-	-	-	-	✓	-	✓
TBD	Gulf Coast Community and Cultural Impact Baselines Survey	-	✓	-	✓	-	-	-	-	-	✓	-	✓
TBD	Gulf of Mexico Environmental Justice Fact Book: Identifying Coastal Communities Affected by Activities on the Outer Continental Shelf	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓
TBD	Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) II	✓	✓	✓	✓	-	-	-	-	-	-	-	✓
TBD	Gulf of Mexico Region Coastal Ambient Air Quality Monitoring Program: Phase II	✓	-	-	✓	-	-	-	✓	-	-	-	✓
TBD	Offshore Wind Energy Facilities Impact on Hydrodynamics and Biological Production in the Gulf of Mexico	-	✓	-	✓	-	-	✓	-	✓	-	-	-
TBD	Seismic Survey Mitigation Measures and Protected Species Observer Report	✓	-	-	✓	✓	-	-	-	-	-	-	✓
TBD	Spatial Ecology of Black-capped Petrels: Marine Spatial Planning and Species Conservation	✓	✓	-	✓	-	-	-	-	-	-	-	✓
TBD	Understanding Impacts of Offshore Carbon Sequestration on the Marine Environment: Informing Operational Management Needs Through Focused Literature Review and Synthesis	✓	-	-	✓	-	-	✓	-	-	-	-	-

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 (**Figure 10**). Through its Alaska Regional Office, BOEM oversees more than one billion acres on the Alaska OCS and more than 6,000 miles of coastline. Currently, BOEM has 21 active leases in Alaska: 15 in the Cook Inlet Planning Area and 6 in the Beaufort Sea Planning Area.

Challenges working in the Alaska OCS include large and remote planning areas; diverse and extreme environmental conditions; and mitigating potential environmental hazards (e.g., seasonal sea ice) associated with offshore activities.

Figure 10. Alaska Region planning areas

Since ESP began 50 years ago, BOEM has invested 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 the BOEM website[14] and on BOEM's Alaska regional website.[15]

When conducting research projects in Alaska, BOEM coordinates with other Federal, state, and local agencies; Alaska Native Tribes, Councils, and Associations; non-governmental organizations; academic institutions; and industry. BOEM strives to enhance community engagement, including with Alaska Native peoples, other Alaskan residents, and the Arctic Council (Kendall et al. 2017; Brooks et al. 2019). BOEM integrates local and Indigenous knowledge at all stages, beginning with the study development process through publication of reports, peer-reviewed papers, scientific proceedings, and conference presentations.

In 1993, BOEM partnered with the University of Alaska (UA) and launched the CMI to collaborate with UA researchers in collecting and disseminating environmental information needed for the development of energy resources in the Alaska OCS. In three decades, CMI has conducted 125 studies—including 13 student-led projects—and leveraged approximately $23 million of Federal funds into almost $47 million of relevant marine-based research, with non-Federal matching funds from more than 50 different organizations.

Since 1979, the Arctic has warmed at four times the rate of the rest of the world, with summer sea ice extent reaching record lows. The loss of ice cover and resulting changes to ocean currents, water chemistry, and productivity influence marine mammal, migratory bird, and fish migration, habitat selection, foods and foraging ecology, productivity, health, and availability to local subsistence harvesters that rely on these resources for food security. Climate change effects also include increased shoreline erosion and permafrost melt that threaten Arctic communities and infrastructure. In addition to climate change effects on natural resources and rural communities, industry must adapt their activities to changes in sea ice conditions and permafrost.

In recent years, marine heatwaves in the North Pacific have had considerable impact on habitats and species in the Alaska OCS. Prolonged periods of higher temperatures are connected to, for example, die offs in seabirds and invertebrates, the northern movement of boreal species, and reduced salmon returns in key watersheds. Analysis of potential impacts must consider the current status of marine populations and ecosystems in the face of these changes, and ecosystem resilience in the face of multiple environmental stressors.

Appendix A includes the tables of proposed studies for FY 2024–2025. **Appendix B** provides the profiles for the proposed studies.

[14] https://www.boem.gov/environment/environmental-studies/environmental-studies-information
[15] http://www.boem.gov/AKpubs

5.2 Decision Context

5.2.1 Current/Relevant Issues

BOEM is examining 1) the effects of a warming climate and increased sea surface temperatures in the northern Pacific Ocean; 2) changes in biological communities, including range expansions of species and introductions of non-native species; and 3) reduction and changes in the timing of freeze up and melt of sea ice.

Industry interest in oil and gas development in Cook Inlet has resulted in BOEM focusing data collection in this area. BOEM needs to collect, analyze, and disseminate baseline data on biological resources; impacts from potential infrastructure development and related project features; oceanographic data for use in oil spill risk analyses; and sea ice dynamics.

BOEM also is evaluating renewable energy and critical mineral mining potential and associated environmental impacts of these activities on the Alaska OCS. Information is needed to understand the potential of tidal and wind energy within Cook Inlet to inform future decisions about site selection and development. Data are also required to facilitate appropriate engineering design, and to investigate potential impacts related to underwater noise and species interactions with tidal energy structures. Additionally, industry has expressed interest in prospecting for gold and other critical minerals in OCS waters off the coast of Nome, Alaska, an area that previously has not been a focus of OCS activities and studies.

Due to the growing interest in critical minerals along the Aleutian Islands, BOEM recently collaborated with NOAA to fund seafloor and water column data acquisition (including multibeam echosounder bathymetry and backscatter, water samples for environmental DNA analysis, and surface water chemistry information) using the innovative saildrone *Surveyor*, an autonomous surface vehicle. The data should help to identify potential hydrothermal vents and will be useful both for initial exploration and evaluation of mineral resources and for understanding the surrounding habitats and ecosystem and the potential impacts of any future seafloor disturbing activities.

On March 13, 2023, the White House published at *Memorandum on Withdrawal of Certain Areas off the United States Arctic Coast of the Outer Continental Shelf from Oil or Gas Leasing*,[16] which states the following:

> *Consistent with principles of responsible public stewardship, and (1) with due consideration of the irreplaceable marine and coastal environments — including for marine mammals, other wildlife, wildlife habitat, scientific research, and Alaska Native subsistence use — of the Beaufort Sea area of the Outer Continental Shelf; (2) independently with due consideration of the vulnerability of the ecosystems and coastal communities to oil spills, particularly where limited or no oil and gas development has yet occurred; and (3) independently with due consideration of the national need to*

[16] https://www.whitehouse.gov/briefing-room/presidential-actions/2023/03/13/memorandum-on-withdrawal-of-certain-areas-off-the-united-states-arctic-coast-of-the-outer-continental-shelf-from-oil-or-gas-leasing/

> *curtail, mitigate, build resilience against, and adapt to the devastating and irreversible consequences of climate change for the human environment and for the marine and coastal environments, I hereby direct as follows:*
>
> *Under the authority granted to me in section 12(a) of the Outer Continental Shelf Lands Act, 43 U.S.C. 1341(a), I hereby withdraw from disposition by oil or gas leasing for a time period without specific expiration the areas designated by the Bureau of Ocean Energy Management as the Beaufort Planning Area of the Outer Continental Shelf that have not previously been withdrawn.*
>
> *The boundaries of the withdrawn areas are more specifically delineated in the attached map. The map forms a part of this memorandum. The withdrawal directed by this memorandum prevents consideration of withdrawn areas for any future oil or gas leasing for purposes of exploration, development, or production.*
>
> *Nothing in this withdrawal affects rights under existing leases in the withdrawn areas.*

Therefore, BOEM Alaska will not conduct any additional oil and gas leasing activities within the Chukchi Sea or Beaufort Sea Planning Areas in the future.

5.2.2 NEPA/Consultation Information Needs

BOEM needs relevant data to better understand, assess, and disclose direct, indirect, and cumulative impacts to biological, ecological, and sociocultural resources from OCS-related activities and climate change. BOEM is prioritizing research in Cook Inlet to gain information on the distribution, population abundance and trend, habitat use, movements, productivity, and health of marine mammals, migratory birds, fish, and invertebrates. Additionally, BOEM needs a better understanding of habitats, food webs, and primary producers. Because of the traditional, cultural, and nutritional importance of fish, marine mammals, migratory birds, and other resources to Alaska Native Peoples, BOEM must address potential effects of OCS activities on subsistence activities and harvest patterns. BOEM also needs information on the potential economic impacts to marine commercial, charter, and recreational fisheries and harvest patterns. As interest in renewable energy in Alaska grows, more specific information is needed on how wind, hydrokinetic, and hydrogen developments in the Alaska OCS could impact resources. In addition to supporting NEPA analyses, information on impacts to vulnerable marine species is required for compliance with other environmental statues, regulations, and EOs, including MMPA, MSFCMA, MBTA, EFH, and EJ.

The effects of climate change, particularly increasing ocean temperatures and marine heat waves, will likely continue to influence the health, distribution, abundance, and productivity of marine species. Current environmental baselines are needed to analyze the potential environmental impacts of OCS energy and marine mineral activities. Though changes to seabird, fish, and invertebrate populations are known to be associated with a recent period of high sea surface temperatures in the North Pacific, it is not known if current biological and ecological responses to climate change will be further exacerbated by OCS-related activities.

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:

1. How do ocean currents and sea ice influence distribution of contaminants from exploration and production activities?
2. How will physical and biological environments change due to reduced sea ice conditions?
3. How do cold temperatures and sea ice influence the fate of spilled oil?

5.4 Alignment With SSQs

BOEM is gaining a better understanding of Arctic and subarctic offshore environments in Alaska. Most investigations collect baseline data on physical, biological, and sociocultural characteristics of planning areas. BOEM supports efforts on ecosystem-based modeling to reduce the level of uncertainty in the many estimates used in decision making. The ability to predict how ecosystems function will lessen the requirement for, and frequency of, long-term baseline monitoring. BOEM also supports research on fates and effects of oil, ocean circulation models, and sedimentation rates in unique habitats. Given the critical importance of the Alaska OCS to Alaska Native peoples, BOEM is working with Alaska Native Tribes, Councils, Boroughs, and Associations to incorporate Traditional Ecological Knowledge in assessing the potential effects of OCS energy and marine mineral activities on subsistence resources and activities.

The Alaska Region has considered the SSQs together with the specific information needs outlined above to develop our list of studies proposed for FY 2024; no studies currently are proposed for FY 2025. The studies proposed for the Alaska Region represent diverse research needs and address SSQs. **Table 5** aligns studies and specific strategic questions.

Although proposed studies were developed in the context of BOEM's conventional energy program, several projects in Cook Inlet address information needs associated with renewable energy development.

Table 5. Alignment of proposed FY 2024 Alaska studies with BOEM programs and SSQs

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	Updating Lower Cook Inlet Seabird Colony Counts	✓	✓	✓	✓	-	✓	✓	-	✓	✓	✓	✓	✓	-	-
2	Adaptation of a Cook Inlet Circulation Model and Calculations	✓	✓	✓	✓	-	✓	-	-	✓	✓	✓	-	✓	-	-
3	Early Detection Plan for Marine Non-native Species in Cook Inlet, Alaska	✓	✓	✓	✓	-	-	✓	-	✓	✓	✓	✓	✓	-	-
4	Sea Ice Climatology Within Cook Inlet, Alaska	✓	✓	-	✓	-	-	✓	-	✓	-	-	-	✓	✓	-
5	Improving Modeling of Oil Spill Weathering in Ice	✓	-	-	✓	-	✓	✓	-	✓	✓	✓	✓	-	-	✓
6	Alaska Coastal Marine Institute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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: How do **ocean currents and sea ice** influence distribution of contaminants from exploration and production activities?	AK 2: How will physical and biological environments change due to **reduced sea ice** conditions?	AK 3: How do **cold temperatures and 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 to leverage resources and foster collaborative relationships. OEP strives 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, which are described in the ESP *Strategic Framework* (BOEM 2020). A comparison of these areas with the national scientific needs identified through environmental assessment and consultations (such as for NEPA analysis for the National OCS Oil and Gas Leasing Program) led to the development of this cycle's 18 study profiles. Furthermore, OEP considered study needs associated with the CMA 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 also is substantially supporting renewable energy initiatives, such as the development and implementation of the NOAA and 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 2024–2025. **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 impacts. 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 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.

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. Though the literature review proposed here will not be completed in time to provide input into the new regulations, this information still would be a useful starting point for future BOEM research into carbon capture, utilization, and sequestration.

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

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

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

The NOMEC Council was established pursuant to the NOMEC Strategy in June 2020 to coordinate agency policy and actions needed to achieve the goals. The Council's mission is to serve as a senior-level point of interagency coordination for the Federal Government. Two interagency working groups (IWGs) report to the Council—the preexisting IWG on Ocean and Coastal Mapping and the newly created IWG on Ocean Exploration and Characterization (IWG-OEC). BOEM staff serve on the NOMEC Council and on each IWG; the Bureau also co-chairs the IWG-OEC. In coordination with the Council and IWGs, ESP is continuing to support implementation of the NOMEC Strategy[17] by funding many different studies focused on BOEM-needed mapping, exploration, and characterization efforts such as NT-21-01 "Facilitating Interagency Partnerships in Support of the Presidential Memo on Ocean Mapping, Exploration, and Characterization." BOEM is collaborating with interagency partners and providing funding to address the geographic and thematic priority areas identified by the IWG-OEC's *Strategic Priorities for Ocean Exploration and Characterization of the United States Exclusive Economic Zone* report.[18]

BOEM continues to support priorities and directives of the Biden Administration, such as racial justice, climate change, and *Build Back Better*, a plan that focuses on the rebuilding the economy through support of small businesses and investment in jobs of the future. In BOEM's case, the plan relates specifically to helping enable growth of the blue economy and 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. This year, OEP proposed studies to assess the effectiveness of engagement with underserved communities regarding offshore wind development and to evaluate community benefits provided to such communities. Another study seeks to better understand the impacts of no new leasing in the National OCS Oil and Gas Leasing Program. Lastly, in collaboration with the Bureau of Land Management, one study proposes to increase BOEM's understanding of subsistence practices and cultural land uses in three regions (southcentral Alaska, the Northern Rocky Mountains of Colorado, and the GOM).

Climate change is altering abiotic conditions throughout the OCS in habitats of special interest to all BOEM programs and regions, with likely negative impacts to sensitive species and habitats that BOEM actively protects (e.g., North Atlantic right whale and cold-water corals). To improve our understanding of the impact of climate change on the OCS, OEP proposes a study to compile, synthesize, and evaluate

[17] https://www.noaa.gov/nomec
[18] https://www.whitehouse.gov/wp-content/uploads/2022/10/NOMEC_OEC_Priorities_Report.pdf

existing information on climate change in OCS environments, particularly those impacts associated with sensitive species and habitats.

Air quality and greenhouse gas emissions remain an important area of study for the Bureau. To effectively manage emissions, BOEM needs to know the environmental impacts from the numerous vessel and helicopter trips conducted in support of BOEM's authorized activities. One study proposed this year would track vessel and helicopter activity to incorporate this data into BOEM's emissions inventory tool, the Outer Continental Shelf Air Quality System (OCS AQS), as well as ESA consultation documents. This data would also inform the National OCS Oil and Gas Leasing Program.

Lastly, 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. Of the five acoustic studies proposed for FY 2024, three relate to offshore wind development; the other two relate to conventional energy.

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, except for the New York Bight Offshore Wind Programmatic Environmental Impact Statement, 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 analysis and consultation needs would enable OEP to have a more robust analysis of potential impacts from OCS activities and to propose more successful mitigation and minimization measures.

For this FY 2024–2025 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 studies proposed by OEP for FY 2024 continue last year's strong focus on marine acoustics (SSQ 2), with five studies focused on better understanding impacts of noise in the ocean. BOEM's acoustic research needs include investigating impacts to marine species (such as marine mammals, sea turtles, fish, and invertebrates), the effect that substrate-borne vibrations might have on the benthic organisms and communities, complex noise exposure to marine mammals, and the relatively new topic of effects of marine vibroseis on marine mammals.

Long-term monitoring is another priority area for OEP this year, with six studies either directly or indirectly related to monitoring efforts (SSQ 9). These studies cover a range of activities including air emissions in the GOM (which also addresses SSQ 5), community benefit provisions related to offshore renewable energy development, and marine life such as marine mammals, sea birds, and sea turtles. Three of these marine life studies could also provide baseline data for a cumulative impact assessment (SSQ 1) in the future.

Four proposed studies focus on social science (SSQ 7), specifically with regards to underserved and/or EJ communities. Advancing our understanding of how permitted activities may potentially impact EJ and underserved communities is once again a priority for ESP, and these studies would help address that need. Two of these studies relate directly to the development of offshore wind power, and a third would look at the socio-cultural and economic impacts on not issuing any new oil and gas leases.

Four studies look to better use new or existing technology (SSQ 8) to advance BOEM science. Two of these proposals focus on advancing the Federal government's animal telemetry capabilities, one would look at using high-resolution satellite imagery to better detect whales, and the fourth proposes using concentrations of dimethyl sulfide as a predictor of the presence of whales. Lastly, by seeking to assess climate change risk and information gaps in sensitive OCS areas, one study looks to address the effect of habitat or landscape alteration from BOEM-regulated activities (SSQ 4).

Table 6 provides a full list of the studies proposed by OEP and their alignment with the SSQs.

Table 6. Alignment of proposed FY 2024 National studies with BOEM programs and SSQs

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	Assessing the Effectiveness of Offshore Wind Lease Stipulations on Engagement with Underserved Communities	-	✓	-	-	-	-	-	-	-	✓	-	-
2	Socio-Cultural and Economic Impacts of Changing Energy Trends	✓	-	-	-	-	-	-	-	-	✓	-	-
3	Establishing a Baseline Offshore Monitoring Program of Birds, Cetaceans, Turtles in Puerto Rico and the Virgin Islands	-	✓	-	✓	-	-	-	-	-	-	-	✓
4	Evaluating Community Benefits Provisions Related to Offshore Renewable Energy	-	✓	-	-	-	-	-	-	-	✓	-	✓
5	Future Directions of Physical Oceanography Research on Offshore Renewable Energy Development at the Bureau of Ocean Energy Management	✓	✓	✓	-	-	-	-	-	✓	-	-	-
6	Synthesis of Climate Change Sensitivity and Information Gaps in Priority Management Areas of the Outer Continental Shelf (OCS)	✓	✓	✓	-	-	-	✓	-	-	-	-	-
7	Using Coast Guard's AIS Vessel and Federal Aviation Administration's NextGen Helicopter Data to Track BOEM-Authorized Activities	✓	✓	✓	✓	-	-	-	✓	-	-	-	✓
8	Next Generation of Animal Telemetry: Space Flight Testing	✓	✓	-	-	-	-	-	-	-	-	✓	✓
9	Relationships with Land and Resources: A Baseline Comparative Study of Subsistence Activities in the United States	✓	✓	-	-	-	-	-	-	-	✓	-	-
10	Vibrational Sensitivity in Mobile Benthic Organisms	✓	✓	✓	-	✓	-	-	-	-	-	-	-

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**
11	Non-Physiological Effects of Marine Vibroseis on Baleen Whales: Field Study of Behavioral Responses	✓	-	-	-	✓	-	-	-	-	-	-	-
12	Using Very High-Resolution Satellite Imagery to Detect Cetaceans	-	✓	-	✓	-	-	-	-	-	-	✓	✓
13	Marine Mammal Hearing Temporary Threshold Shift and Auditory Recovery from Complex Noise Exposure	✓	✓	✓	-	✓	-	-	-	-	-	-	-
14	Behavioral and Physiological Responses of Sea Turtles to Sound	✓	✓	✓	-	✓	-	-	-	-	-	-	-
15	Non-Physiological Effects of Marine Vibroseis on Bearded Seals: Lab Study on Masking Effect	✓	-	-	-	✓	-	-	-	-	-	-	-
16	Integrating Dimethyl Sulfide (DMS) Gradients into Dynamic Management to Predict North Atlantic Right Whale Occurrence in the Northeast	-	✓	-	✓	-	-	-	-	-	-	✓	-
17	Building National Infrastructure for the Monitoring of Wildlife Movements	✓	✓	-	✓	-	-	-	-	-	-	✓	✓
18	National Outer Continental Shelf (OCS) Oil Spill Occurrence Rates	✓	-	-	-	-	✓	-	-	-	-	-	-

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

7 References

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

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

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

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

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

Musial W, Tegen S, Driscoll R, Spitsen P, Roberts O, Kilcher L, Scott G, Beiter P (National Renewable Energy Laboratory and the Alliance for Sustainable Energy, LLC, Golden, CO). 2019. Survey and assessment of the ocean renewable resources in the US Gulf of Mexico. New Orleans (LA): Bureau of Ocean Energy Management. 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 (National Renewable Energy Laboratory and the Alliance for Sustainable Energy, LLC, Golden, CO). 2020. Offshore wind in the US Gulf of Mexico: regional economic modeling and site-specific analyses. New Orleans (LA): Bureau of Ocean Energy Management. 94 p. Report No.: OCS Study BOEM 2020-018.

The White House. 2021. Executive Order on tackling the climate crisis at home and abroad. Washington (DC): The White House. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/

APPENDIX A: Tables of Proposed Studies for FY 2024–2025

Table A-1. Atlantic (OREP) studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
62	MM	Atlantic Marine Assessment Program for Protected Species (AMAPPS)
64	AQ	BOEM Offshore Wind Energy Facility Emission Estimating Tool Version 3.0
67	HE	Improving Methods and Identifying Best Practices for Defining and Delineating Low-Relief Hardbottom Essential Fish Habitat in Wind Energy Areas – Case Study in Carolina Long Bay
71	SE	Collecting Fisher's Ecological Knowledge (FEK) for Use in Gulf of Maine Offshore Wind
73	AQ	Cumulative Air Quality Impacts Modeling Analysis
75	PO	Ocean Environmental Monitoring and Sound Propagation Study at Mid-Atlantic Shelfbreak Offshore Wind Area
79	SE	Offshore Landscape, Seascape, and Visual Impact Mitigation Study

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

Table A-2. Atlantic (MMP) studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
82	MM	Baseline Characterization of Communities on Sand Shoals and Nearby Habitats in the Gulf of Mexico
86	IM	Coastal Marine and Ecological Classification Standard Application: Offshore Energy and Minerals Development
89	HE	Developing a Critical Minerals Environmental Assessment Framework (CMEAF) for Critical Minerals Activities
92	HE	Extrapolating Benthic Recovery Estimates Beyond Single-project Constraints
95	HE	In Situ Sampling at a Historic Equipment Test Site on the Blake Plateau
99	HE	Modeling Food Web Effects from Dredging

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

Table A-3. Pacific studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
102	HE	Characterization of Water Column Habitats to Understand Potential Impacts from Deepwater Energy and Mineral Development
106	MM	Developing a Next Generation Tag Technology for Sea Otters (*Enhydra lutris*)
109	SE	Port Infrastructure Needs of Commercial and Recreational Fisheries Along the U.S. West Coast
112	MM	Pre-development Distribution and Behavior of Key Coastal Cetacean Species Near the Morro Bay Wind Energy Lease Area
115	SE	Traditional Native Hawaiian Voyaging and Cultural Fishing and Boating Practices on the OCS
118	MM	Understanding Cetacean Ecology in the California Wind Energy Lease Areas (and Related to Floating Offshore Wind) Through Acoustic Analysis

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

Table A-4. Gulf of Mexico studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
121	SE	A Data Inventory and Assessment of Submerged Aircraft Loss Records on the OCS
124	SE	Evaluating the Social Vulnerability of Fishing Communities when Siting Offshore Wind Energy Developments in the Gulf of Mexico
127	SE	Gulf Coast Community and Cultural Impact Baselines Survey
130	SE	Gulf of Mexico Environmental Justice Fact Book: Identifying Coastal Communities Affected by Activities on the Outer Continental Shelf
134	MM	Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) II
137	AQ	Gulf of Mexico Region Coastal Ambient Air Quality Monitoring Program: Phase II
140	HE	Offshore Wind Energy Facilities Impact on Hydrodynamics and Biological Production in the Gulf of Mexico
144	MM	Seismic Survey Mitigation Measures and Protected Species Observer Report
147	HE	Spatial Ecology of Black-capped Petrels: Marine Spatial Planning and Species Conservation
150	FE	Understanding Impacts of Offshore Carbon Sequestration on the Marine Environment: Informing Operational Management Needs Through Focused Literature Review and Synthesis

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

Table A-5. Alaska studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
154	PO	Adaptation of a Cook Inlet Circulation Model and Calculations
157	HE	Alaska Coastal Marine Institute
159	HE	Early Detection Plan for Marine Non-native Species in Cook Inlet, Alaska
162	FE	Improving Modeling of Oil Spill Weathering in Ice
165	PO	Sea Ice Climatology Within Cook Inlet, Alaska
168	HE	Updating Lower Cook Inlet Seabird Colony Counts

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

Table A-6. National studies proposed for FY 2024, alphabetized by title

Profile Page #	Discipline	Study Title
171	SE	Assessing the Effectiveness of Offshore Wind Lease Stipulations on Engagement with Underserved Communities
175	MM	Behavioral and Physiological Responses of Sea Turtles to Sound
179	HE	Building National Infrastructure for the Monitoring of Wildlife Movements
183	HE	Establishing a Baseline Offshore Monitoring Program of Birds, Cetaceans, Turtles in Puerto Rico and the Virgin Islands
186	SE	Evaluating Community Benefits Provisions Related to Offshore Renewable Energy
190	PO	Future Directions of Physical Oceanography Research on Offshore Renewable Energy Development at the Bureau of Ocean Energy Management
195	HE	Integrating Dimethyl Sulfide (DMS) Gradients into Dynamic Management to Predict North Atlantic Right Whale Occurrence in the Northeast
199	MM	Marine Mammal Hearing Temporary Threshold Shift and Auditory Recovery from Complex Noise Exposure
203	FE	National Outer Continental Shelf (OCS) Oil Spill Occurrence Rates
206	MM	Next Generation of Animal Telemetry: Space Flight Testing
208	MM	Non-Physiological Effects of Marine Vibroseis on Baleen Whales: Field Study of Behavioral Responses
210	MM	Non-Physiological Effects of Marine Vibroseis on Bearded Seals: Lab Study on Masking Effect
213	SE	Relationships with Land and Resources: A Baseline Comparative Study of Subsistence Activities in the United States
217	SE	Socio-Cultural and Economic Impacts of Changing Energy Trends
221	HE	Synthesis of Climate Change Sensitivity and Information Gaps in Priority Management Areas of the Outer Continental Shelf (OCS)
225	AQ	Using Coast Guard's AIS Vessel and Federal Aviation Administration's NextGen Helicopter Data to Track BOEM-Authorized Activities
229	MM	Using Very High-Resolution Satellite Imagery to Detect Cetaceans
233	HE	Vibrational Sensitivity in Mobile Benthic Organisms

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 2024–2025 Study Profiles Organized by Region

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Atlantic Marine Assessment Program for Protected Species (AMAPPS)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Tim White (timothy.white@boem.gov), Jeri Wisman (jeri.wisman@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2024–2029
Final Report Due	TBD
Date Revised	February 6, 2023
Problem	Updated fine-scale information on the distribution, abundance, space use, and behavior of marine wildlife needed for planning energy development activities and conducting environmental analyses.
Intervention	Aerial observations, shipboard observations, oceanographic sampling, telemetry and passive acoustic monitoring can be used to collect ecological data, covering all major species of interest.
Comparison	Improve discovery of and access to data and study products to compare anthropogenic impacts in living marine resources.
Outcome	Provide important information to inform both BOEM and Bureau of Safety & Environmental Enforcement (BSEE) regulatory needs, as well as other agencies and stakeholders involved in effective management and conservation of Atlantic protected species.
Context	Industrial activities on the Atlantic Outer Continental Shelf.

BOEM Information Need(s): The next phase of AMAPPS science will focus more survey effort on targeting wind areas and leases using innovative technologies and traditional surveys to inform pre- and post-construction planning. Collecting multiple layers of information within and outside these boundaries will help BOEM better connect the relationships between localized systems with high potential for development and the broader environment.

Background: AMAPPS was initially conceived as a long-term research and monitoring program, partnering with the U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and U.S. Navy. There is also new potential for private partnerships. The third 5-year phase ends in FY2023. Data collected in association with AMAPPS developed a better understanding of the distribution and abundance gradients for the species of interest in the Atlantic. Extensive aerial and shipboard survey effort continues to produce updated distribution models for the Northeast and fills gaps in the South Atlantic Bight. AMAPPS leads the field in high-resolution aerial imagery surveys, developing state-of-the-art camera systems and deep learning algorithms to automatically detect and classify seabirds, cetaceans, and turtles in aerial imagery. Moving forward it is imperative to continue this unique broad-scale ecological data collection, as well as fine-scale focus on areas and species of interest. These data are needed in order to detect climatological or other effects on this ecosystem that may be happening with or without the influence of BOEM-related activities on the

outer continental shelf.

Objectives: AMAPPS is a collaborative program involving BOEM, U.S. Navy, NMFS, and FWS. The program collects seasonal data on the abundance, distribution, ecology, and behavior of marine mammals, sea turtles, and seabirds throughout the Atlantic exclusive economic zone. It provides spatially explicit information in a format that Federal decision-makers can use with living marine resource responsibilities. This next iteration of AMAPPS is envisioned as an extension of previous AMAPPS projects as well as to engage more partners and expand the research program**.**

Methods: AMAPPS activities by category:

- **Spatial-temporal distribution patterns and abundance estimates** of protected species collected over multiple scales and years and develop models and associated tools to translate these survey data into seasonal, spatially explicit density estimates incorporating habitat characteristics.
- **Tagging studies** of protected species to develop corrections for availability bias in the abundance survey data and to investigate behavior and ecology of species in areas of interest.
- **Alternative platforms and technologies** to improve population assessment studies (e.g., eDNA and satellite remote sensing).
- **Operationalize cost-efficient remote sensing-and machine learning-based methods** developed on AMAPPS to survey and monitor marine wildlife to improve the quality of population estimates and distribution mapping while enhancing personnel safety.
- **Using very high-resolution satellite imagery to detect cetaceans**. Several recent technological advances make this technology on the cusp of operational feasibility: 1) the launch of the Maxar WorldView-3 satellite with 30cm resolution; 2) the planned launch of the Maxar Legion program with dramatically improved revisit rates; 3) proof of concept academic studies; and 4) advances in deep learning tools which enable semi-automated identification and classification of objects.
- **Plankton sampling** to examine potential prey and associations with higher tropic levels.

Specific Research Question(s):

1. What spatial scales are required to develop reliable spatially-explicit products of distribution and abundance for the WEAs without sacrificing resolution?
2. How can technologies like eDNA and satellite remote sensing be used most effectively in the larger GOM and the WEAs to resolve species-specific occurrence and ecological community structure?
3. What are the natural and anthropogenic drivers of observed variability in these time series?
4. Can we improve spatially-explicit abundance and distribution models with additional data, in particular, with respect to potential seasonal data gaps (e.g., fall and winter)?
5. Have there been changes in abundance and distribution in marine mammal species in the northern Gulf in recent years? If so, do these changes reflect long-term trends in population size and distribution of these species and others occurring in similar habitats?

Affiliated WWW Sites: Atlantic Marine Assessment Program for Protected Species

References: None

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	BOEM Offshore Wind Energy Facility Emission Estimating Tool Version 3.0
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Jacob Wolf (Jacob.Wolf@boem.gov), Katsumi Keeler (Katsumi.Keeler@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2025
Final Report Due	September 30, 2024
Date Revised	November 04, 2022
Problem	EPA guidance from April 2022 indicates the current port emission inventories within the BOEM Offshore Wind Energy Facility Emission Estimating Tool version 2.0 are out of date. This potentially affects all wind energy development on the Outer Continental Shelf (OCS) which is supported by this tool.
Intervention	Updating the port emission inventories to the most recent EPA guidance will correct any erroneous calculations developed using previous port emission inventories. In addition, enhancements and improvements to the user interface (UI) will promote usage of this tool and provide consistency to analyses and submissions.
Comparison	With no updates to this tool, incorrect output will be generated with respect to the estimated emissions from ports used in the construction, operation and maintenance, and decommissioning of offshore wind facilities on the OCS. This will add time to the development of any submissions in which these emissions are necessary, as well as lead users away from this tool, and any other associated outputs generated within this tool.
Outcome	An updated tool will allow end users to correctly estimate emissions from ports expected to be used in the development of offshore wind energy on the OCS, have a more robust analysis of avoided emissions with the inclusion of a social cost of greenhouse gas calculation, and overall improvements to the UI will promote consistent use of this tool by the end user.
Context	All offshore wind planning areas.

BOEM Information Need(s): The current BOEM Offshore Wind Energy Facility Emission Estimating Tool version 2.0 (BOEM Wind Energy Tool) is out of date with respect to Port Emission Inventory guidance from the Environmental Protection Agency (EPA). This potentially affects all proponents of wind energy development on the OCS as their submissions require the estimation of emissions from activities related to the construction, operation and maintenance, and decommissioning of any proposed offshore wind development. For each of BOEM's regions with offshore wind activity (Atlantic, Pacific, and the Gulf of Mexico), this study will obtain emissions estimates for each phase of the lease: site characterization, site assessment, construction, operation, and decommissioning. These improved emissions estimates will better inform EAs and EISs that will be developed in the future in support of offshore wind leasing. The

public will be better informed because they will have reasonable estimates of project emissions and potential impacts on neighboring areas. Additionally, improvements to the user interface (UI) will promote the use of this tool among offshore wind energy developers and provide more consistency in their associated analyses within COP's and EIS's submitted to BOEM.

Background: EPA guidance from April 2022 (EPA-420-B-22-011) indicates the current port emission inventories within the BOEM Offshore Wind Energy Facility Emission Estimating Tool version 2.0 are out of date. Updating to the most recent EPA guidance will provide the end user with the most relevant port emission inventory data. This will allow the end user to more accurately calculate the total emissions, to and from the proposed ports, parse the amount of Federal Waters Emissions, State Waters Emissions, twenty-five mile emissions (typically used for the OCS air permit), the project's avoided lifetime emissions, and the net emissions. This information is used in the NEPA process to determine level of impacts of the project on the Air Quality Geographic Area of Analysis (AQ-GAA). Currently, this tool only supports the Atlantic region. Expanding this to cover the Gulf of Mexico and Pacific would increase its utility. Much of our current knowledge of Pacific offshore lease air impacts are derived from East Coast projects and documentation. The Pacific emissions may be quantitatively different. Possible reasons are stricter California air quality standards, the use of ultra-low sulfur marine diesel in California, and the use of floating (not fixed) infrastructure off the Pacific.

Objectives: Provide improved emissions calculations through updating the current emissions inventory calculator.

Methods: This project will develop and implement the following tasks while maintaining the 'stand-alone' nature of the tool such that the end user will be able use this tool with no other support files. Bi-Weekly (or other agreed upon frequency) meetings will provide updates and support budget tracking. User Acceptance Testing (UAT) will be required prior to completion by the developer.

- Update and expand the tool database:
    - Complete an update to the port emission inventories following EPA guidance (April 2022).
    - Expand the domain covered to include the Gulf of Mexico and the Pacific OCS areas.
        - Quantify air emissions that can be expected for all leasing activities by stage for four Pacific offshore wind areas.
        - Establish approvable methodologies for deriving this emissions information.
- Allow the administrator the ability to modify emissions as needed.
- Provide an updated users guide.
- Make needed modifications and additions to the UI, such as:
    - Inclusion of an AVoided Emissions and geneRation Tool (AVERT) region confirmation process if lease area does not relate to AVERT region.
    - Clarification and description of the various lease areas.
    - Addition of CO_2E as an output and include output calculations related to the Social Cost of Greenhouse Gasses (SCC-GHG) for each pollutant.
    - Addition of a 'quick-add' option for decommissioning estimates that duplicate construction estimates.

- Add interactive support within the application to further enhance the UI as needed, such as:
    - Development of an interactive map of ports, ship lanes, and airports to lease area.
    - Inclusion of a filter on the output that allows the user to further parse emissions by year.
    - Addition of a default number of vessels and trips.
    - Allow the end user to select vessel engine type.
    - Allow the end user to override default avoided emissions.

Specific Research Question(s):

- What air emissions are expected from offshore wind operations in the Pacific, Gulf of Mexico, and Atlantic?
- Are these air emissions significant?
- Are there potential mitigations for these air emissions?

Affiliated WWW Sites: N/A

References:

Transportation and Climate Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. 2022. Port emissions inventory guidance: methodologies for estimating port-related and goods movement mobile source emissions. 235 p. Report No.: EPA-420-B-22-011.

Chang R, Mendenhall S, Lamie C, Perez H, Billings R. 2021. User's guide for the offshore wind energy facilities emission estimating tool, version 2.0. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 32 p. Report No.: OCS Study BOEM 2021-046.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Improving Methods and Identifying Best Practices for Defining and Delineating Low-relief Hardbottom Essential Fish Habitat in Wind Energy Areas – Case Study in Carolina Long Bay
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Seth Theuerkauf (Seth.Theuerkauf@BOEM.gov), Brandon Jensen (Brandon.Jensen@BOEM.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2023–2025
Final Report Due	March 2025
Date Revised	March 31, 2023
Problem	Carolina Long Bay contains hardbottom Essential Fish Habitats (EFH) that are at risk of impacts from offshore wind development. The National Marine Fisheries Service (NMFS) Southeast Regional Office (SERO) has expressed specific concerns regarding possible presence of unidentified low- and high-relief habitats in this area. Current surveying and data analysis methods are limited in their ability to detect low-relief, often cryptic habitats that may be ecologically significant and pervasive throughout the lease area and transmission corridor.
Intervention	Review existing survey and assessment data for Carolina Long Bay to investigate ability to detect low-relief hardbottom habitats using new AI-based methods. Conduct new targeted hydrographic and ground-truthing surveys to rigorously map the distribution and type of hardbottom habitats in Carolina Bay, with broader methodological applicability to other regions with similar habitats.
Comparison	Prior ecological assessments at Carolina Long Bay provide critical data for initial interpretation of select hardbottom habitats in Carolina Long Bay, yet new field and data processing methods have since developed that could substantially improve our understanding of EFH within the lease areas. Refinement and application of these new methods will improve the ability to map habitats of concern within Carolina Long Bay in support of avoiding, minimizing impacts, and guiding mitigation measures to protect EFH.
Outcome	Improved habitat maps to inform EFH assessments, consultations, and permitting for Carolina Long Bay, as well as informing Marine Minerals Program (MMP) G&G Authorizations, leasing, and the National Offshore Sand Inventory. Improved methodology and guidelines to inform habitat mapping in support of other offshore wind (OSW) activities in the Atlantic and Gulf OCS.
Context	Carolina Long Bay, North Carolina, Atlantic OCS.

BOEM Information Need(s): NMFS has expressed concerns to BOEM regarding the presence of sand, low-relief 'pavement,' and high-relief hardbottom (e.g., ledges) Essential Fish Habitat (EFH) within the Carolina Long Bay lease areas and potential transmission corridors. While broad multibeam, sidescan, and limited direct visual data for certain high-relief hardbottom features exist within the lease areas from prior BOEM-supported work (Taylor et al. 2016), new field data is needed to pair with advanced

modeling methods that require refinement to delineate low-relief habitat features of management concern within the lease areas. Review of existing data as well as new predictive models and classified maps derived from this effort will be used to inform permitting decisions for Carolina Long Bay and provide recommendations that could be used to update BOEM guidelines on benthic habitat surveying (i.e., U.S. Department of Interior, 2019). This region is also a high priority to the Marine Minerals Program (MMP), where the sand need is considered substantially higher than the current supply (Taylor Engineering, Inc., 2020). The improved guidance on benthic habitat mapping that is an outcome of this study will allow for informed development of MMP sand resources and support the MMP's National Offshore Sand Inventory. The field and data processing methods developed in this study will be directly applicable towards upcoming survey work in Carolina Long Bay, and broadly applicable for future lease development activities in the South Atlantic, Gulf of Mexico, and US territorial regions that share similar marine habitats. Additionally, given overlap in NOAA researchers between this study and the Southeast Fishery Independent Survey (SEFIS, NMFS Southeast Fisheries Science Center), an opportunity exists to include additional sampling points within the Carolina Long Bay lease areas during the upcoming SEFIS survey at no additional cost to this project. These data will link economically and ecologically important species to the EFH present in the lease areas and will provide valuable insights for future EFH consultations for Carolina Long Bay.

Background: In June 2022, the Carolina Long Bay renewable energy leases (OCS-A 0545 and OCS-A 0546) were issued. Both lessees are currently developing survey plans to support their Site Assessment Plan and are planning broader surveying campaigns for subsequent years to support their Construction and Operations Plan. Beginning in 2014, NOAA NCCOS conducted extensive habitat mapping within the Carolina Long Bay lease areas–providing a strong foundation for understanding habitat interactions, particularly for high-relief hardbottom habitat. Since this study, NOAA NCCOS has continued to develop field and data processing methods that extend beyond high-relief hardbottom habitat towards cryptic, low-relief habitats that are likely present throughout the lease area and are of EFH concern. The new methods have been developed in coral reef and unconsolidated habitats and require deeper evaluation and refinement with ground-truthing to ensure their rigor for delineating a range of hardbottom EFH features found in Carolina Long Bay. An opportunity exists to strengthen and refine NOAA NCCOS' field and data processing methods towards broad scale implementation by the Carolina Long Bay lessees during survey campaigns in support of their Construction and Operations Plans. The outcome of this project will be new interpretive tools for delineation of a broad range of EFH, as well as a fish community assessment linking fish species with EFH within Carolina Long Bay to inform future EFH consultations. These tools and resources can be immediately applied towards the management needs of Carolina Long Bay but would also more broadly be applicable to other lease areas with similar habitat features (e.g., South Atlantic, Gulf of Mexico, and US Territory regions).

Objectives: Inform site assessment and permit review for construction and operations for development of the Carolina Long Bay renewable energy lease areas through the following:

1. Review and synthesize existing data on the distribution of hardbottom habitats, including high-relief habitats (e.g., ledges) and cryptic low-relief habitats (e.g., pavement); assess data gaps for ground-truthing habitat classifications.
2. Acquire new ground-truthing data to support expanded habitat maps focused on quantifying the distribution of a broad range of high- and low-relief hardbottom habitats in Carolina Long Bay. Collect fish community data through additional SEFIS sampling points within the Carolina Long Bay lease areas to support a fish community assessment that describe linkages between species and EFH.

3. Develop interpretive tools (e.g., data processing, visualization) and best practices (e.g., survey instrumentation and procedures) for how hardbottom habitat, and particularly low-relief hardbottom and pavement, are quantified, detected, and delineated to support OSW planning and permitting.

Methods: This project will be accomplished in three phases:

Phase 1 (Q3 FY23 - Q2 FY24): NCCOS will review previously collected sidescan and multibeam sonar data to evaluate the potential for detection and delineation of low-relief hardbottom. A gap analysis will determine requirements for additional multibeam hydrographic survey and ground-truthing data, as well as identify key areas for fish community data collection.

Phase 2 (Q3 FY24 - Q1 FY25): NOAA will conduct new hydrographic, ground-truthing, and fish community surveys in key areas of Carolina Long Bay identified in the review and gap analysis. NOAA research ships will conduct high-resolution multibeam and shallow sub-bottom sonar surveys to derive initial seabed habitat classification maps, followed by a rigorous benthic imaging and ground-truthing survey employing drop cameras and new micro-AUVs with camera payloads. Statistical and predictive models will be developed to define seabed habitat classes and validated with ground-truthing observations. Resolution of maps, level of detail in habitat classes, and prediction uncertainty will be assessed as part of the modeling. SEFIS survey vessels will collect fish community and visually-derived habitat data (i.e., drop cameras) at sampling points within the Carolina Long Bay lease areas.

Phase 3 (Q3 FY24 - Q1FY25): NOAA will produce interpretive geospatial data tools and best practices for remote sensing (e.g., multibeam sonar frequency, drop camera, micro-AUV, or ROV) and ground-truthing observations for delineating and quantifying hardbottom habitats to guide and inform requirements from government or lessee-led surveys for site assessments, design, and construction review processes. NOAA will also develop a fish community assessment that describes linkages between fish species and habitats within Carolina Long Bay to support future EFH consultations.

Specific Research Question(s):

1. What are the data requirements and appropriate modeling approaches to classify and quantify the distribution and types of hardbottom (e.g., low-relief) and EFH in offshore wind areas?
2. What are the best practices in sensor selection and survey design for assessing the spatial distribution of hardbottom habitats in the Carolina Long Bay lease areas?
3. What are linkages between EFH and fish communities within Carolina Long Bay lease areas?

Affiliated WWW Sites: N/A

References:

Taylor JC, Paxton AB, Voss CM, Sumners B, Buckel CA, Vander Pluym J, Ebert EB, Viehman TS, Fegley SR, Pickering EA, et al. 2016. Benthic habitat mapping and assessment in the Wilmington-East Wind Energy Call Area. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management and U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 149 p. OCS Study BOEM 2016-003 and NOAA Technical Memorandum 196.

Taylor Engineering, Inc. 2020. U.S. Army Corps of Engineers South Atlantic Division Sand Availability and Needs Determination (SAD SAND) Summary Report. Jacksonville (FL): U.S. Army Corps of Engineers. 256 p. Report No.: W912BU-15-D-0006.

U.S. Department of Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs (BOEM OREP). 2019. Guidelines for providing benthic habitat survey information for renewable energy development on the Atlantic Outer Continental Shelf pursuant to 30 CFR Part 585. 9 p.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Collecting Fishers' Ecological Knowledge (FEK) for Use in Gulf of Maine Offshore Wind Planning
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brandon Jensen (brandon.jensen@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	January 27, 2023
Problem	Fishers' Ecological Knowledge (FEK) provides a rich and untapped source of information that can be used to inform BOEM's decisions regarding offshore wind but has been underutilized.
Intervention	Collection of FEK with interviews, workshops, mapping, and other methods.
Comparison	FEK will enhance other forms of information collection about fishing activity.
Outcome	Spatial data and a study report will be expected as a minimum deliverable. With FEK, BOEM will be able to better understand important fisheries concerns and aid in the avoidance, minimization, and mitigation of impacts to fishermen.
Context	Gulf of Maine

BOEM Information Need(s): BOEM relies on existing information about the use of the ocean by fishers that is collected through monitoring such as vessel management system (VMS), vessel trip reporting (VTR), and automatic identification system (AIS) data. These methods do not capture all of the activity and often miss important fishing activities on the OCS. BOEM uses this information in the analysis of impacts to fishers and for appropriate mitigation measures. Fisher's Ecological Knowledge (FEK) is a type of traditional ecological knowledge that can be defined as "a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes et al. 2000). Researchers in the Gulf of Maine have acknowledged the importance of collecting FEK to fill in data gaps and to provide context to numerous fisheries population trends and habitat associations. An effort to collect, verify, and incorporate FEK in the Gulf of Maine will improve our information base and thus the decisions made by BOEM. This information will be applied to BOEM's spatial planning efforts to develop and manage lease areas in the Gulf of Maine.

Background: The Gulf of Maine is a complex ecosystem that forms the basis of a rich and dynamic fishing economy. While the region is extensively studied for fisheries management, there are many unknowns regarding these fisheries. Past efforts for collect FEK in the Gulf of Maine have provided some indications of the challenges and benefits to engaging these communities. St. Martin and Hall-Arber (2008) found that in their efforts to engage with the broad fishing community, individuals withheld fishing location information from each other and Federal resource managers to protect their interests.

In a more recent study, DeCelles et al. (2017) found that combining FEK and scientific studies improved the spatial and temporal resolution of information related to cod spawning activities on Georges Bank. The Gulf of Maine ecosystem is changing rapidly due to warming of the ocean that results in changing distributions of key marine species. With the development of offshore wind, there is a new need for updating fisheries information and collecting baseline data. A greater understanding of the marine ecosystem in the Gulf of Maine and the people who rely on it is needed to contextualize scientific data both spatially and temporally for an improved understanding of ocean use. A key aspect missing is the ecological knowledge gained by fishers who have been using this area for generations and recognize the changes that are occurring.

Information about past and current fishing grounds, using the changes that are occurring can help with predictions for the future. This is true not only for the areas fished, but for the socioeconomic dynamics in the region and the impacts to the way of life and economy of the region. Mapping of fishing grounds using FEK is one aspect important to understanding the ecosystem. This information can be used to understand where gear types are used as well as which ports. Historical use of fishing grounds and how they are changing can be captured.

Objectives: The objective of this study is to improve BOEM's understanding of the use of the Gulf of Maine for fishing and the importance of fishing to the regional economy through collection of FEK. BOEM would partner with the Responsible Offshore Science Alliance (ROSA) and potentially other interested organizations to conduct this study.

Methods: First, this study will identify local fishing communities willing to provide FEK. Next, these data and information efforts will require interviews and/or workshops to collect FEK. Participatory mapping of fishing grounds is one potential method to capture FEK. Importantly, clear methods for documenting, validating, and analyzing FEK must be established and executed. These data must be synthesized in an acceptable format (i.e., GIS and report documentation) to ensure the information can be incorporated into planning and resource management decisions. Provide guidance through workshops on navigating and interacting with available spatial data tools like Marine Cadastre or the Regional Ocean Portals (e.g., NROC). Provide regular updates to fishermen regarding the spatial planning process and data needs in the Gulf of Maine. This effort will also require considerations for data confidentiality to ensure that fishing community information collected for this study are not misused. This will be very important to instill confidence among fishers to accurately collect FEK.

Specific Research Question(s):

1. Where are the historical fishing grounds located in the Gulf of Maine based on FEK?
2. How have these fishing grounds changed over the past few decades?

Affiliated WWW Sites: N/A

References:

Berkes F, Colding J, Folke C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 10:1251–1262 .

DeCelles GR, Martins D, Zemeckis DR, Cadrin SX. 2017. Using fishermen's ecological knowledge to map Atlantic cod spawning grounds on Georges Bank. ICES Journal of Marine Science 74:1587–1601.

St. Martin K, Hall-Arber M. 2008. Creating a place for community in New England fisheries. Human Ecology Review 15(2):161–170.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Cumulative Air Quality Impacts Modeling Analysis
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Jacob Wolf (Jacob.Wolf@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2024–2025
Final Report Due	September 30, 2025
Date Revised	January 06, 2023
Problem	Cumulative air quality impacts could occur throughout the Atlantic Outer Continental Shelf (OCS). Current projects are analyzed at the individual level for impacts while accounting for the potential of overlapping projects at the regional level would lead to the development of a more robust and complete impact assessment.
Intervention	The development or utilization of a computerized system for predicting air quality by calculating the chemistry and physics of air pollutants as determined by pollutant emissions within the context of the background, natural air chemistry and predicted meteorology will provide a baseline of regional emissions. In addition, modifying the emissions inventory to account for cumulative construction and operation and management phases of multiple Atlantic OCS projects will provide the necessary potential impacts to the area.
Comparison	Running the air quality model with default emissions and then comparing it to the results of a duplicate run with an emissions scenario will allow the end user to determine the overall impact of proposed OCS project development with a focus on the 'worst case scenario,' which accounts for the most feasible simultaneous construction and operations and management of active lease areas.
Outcome	The predicted outcome of this study would provide a more complete picture of potential impacts to the East Coast and Atlantic OCS from multiple OCS projects in various stages of development.
Context	This study profile would cover the Atlantic OCS domain with boundary and initial conditions from regional NWP models.

BOEM Information Need(s): Cooperating agencies involved in the review of NEPA air quality analyses have expressed interest in the development of regional scale analyses of potential development scenarios and anticipated emissions of wind development on the Atlantic OCS. The development of these analyses will better inform decision-makers and provide for more strategic and sustainable development. Specifically, impacts of offshore renewable construction and operations and maintenance emissions will be assessed for non-attainment and Class I areas. This information will assist BOEM in the development and analysis of project specific EIS's as a part of the NEPA review process.

Background: There have been previous attempts to demonstrate the application and skill of the coupled WRF-CMAQ modeling system at fine scales, as well as to evaluate said model against high-quality meteorological and air quality observation datasets (Appel et al., 2014). This research provides a foundation for the utility of a coupled air quality model but lacks the possible impacts of an emissions scenario that accounts for the potential cumulative impacts of Atlantic OCS development. Defining the domain to include the Atlantic OCS and onshore areas in a unified domain will provide a consistent initial and boundary conditions to air quality dispersion models along with emission inventories which can then be modified to account for possible cumulative activities. Further expanding this to include Pacific and Gulf of Mexico domains would assist in accomplishing BOEM DEIS reviews in the associated regions.

Objectives: The objective of this study is to provide a more complete picture of potential impacts to the East Coast and Atlantic OCS from multiple OCS projects in various stages of development.

Methods: This study will be to first run a regional air quality model over a defined period with background emissions and compare that output to that of the air quality model with an emissions scenario that encompass the actions of Atlantic OCS development, operations and maintenance, and decommissioning and their associated vessel emissions related to those actions. Of particular interest will be the 'worst case scenario' in which the realistically feasible simultaneous construction activities are evaluated across the Atlantic. Parsing of the emissions between state waters, the OCS lease area, and background emission sources will inform decision-makers to provide for more strategic and sustainable development.

This project will utilize either a stand-alone or coupled air quality modeling system with key components including a numerical weather prediction model, a meteorology-chemistry interface processer, an emissions inventory data in a model ready format, and an air quality model resolved in space and time. A baseline condition will be calculated and then evaluated to the output of an emissions scenario that encompasses proposed projects along the Atlantic OCS in various stages of construction, operation and maintenance, and decommissioning. The development of the 'worst case' emissions scenario of feasible construction and operations and maintenance activities will allow for the greatest level of impacts to be evaluated. This analysis will provide context to the potential emissions and impacts from these activities.

Specific Research Question(s)

1. How do cumulative air emissions from BOEM activities affect onshore areas, including non-attainment and Class I areas?
2. Are current impact level definitions appropriate in a cumulative framework and if not, what would be representative?
3. What are the impacts from wind wake parameterization in downstream pollutant transport?

Affiliated WWW Sites: https://www.epa.gov/cmaq/evaluation-cmaq-applications-neighborhood-scales#2011DISCOVER

References:

Appel KW, Gilliam RC, Pleim JE, Pouliot G, Wong DC, Roselle SJ, Mathur R. 2014. Improvements to the WRF-CMAQ modeling system for fine-scale air quality applications to the DISCOVER-AQ Baltimore/Washington D.C. campaign. EM: Air and Waste Management Associations Magazine for Environmental Managers. September 2014:16–21.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Ocean Environmental Monitoring and Sound Propagation Study at Mid-Atlantic Shelfbreak Offshore Wind Area
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Shane Guan (shane.guan@boem.gov), Mary Boatman (mary.boatman@boem.gov), Tom Kilpatrick (Thomas.kilpatrick@boem.gov)
Procurement Type(s)	Cooperative Agreement (Competitive)
Performance Period	FY 2024–2028
Final Report Due	TBD
Date Revised	February 8, 2023
Problem	Environmental assessments on offshore renewable energy development require accurate modeling and effective monitoring. Neither traditional sound propagation modeling nor existing acoustic monitoring address broader issues such as ecological dynamics and oceanographic processes related to offshore wind development.
Intervention	Undertake comprehensive analyses incorporating real-time physical oceanographic variables into active and passive acoustic datasets collected *in situ*, in addition to on site propagation measurements.
Comparison	The proposed study will deploy active and passive acoustic sensors in the vicinity of the National Science Foundation's Pioneer Array ocean observation platform to collect active and passive acoustic datasets and to conduct sound propagation measurements.
Outcome	Improve understanding of the sub-mesoscale and mesoscale oceanographic processes and changes in relation to offshore wind planning and development at the mid-Atlantic shelfbreak region. Validate regional sound propagation models.
Context	Atlantic seaboard offshore wind development area.

BOEM Information Need(s): To manage development of the U.S. Outer Continental Shelf (OCS) energy and mineral resources in an environmentally responsible way requires the Bureau of Ocean Energy Management (BOEM) to have the best scientific information to conduct accurate modeling and effective monitoring for environmental impact assessment. However, due to the large spatial and temporal scales of the affected area and the ever-changing environment, comprehensive impact assessments that address long-term ecosystem level effects can be extremely challenging. Traditional sound propagation modeling for noise effect analysis often uses historical environmental variables that may not reflect oceanographic regime shifts due to climate change, which could result in less accurate predictions of impact zones. Additionally, most existing acoustic monitoring only evaluates species calls and signal/noise characteristics collected at the recording sites without incorporating oceanographic variables. This makes it challenging to address broader issues such as ecological dynamics and oceanographic processes related to offshore wind planning and development (e.g., Bergström et al. 2014).

Background: The National Science Foundation (NSF) funds and maintains a coastal ocean observation system called Pioneer Array through its Ocean Observatories Initiative (OOI; Gawarkiewicz et al. 2018; Gawarkiewicz and Plueddemann 2020). Currently deployed at the edge of the continental shelf south of New England, the Pioneer Array is designed to study shelfbreak processes and shelf-deep ocean exchange. As the primary scientific objectives of the Pioneer Array are to study shelfbreak exchange processes, instruments currently equipped to the Array are designed to measure physical and chemical oceanographic and meteorological parameters.

In 2024, NSF plans to relocate the Pioneer Array to the mid-Atlantic shelfbreak between Virginia and North Carolina. The proposed new location is in proximity (~20 km) of the planned Kitty Hawk Wind Farm and CVOW, and also an important migratory corridor for the North Atlantic right whales (NARW; Salisbury et al. 2015). The timing of the Pioneer Array relocation will likely allow for 6-12 months of baseline monitoring in 2024 before wind farm construction begins. NSF has indicated that it would provide a good opportunity to deploy acoustic sensors along with the Pioneer Array to address potential environmental effects from offshore wind development in the area.

Specifically, this study will deploy and collect time series data from bottom-mounted and/or moored active and passive acoustic recorders at the Pioneer Array location for long-term environmental monitoring. Limited acoustic datasets will be transmitted via Pioneer Array's satellite telemetry system real-time and made available for the public. In addition, low-intensity (<160 dB re 1 µPa) low-frequency (<2 kHz) source (e.g., Lubell) will be deployed on the Array and be used intermittently to study propagation conditions at the mid-Atlantic shelfbreak region.

In addition, real-time passive acoustic data will be used to alert on the potential occurrence of unusual oceanographic events so that appropriate actions can be taken to investigate them (e.g., changes in soundscape characteristics due to increased mixing). These detections can also be used to inform regulators on the presence of endangered species (e.g., NARW) for mitigation measures. Detailed long-term acoustic time series in combination with propagation measurements have been successfully used to study ocean climate changes (Munk et al. 1995; Worcester et al. 2005) and to investigate sub-mesoscale and mesoscale oceanographic processes such as stratification and circulation in the Arctic (e.g., Sagen et al. 2017; review by Worcester et al. 2020; Worcester and Ballard 2021). Similar approaches can be applied to gain understanding on the dynamics of the Gulf Stream as it is undergoing some remarkable changes in the past decade or so (Seidov et al. 2019; Boers 2021). Some of the oceanographic changes are suspected to cause adverse consequences in the ontogeny, migration, and distribution of several ecologically and commercially important species (e.g., Fuchs et al. 2020). The results of the proposed study will shed light on the linkage between the oceanographic processes and ecosystem dynamics in relation to offshore wind development at the mid-Atlantic shelfbreak.

Additionally, dedicated sound propagation study using low-intensity low-frequency active source(s) and built-in transponders on the Pioneer Array will provide validations to existing propagation models such as those established by RODEO (Lin et al. 2017). Results from the propagation study along with newly collected oceanographic parameters will also serve as references for future models by BOEM's Center for Marine Acoustics for impact prediction.

Finally, active and passive datasets from this study will be fed into BOEM's broader Atlantic regional PAM network to investigate diurnal, seasonal, and annual occurrence and abundance of planktons, fishes, and marine mammals near offshore wind farm areas. The results will be used to provide critical

information to BOEM regarding the potential long-term environmental effects from offshore wind development.

Objectives: The proposed study will achieve the following objectives.

- Gain knowledge on the ecosystem dynamics and sub-mesoscale and mesoscale oceanographic processes from acoustic observations by incorporating physical and chemical variabilities collected at the study site for offshore wind development impact modeling and assessment.
- Gain knowledge on general sound propagation conditions in the study area; and provide validation and references to existing propagation models and future modeling efforts, respectively.
- Gain knowledge on the presence, distribution, and potential changes in habitat use of planktons, fishes, and marine mammals, as well as the dynamics of marine soundscape (geophony, biophony, and anthrophony) in relation to offshore wind development at the Kitty Hawk and CVOW sites for impact assessment.

Methods: The proposed study would deploy active and passive acoustic arrays in the vicinity of the NSF's OOI Pioneer Array ocean observing system to conduct long-term environmental monitoring. Acoustic time series data collected will be used to investigate the presence and distribution of marine organism over the monitoring period. The temporal species occurrence will be studied along with oceanographic variables to understand the ecosystem variations at the study area. The proposed study would also deploy low-intensity active acoustic sensor(s) in the area to conduct acoustic propagation study. Acoustic datasets will be analyzed in conjunction with physical oceanographic variables collect in situ to gain understanding of sub-mesoscale and mesoscale oceanographic processes at the mid-Atlantic shelfbreak offshore wind development area.

Specific Research Question(s): The specific research questions are listed below.

1. What are the variations of the oceanographic processes such as stratification, mixing, circulation, and temperature variation in the study area derived from acoustic datasets and sound propagation measurements conducted over the study period?
2. What are the soundscape characteristics and dynamics at the study area, and how do the changes in soundscape and marine life presence, abundance, distribution, and/or habitat use relate to oceanographic parameters over the monitoring period?
3. What are the general sound propagation conditions in the study area and how do the measurements differ from existing model?
4. Are sounds produced during the construction or operations phase of the two nearby windfarms detectable on the Pioneer array? If so, what are the SNR in terms of ambient noise level and oceanographic conditions?
5. Are there any changes in plankton, fish, and marine mammal presence, distribution, and/or habitat use associated with offshore wind development in the shelfbreak region of the mid-Atlantic area as derived from active and passive acoustic datasets?

Affiliated WWW Sites: OOI Pioneer Array: https://oceanobservatories.org/array/coastal-pioneer-array/

References:

Bergström L, Kautsky L, Malm T, Rosenberg R, Wahlberg M, Capetillo NÅ, Wilhelmsson D. 2014. Effects of offshore wind farms on marine wildlife – A generalized impact assessment. Environ. Res. 9, 034012.

Fuchs HL, Chant RJ, Hunter EJ, Curchitser EN, Gerbi GP, Chen EY. 2020. Wrong-way migrations of benthic species driven by ocean warming and larval transport, Nature Climate Change. 10:1052–1056.

Gawarkiewicz G, Plueddemann AJ. 2020. Scientific rationale and conceptual design of a process-oriented shelfbreak observatory: The OOI Pioneer Array. Journal of Operational Oceanography. 13:19–36. doi:10.1080/1755876X.2019.1679609.

Gawarkiewicz G, Todd RE, Zhang W, Partida J, Gangopadhyay A, Monim M-U-H, Fratantoni P, Mercer AM, Dent M. 2018. The changing nature of shelf-break exchange revealed by the OOI Pioneer Array. Oceanography. 31(1):60–70.

Lin Y-T, Newhall AE, Miller JH, Potty GR, Vigness-Raposa KJ. 2019. A three-dimensional underwater sound propagation model for offshore wind farm noise prediction. JASA Express Letters. 145:EL335–EL340. doi:10.1121/1.5099560.

Munk WH, Worcester PF, Wunsch C. 1995. Ocean Acoustic Tomography. Cambridge University Press, Cambridge, UK.

Sagen H, Worcester PF, Dzieciuch MA, Geyer F, Sandven S, Babiker M, Beszczynska-Möller A, Dushaw BD, Cornuelle B. 2017. Resolution, identification, and stability of broadband acoustic arrivals in Fram Strait. The Journal of the Acoustical Society of America. 141, 2055–2068. doi:10.1121/1.4978780.

Salisbury DP, Clark CW, Rice AN. 2016. Right whale occurrence in the coastal waters of Virginia, U.S.A.: Endangered species presence in a rapidly developing energy market. Marine Mammal Science. 32:508–519. doi:10.1111/mms.12276.

Seidov D, Mishonov A, Reagan J, Parsons R. 2019. Resilience of the Gulf Stream path on decadal and longer timescales. Scientific Reports. 9:11549. doi:10.1038/s41598-019-48011-9

Worcester PF, Dzieciuch MA, Sagen H. 2020. Ocean acoustics in the rapidly changing Arctic. Acoustics Today. 16(1), 55–64.

Worcester PF, Munk WH, Spindel RC. 2005. Acoustic remote sensing of ocean gyres. Acoustics Today. 1(1), 11–17.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
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 2024–2026
Final Report Due	TBD
Date Revised	March 6, 2023
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. 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 the 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 (UKDB 2020); 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
- Explore how wind turbine arrays affect views of the rising sun and how these effects could be avoided

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?

Affiliated WWW Sites: N/A

References:

Firestone J, Kempton W, Lilley MB, Samoteskul K. 2012. Public acceptance of offshore wind power across regions and through time, Journal of Environmental Planning and Management. 55(10):1369–1386. http://dx.doi.org/10.1080/09640568.2012.682782

May R, Nygård T, Falkdalen U, Åström J, Hamre Ø, Stokke BG. 2020. Paint it black: efficacy of increased wind-turbine rotor blade visibility to reduce avian fatalities. Ecology and Evolution 10:8927–8935. doi.org/10.1002/ece3.6592.

[UKDB] U.K. Department for Business, Energy and Industrial Strategy's Offshore Energy Strategic Environmental Assessment Programme. 2020. Offshore energy strategic environmental assessment: review and update of seascape and visual buffer study for offshore wind farms. White Consultants, Northumbria University.

[USDOI] United States Department of the Interior. 2013. Best management practices for reducing visual impacts of renewable energy facilities on BLM-administered lands. Cheyenne (WY): Department of the Interior, Bureau of Land Management. 342 p.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Baseline Characterization of Communities on Sand Shoals and Nearby Habitats in the Gulf of Mexico
Administered by	Marine Minerals Program
BOEM Contact(s)	Brian Cameron (Brian.Cameronjr@boem.gov); Barton Rogers (Barton.rogers@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	March 24, 2023
Problem	BOEM needs to better understand the relationships of marine species utilizing sand shoals as compared to nearby non-shoal habitat in the GOM. Sand shoals are targeted as locations to dredge for coastal restoration projects. More information on baseline communities of sand shoal habitats, including species preferences (both biotic and abiotic) and food web interactions, is needed to understand their ecological value and the effects of dredging.
Intervention	Characterize the communities (both nekton and benthos) present on sand shoal habitats, dredged areas on shoals, and non-shoal areas by examining metrics such as species composition, abundance, richness, diversity, food web interactions, etc., to better understand the effects of dredging on sand shoals.
Comparison	Compare the ecological communities present and their food web dynamics on multiple sand shoals, dredged shoal areas, and the surrounding non-shoal areas to provide a comprehensive understanding of the role sand shoals play in across these habitats and communities.
Outcome	The results of this study would provide valuable baseline data on sand shoal ecosystems and species interactions in the northern GOM that could be used to improve existing mitigation strategies designed to reduce the effects of dredging on marine resources, including protected species.
Context	GOM predominantly but this information could be applied across the OCS for marine minerals and renewable energy activities.

BOEM Information Need(s): This study will provide information to support analysis of affected resources, monitoring, cumulative effects, and compliance for dredging in the Outer Continental Shelf (OCS). This study will characterize the communities present on sand shoal habitats, dredged areas on shoals, and non-shoal habitats. This study will examine the food web dynamics in these three habitat types and then comparing those against each other, to help understand how the communities on sand shoals may be affected by dredging. Studies suggest that the sand shoals provide specific habitat for many nekton and benthic species (Nelson et al., ongoing; Xue et al., ongoing; Pickens and Taylor, 2020). This study will examine the abundance and food web interactions in shoal, dredged shoal, and non-shoal habitats to improve BOEM's understanding of the value of shoals and the effects of dredging on shoals. The information gathered through this study will inform BOEM's decision making regarding the issuance

of sediment leases and mitigation measures. This information will provide data for BOEM's NEPA requirements and Section 7 consultations for sediment dredging and the eventual installation of renewable energy structures.

Background: BOEM has responsibility for overseeing non-energy mineral exploration, leasing, and production. Sand shoals are a primary area for dredging to restore areas along the GOM coast. There is a high demand for sediment to support coastal resiliency, specifically there is an identified need for over 200 million cubic yards (mcy) of offshore sediment for Texas, as well as an ever-increasing need off the coasts of Louisiana, Mississippi, Alabama, and Florida. As the nation's sole steward of these finite, public resources, it is imperative that BOEM understands these resources so that they can be most effectively managed. This proposed study would extend BOEM's knowledge beyond current ongoing studies that are evaluating the ecological recovery after dredging on Ship Shoal (Nelson et al. ongoing) and non-linear sedimentation of dredged areas (Xue et al. ongoing). Early results indicate that the benthos and productivity are altered by dredging, at least up to a year post dredging (Nelson et al. ongoing). It is anticipated that the benthos may recover to a new equilibrium in 2-4 years past dredging (Newel and Seiederer, 1998; Newel and Seiderer et al., 2003). This study would build upon this information, particularly comparing the shoal to the nearby non-shoal habitat and comparing inter-shoal variability. It is known that certain species spend lots of time on or around shoals, the relationship is not fully understood. For example, sea turtle data from U.S. Geological Survey (USGS) (Hart et al., 2020) suggest sea turtles forage in the NW GOM sand shoal areas, from Heald Bank to Ship Shoal. Gelpi et al. (2009) and Condrey and Gelpi (2009) observed abundances of female blue crabs actively spawning, hatching their eggs, and foraging in federal waters within the Ship, Trinity, Tiger Shoal Complex off the Louisiana coast. It has been hypothesized that an abundance of blue crabs may be related to this site fidelity of sea turtles. However, predator-prey relationships between sea turtles and blue crabs have not been confirmed on sand shoals and this study would further investigate and characterize this potential relationship. This study would also allow data collection to support the study recently completed by BOEM and the National Marine Fisheries Service for the creation of shoalMATE (Pickens and Taylor, 2020). ShoalMATE is a software developed to help evaluate project footprints for Essential Fish Habitat. BOEM needs to understand all major predator-prey relationships on shoals, dredged areas, and non-shoal habitat.

Data from previous sand shoal studies focused on understanding the habitat value and function of shoal/ridge/trough complexes could be useful to determine likely dominant predators such as sharks and other fishes (Normandeau Associates, Inc., 2014; Nelson et al., Ongoing). Current studies focusing on the ecological function and recovery of biological communities within sand shoal habitats, within the Gulf of Mexico, could provide additional data and analysis of species within Ship Shoal (Nelson et al., ongoing). Literature research should be conducted to determine diet of many important species, such as Seney (2016) on the diet of the Kemp's Ridley sea turtles and Molter et al. (2022) on the diet of Loggerhead sea turtles.

Objectives: The major objectives are to:

1. Conduct an existing data review of common nekton and benthos abundance and predator-prey relationship data within the Ship Shoal, Trinity Shoal, and Sabine/Heald Banks areas.
2. Collect abundance information for abundance nekton and benthos found in shoals, dredge shoal areas, and surrounding non-shoal habitat in the NW GOM.
3. Examine the food web dynamics among these abundant species to determine the predatory-prey relationships between these three habitats.

4. Determine if there is any correlation of the in abundance or predator-prey relationship by physical aspects, such as dissolved oxygen, water temperature, grain size, sedimentation, etc.

Methods: This study will advance our understanding of the relationship between species that occur on shoals, dredge shoal areas, and surrounding non-shoal habitat. A data review should be conducted that will provide BOEM with some initial background data and gap analysis with Ship Shoal, Trinity Shoal, and Sabine/Heald banks. Species abundance and predator-prey relationships for the more abundant taxa should be assessed for shoals, dredge shoal areas, and surrounding non-shoal habitat. The sampling design should allow for a strong statistical evaluation of shoal, dredged shoal, and non-shoal habitats, with adequate replication. Multiple shoals should be sampled, such as Trinity, Ship and Heald Bank, to see if there is any variation in abundance and food web dynamics among shoals and banks listed above. The presence and abundance of species could be assessed with traditional methods such as trawls, longlines, crab traps, benthic cores, grab samples, etc. These new data could be compared to that from previous studies to determine any trends or comparisons between these three habitats. The new data could be compared to trends or patterns observed through other sources such as the Ocean Biodiversity Information System (OBIS), Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPS), USGS, ShoalMATE, etc. Environmental parameters should be sampled and then taken into consideration when comparing communities at the three different habitats. The fluid mud model being developed by Xue et al. (ongoing) could be integrated to see if any abundances or trophic relationships vary due the fluid muds. Cost effective techniques and new technology should be considered such as isotopes, telemetry, high-resolution sonar, video, long-term continuous environmental instruments, etc.

Specific Research Question(s):

1. How does the abundance and predator-prey relationship of common nekton and benthic species compare from shoal, dredged shoal, and non-shoal habitats as well as between shoals?
2. Is there any correlation with shoal characteristics and environmental parameters with species abundance and predatory-prey relationships compared between shoal, dredged shoal, and non-shoal habitats?

Affiliated WWW Sites: N/A

References:

Gelpi Jr. CG, Condrey RE, Fleeger JW, Dubois SF. 2009. Blue Crab, Callinectes sapidus, spawning, hatching, and foraging grounds in Federal (US) waters offshore of Louisiana. Bulletin of Marine Science – Miami – November 2009.

Condrey RE, Gelpi CG. 2010. Blue Crab (*Callinectes sapidus*) use of the Ship/Trinity/Tiger Shoal Complex as a nationally important spawning/hatching/foraging ground; discovery, evaluation, and sand mining recommendations based on blue crab, shrimp, and spotted seatrout findings. Coastal Marine Institute. OCS Study MMS 2009-043.

Hart KM, Iverson AR, Bucklin DN, and Rubio C. 2020. Predicting multi-species foraging hotspots for marine turtles in the Gulf of Mexico. Endangered Species Research 43:253-266.

Molter CM, Norton TM, Hoopes LA, Nelson SE Jr, Kaylor M, Hupp A, Thomas R, Kemler E, Kass PH, Arendt MD, et al. 2022. Health and nutrition of loggerhead sea turtles (Caretta caretta) in the southeastern United States. J Anim Physiol Anim Nutr (Berl). 106(1):205–219. Doi: 10.1111/jpn.13575. Epub 2021 Jun 13. PMID: 34120377.

Nelson J, Xu K, Roberts B, Rieucau G, Johnson DS, Valladares J. Ongoing. Ecological function and recovery of biological communities within sand shoal habitats within the Gulf of Mexico. BOEM Cooperative Agreement M19AC00015.

Normandeau Associates, Inc. 2014. Understanding the habitat value and function of shoal/ridge/trough complexes to fish and fisheries on the Atlantic and Gulf of Mexico Outer Continental Shelf. Draft literature synthesis for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M12PS00031. 116 p.

Pickens BA, Taylor JC. 2020. Regional essential fish habitat geospatial assessment and framework for offshore sand features. NOAA Technical Memorandum NOS NCCOS 270 and BOEM OCS Study 2020-002. Beaufort, NC. 367 pp. doi:10.25923/akzd-8556.

Seney EE. 2016. Diet of Kemp's ridley sea turtles incidentally caught on recreational fishing gear in the northwestern Gulf of Mexico. Chelonian Conservation and Biology. 15(1):132–137.

Xue ZG, Xu K, Maiti K, Glaspie C. Ongoing. Impact of non-linear sedimentation on dredge area benthic ecosystem on the Louisiana Shelf. M20AC10001.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Coastal Marine and Ecological Classification Standard Application: Offshore Energy and Minerals Development
Administered by	Marine Minerals Program
BOEM Contact(s)	Lora Turner (lora.turner@boem.gov), Brandon Jensen (brandon.jensen@boem.gov), Kerby Dobbs (kerby.dobbs@boem.gov), Paul Knorr (paul.knorr@boem.gov), Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	March 20, 2023
Problem	The Coastal and Marine Ecological Classification Standard (CMECS) provides a system for seafloor characterization, comprising 1) a collection of defined habitat units for standardized data classification, and 2) a framework for synthesizing this information. An improved methodology or workflow for applying CMECS to survey data that is tailored to BOEM requirements is needed to overcome complex inconsistencies in data interpretation when classifying and categorizing habitats for offshore wind and offshore dredging environmental consultations.
Intervention	Develop BOEM seafloor characterization protocols (guidance) that incorporate the CMECS's substrate and geoform habitat units that are relevant to energy and mineral site characterization that will allow BOEM and its stakeholders to interpret survey data consistently across study areas and temporal intervals and provide standardized characterization of the seafloor.
Comparison	N/A
Outcome	Enhanced existing and/or new CMECS - based seafloor classification protocols that allow BOEM and its stakeholders to meet the requirements of consultations with consistent and standardized characterization for our impact assessments in turns aids decisions on future site for wind and dredging events. These may include documents identifying relevant habitat units; specific methods analysis; decision-based workflows; an image gallery with examples of CMECS classifications. This project will also consult with stakeholders/contractors to co-produce resources that will be useful to them.
Context	Atlantic, Pacific, Gulf of Mexico, and Alaska Outer Continental Shelf waters.

BOEM Information Need(s): BOEM, other federal agencies, and their stakeholders are responsible for developing impact analyses of offshore activities, such as wind energy development, mineral extraction, and dredging. To develop these impact analyses, BOEM needs standardized characterizations of the seafloor that describe benthic habitat consistently across all sites and temporal intervals. BOEM and its stakeholder need the results of site characterization in a consistent description to evaluate the impact of proposed activities on physical, biological, and socioeconomic resources as well as seafloor and

subseafloor settings which could be affected by activities such as infrastructure construction and dredging.

Background: Consistent, characterized, and usable descriptors for offshore resource communities are not a new concept. The CMECS enhances scientific understanding, advances ecosystem-based and place-based resource management and safeguards coastal communities.[1] The purpose of habitat classification is "to provide a language through which data and information regarding habitats can be communicated and managed" (McDougal et al. 2007). In 2021, the White House-approved National Ocean Mapping, Exploration, and Characterization Strategy Implementation Plan Objectives 2.1 (Standard Ocean Mapping Protocol) and 3.2 (Exploration and Characterization Standards and Protocols) further highlight the importance of making data usable and the need for guides to facilitate application.[2]

Presently, during some environmental consultations between BOEM and outside agencies, the lack of a consistent language to analyze habitats frequently leads to confusion and time-consuming miscommunication. Furthermore, too often habitat areas are characterized in multiple ways and when communities are not using the same metrics it lends to a pervasive problem of not being able to communicate in a shared language on the amount and quality of habitat. Adequate site-specific habitat information is needed to inform environmental consultations.

Objectives:

- Establish and codify primary substrate and bedform variable descriptors in a classification framework for offshore energy and mineral site characterization. This classification scheme will supplement CMECS in areas where the substrate component does not present the necessary level of description for offshore energy and mineral site characterization.
- Develop documents identifying relevant habitat units, decision-based workflows, and an image gallery with examples of CMECS classifications. These documents will assist in bridging habitat mapping standards, to classify and categorize habitats, in order to inform offshore wind and offshore dredging environmental consultations with consistent and standardized characterizations.

Advance outcomes, such as:

- A documented new protocol and/or advancement of existing protocols, guidelines and standards is needed in the near-term to increase efficiencies and change status quo in survey mapping and characterization.[3]
- Data submissions with consistent description application would transform the data deliverable review process and enable data serviceability.

Methods:

- Convene and facilitate a workshop with key stakeholders (e.g., NOAA, USGS, NPS, State, EPA, GARFO, Academia, NGO, National Ocean Mapping, Exploration, and Characterization Interagency Working Groups, and Developers) to 1) identify and bound issues with data

[1] https://www.ncei.noaa.gov/products/coastal-marine-ecological-classification-standard
[2] https://www.noaa.gov/sites/default/files/2021-11/210107-FINALNOMECImplementationPlan-Clean.pdf
[3] https://iocm.noaa.gov/standards/cmecs-home.html

interpretation and mapping for Essential Fish Habitat and 2) gather recommendations for the development of protocols and guidance resources.

- Identify study areas that include offshore energy and mineral sites in the Atlantic, Gulf of Mexico, Pacific and/or Alaska as reference sites.
- Describe the substrate environment in a consistent and repeatable way with NOAA National Marine Fisheries consultations and the broader coastal communities improves discussions and analysis of potential environmental risk discussed.
- Use the existing source data and derived data products for those sites.
- Utilize CMECS as the classification framework and review below references and other existing classification systems information relevant to this system to supplement as needed. For example, species taxonomy or substrate mineralogy, which are not included in CMECS?
- Identify variables to characterize wind energy and marine minerals sites. Establish a substrate classification scheme structure for offshore wind energy and marine mineral site planning and activities.
- Apply the substrate and offshore sand feature classification scheme within an energy and mineral site.
- Provide products: 1) visual aids such as decision trees when working within CMECS; 2) a written or graphic aid (such as a sheet of notes) that can be referred to for help in understanding CMECS application (primary audience developers, scientists' interpreters) to ease the complexity with examples of using substrate variable descriptors (modifiers); 3) map products; 4) a web application (preferably in ArcGIS Online); and 5) a hierarchical diagram of CMECS scheme for substrate component associated with offshore energy and mineral activities
- Verify, validate, and document.

Specific Research Question(s):

1. What are the primary substrate variable descriptors needed to adequately characterize a habitat within an energy and mineral site to inform National Environmental Policy Act analyses?
2. What are the minimal protocols? What are the scientific and engineering setting/cross walk within the CMECS substrate component needed to ensure consistent information for consultation use and assessment?
3. Which scale (e.g., 1:24k, 1:100k, etc.) should features/sediment bodies be mapped to sufficiently meet the needs of an Essential Fish Habitat consultation? Are different scales appropriate for different types of consultation/applications?
4. What data types to be realized?

Affiliated WWW Sites: N/A

References:

McDougall PT, Janowicz M, Franks Taylor R. 2007. Habitat classification in the Gulf of Maine: a review of schemes and a discussion of related regional issues. Gulf of Maine Council on the Marine Environment. 15p. http://www.gulfofmaine.org/habitatclassification/Habitat-Classification-in-the-Gulf-of-Maine-12-19-07.pdf

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Field	Study Information
Title	Developing a Critical Minerals Environmental Assessment Framework (CMEAF) for Critical Minerals Activities
Administered by	Marine Minerals Program
BOEM Contact(s)	Paul O. Knorr (paul.knorr@boem.gov), Shannon Cofield (shannon.cofield@boem.gov), Daniel Lasco (daniel.lasco@boem.gov), Jennifer Le (jennifer.le@boem.gov), Mark Leung (mark.leung@boem.gov), Mark Mueller (mark.mueller@boem.gov), Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	February 10, 2023
Problem	The Outer Continental Shelf (OCS) contains many of the critical mineral (CM) resources needed to supply the domestic and global alignment towards increased green energy sources. BOEM needs to expand its environmental framework for managing the development of CM resources.
Intervention	BOEM will engage researchers through the National Academies of Sciences, Engineering, and Medicine (NASEM) to develop a comprehensive framework to oversee CM activities.
Comparison	This study will assist BOEM in the development of robust NEPA-compliant environmental analyses for a new line of activity with few existing analogues.
Outcome	This study will provide essential information for environmental analysts when evaluating exploratory prospecting requests, lease sale requests, lease sales, and monitoring of extractive activities.
Context	All OCS areas that may contain critical mineral resources, including the Extended Continental Shelf.

BOEM Information Need(s): Information needed by analysts related to the habitats where critical minerals (CM) occur (e.g., baseline conditions of the surrounding environment, relevant parameters, potential impacts of exploration and recovery activities, and mitigation options) is sparse. Documentation of prospecting, extraction, monitoring, and mitigation methods, data, and references are found in scientific journals, governmental publications, and industry literature. In the event of an unsolicited request for a lease sale (30 CFR 581.11), BOEM has the obligation to inform the applicant within 45 days whether the steps leading to a lease sale will be initiated. BOEM staff need recent, focused, and reliable references and guidelines to expeditiously evaluate the initial request as well as the continuous in-depth environmental analyses following the initial 45-day request response period. This project will develop a Critical Minerals Environmental Analyses Framework (CMEAF), consisting of identifying references, guidelines, and baseline data needs necessary for effective stewardship of OCS resources and environments. In the longer term, BOEM also needs to identify and prioritize information needs that can be addressed by future CM studies.

Background: The U.S. is lagging other nations in domestic CM planning and investments, including scientific research on CM in the U.S. Exclusive Economic Zone (EEZ). The International Seabed Authority (ISA) has jurisdiction over deep sea mining in international waters and has issued 31 contracts for exploration and exploitation of deep-sea minerals, primarily polymetallic nodules in the Clarion-Clipperton Fracture Zone (CCZ), which covers about 1,700,000 square miles between Hawaii and Mexico (Sharma, 2017). Although work related to environmental assessment and baseline data collection has been performed internationally, those analyses do not conform with or fulfil the requirements of environmental analyses performed in the U.S. under the National Environmental Policy Act (NEPA) and the ecosystem of associated laws and regulations. A series of recent Executive Orders (i.e., EO 13817, EO 13953, EO 14017) recognize this issue and direct federal agencies to take actions to bolster development of domestic CM resources. BOEM's Marine Minerals Program (MMP) has a series of rules regulating competitive mineral prospecting (30 CFR 580), leasing (30 CFR 581), and operations (30 CFR 582).

Critical minerals are found as polymetallic nodules ("nodules") on abyssal plains, ferromanganese crusts ("crusts") on the flanks of seamounts, seafloor massive sulphides (SMS) associated with hydrothermal vents (e.g., "black smokers"), phosphorites, and nearshore placer deposits ("placers"). Nodules, which contain manganese, cobalt, nickel, and other minerals, accrete on the abyssal seabed, have attracted the most interest from industry and will likely be the first type of deep-sea mineral to be mined (Mizell et al., 2022). Nodule recovery is expected to have fewer environmental impacts compared to mining crusts and SMS deposits and is the primary, but not exclusive, focus of this study's efforts.

During 2021 BOEM received inquiries about Bureau regulations governing CM leasing and the type of environmental information needed to support such decisions in the BOEM regions. In 2022, the Inflation Reduction Act expanded some aspects of BOEM's oversight to include portions of the territorial EEZ where nodules are thought to occur. In light of potential impending requests to develop OCS critical mineral resources, BOEM needs this CMEAF project to inform environmental assessment guidance related to prospecting, leasing, and developing offshore CM, culminating in a comprehensive document that addresses the CM affected environment, the impact of CM recovery, transport, and refining processes, baseline data needed to assess these systems, and the environmental impacts associated with various prospecting and operational methods. The primary focus will be on nodules.

Related projects, funded by the Marine Minerals Program, are planned that will generate a series of references covering CM resource evaluation (started in FY22), including prospecting, mining, and the novel and complex extraction technologies used to execute these operations, existing environmental documentation (starting in FY23), and economic guidance (starting in FY24). These three reviews will document the mineral resources, associated environment, and economic guidance needed to evaluate CM activity requests and will assist analysts as they develop information for decision-makers. The MMP studies may provide useful information to the CMEAF study proposed here, which will inform environmental analyses.

The CMEAF study will also benefit related initiatives, including the Status of the Outer Continental Shelf (SOCS) project, and the National Offshore Critical Minerals Inventory (NOCMI), hosted within the existing Marine Minerals Information System (MMIS). The baseline data requirements identified by the CMEAF will inform the development of the MMIS as it expands to contain CM data.

Objectives: This study will improve BOEM environmental analyses by developing a series of critical minerals environmental assessment framework (CMEAF) documents.

- The focus of this study is to identify information needs, determine which baseline environmental parameters should be gathered, and collect and collate existing information.
- The CMEAF should identify, describe, and prioritize information gaps that can be addressed by future CM environmental studies, including studies related to:
    - Identifying the environmental analyses information needed and data gaps associated primarily with nodules, while crusts, SMS, phosphorites, and placers will collectively receive less attention.
    - Identifying assessment needs specific to CM prospecting, leasing, and operations (i.e., testing, mining, decommissioning), culminating in a comprehensive document, which will describe: habitats where CM are found; the surrounding ecosystem; environmental impacts, including cumulative effects, associated with CM prospecting and operations actions; potential mitigations to reduce the impacts of CM actions; broader impacts of the associated CM transport and refining processes (e.g., vessel traffic, emissions, climate impact); and baseline data needed to assess these systems.
- All CMEAF documents will be accompanied by copies of referenced materials for MMP analyst use in developing further environmental assessment protocols. Development of specific standards, sampling methods, and detailed implementation guidelines are not anticipated to be part of this project.

Methods: BOEM will work with the National Academies of Sciences, Engineering, and Medicine (NASEM) to facilitate the implementation of this study by engaging affiliated academic partners to develop authoritative environmental recommendations in collaboration with BOEM staff and in conjunction with a series of workshops to solicit pertinent information related to environmental assessment of deep sea mineral activities from stakeholders (e.g., non-governmental organizations, environmental groups, industry, Tribes and other indigenous groups). Existing pertinent information from similar efforts (e.g., sand and gravel, renewable energy studies, oil and gas studies, terrestrial resource studies, the International Seabed Authority's draft environmental guidelines) can provide a starting point for these workshops. The information will be synthesized into a written report.

Specific Research Question(s):

1. What is the baseline environment associated with deep sea critical mineral resources?
2. What are the potential impacts associated with deep sea critical mineral prospecting and operations activities?
3. What are potential mitigations that can be applied to deep sea critical mineral prospecting and operations activities?

Affiliated WWW Sites: N/A

References:

Mizell K, Hein JR, Au M, Gartman A. 2022. Estimates of metals contained in abyssal manganese nodules and ferromanganese crusts in the global ocean based on regional variations and genetic types of nodules. In: Sharma R, editor. Perspectives on deep-Sea mining. Cham (Switzerland): Springer Cham. p. 53–80.

Sharma R. 2017. Deep-sea mining: current status and future considerations. In: Sharma R, editor. Perspectives on deep-Sea mining. Cham (Switzerland): Springer Cham. p. 3–21.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Extrapolating Benthic Recovery Estimates Beyond Single-project Constraints
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.hansen@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2025
Final Report Due	TBD
Date Revised	March 31, 2023
Problem	Dredging activities directly remove the benthos from the immediate dredge cut area, which may affect productivity and food webs. Field monitoring at every site and for every dredge event is not feasible, so a model will allow for more accurate estimates of recovery. Current impact assessments infer recovery patterns without incorporating quantifiable estimates based on the vast amount of field data that has been collected.
Intervention	If rate of recovery relative to dredging conditions (considering natural fluctuations) can be better quantified, BOEM can improve impact assessments and make more appropriate recommendations for dredge operations.
Comparison	This study aims to model benthic recovery relative to different dredge frequencies and environmental conditions using existing datasets that have monitored pre- and post-dredge benthic communities.
Outcome	An empirical formula that allows BOEM to input different dredge project parameters to estimate, including uncertainty, benthic recovery on both small and large scales.
Context	Atlantic and Gulf of Mexico Outer Continental Shelf (OCS) waters 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 invertebrate recovery when site-specific data are not available. In the process of excavating sediment, dredges can remove, bury, or otherwise potentially harm benthic invertebrates (mostly infauna but also some epifauna), a source of biomass that is important prey to higher trophic animals. Benthic invertebrates can recolonize within months to years, depending on operational and environmental factors, including the frequency of impacting events (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, budget, etc. These short-term studies may also miss larger scale patterns such as impacts from successive dredging or changes in recruitment trends. An empirical model to quantify estimated recovery rates will improve benthic impact assessments, including related to mesoscale and 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). Nearly every dredge project has monitored pre- and post-dredge benthos at least once, resulting in a large and geographically diverse dataset. These data from individual studies, however, have not been synthesized into a broader, mesoscale model of recovery.

In addition to how physical and environmental conditions affect potential recovery to a pre-disturbed state, the frequency of dredge events may also affect how the benthos recolonize. While benthic recovery should consider a return to pre-dredge biodiversity, this study focuses on a return to pre-dredge biomass based on the assumption that biomass provides the basic energy input to the food web (Gascuel et al., 2005). 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. Relative abundance of biota (i.e., biomass abundance *B* relative to carrying capacity *K*) is then calculated as:

$$\frac{B}{K} = 1 - F * \frac{d}{r}$$

where *F* is trawling frequency, *d* is the depletion of biota (as a proportion), and *r* is the recovery rate. This study aims to adapt this formula using dredge parameters. Full recovery would occur when post-dredge abundance matches carrying capacity (i.e., *B*=*K*) and thus the ratio =1. It is hypothesized that more frequent dredging would lead to greater depletion of benthic invertebrates, longer recovery rates, and therefore lower relative abundance of biota.

Objectives: The study aims to quantify benthic invertebrate biomass recovery after dredging (*F*), along with other parameters (e.g., *d* and *r*), and receive an estimate (plus uncertainty) of benthic recovery (the ratio *B/K*). With this model, it would be possible to estimate recovery more accurately when (1) field data are not collected, (2) successive dredging occurs, and (3) availability of adjacent undisturbed area changes.

Methods: This model will investigate how benthic invertebrate biomass recovery is related to dredge depth and frequency using existing datasets from dredge projects or studies (e.g., "Natural Habitat Associations And The Effects Of Dredging On Fish At The Canaveral Shoals, East-Central Florida," "Ecological Function And Recovery Of Biological Communities Within Sand Shoal Habitats Within The Gulf Of Mexico," and dredge-related surveys funded by the U.S. Army Corps of Engineers [USACE]). 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., biomass, abundance, and richness), sediment profile imaging, grain size analysis, dredging activity, bathymetry, and a variety of environmental variables like season and hydrodynamics. As feasible, the model will include covariates to account for environmental and seasonal fluctuations. Environmental covariates will be tested for significance, then built into calculations of inputs (e.g., *d* and *r*). All experimental data will be mined from BOEM-funded studies, USACE, academia, and state resource managers, among others. These data will be analyzed to calculate both an empirical formula, as well as input parameters.

The final product will be a logistic growth model that represents how benthic recovery varies with dredge frequency, depletion, and recovery, including measures of uncertainty (similar to the formula above). Existing data would be used to calculate input parameters *F*, *d*, and *r* (see Hiddink et al. 2017 for details). For example, the results of a BOEM-funded study to characterize the intensity of dredging (OCS

Study BOEM 2018-019, "Using Dredge Plant Operational Data to Measure Cumulative Use and Cumulative Impacts") could be used to calculate dredge frequency *F*. These inputs would then quantitatively estimate relative abundance. The model 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 between the two different types of activities. This model will support a user interface so that any BOEM analyst may generate an estimate of benthic invertebrate recovery. An instruction manual will accompany the interface so that a BOEM analyst is prompted to input relevant information from the proposed project (e.g., location, season, dredge cut depth). These values will feed into the model and calculate recovery.

Specific Research Question(s):

1. How does recovery of benthic invertebrate biomass vary with dredge frequency?
2. What are the quantitative estimates, range, and dimensions of benthic recovery for different dredge depths and frequencies?
3. How do successive dredge events cumulatively affect benthic invertebrate biomass recovery?

Affiliated WWW Sites: N/A

References:

Crowe SE, Bergquist DC, Sanger DM, Van Dolah RF. 2016. Physical and biological alterations following dredging in two beach nourishment borrow areas in South Carolina's coastal zone. Journal of Coastal Research. 32(4):875–889.

Gascuel, D, Y-M Bozec, E Chassot, A Colomb, M Laurans. 2005. The trophic spectrum: theory and application as an ecosystem indicator, ICES Journal of Marine Science. 62(3):443–452. https://doi.org/10.1016/j.icesjms.2004.12.013

Hiddink JG, Jennings S, Sciberras M, Szostek CL, Hughes KM, Ellis N, Rijnsdorp AD, McConnaughey RA, Mazor T, Hilborn R, Collie JS. 2017. Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance. Proceedings of the National Academy of Sciences. 114(31):8301–8306.

Michel J, Bejarano AC, Peterson CH, Voss C. 2013. Review of biological and biophysical impacts from dredging and handling of offshore sand. Herndon (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 258 p. Report No.: OCS Study BOEM 2013-0119.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	In Situ Sampling at a Historic Equipment Test Site on the Blake Plateau
Administered by	Marine Minerals Program
BOEM Contact(s)	Michael Rasser (michael.rasser@boem.gov), Mark Mueller (mark.mueller@boem.gov), Paul Knorr (paul.knorr@boem.gov)
Procurement Type(s)	TBD
Performance Period	FY 2024–2028
Final Report Due	TBD
Date Revised	May 18, 2023
Problem	Critical minerals are important to the economic and national security of the United States, yet little is known about the environmental impacts of mining seabed minerals in the deep sea because baseline studies and post-mining activity environmental assessments are limited or unavailable.
Intervention	This analysis will continue ongoing interagency efforts to study, plan, and manage for potential environmental impacts of critical mineral by studying an area that was historically impacted by large-scale testing of mining equipment.
Comparison	A natural experiment approach will be utilized, with in-situ sampling conducted in both impacted and control areas. This will allow a comparison of physical and biological characteristics that may be the result disturbance.
Outcome	An improved understanding of the potential long-term environmental impacts of deep-sea mining-related disturbance can inform future assessment analyses policy and management decision making.
Context	Sampling will occur at control and impact sites within a 20 x 15 km area of the U.S. Atlantic OCS that experienced seabed disturbance 50 years ago. This provides a unique opportunity to assess long-term recovery of a seabed mining operation that will be broadly applicable to all BOEM planning areas.

BOEM Information Need(s): BOEM needs to better understand the environmental impacts of seabed mineral mining on the OCS. Information from this study will be used to support future BOEM activities, particularly those related to the development of critical marine minerals. The study will also inform NEPA-mandated environmental assessments for BOEM's Marine Minerals Program by increasing our understanding of long-term benthic recovery processes and about critical mineral-rich seafloor habitats

Background: On June 4th, 2019 the Department of Commerce released EO 13817,"A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals." The strategy directs the DOI to identify new domestic supplies of these minerals, ensure access to information necessary for the study and production of minerals, and expedite permitting for minerals projects, all "in a safe and environmentally responsible manner." The OCSLA assigns DOI/BOEM responsibility for developing OCS non-energy minerals, including critical minerals, while ensuring environmental protection. Significant deposits of several critical minerals are found within the U.S. EEZ (Hein et al. 2016) but are not currently included in mineral resource assessments (Schultz et al. 2017; Fortier et al. 2018).

Marine areas with mineral-rich hard substrates support benthic communities that may differ in their response and recovery from disturbances such as extractive activities. These areas can support diverse communities including some rare species, yet basic ecological information such as faunal composition, population sizes, distribution, and connectivity is lacking. A sufficient understanding of the ecological impacts of mineral extraction is constrained by inadequate observational and baseline data. While a few studies have monitored changes during seafloor mining demonstration activities, they were limited by a lack of knowledge regarding the local and regional seafloor environment prior to commencement of extractive activities (Jones et al. 2018).

This study will continue interagency analysis of an historic deep-sea mining test site on the Blake Plateau (BP) in the U.S. Atlantic Ocean. Geological and mineral assessments on the BP began in the 1960s, leading to manganese nodule prospecting and extraction equipment-testing activities by Deepsea Ventures, Inc. (DV) in 1970. In addition, there were dedicated geologic and resource assessments in the early 1980s by the USGS and partners. There is semi-quantitative information of nodule/pavement abundance, geochemical data, and other associated records obtained from DV and other published sources. DV published documentation about the systems they developed and utilized. The USGS also has seismic reflection data, deep tow camera images, samples, (hundreds of pounds of nodules and sediments), and other associated records. This historical context provides a unique time series of seafloor disturbances, enabling assessment of disturbance recovery across a range of substrates and habitat types.

BOEM, USGS, and NOAA have been collaborating and planning for this joint study since 2018. On June 29, 2019 NOAA Ship *Okeanos Explorer* performed a systematic multibeam survey surrounding the "Deepsea Ventures Site." This initial mapping effort enabled a return visit by the *Okeanos Explorer* in 2019 to conduct an 8-hour exploratory Remotely Operated Vehicle (ROV) dive guided by USGS and BOEM input.[1] The dive documented evidence of past activities including a "patio block" marker installed by the USGS and apparent seafloor disturbances from equipment consistent with the types of seafloor mining equipment thought to have been used in the 1960's. This information was documented during a USGS-archival research visit to The Mariners' Museum in Newport News, VA, where copies were made of historical documents detailing the site's coordinates and historic activities. USGS has recovered important data from internal USGS records (e.g., tow camera imagery of the seafloor) about their 1980's fieldwork at the site and is reviewing this data.

The first phase of this study (MM-21-03: Investigation of an Historic Seabed Mining Site on the Blake Plateau) is expected to finish in 2023. In 2022, USGS, BOEM, and NOAA scientists contracted Ocean Infinity America to conduct a high-resolution mapping survey of the seafloor within the 50 km^2 study area using a Hugin 6000 AUV. The survey identified widespread sea floor disturbance throughout the study area and many of the patio markers deployed by the USGS. These results are being used to develop a precise, cost-effective sampling plan for collecting in-situ samples using an ROV. The purpose of the second phase of work proposed here is to conduct a second research cruise to implement the ROV-based sampling plan.

Objectives: Provide needed information for future NEPA assessments by evaluating the potential environmental impacts from seafloor manganese nodule extraction, including to any endemic fauna, to

[1] https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/nov7/nov7.html

better inform understanding of disturbance recovery, leveraging unusual access to a historically impacted site.

Methods: In-situ collection of geological and biological data at locations in both the disturbed areas and control areas. Samples will be analyzed to characterize and statistically compare control and impacted sites. It is expected that one 10-day cruise with a remote underwater vehicle (ROV) will be required to complete this work. More specific methods and analyses planned are as follows:

Geological Components

Seafloor collections: Samples of rocks, including crusts, nodules, pavements, and other lithologies hosting critical minerals, will be collected to characterize the composition and concentration of minerals within the targeted areas and determine where information on geochemical distribution of mineral phases is absent from past sampling. Recovered samples will be analyzed for mineral composition and major/minor/trace element concentrations. The isotope content of the nodules and crusts can also be analyzed to elucidate the paleoenvironmental conditions that influenced their formation.

Sediment samples will be collected for analysis of depositional history in and around experimental areas, identification sediment provenance and transport, and determination of mineral content. Where bottom currents are high, excessive erosion of the exposed rock leads to the surrounding sediments possibly being enriched.

Seafloor Morphology: High-resolution imagery and mapping over target environments will be used to quantify levels of disturbance from anthropogenic and natural sources and to provide information on the physical environment of undisturbed areas. Opportunities to utilize repeat surveys of target locations will allow changes to be tracked over short time scales.

Biological Components

Environmental Characterization: Water mass characterization (e.g., depth, temperature, dissolved oxygen, nutrients, particulate organic matter) will be conducted around targeted areas.

Community and Species Analysis: Dominant megafaunal invertebrates (e.g., crustaceans, echinoderms, sponges) and fish will be quantified and identified to the lowest possible taxon from video and digital still imagery, with targeted collections of individuals for voucher specimens. Habitat associations will be examined by comparing the faunal densities, community composition, and diversity among substrate types (nodules, pavement, crust, sediments). Species composition will be examined to identify any indicator species that may be representative of these habitats and useful for monitoring.

Population Ecology and Connectivity: Population genetics may be used to address connectivity among these systems and the adjacent seafloor. eDNA and animal telemetry networks provide a possible avenue to determine pelagic megafauna association with benthic habitat.

Specific Research Question(s):

1. What sensitive habitats and species are associated with critical mineral deposits and formations?
2. Are there biological or geological differences between previously disturbed areas and control sites?
3. What are the potential habitat and related environmental impacts of deep-sea seabed mining?

Affiliated WWW Sites: N/A

References:

Fortier SM, Nassar NT, Lederer GW, Brainard J, Gambogi J, McCullough EA. 2018. Draft critical mineral list—Summary of methodology and background information—U.S. Geological Survey technical input document in response to Secretarial Order No. 3359: U.S. Geological Survey Open-File Report 2018–1021, 15 p., https://doi.org/10.3133/ofr20181021.

Hein JR, Koschinsky A, Mikesell M, Mizell K, Glenn CR, Wood R. 2016. Marine Phosphorites as Potential Resources for Heavy Rare Earth Elements and Yttrium. Minerals, 6, 88. https://doi.org/10.3390/min6030088

Jones DOB, Amon DJ, Chapman ASA. 2018. Mining Deep-Ocean Mineral Deposits: What are the Ecological Risks? Elements 14:225-330

Schulz KJ, DeYoung JH Jr, Seal RR II, Bradley DC, eds. 2017. Critical mineral resources of the United States—Economic and environmental geology and prospects for future supply: U.S. Geological Survey Professional Paper 1802, 797 p., http://doi.org/10.3133/pp1802.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Modeling Food Web Effects from Dredging
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.Hansen@boem.gov), Barton Rogers (Barton.Rogers@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	February 7, 2023
Problem	Primary consumers and forage fish are a critical component in coastal and shelf food webs. The effects of removal of both primary producers and first-level consumers to the food web is unknown.
Intervention	Model the reliance of higher trophic levels on primary producers and primary consumers.
Comparison	Model the reduction of benthic primary producers and primary consumers to existing food webs. Determine the spatial and temporal extent of when reduction is no longer measurable.
Outcome	We expect to quantify the effects of dredging on primary producers and primary consumers of a local food web.
Context	Gulf of Mexico and South Atlantic Outer Continental Shelf, <30-m depths

BOEM Information Need(s): Dredging assumes complete removal of primary producers and primary consumers within the relatively small dredge footprint. The effect of the removal of this prey base on higher trophic levels is difficult to study but is necessary to understand ecosystem impacts. This study would attempt to link the small-scale (space and time) perturbations with the potential for scalable ecosystem effects. This information would be used by both BOEM analysts in National Environmental Policy Act (NEPA) and essential fish habitat (EFH) documents, as well as by resource management agencies (e.g., Fishery Management Councils).

Background: Primary producers (e.g., benthic macroalgae, diatoms, etc.) support a variety of primary consumers (e.g., benthic infauna, epifauna, and plankton), which link to higher trophic levels including fishes, crustaceans, and birds. Benthic primary producers and primary consumers are typically found in BOEM dredging areas. Dredging therefore may affect a variety of linkages and guilds.

Several food web models have been developed on regional scales (Figure 1, SAFMC 2016). These models help elucidate important relationships between predator and prey. For example, Okey et al. (2014) found that in the South Atlantic Bight, an increased biomass of striped bass, bluefish, large coastal sharks, small coastal sharks, and highly migratory species correlated with the increase in forage fishes like Atlantic menhaden and squids (reviewed by Pickens et al. 2020). Disruptions to these food webs are less understood, however.

In Figure 1, for example, if the food web exactly overlaps a dredge site, some of the nodes on the lowest trophic level may be severely depleted or completely removed. Presumably when an area is dredged, any accumulated/settled detritus could be lost by either removal by the dredge or relocated by mobilization into currents, potentially have a large effect on the food web. Primary consumers, like infauna and echinoderms, may lose a prey source. If they are a specialist and cannot substitute the food source, they may experience decreased fitness. If they are generalists and can easily switch to alternative prey items, there may be no effect. On a larger spatial scale that more accurately represents a foraging range, there may be no effect regardless of specialist compared to generalist feeding strategies. Similarly, after time, those lowest trophic levels will rebuild such that effects will no longer be measurable.

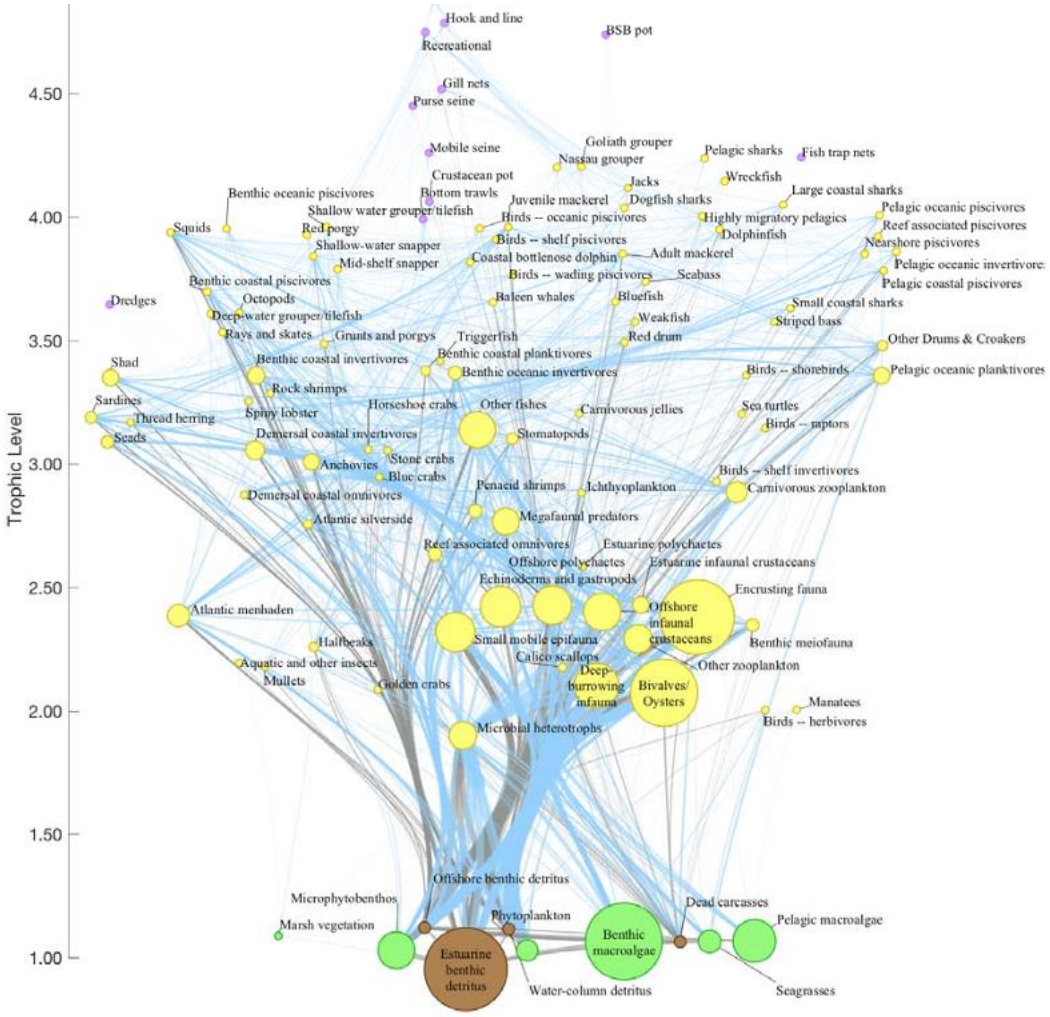

Figure 1. South Atlantic Bight Food web. Nodes are colored based on type (green = producer, brown = detritus, yellow = consumer, purple = fleet). Blue for all edges except flows to detritus, which are grey. (SAFMC 2016).

Objectives: Quantify effects of dredging to dynamic food webs.

Methods: This study would leverage other ecosystem studies funded by BOEM (e.g., Ecological Function And Recovery Of Biological Communities Within Sand Shoal Habitats Within The Gulf Of Mexico and

Natural Habitat Associations And The Effects Of Dredging On Fish At The Canaveral Shoals, East-Central Florida). If food web models from these two studies can be manipulated such that components can be removed or reduced and we can measure that effect, BOEM would prioritize these existing models to better understand the effects of dredge to trophic relationships at two geographically distinct dredge sites (i.e., Atlantic coast of FL and Gulf of Mexico). Alternatively, if they are static, a new model or Ecological Network Analysis may need to be created to analyze food web carbon flows and effects of dredging. Using a pre-dredge model, researchers could simulate different types of dredge-related disruptions (e.g., the removal of primary producers and/or primary consumers). By first modeling the removal of a food web component, changes to related nodes can be estimated. These measurable impacts should be investigated over different spatial and time scales. Spatial scales should seek to represent both the perturbation (i.e., dredge footprint) as well as different foraging ranges. When impacts from a simulated perturbation are no longer detectable through time, or swamped by natural variation, we can assume the system has recovered. Because nodes can be altered, it would also be possible to change the food web to reflect changes in a community, for example in response to climate change. Products include a summary of different scenarios and outcomes in a report or publication, as well as up to two dynamic food web models that can be manipulated by a BOEM analyst using instructions on inputs and controls.

Specific Research Question(s):

1. How does disruption to primary producers and/or primary consumers (e.g., from dredging) affect other parts of a food web?
2. At what spatial scale is this measurable?
3. How long is the effect detectable?
4. What is the effect of changing conditions (such as sea level rise) on food web dynamics and how do these changes alter the effects of dredging?

Affiliated WWW Sites: N/A

References:

Okey TA, Cisneros-Montemayor AM, Pugliese R, Sumaila RU. 2014. Exploring the trophodynamic signature of forage species in the U.S. South Atlantic Bight ecosystem. Fisheries Centre Working Paper 2014-14, University of British Columbia Fisheries Centre, Vancouver, Canada.

Pickens BA, Taylor JC, Hansen D. 2020. Volume 1: fish habitat associations and the potential effects of dredging on the Atlantic and Gulf of Mexico Outer Continental Shelf, literature synthesis and gap analysis. In: Pickens BA, Taylor JC, editors. Regional essential fish habitat geospatial assessment and framework for offshore sand features. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 122 p. Report No.: OCS Study BOEM 2020-002 and NOAA NCCOS Technical Memorandum 270. https://doi.org/10.25923/akzd-8556

[SAFMC] South Atlantic Fishery Management Council. 2016. Policy considerations for South Atlantic food webs and connectivity and essential fish habitats. December 2016. 9 p.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Characterization of Water Column Habitats to Understand Potential Impacts from Deepwater Energy and Mineral Development
Administered by	Pacific OCS Region
BOEM Contact(s)	Jennifer Le (jennifer.le@boem.gov), Paul Knorr (paul.knorr@boem.gov), Mark Leung (mark.leung@boem.gov), Mark Mueller (mark.mueller@boem.gov), Donna Schroeder (donna.schroeder@boem.gov), Mike Rasser (michael.rasser@boem.gov)
Procurement Type(s)	Cooperative Agreement, Interagency Agreement(s)
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	April 27, 2023
Problem	Despite being the largest habitat type in the world, there are large knowledge gaps concerning water column biology and chemistry. Energy and mineral development could impact the water column and its biota through discharges, introduction of anthropogenic structures and noise, and changes in local hydrography. To inform environmental reviews associated with lease area identification and NEPA documents, BOEM needs to first identify relevant water column parameters and catalog local biodiversity that could be affected by BOEM-approved projects, such as offshore renewable energy development, marine minerals operations, and conventional energy development.
Intervention	This study proposes to leverage planned research cruises for water column data collection. The addition of a water column component could add value in ways that are cost-effective and complementary to planned cruise plans and operations.
Comparison	Multiple water column samples (including for environmental DNA (eDNA) analysis) and underwater video will be collected within one or more regions prospective for leasing offshore Hawai'i. The samples will describe a snapshot of water column structure that could provide insight on the variety and extent of deepwater habitats and inform future investigations that describe the ecosystem at finer scales should development proceed.
Outcome	Integration of water column data into environmental analyses could lead to more informed decision-making and more effective environmental protections.
Context	Hawai'i EEZ and other areas of BOEM interest with planned research cruises.

BOEM Information Need(s): Existing knowledge gaps of water column habitats are relatively broad and include foundational themes such as what lives in the water column and where, how the water column is structured, natural variability, anthropogenic influences, and likely unknown unknowns (Netburn 2018, Interagency Working Group on Ocean Exploration and Characterization 2022). This study will generate data to characterize water column environments that could potentially be disrupted by BOEM-managed activities, which may manifest through seafloor or sea surface mechanisms. The resulting data

will contribute to baseline knowledge of pelagic systems that are highly dynamic and difficult to study. With industries moving into deeper waters further offshore, these water column data are necessary to understand environmental conditions and associated natural variation. For example, baseline environmental data can improve understanding of environmental risks and potential impacts of floating offshore wind, such as changes in organism behavior and displacement (Maxwell et al. 2022). Additionally, current seabed mining technologies are expected to produce sediment plumes with unknown environmental impacts (Gollner et al. 2017, Gillard et al. 2019). BOEM needs baseline data for these water column habitats to identify which resources may be impacted and assess what those impacts are likely to be. This study is responsive to a FY 2024–2025 Stakeholder Input letter that emphasizes the need to collect water column data to help inform potential OCS development activities.

Background: Although the pelagic ocean is the largest ecosystem on earth, it remains poorly characterized and understood due to its vast size and three-dimensional, highly dynamic nature (e.g., Perelman et al. 2021). Very little of the water column, especially that deeper than the epipelagic (0–200 m), has been described in any detail (Netburn 2018). However, we know that important processes occur throughout the water column, such as the biological pump (Passow and Carlson 2012), diel vertical migration (Sutton 2013, Kelly et al. 2019), other mechanisms for connectivity (Sutton 2013), and food web dynamics (Choy et al. 2017). As industries move to deeper waters of the OCS, it is imperative to learn more about potential impacts to these habitats, specifically sites of commercial interest.

Water column information can be collected by traditional oceanographic equipment, especially when supplemented by new techniques and technology. In addition to physical and chemical profiles of the water column, Conductivity-Temperature-Depth (CTD) rosette casts can collect water samples to evaluate the biological community through eDNA sampling. Cameras can also be integrated onto CTD rosettes to help image these pelagic environments; deeper habitats are rarely visualized. This study is intended to fund the integration of a complementary water column component into planned marine mineral and offshore wind-related research cruises in locations of BOEM interest. Some examples are surveys for floating offshore wind projects and the planned Hawai'i Crescent resource evaluation cruise that is co-funded by BOEM's Marine Minerals Program and Pacific OCS Region.

This study could also contribute to national and international initiatives. The National Strategy on Ocean Mapping, Exploration, and Characterization (NOMEC) has identified the water column as one of its national strategic priorities, in particular improved characterization of water column biology, biogeochemistry, physical properties, and oceanographic trends (Interagency Working Group on Ocean Exploration and Characterization 2022). The Japanese government's Strategic Innovation Promotion (SIP) Program has provided considerable funding to support research and development of low-cost and highly efficient technologies and procedures to assess the environmental impact of resource exploration and extraction, including in the midwater. BOEM should evaluate potential collaborations related to past and planned NOMEC and SIP activities.

Objectives: The purpose of this study is to collect water column data that support BOEM information needs in conducting environmental analyses. Specific objectives include:

- Characterize water column habitats in areas of BOEM interest by collecting baseline environmental data.
- Test water column techniques and technologies for integration into resource evaluation and environmental monitoring operations. Given limited days-at-sea, the development of a low-cost

sampling and sensor instrumentation package/module that is easily integrated and deployed with standard operations would be ideal.

Intended study outcomes are data products (e.g., species inventories, habitat maps, physical and biogeochemical profiles) that synthesize and summarize findings for BOEM use, such as in describing the affected environment, assessing potential impacts, and developing adequate mitigation measures.

Methods: BOEM anticipates partnering with an academic institution to collect environmental data, such as temperature, salinity, turbidity, oxygen, pH, carbon, and species presence/absence and distribution (via active acoustics, such as side-scan sonar, and eDNA), from water column habitats on appropriate cruises of opportunity. Planning must occur well in advance to ensure that the midwater component is fully integrated in science operations. We anticipate funding new or expanded water column components on approximately three cruises. The scope of water column operations on each cruise will be designed to address the highest priority BOEM information needs while taking into account any pre-existing science plans and available planning horizon. One potential opportunity is the Hawai'i Crescent resource evaluation expedition. Optical sensors (e.g., high-definition cameras, shadowgraphs) will be integrated onto a CTD rosette to survey the water column and water samples will be collected for eDNA analysis. Tow net sampling will complement the CTD operations; net-caught organisms will be provisionally identified morphologically before DNA barcoding to validate species identifications. Any imagery collected (e.g., via CTD rosette-mounted camera, remotely operated vehicle) will be analyzed.

Specific Research Question(s):

1. What water column features and anomalies exist that can be remotely imaged, e.g., via split-beam sonar?
2. What are the physical and chemical properties of the water column nearby prospective lease areas?
3. What pelagic biological communities live at what depths? Do they exhibit any behaviors of note?

Affiliated WWW Sites: N/A

References:

Choy CA, Haddock SHD, Robison BH. 2017. Deep pelagic food web structure as revealed by in situ feeding observations. Proceedings of the Royal Society B. 284: 20172116. http://doi.org/10.1098/rspb.2017.2116

Gillard B, Purkiani K, Chatzievangelou D, Vink A, Iversen MH, Thomsen L. 2019. Physical and hydrodynamic properties of deep sea mining-generated, abyssal sediment plumes in the Clarion Clipperton Fracture Zone (eastern-central Pacific). Elementa: Science of the Anthropocene. 7:5. https://doi.org/10.1525/elementa.343

Gollner S, Kaiser S, Menzel L, Jones DOB, Brown A, Mestre NC, van Oevelen D, Menot L, Colaco A, Canals et al. 2017. Resilience of benthic deep-sea fauna to mining activities. Marine Environmental Research. 129: 76-101. https://doi.org/10.1016/j.marenvres.2017.04.010

Interagency Working Group on Ocean Exploration and Characterization. 2022. Strategic priorities for ocean exploration and characterization of the United States Exclusive Economic Zone. https://www.whitehouse.gov/wp-content/uploads/2022/10/NOMEC_OEC_Priorities_Report.pdf

Kelly TB, Davison PC, Goericke R, Landry MR, Ohman MD, Stukel MR. 2019. The importance of mesoplankton diel vertical migration for sustaining a mesopelagic food web. Frontiers in Marine Science. 13. https://doi.org/10.3389/fmars.2019.00508

Netburn, AN. (Editor). 2018. From surface to seafloor: exploration of the water column (workshop report), Honolulu, HI, 4-5 March 2017. NOAA Office of Ocean Exploration and Research. Silver Spring, MD. NOAA Technical Memorandum OAR OER; 003. 34 pp. DOI: https://doi.org/10.25923/rnjx-vn79

Passow U, Carlson CA. 2012. The biological pump in a high CO_2 world. Marine Ecology Progress Series. 470:249–271. doi: 10.3354/meps09985

Perelman JN, Firing E, van der Grient JMA, Jones BA, Drazen JC. 2021. Mesopelagic scattering layer behaviors across the Clarion-Clipperton Zone: implications for deep-sea mining. Frontiers in Marine Science. 10. https://doi.org/10.3389/fmars.2021.632764

Sutton TT. 2013. Vertical ecology of the pelagic ocean: classical patterns and new perspectives. Journal of Fish Biology. 83:1508-1527. doi:10.1111/jfb.12263

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Developing a Next Generation Tag Technology for Sea Otters (*Enhydra lutris*)
Administered by	Pacific OCS Region
BOEM Contact(s)	Kimberly Klein (kimberly.klein@boem.gov)
Procurement Type(s)	Intraagency Agreement
Performance Period	FY 2023–2027
Final Report Due	TBD
Date Revised	April 25, 2023
Problem	Studies of sea otters have relied on visual observation or abdominally implanted radio telemetry technology resulting in incomplete information.
Intervention	This study would develop a low-cost, solar-power tag that provides GPS locations via a LoRa transmission network capable of delivering real-time data.
Comparison	New tagging technology will provide sea otter movement, dispersal, and habitat use, along with baseline information prior to disturbance (e.g., vessel traffic) or other events (e.g., oil spills) near the wind energy lease areas offshore Morro Bay, California.
Outcome	Move sea otter flipper tag development from prototype to production, in line with the goals of a new BOEM Center for Innovative Ocean Monitoring
Context	Alaska, Washington, Oregon, California, National

BOEM Information Need(s): Tracking data is critical for BOEM's analyses of impacts of energy development on animal movement and habitat use and in response to disturbance (e.g. vessel traffic, construction, operations, etc.) and catastrophic events (e.g. oil spills). Existing tag technology is not well suited for some species. Tools are needed that can provide higher resolution real-time location data at lower cost. Sea otter tracking has been particularly difficult because thick fur and destructive chewing prevents external attachment of tags or devices. Instead, biologists have been tracking sea otters using abdominally implanted VHF transmitters. Collection of data from these transmitters is expensive and invasive, requires heavy personnel attendance, and is limited by weather conditions, geography, and battery life. Technological advances are necessary for monitoring the threatened sea otters near energy development areas, including wind energy leases offshore Morro Bay, California and, in the future, near the Coos Bay Call Area offshore Oregon, where reintroduction is being considered (USFWS 2022).

Background: This project would leverage extensive research and development by the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA). To date, project partners have developed hardware small enough to be encased in a durable, waterproof tag similar to a livestock ear tag. It is made of a chew-resistant non-toxic material like that in KONG© pet toys and is permanently attached to the rear flipper through a small (10 mm) perforation of the interdigital webbing. Clear resin windows provide solar exposure to photovoltaic cells. Data can be transmitted to network gateway receivers via Long Range Wide Area Network (LoRaWAN) and Internet of Things (IoT) technology. Fixed or mobile gateways can then relay data to a wireless or satellite network. No field trials have yet been

conducted, but a prototype tested well on captive sea otters at the Monterey Bay Aquarium and was shown to reliably communicate with a LoRaWAN gateway 350 m away. Once developed, the tag can be modified for seals, sea lions, diving birds, or other species too small or unsuited for other transmitters. USGS has committed substantial funding for field work and personnel. In-kind support will be provided by California Department of Fish and Wildlife and U.S. Fish and Wildlife Service (USFWS).

Objectives:

1. Update existing prototype to: a) ensure design resilience to supply chain vulnerabilities; b) include accelerometer to differentiate sea otter behaviors so that tags can conserve power when animals are submerged; and c) include pressure, temperature, and/or other sensors.
2. Conduct power and range testing to calibrate the tag performance in marine ecosystems.
3. Test the new prototype by tagging 5 wild sea otters. If 80% successful, deploy 5 additional tags, otherwise refine technology and redeploy 5 new tags. Deploy implanted VHF transmitters for comparison with GPS/LoRa tags and to aid in tag recovery (if needed).
4. Develop data analysis procedures. Modify existing (i.e., migratory bird) USGS methods for data acquisition, analysis, interpretation, and presentation.
5. Deploy new technology on 30 sea otters at Morro Bay, California, where energy development and sea otter occupancy overlap (Larson and Bodkin 2015). Provide temporal and spatial data from sea otters for use in BOEM NEPA analyses.

Methods: Tag updates will include the recruitment of an electrical engineer as an employee of USGS or NASA at NASA Ames Research Center. Development will include the procurement of material supplies, fabrication of second-generation prototypes, testing of tags on captive sea otters, and range testing in ocean environments. Pilot testing will require capture of up to 10 wild sea otters, attachment of flipper tags, and surgical implantation of VHF tags by a veterinarian. Researchers will deploy LoRa base-station receivers to collect data from flipper tags. Tracking data from VHF tags will be collected for comparison. Once tag performance has been validated on 10 sea otters, deployment will commence with the capture of 30 sea otters at Morro Bay. Project results will be published and provided to BOEM.

Specific Research Question(s):

1. What is the range and variance of LoRa data transmission over marine water? How does the quality of data from GPS/LoRa flipper tags compare to VHF methods?
2. How much power can be generated, for example power down when tags are underwater; and how can firmware be optimized to regulate power and support supply chain resilience?
3. How can existing sensor technology such as pressure sensors and/or accelerometers be incorporated into the flipper tag to gather data on diving depth and duration? Can diving behavior be used to predict solar power generation and battery use for other species?
4. What production factors will enable the development of new configurations for other species? What additional types of biological and environmental sensors can be incorporated?
5. What are the baseline behaviors, habitat use, and movement patterns of sea otters near the Morro Bay wind energy lease areas prior to possible effects of development activity.

Affiliated WWW Sites: N/A

References:

Larson SE, Bodkin JL. 2015. The conservation of sea otters: a prelude. In Larson SE, Bodkin JL, and VanBlaricom GR, editors. Sea otter conservation. Cambridge (MA): Academic Press. 447 p.

[USFWS] U.S. Fish and Wildlife Service. 2022. Feasibility assessment: sea otter reintroduction to the Pacific Coast. Report to Congress prepared by the U.S. Fish and Wildlife Service, Region 9, Portland, Oregon; and Region 10, Sacramento, California. Sea Otter Feasibility Assessment | U.S. Fish & Wildlife Service (fws.gov)

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Port Infrastructure Needs of Commercial and Recreational Fisheries Along the U.S. West Coast
Administered by	Pacific OCS Region
BOEM Contact(s)	Ingrid Biedron (ingrid.biedron@boem.gov), Sara Guiltinan (sara.guiltinan@boem.gov), Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2025
Final Report Due	TBD
Date Revised	April 25, 2023
Problem	Limited baseline information exists concerning port infrastructure that supports existing users, especially commercial fishing, even though such infrastructure may be dramatically affected by changes associated with offshore wind development or oil and gas platform decommissioning activities.
Intervention	This study will summarize the potential port infrastructure requirements and upgrades necessary for offshore energy activities, how those upgrades may conflict with or benefit other port users and working waterfronts, and identify any port-related industry synergies that may increase mutual benefit.
Comparison	Using information from previous port studies and guided discussion among stakeholders, this study will investigate in greater detail the interactions between offshore wind-related port upgrades and other port-based industries.
Outcome	Potential port-use and space-use conflicts and synergies information will be documented to inform BOEM's review of construction and operation plans and to evaluate suitable mitigation measures, leasing processes, BOEM and other agencies' environmental reviews, potential mitigations, and inter-industry negotiations.
Context	All West Coast ports in the Pacific OCS Region.

BOEM Information Need(s): BOEM and other decisionmakers need to understand how offshore renewable energy development may affect other port-based industries, especially commercial fishing. Such information will be critical to evaluate offshore wind construction and operation plans and mitigation measures to address potential impacts and to support inter-industry negotiations, including those needed to obtain Coastal Zone Management Act (CZMA) consistency determinations.

The entire coast needs to be assessed due to the connectivity of fisheries among ports, especially for those that pursue migratory species (e.g., Highly Migratory Species [tunas, swordfish], Coastal Pelagic Species [market squid, anchovies, sardines], Pacific Salmon). In addition to being a general Pacific Region need, this coast-wide understanding is being requested by Washington State Treaty Tribes which are co-managers of fishery resources that enter their usual and accustomed areas.

Background: Previous and currently ongoing studies have documented the need for infrastructure upgrades at West Coast ports in order to support possible fabrication, assembly, staging, and/or operations and maintenance of offshore wind energy infrastructure. The possible interactions between the offshore wind industry and other port-based industries (e.g., commercial and recreational fishing, aquaculture, eelgrass mitigation areas) regarding port upgrades have not yet been investigated on the West Coast. There may be potential for space-use conflicts (e.g., competition for berths) and for synergies (e.g., deeper dredging improving safety and navigability for all vessels). Understanding these potential conflicts and synergies will help inform BOEM and other agencies' offshore wind energy planning and environmental reviews, the local harbor permitting decisions, and enhance inter-industry negotiations, mitigations, and mutual benefits.

Objectives: This study will document existing port industries infrastructure needs, infrastructure needs for desired working water fronts, and potential space-use conflicts and space-use synergies among port-based industries (especially commercial fishing) from port infrastructure upgrades necessary for offshore wind energy development.

Methods: Researchers will use documented offshore wind energy industry port infrastructure needs from previous studies to inform the inter-industry interaction investigation. Researchers will analyze available data relevant to port industries and use ethnographic tools to collect new information on other industries' port infrastructure needs and anticipated interactions with offshore wind industry infrastructure (Culver et al. 2007; Pomeroy et al. 2011). The methods used by California Sea Grant researchers in their investigation of "Commercial Fisheries of the Santa Barbara Channel and Associated Infrastructure Needs" are transferable and appropriate for this study (Culver et al. 2007; Pomeroy et al. 2011). These methods may include, but are not limited to:

- Use published information and site visits to acquire and summarize existing information on port infrastructure and services (e.g., analyze landings data, mapping facilities and access points, etc.).
- Collect new information about the importance of port infrastructure and services from commercial and recreational fishers and persons knowledgeable about West coast commercial fisheries using methods (e.g., guided discussions, workshops) appropriate to the source.
- Collect new information about the importance of port infrastructure and services from other port industries (e.g., aquaculture) using methods (e.g., guided discussions, workshops) appropriate to the source.

Specific Research Question(s): For port facilities that may be affected by offshore energy leases:

1. By industry, gear, and fishery, what existing port infrastructure or services are a) used, b) critically used, and c) desired? Are there seasonal patterns of use? What future infrastructure services may be needed because of climate change?
2. Given local space constraints, are there facilities or services that could be obtained or improved during future port upgrades that would benefit existing industries (including fisheries) and/or enable new ones? Are there any facilities currently being subsidized that could benefit from additional use?
3. Are there specific port infrastructure or services critical to Tribal needs?
4. Would expected infrastructure changes disproportionately affect (benefit/harm) stakeholders?

Affiliated WWW Sites: N/A

References:

Culver CS, Richards JB, Pomeroy CM. 2007. Commercial fisheries of the Santa Barbara channel and associated infrastructure needs. California Sea Grant Publication No. T-062. 100 p. https://repository.library.noaa.gov/view/noaa/42127/noaa_42127_DS1.pdf

Pomeroy C, Thomson CJ, Stevens MM. 2011. California's North Coast fishing communities historical perspective and recent trends. California Sea Grant Publication No. T-072. 340 p. https://www.opc.ca.gov/webmaster/ftp/pdf/docs/CA_NCoastFCP.pdf

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Field	Study Information
Title	Pre-development Distribution and Behavior of Key Coastal Cetacean Species Near the Morro Bay Wind Energy Lease Area
Administered by	Pacific OCS Region
BOEM Contact(s)	Ingrid Biedron (ingrid.biedron@boem.gov), Desray Reeb, (desray.reeb@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	April 27, 2023
Problem	Wind lease sales offshore Morro Bay, California have been completed, and post leasing survey activities are expected to begin within the next year. Morro Bay and the vessel transit routes are areas used by many coastal cetacean species, including gray whales, killer whales, bottlenose dolphins, and resident harbor porpoise. Relatively little is known about the habitat use and interaction of these four key protected coastal species in this area, information that is needed in order to accurately assess potential impacts from offshore wind energy activities.
Intervention	This is a pilot field-based program focused on collecting habitat use and interaction data when the target species are known to be present in the area.
Comparison	These baseline data would be used for comparison with data collected during survey, construction, and post-construction activities.
Outcome	This study will provide direct measurements of habitat use and interaction of protected cetaceans in Morro Bay and in key corridor areas for service and supply vessels to and from the wind energy lease area. Such data will be vital in the implementation of management and monitoring plans for both the lease area and be informative to the proposed Chumash Heritage National Marine Sanctuary.
Context	Coastal Morro Bay, California

BOEM Information Need(s): Limited information is available about the habitat use and interactions of many coastal cetacean species that occur in and around Morro Bay, including the potential mixing of endangered western gray whales with protected eastern gray whales. Interactions between mammal-eating killer whales and gray whales, as well as potential interactions between nomadic bottlenose dolphins and resident harbor porpoise need to be better understood in order to more accurately assess and interpret potential impacts from offshore wind development. The current BOEM-funded study, "Vulnerability Index to Scale Effects of Offshore Renewable Energy on Marine Mammals and Sea Turtles of the U.S. West Coast (VIMMS)" (BOEM 2022a), shows that the data needed to create risk assessments for resident harbor porpoise (and other species highlighted in this study) in the Morro Bay area are not available. This study is a pilot initiative to begin addressing those data gaps. BOEM needs this type of ecological information to accurately assess and interpret potential impacts from offshore wind

development and associated activities on protected species under the Endangered Species Act and the National Environmental Policy Act.

Background: Impacts to marine mammals are of high concern to stakeholders, as evidenced in the recent misinformed linkages of whale mortalities to offshore wind activities in the Atlantic, emphasizing the need for robust pre-development, or current condition, data on the habitat use of these protected species.

BOEM has funded several studies related to the distribution and abundance of Pacific OCS marine mammals, and the results of the VIMMS study (BOEM 2022a) support the need for habitat use data on the degree of overlap of migratory western (endangered) and eastern gray whales, harbor porpoise, bottlenose dolphin, and killer whales in the coastal waters of Morro Bay to more accurately inform impact assessments from offshore wind on these species. The information provided by this proposed study would fill existing habitat use and interaction data gaps and complement and expand the acquisition of area specific acoustic data (previous data collected by Scripps Institution of Oceanography ["Scripps"] and data currently being collected by the current BOEM-funded study, "ADRIFT: Spatial and Temporal Distribution of Cetaceans in the California Current Ecosystem Using Drifting Archival Passive Acoustic Monitoring" (BOEM 2022b), will be integrated). This proposed study will provide information to inform environmental assessments and decision-making, including potential mitigation strategies, during the offshore wind development process.

Objectives: The objective of this study is to understand the habitat use and interactions of four protected coastal cetacean species that occur in and around Morro Bay, and which are likely to interact with vessels transiting to and from the Morro Bay wind energy lease area.

Methods: A focused field program with drone-based individual photo-identification and spatially explicit photogrammetry will be executed to elucidate habitat use, individual patterns of residency, and inter-species interactions. PAM will be used to complement and expand the photogrammetry data to inform movement patterns. Existing passive acoustics data will be integrated to further inform these outcomes. These methodologies will be applied to conduct spatially explicit mark-recapture studies of the distribution and density of resident harbor porpoise at scales that currently do not exist, and to determine occurrence of migratory gray whales, nomadic bottlenose dolphins, and killer whales through the coastal waters in and around Morro Bay. Gray whale image data will be submitted to Flukebook for whale ID matching to distinguish between Eastern and Western Pacific gray whales.

Pilot field studies will be appropriately permitted and will involve efficient and cost-effective shore-based small boat operations to collect these data over one month per year when the species of interest are expected to be in the study area. These field studies will continue for a period of three years. This study will be strategically coordinated with ongoing PAM and shore-based observations to provide larger-scale and longer-term comparisons.

Existing PAM data from Scripps and the ADRIFT study (BOEM 2022b) for this area and/or surrounding areas will be synthesized into study results, providing supplemental data for the study.

Specific Research Question(s):

1. How do resident harbor porpoise, gray whales, killer whales and bottlenose dolphins use Morro Bay and potential transit corridors to and from the port of Morro Bay to the wind energy lease area?

2. Are Endangered Western Pacific Gray whales present in potential transit corridors of the Morro Bay wind energy lease area?
3. Can any interactions between these species be defined?

Affiliated WWW Sites: N/A

References:

[BOEM] Bureau of Ocean Energy Management. 2022a. A vulnerability index to scale effects of offshore renewable energy on marine mammals and sea turtles of the U.S. West Coast (VIMMS). Study profile PC-21-04. 4 p. https://www.boem.gov/PC-21-04

BOEM. 2022b. ADRIFT: Spatial and temporal distribution of cetaceans in the California Current Ecosystem using drifting archival passive acoustic monitoring. Study profile PC-20-04. 5 p. https://www.boem.gov/PC-20-04

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Field	Study Information
Title	Traditional Native Hawaiian Voyaging and Cultural Fishing and Boating Practices on the OCS
Administered by	Pacific OCS Region
BOEM Contact(s)	Linette Makua (linette.makua@boem.gov), Dave Ball (david.ball@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	April 27, 2023
Problem	BOEM needs a better understanding of the types of traditional Native Hawaiian cultural concerns that could be affected by OCS energy development offshore Hawai`i for consideration in leasing decisions, National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) reviews, and offshore wind energy plan reviews. Successful outreach to the Native Hawaiian and kamaʻāina community is often inhibited by incomplete information and a lack of BOEM's presence in the community.
Intervention	Guided discussions (purposeful sampling) between BOEM and Native Hawaiians and the local community
Comparison	Characteristics of traditional voyaging areas and cultural fishing practices unique to Hawai`i and their vulnerability to prospective offshore energy development
Outcome	Human dimension data (both qualitative and quantitative) on Hawaiian cultural fishing/boating and traditional voyaging pathways and new cultural information to aid characterizing these important cultural practices. BOEM can better engage with the communities when informed and can best analyze possible impacts and identify potential future mitigations. Analysis of traditional voyaging path vulnerabilities and Native Hawaiian and kamaʻāina attitudes toward offshore wind energy projects will be valuable for energy planning.
Context	Potential leasing areas on the OCS of Hawai`i.

BOEM Information Need(s): The goal is to obtain information to ensure orderly OCS development offshore. This study will inform floating offshore wind NEPA analyses and NHPA Section 106 consultations in Hawai`i and help BOEM understand potential impacts to traditional Native Hawaiian voyaging activities and current cultural fishing activities. Hawai`i is undergoing a transformation to move from being almost completely reliant on imported fossil fuels to one that is powered by clean renewable energy. Hawai`i was the first state to commit to 100% clean renewable energy for electricity, to a net-negative emissions goal. This study effort integrates environmental science with historical and traditional knowledge and compliments other BOEM-funded studies (D'Iorio et al. 2015, Watson et al. 2022, Van Tilburg et al. 2017).

Background: The State of Hawai`i Energy Office has repeatedly stated, in 2017 and 2022, that they lack information necessary to conduct outreach activities for NEPA impact analyses.[1] Native Hawaiians are known to have ancestral ties to the ocean. Understanding the types and areas of cultural activities (e.g., celestial navigation and cultural fishing) is essential to consider during planning for offshore development. Outrigger canoeing has been revived as a Hawaiian practice, along with ocean navigation and boat construction.

Objectives: Synthesize archival data on traditional voyaging and cultural fishing resources that could be affected by offshore wind energy development. Concerns exist about light impact from turbines and the view obstruction on traditional navigators and cultural fishing practices. This study will provide potential visual impacts areas in advance of planning efforts to facilitate kama'āina[2] and Native Hawaiian community engagement and public outreach. This study may assist BOEM in visual analysis in Area(s) of Potential Effect (APEs). The timing of this effort is critical as collecting these data substantially (e.g., 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.

Develop a tool to visualize renewable energy build out to increase understanding of how offshore development will impact voyaging and cultural fishing and boating use. This may include, but is not limited to, a Hawaiian fishing/boating and traditional voyaging pathways in an exportable database format and GIS shapefiles or story maps, and a traditional naming "glossary" for voyaging, seafaring, marine environment, fish, and marine mammals.

Methods: Compile data from archival and secondary sources. Compile and summarize information from Native Hawaiian communities regarding traditional use that could be impacted by offshore development. Conduct guided in-person discussions (purposeful sampling method or another similar methodology) with navigators and cultural fishers in the kama'āina and Native Hawaiian communities. Collect human dimensions data from leaders in the community. Together with the Native Hawaiian community, BOEM will identify and implement protocols to address potentially sensitive information that will be excluded from the published final report. Identify best practices for incorporating traditional knowledge into analyses for NHPA and NEPA reviews. Prepare final report(s) of findings that detail(s) these efforts and maps/visual aids, as well as an exportable database of discussion results.

Specific Research Question(s):

1. What areas of traditional voyaging are of significance to the Native Hawaiian Community?
2. What areas of cultural boating and fishing are of significance to the Native Hawaiian and kama'āina community?
3. How can mitigation for potential impacts from offshore wind energy development be adapted to the unique culture and values of Hawai`i and Pacific Islanders?

Affiliated WWW Sites: N/A

[1] There is a PROUA effort on voyaging. PROUA did not map specific traditional and customary Hawaiian uses of the ocean. Workshops were held in eight locations throughout Hawai`i providing a foundation to build upon. See D'Iorio et al. 2015.

[2] A kama'āina may be considered to be someone who lives in Hawaii for a long time, or may be expanded to include people who once lived there but have moved away. Kama'āina is not necessarily ancestry based.

References:

D'Iorio M, Selbie H, Gass J, Wahle C. 2015. The Pacific regional ocean uses atlas, data and tools for understanding ocean space use in Washington, Oregon and Hawaii. Camarillo (CA): U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region. 702 p. Report No.: OCS Study BOEM 2015-014.

Van Tilburg H, Watson TK, Faria K, Hoomanawanui K, Ho-Lastiama I, Ritte W, Maly K, Nahoopii M, Horcajo K, Kaupiko K, et al. 2017. A guidance document for characterizing Native Hawaiian cultural landscapes. Camarillo (CA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 208 p. Report No.: OCS Study BOEM 2017-023.

Watson TK, Hoomanawanui K, Thurman R, Thao B, Boyne K. 2017. Na 'Ikena I kai (seaward viewsheds): inventory of terrestrial properties for assessment of marine viewsheds on the eight main Hawaiian islands. Camarillo (CA): U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region. 140 p. Report No.: OCS Study BOEM 2017-022.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Understanding Cetacean Ecology in the California Wind Energy Lease Areas (and Related to Floating Offshore Wind) Through Acoustic Analysis
Administered by	Pacific OCS Region
BOEM Contact(s)	Ingrid Biedron, (ingrid.biedron@boem.gov), Desray Reeb, (desray.reeb@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	April 27, 2023
Problem	The potential environmental effects to protected marine mammal species from floating wind energy offshore California are currently unknown. This study could provide information needed to understand future effects of offshore floating wind in this region.
Intervention	This study proposes to address current condition data gaps about the effects of offshore wind energy on cetaceans by doing fine-scale monitoring at the two California wind energy lease areas, including below water 3D passive acoustic tracking, active acoustic prey observations, and oceanographic measurements to provide information of the species present, their movements within the wind energy lease areas, assess prey availability, and describe oceanographic characteristics that support the use of these areas.
Comparison	This study will provide data about current conditions to inform comparisons with future monitoring data.
Outcome	Detailed understanding of marine mammal habitat use and oceanographic conditions (including soundscape) in the wind energy lease areas will inform future environmental monitoring needs and mitigation strategies to ensure minimal impact to these protected species.
Context	Morro Bay and Humboldt wind energy lease areas (offshore California)

BOEM Information Need(s): BOEM is required to evaluate the impacts to protected marine mammal species under the NEPA and ESA, and comply with the MMPA. Potential impacts from floating offshore wind (FOSW) on marine mammals and their habitat use are currently uncertain and expected to vary some from the effects of non-floating offshore wind structures due to the differing structure of the turbines, including potential cabling to stabilize the structures. Thus, it is imperative for BOEM to collect current condition data within the California wind energy lease areas to be able to accurately assess, avoid, minimize, and mitigate potential impacts. Addressing these needs is one of BOEM's highest-priority mission areas for Pacific OCS environmental studies in FY 2024.

Background: Since no large-scale FOSW farms have been built in U.S. waters, the potential impacts of FOSW installations on California's marine environment are currently only speculative. Based on studies in other regions in the U.S. and globally, and on common impacts from other anthropogenic sources,

including marine renewable development, potential impacts from FOSW include displacement from important habitats, entanglement (with FOSW mooring lines and cabling or from secondary entanglement in fishing gear that may attach to FOSW lines), increased underwater noise levels, collision (with turbines or with ships transiting to the installations for servicing), and exposure to electromagnetic fields from cabling (Copping and Hemery 2020; Rafter et al. 2019). Operation of the FOSW installations may attract or repel animals and these behavioral changes may affect species diversity, trophic interactions, feeding and reproduction activities, and biomasses (Copping and Hemery 2020).

This study would be uniquely positioned to expand on existing knowledge from an extensive monitoring program covering southern California waters and, specifically, the Morro Bay area near the wind energy lease area (Rafter et al. 2019). During a four-month monitoring effort based on an instrument located just south of the Morro Bay wind energy lease area (35° 24.00 N, 121° 33.75 W, depth 1,000 m), Scripps Institution of Oceanography ("Scripps") documented that the region is visited by several marine mammal species of concern for wind development, some of which only occur seasonally, specifically blue, fin, and humpback whales, as well as Cuvier's and Baird's beaked whales, killer and sperm whales, among other baleen and toothed whale species (Rafter et al. 2019).

However, information for this area is lacking on several aspects: 1) temporal and spatial knowledge on cetacean habitat use of the Morro Bay wind energy lease area covering more than four months and one site, and 2) an understanding of how cetaceans are taking advantage of possible prey resources in in various depth zones of the water column in the region. These questions will be addressed by this study. Oceanographic measurements allow for habitat modeling. New, finer-scale data will aid our understanding of possible interactions with offshore wind installations to inform future mitigation efforts.

Objectives: The objective of this study is to understand when, how, and why marine mammals are using the habitat within the Morro Bay and Humboldt wind energy lease areas, within the context of climate change, to provide data about current conditions to inform comparisons with future monitoring data.

Methods: Two to four bottom-founded monitoring systems could be deployed (either one system in each wind energy lease area, or two systems in each wind energy lease area to account for the ecological differences presented by the shelf slope across both wind energy lease areas; the estimated cost is for two arrays).

Within each wind energy lease area, we would place an array of sensors for conducting subsurface monitoring, which would include:

- Two four-channel passive acoustic monitoring (PAM) packages to localize toothed whales with a small aperture array
- One mooring spanning the seafloor to 200 m below water, holding:
    - One-channel passive acoustic recorder, used in conjunction with the four-channel PAM systems in a large aperture array to localize baleen whales
    - Two split-beam Simrad Wideband Acoustic Transceiver fisheries echosounders, capable of localizing targets in their acoustic beam within ~300 m from the transducer face
    - two oceanographic sensors positioned along the mooring to measure physical conditions (temperature, salinity, dissolved oxygen)

This array is specifically designed for concurrent recording of prey density and distribution across the water column (active acoustics) with predation pressure and individual foraging behavior in 3D (passive acoustics). Scripps has been deploying these systems for many years for the U.S. Navy.

Specific Research Question(s):

1. What is the spatial and temporal use of marine mammals in the Morro Bay and Humboldt wind energy lease areas?
2. Are marine mammals taking advantage of the diel vertical migration of prey resources in the wind energy lease areas?
3. What does the current oceanographic environment look like in the wind energy lease areas (temperature, salinity, oxygen, pH, fluorescence, and currents)?
4. How do the answers to the above three questions provide a more thorough understanding of the impacts of FOSW on cetacean ecology in California wind energy lease areas?
5. How do we describe the soundscape of these regions?

Affiliated WWW Sites: N/A

References:

Copping AE, Hemery LG. 2020. OES-Environmental 2020 state of the science report: environmental effects of marine renewable energy development around the world. Report for Ocean Energy Systems (OES). doi:10.2172/1632878.

Rafter MA, Rice AC, Gottlieb RS, Trickey JS, Hildebrand JA, Baumann-Pickering S. 2019. Passive acoustic monitoring of marine mammals offshore Diablo Canyon November 2012–March 2013. Marine Physical Laboratory, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA. 40 p. MPL Technical Memorandum #637.

Field	Study Information
Title	A Data Inventory and Assessment of Submerged Aircraft Loss Records on the OCS
Administered by	New Orleans Office
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov), James Moore (james.moore@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	May 17, 2023
Problem	BOEM has a deficiency in information pertaining to submerged aircraft lost over the Outer Continental Shelf (OCS). Much of BOEM's archaeological research has focused on shipwrecks and submerged landforms, neglecting efforts into the research and inventory of lost aircraft. BOEM is required under the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA) to assess potential impacts to historic and cultural resources that may be adversely affected by its approved actions.
Intervention	A comprehensive review of records and databases will be detailed to present a data inventory of various databases and records of sunken aircraft along the OCS. The review will help BOEM target information collection for future cultural resource assessments and archaeological database development.
Comparison	Information from historic records and data from several separate databases and associated digital records will be documented.
Outcome	A listing of historical records and data sources that will help BOEM target information collection on potential sunken aircraft sites along the OCS.
Context	Federal OCS

BOEM Information Need(s): Given aviation technology is relatively new in the broad history of the U.S., submerged aircraft are types of cultural resources that have been predominantly overlooked in planning considerations for Federal offshore industrial development. Thus, an inventory of general information regarding these resources will assist BOEM in the development of a future database. This will aid BOEM with its Section 110 responsibilities under the National Historic Preservation Act (NHPA) and National Environmental Policy Act (NEPA).

Background: On February 20, 2019, a survey company operating in the Gulf of Mexico snagged a sunken aircraft with the umbilical of a Remotely Operated Vehicle (ROV) while in the process of deploying an Ocean Bottom Node. While attempting to free the vehicle, portions of the wreckage associated with a propeller were dislodged, causing damage to the site and undermining its integrity. Incidents like these could be prevented if we knew where aviation losses have occurred in our operational areas. Further, if aircraft loss data were made more widely available, these data would assist survey companies in preparing more accurate interpretations of geophysical data for BOEM review. This has proven

successful with our existing shipwreck databases that were developed using similar studies in the past. BOEM's information management system is focused primarily on data relating to shipwrecks and prospective paleocultural sites on the Outer Continental Shelf (OCS). A comprehensive overview of submerged aircraft, however, would provide much-needed documentation of sources and loss data locations that could be integrated into new aircraft databases as a follow-on to this data inventory study.

According to the National Park Service (NPS), "much of America's 20th century history is inextricably linked to aviation. At times, American inventors, scientists, engineers, pilots, and military and civilian leaders headed pioneering efforts to develop aviation technology and uses. In different periods, the United States lagged behind other nations and needed highly dedicated and costly efforts to catch up" (1998).

Objectives: The study's objective is to create a comprehensive listing of the types of printed and digital records available at private libraries, Universities, and State and Federal Agencies.

Methods: Existing databases and records will be identified and reviewed for their information potential. The study will further rank data sources based on the rapid availability and potential for incorporation into BOEM's operational GIS planning tools.

Potential Database Resources:

- Air Force Historical Research Agency
- Air Force Legacy Program
- Army Center of Military History
- Aviation Archaeological Investigation and Research
- Civil Aeronautics Board
- Defense POW/MIA Accounting Agency
- Department of Defense Legacy Resources Management Program
- Heritage Preservation Services Program
- National Air and Space Museum
- National Aeronautics and Space Administration
- National Archives
- National Park Service
- National Register of Historic Places
- National Transportation and Safety Board
- National Trust for Historic Preservation
- Naval Historical Center
- U.S. Coast Guard Museum State Historic Preservation Offices

Specific Research Question(s):

- Which institutions, agencies, and repositories have data or records on submerged historic aircraft losses?
- Are these data usable or comprehensive enough for BOEM's operational permitting needs?

- What kinds of records does each potential source include (or doesn't include), e.g., time period of aircraft or loss incident, type and purpose of craft (military, commercial, private, offshore industry service, etc.), human casualty reports, etc.?
- How feasible would internal database development be using these data, and what further resources may BOEM require?

Affiliated WWW Sites: N/A

References:

National Park Service (NPS), Department of the Interior. 1998. Guidelines for evaluating and documenting historic properties. Milbrooke AE, editor. National Register Bulletin 43. Washington (DC): U.S. Government Printing Office.

Field	Study Information
Title	Evaluating the Social Vulnerability of Fishing Communities when Siting Offshore Wind Energy Developments in the Gulf of Mexico
Administered by	New Orleans Office
BOEM Contact(s)	Mariana Steen (mariana.steen@boem.gov)
Procurement Type(s)	Interagency Agreement or Contract
Performance Period	FY 2024–2026
Final Report Due	December 2026
Date Revised	February 7, 2023
Problem	BOEM continues to seek a better understanding of potential social effects resulting from authorized Outer Continental Shelf (OCS) activities. Current information is needed to better support meaningful engagement and inform decision-making and mitigation, when appropriate.
Intervention	Develop geospatial data that will enhance BOEM's ability to assess and mitigate potential impacts to commercial fishing communities during the offshore wind siting and development processes.
Comparison	This study, in part, will evaluate methodologies for linking fishing territories to onshore communities to compare the potential impacts to communities from offshore wind siting.
Outcome	Identification and characterization of commercial fishing communities reliant upon fishing grounds within exiting GOM WEAs and the incorporation of this information into geospatial data that can be used to site future wind energy lease areas in the Gulf of Mexico.
Context	Gulf of Mexico OCS

BOEM Information Need(s): There is a need for BOEM to better understand the dependency and social vulnerability of onshore commercial fishing communities, to potential impacts or altered access to fishing grounds located within Gulf of Mexico (GOM) Wind Energy Areas (WEAs) when siting offshore wind lease areas. Doing so would allow BOEM to better understand the potential impacts to commercial fishing communities before lease areas are sited. This is relevant to BOEM, as a priority of the Bureau is to mitigate impacts to commercial l fisheries from offshore wind developments, which is evident by BOEM's announcement of draft fisheries mitigation guidance released for public comment on June 23, 2002. Although this study is developed in the context of renewable energy, results will also be relevant and apply to other BOEM program areas (e.g., carbon capture and sequestration lease area siting) and analyses conducted to fulfill obligations under NEPA and other environmental statutes.

Background: BOEM's New Orleans Office worked with NOAA's NCCOS to collaboratively develop a spatial suitability model used to site WEAs in the GOM in a manner that reduced environmental impacts and space-use conflicts amongst ocean users to the greatest extent practicable (Randall et al., 2022). Commercial fishing is an important economic driver in the Gulf of Mexico region (NMFS 2021), and considerations of use patterns are important for ocean planning and conflict reduction. As such, the

model included commercial fishing effort data that allowed BOEM and NOAA to consider use patterns of fishing vessels for several socio-economically valuable fisheries (e.g., commercial shrimp). However, the model did not consider if particular commercial fishers and associated onshore communities may be more vulnerable to impacts associated with offshore wind development (i.e., displacement) and may have a lower ability to successfully respond and adapt to change. Doing so would allow BOEM to enhance its analyses of the impacts of offshore wind energy siting on fishing communities, including fishermen and shoreside support businesses (e.g., seafood processors, marinas, etc.), by working to incorporate relative importance/reliance or vulnerability metrics into spatial analyses to achieve more socially equitable outcomes (Chollett et al., 2022).

Objectives: The objectives of this study include:

- The identification and characterization of onshore commercial fishing communities at risk from impacts associated with offshore wind developments in existing GOM WEAs.
- The identification and augmentation of existing social vulnerability indices for identified, at risk commercial fishing communities.
- The development of standardized methodologies for creating geospatial data layer(s) that incorporate the social vulnerability indices utilized in this study for future use in spatial suitability models.

Methods: Social scientists with NOAA's SEFSC are in the process of developing datasets that link locational fishing effort data to landings and revenue data for the GOM commercial shrimp, reef fish (bandit reel and bottom longline), and highly migratory species (pelagic longline) fisheries. This study would leverage methodologies currently being developed for that effort, which focuses on eastern GOM fisheries, and expand the datasets to include BOEM's GOM Call Area for the commercial shrimp, reef fish, and highly migratory species fisheries. NOAA curates a suite of datasets including high-resolution vessel monitoring system data detailing fishing locations, and logbook data detailing, inter alia, catches and revenues, that would allow for the identification of "fishing territories" (*sensu*, Durrenberger and Pálsson 1987) that can be mapped. This dataset can then be used by geospatial analysis experts within NOAA's NCCOS to identify connections to shoreside commercial fishing communities, including dealers, processors, and ports, most at-risk to impacts associated with offshore wind developments in existing WEAs and augment existing social vulnerability indices (e.g., NOAA's Social Indicator Tool for Coastal Communities) that can be used to inform the development of geospatial data tailored to wind development needs. If communities with limited socio-economic data are identified to be reliant upon fishing grounds within existing WEAs, then ground truthing efforts would be necessary in order to obtain a more specialized scope/characterization of the vulnerability of impacted communities. Examples of social indicators that can be considered include commercial fishing reliance (i.e., measures the presence of commercial fishing in relation to population size of a community through fishing activity) and environmental justice indicators (e.g., poverty and demographics). Staff with NOAA's NCCOS would then develop the methodologies (e.g., code development, weighting schema, geodatabase development, etc.) needed to create geospatial data layer(s) that incorporate the social vulnerability indices. The geospatial data developed as part of this study will be uploaded into existing geoplatforms (e.g., Marine Cadastre) used for marine and coastal planning, and they can be updated and incorporated into spatial suitability models used in future siting efforts (e.g., to site offshore wind lease areas within existing BOEM WEAs).

Specific Research Question(s): Research questions include the following:

1. What commercial fishing communities utilize fishing grounds within existing GOM WEAs?
2. What is the relative importance of those fishing grounds to identified communities and the social vulnerability of those communities to potential impacts?
3. How can this information be used to create geospatial data (i.e., methodologies) for use in suitability models used to site offshore wind energy developments in a manner that increases socially equitable outcomes for commercial fishing communities, including underserved fishing communities?

Affiliated WWW Sites: N/A

References:

Chollett I, Perruso L, O'Farrell S. 2022. Toward a better use of fisheries data in spatial planning. Fish and Fisheries. 00:1-14.

Durrenberger EP, Pálsson G. 1987. Ownership at sea: fishing territories and access to sea resources. American ethnologist. 14(3):508-22.

NOAA, NMFS. 2021. Fisheries of the United States, 2019. U.S. Department of Commerce, NOAA Current Fishery Statistics No. 2019. Available at: https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states

Randall AL, Jossart JA, Matthews T, Steen M, Boube I, Stradley S, Del Rio R, Inzinna D Oos C, Coats L, et al. 2022. A wind energy area siting analysis for the Gulf of Mexico call area. New Orleans (LA):U.S. Department of Interior, Bureau of Ocean Energy Management. National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science. p. 204. Available at: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/GOM-WEA-Modeling-Report-Combined.pdf

Field	Study Information
Title	Gulf Coast Community and Cultural Impact Baselines Survey
Administered by	New Orleans Office
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov), Dustin Reuther (dustin.reuther@boem.gov), Sindey Chaky (sindey.chaky@boem.gov), Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Cooperative Agreement or Indefinite Delivery/Indefinite Quantity
Performance Period	FY 2024–2029
Final Report Due	TBD
Date Revised	February 8, 2023
Problem	BOEM needs additional information to more clearly characterize the indirect effects of OCS activities and industries on specific Gulf of Mexico communities to better collaborate with communities and Federal and state agencies in mitigating potential adverse effects. A broad range of baseline data are needed to define EJ communities, account for community and behavioral change before new operations like renewable energy, green hydrogen and carbon sequestration are employed in the Gulf of Mexico.
Intervention	Collect baseline datasets along coastal Gulf communities that may be affected by wind and carbon sequestration activities
Comparison	These datasets will serve as the baseline social factors data for comparison purposes in future NEPA and other BOEM decision documents. Specifically, the baseline data will be used to compare post-activity community change to document how wind and carbon sequestration programs affect community change (e.g., socio-economic, related infrastructure, air quality and health, demographic).
Outcome	Compliance with documenting and attributing impacts from program activities, including impacts on EJ and Tribal communities.
Context	Port Arthur, Holly Beach, Cameron, Lake Charles, Freeport, Galveston, Texas City, southern Houston, and the Houston Galveston-Brazoria area.

BOEM Information Need(s): BOEM requires more detailed and accurate baseline data and information about local level impacts to coastal communities than what is currently available through datasets typically used by Federal agencies to assess impacts (e.g., census data, EJ Screen, etc.). Information gaps exist regarding Gulf Coast communities, which are often rural and vulnerable to land loss, subsidence, and other natural and anthropogenic effects that have been occurring for decades. This data need is reinforced by Executive Orders 12898, 13175 and 14008, which direct Federal agencies to consider and communicate the potential disproportionate effects of their actions on low income, minority, and Indigenous populations. The White House Environmental Justice Executive Council and the Department of the Interior have indicated that EJ analyses should be expanded, when appropriate, to include such issues as social and economic equity and climate change. Further, BOEM requires this information to comply with the National Ambient Air Quality Standards (NAAQS) in OCSLA under section 5(a)(8); with

Section 110 of the National Historic Preservation Act; and to describe social, environmental, and cumulative impacts under the National Environmental Policy Act (NEPA). The baseline data used in the analyses under these various mandates could be improved to make more accurate assessments of effects, especially in NEPA documents.

Background: Renewables, carbon sequestration, and green hydrogen have not been implemented in the Gulf yet; gathering data as early as possible will provide multiple years for BOEM to build a robust baseline dataset that will be used for future comparative purposes. Existing baseline data (e.g., socio-economic, related infrastructure, air quality and health, demographic, etc.) from the Gulf of Mexico have proven of limited direct use for BOEM's actions and even less applicable to novel renewable energy and forthcoming carbon sequestration activities in the Gulf. This is further confounded by the likelihood that offshore renewables will interact with conventional energy and its supporting industries in numerous ways. It will be difficult to get a handle on baselines in the Gulf of Mexico (the nation's primary energy corridor) as compared to other OCS regions. This underscores the importance of committing resources prior to the start of new green-energy development before this burgeoning sector becomes similarly nebulous in impacts, effects, and spread. Since these activities are administration priorities, BOEM needs to strategically allocate substantial study funds now to be ready for major actions across the region.

There are several coastal communities adjacent to the call areas and/or adjacent to port and support facilities that utilize the coastal resources for subsistence, employment, and traditional practices and value its cultural aesthetic. Initial areas of focus identified include Port Arthur, Holly Beach, Cameron, Lake Charles, Freeport, Galveston, Texas City, and southern Houston. Also, the Houston Galveston-Brazoria area is in nonattainment status for the 8-hr ozone (O_3) NAAQS. This is a substantial geographic area for data collection, and this is reflected in the associated study costs. These baseline and monitoring datasets would be the first of their kind and could prove instrumental in identifying the effects of development and, subsequently, directly inform novel mitigation actions that would bolster development efforts across the nationwide Outer Continental Shelf (OCS).

Objectives: The objective of this study is to produce baseline datasets that would inform and enhance our cumulative impacts and social factors sections of forthcoming NEPA and environmental justice work. This study does not analyze a specific action, but rather provides the necessary baselines to compare the effects of future agency actions to measure change.

Methods:

1. Embed ethnographers and social scientists directly into the communities most likely to be impacted by foreseeable OCS wind development to capture baseline conditions and cumulative impacts through the lived experiences and dispositions of community members using participant observation and unstructured discussions. Then, using a citizen-science approach, empower community members to present their needs and observed impacts first-hand to better reach decision-makers in an effective manner. Continue monitoring the community after post-construction to understand what the salient post-construction impacts and concerns are in the community, as opposed to perceived pre-construction concerns, as well as temporary versus long-term concerns.
2. Use this boots-on-the-ground ethnographic perspective to ground truth and augment desktop analyses of potential environmental justice communities in the affected environment of these OCS wind developments. Such a perspective could also greatly facilitate outreach and

engagement with environmental justice communities, by identifying key points of concern to environmental justice communities (laying the foundation to explore mitigation methods), key contacts, and establishing a shared sense of understanding borne from direct ethnographic research.

3. Establish a baseline assessment to document changes and impacts to critical transportation and infrastructure to the communities. For example: will wind development projects place an unforeseen burden on local road systems?
4. Conduct air monitoring to assess effects from increase coastal usage from construction crews, port activity, increases in vessel traffic, and any modifications to fishing practices using an existing BOEM mobile air quality monitoring station.
5. Inventory cultural and historic resources that will likely be adversely affected by viewshed alteration.
6. Conduct a financial impacts analysis of coastal property valuation pre-and post-wind tower installation.
7. In coordination with U.S. Army Corps of Engineers Civil Works Program, States and Local communities, document how BOEM Gulf of Mexico Region can leverage its various programs including Marine Minerals, to harden shorelines and reduce or eliminate impacts to threatened coastal communities.
8. Develop customized outreach and engagement plans utilizing these proposed baseline assessments to streamline and assist with meeting President Biden's target of 30 Gigawatts from offshore wind by 2030.

Specific Research Question(s):

1. What are the baselines that need to be collected to measure community impact from an agency activity?
2. What are the various community concerns and are they temporary or long-term?
3. What are the effects of renewable and Carbon Capture and Storage development on communities?
4. What are the most effective definitions of "EJ communities" to use in relation to the Gulf call areas for renewable energy and how do we define those areas in future program activities?

Affiliated WWW Sites: N/A

References: None

Field	Study Information
Title	Gulf of Mexico Environmental Justice Fact Book: Identifying Coastal Communities Affected by Activities on the Outer Continental Shelf
Administered by	New Orleans Office
BOEM Contact(s)	Dustin Reuther (dustin.reuther@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2024–2028
Final Report Due	TBD
Date Revised	February 8, 2023
Problem	Currently there is no comprehensive resource for the identification and characterization of Gulf of Mexico environmental justice (EJ) communities as they relate to BOEM-adjacent activities, such as from onshore infrastructure previously identified, and resource management.
Intervention	A study which uses mixed methods to identify and characterize Gulf of Mexico EJ communities of particular interest to BOEM, especially as they relate to environmental impact analyses conducted by BOEM.
Comparison	This study would capture the current baseline for any EJ analyses and outreach efforts related to oil and gas, marine mineral management, and future renewable energy development in the Gulf of Mexico region, and thus serve as the comparison for future studies and analyses.
Outcome	This study would assist BOEM in understanding the EJ landscape of the region to better factor in EJ considerations in NEPA analyses as well as to conduct engagement and outreach more effectively to those communities through the development of an Environmental Justice Fact Book reference document.
Context	Gulf of Mexico Region

BOEM Information Need(s): Multiple vulnerable communities exist across the Gulf of Mexico (GOM) region, many of which would classify as environmental justice (EJ) communities based on widely accepted definitions and Federal guidance. While BOEM has sponsored EJ-related studies in the GOM in the past, these have mostly focused on specific locales, and have not taken a holistic, systematic view of the region. BOEM requires a clearer and more thorough understanding of these communities to better inform Bureau decision makers as mandated by the National Environmental Policy Act (NEPA), the Outer-Continental Shelf Lands Act (OCSLA) and various Executive Orders (EOs; 12898, 13985, 14008). Particularly, BOEM needs a better understanding of which EJ communities are most directly and indirectly impacted by BOEM-related actions and what sorts of cumulative stressors exist within those communities. 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. Further, this data would be an important resource in strengthening BOEM outreach and engagement activities across the region. In addition to understanding which communities BOEM should be engaging, BOEM needs to understand regional community-based capacity for engagement/outreach. This will help

BOEM in planning outreach and engagement efforts for its Gulf programs by identifying where organizational capacity already exists and where BOEM might need to extend extra efforts.

Background: Regionally, BOEM has sponsored a handful of EJ-specific studies in limited geographies (e.g., Hemmerling and Colten 2003, 2017) and a larger number of ethnographic studies which touch upon EJ concerns (e.g., Austin et al. 2014; Regis and Walton 2022). The region has also been the focus of many academic studies on EJ, including Bullard's (1990) landmark Dumping in Dixie. Some of these studies have highlighted the connection between oil and gas development and EJ concerns. For example, one study found EJ populations in coastal Louisiana communities 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 and carbon capture and storage (CCS) 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 BOEM analyses.

EJ communities can have compounding stressors impacting them, such as air quality, environmental degradation, weather events, economic stress, etc. To give an example, weather-related oil and gas spills, such as the onshore Murphy Oil refinery spill following Hurricane Katrina, have negatively affected EJ communities. With increasingly worsening hurricanes, this has compounding EJ implications, for example, following Hurricane Ida there were over 1,500 reports of pollution incidents in Louisiana and the OCS and NOAA identified 55 spills (Migliozzi and Tabuchi 2021; U.S. Coast Guard 2021). Further compounding the environmental impacts to the integrity of oil and gas infrastructure (and subsequent human impacts), 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, and also, that 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). Thus, in this example, it can be seen how some GOM EJ communities are impacted by the compounding effects of global climate, local environmental deterioration, oil and gas procurement and refining, and local and national policies.

Objectives: BOEM requires a better understanding of how to systematically identify and characterize EJ communities of concern and existing stressors within those communities (e.g., air quality) that contribute to cumulative impacts. This identification will make use of existing and forthcoming resources, such as the GOM Infrastructures Fact Book (GM-23-03). Also, BOEM seeks a strategy to identify organizational capacity and existing leadership within those communities so that BOEM can better plan outreach/engagement efforts.

Methods: This mixed-methods study will incorporate literature review, desktop analyses of geospatially-linked quantitative and qualitative data, unstructured phone and/or videoconferencing calls, and short-term ethnographic fieldwork. Literature review of existing research will both refine the methodology of the subsequent desktop analysis as well as provide information for community profiles in the final product. This method can take advantage of BOEM's ongoing "Digital Curation: Streamlining Access to Research Across Gulf of Mexico Communities" study (GM-17-11), which has qualitatively coded BOEM reports and academic literature using MAXQDA software. Desktop analyses will utilize existing datasets,

such as the Census Bureau's American Community Survey and/or the decennial census, existing tools, such as EPA's EJScreen and NOAA NMFS' Social Indicator Tool, as well as BOEM datasets, such as onshore infrastructure from GOM development captured in the existing and upcoming GOM Infrastructure Fact Books (e.g., GM-23-03). The specifics of these desktop analyses will be informed by efforts from past GOM EJ study efforts, the ongoing BOEM GOM EJ Technical Workshops (GM-21-x03), and both BOEM's national EJ Best Practices work and Characterization of EJ Communities pilot study (NT-23-05). For example, part of the desktop analysis could be to focus on infrastructure identified in the GOM Infrastructure Fact Book and then use EJ tools to scope surrounding communities and to also identify agencies responsible for regulating those facilities and whether those agencies or the facilities have EJ plans/programs. Unstructured phone and/or videoconferencing interviews with community leaders and EJ-related organizations will enhance information collected about EJ communities during the desktop analysis phase. The lower cost of remote interviews through telephone calls or videoconferencing calls allows for a greater spread of effort across the region. Short-term ethnographic fieldwork (such as rapid ethnographic assessment methods) will be used for communities which are deemed as particularly important to BOEM's EJ considerations through the previous methods. This is especially important for communities where existing data (such as the American Community Survey) is of low reliability (which can be expected for many small, rural communities across the region).

Specific Research Question(s):

1. How should "EJ communities" be conceptualized for this project to best augment BOEM's NEPA analyses and outreach efforts? Does existing data favor particular ways of defining and identifying EJ communities? How might disparate data sources be best translated/synthesized within the overarching project?
2. In what ways can we prioritize focus to specific communities to efficiently utilize BOEM resources?
3. What are the characteristics of identified EJ communities? These characteristics could include, for example, demographic data, short histories, economic information, language considerations, etc. What existing stressors exist in these communities which past, current, and reasonably foreseeable BOEM actions could interact with?
4. What leadership and organizational capacity exists within these communities that BOEM could draw upon for informational needs, information dissemination, and communication/outreach?

Affiliated WWW Sites: N/A

References:

Austin D, Marks B, McClain K, McGuire T, McMahan B, Phaneuf V, Prakash P, Rogers B, Ware C, Whalen J. 2014. Offshore oil and Deepwater Horizon: social effects on Gulf Coast communities, volume I. New Orleans (LA): U.S. Dept. of the Interior, Bureau of Ocean Energy Management. 266 p. Report No.: OCS Study BOEM 2014-617.

Bullard, RD. 1990. Dumping in Dixie: Race, Class, and Environmental Quality. Boulder CO: Westview Press.

Dalbom C, Hemmerling SA, Lewis JA. 2014. Community resettlement prospects in southeast Louisiana: a multidisciplinary exploration of legal, cultural, and demographic aspects of moving individuals and communities. New Orleans (LA): Tulane Institute on Water Resources Law and Policy.

Laska S, Wooddell G, Hagelman R, Gramling R, Teets Farris MT. 2005. At risk: the human, community and infrastructure resources of coastal Louisiana. Journal of Coastal Resource 44:90–111.

Hemmerling SA, Colten CE. 2003. Environmental justice considerations in Lafourche Parish, Louisiana. New Orleans (LA): U.S. Department of the Interior, Minerals Management Service. 354 p. Report No.: OCS Study MMS 2003-038.

Hemmerling SA, Colten CE. 2017. Environmental justice: a comparative perspective in Louisiana. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 197 p. Report No.: OCS Study BOEM 2017-068.

Hemmerling SA, DeMyers CA, Parfait J. 2021. Tracing the flow of oil and gas: a spatial and temporal analysis of environmental justice in coastal Louisiana from 1980 to 2010. Environmental Justice 14(2):134–145.

Migliozzi B, Tabuschi H. 2021. After Hurricane Ida, oil infrastructure springs dozens of leaks. New York Times. [accessed January 26, 2022]. https://www.nytimes.com/interactive/2021/09/26/climate/ida-oil-spills.html

Regis H, Walton S. 2019. Subsistence in coastal Louisiana, volume 1: an exploratory study. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 172 p. Report No.: OCS Study BOEM 2020-063.

U.S. Coast Guard. 2021. UPDATE 3: Coast Guard continues to support Hurricane Ida recovery efforts. [accessed January 26, 2022]. https://content.govdelivery.com/accounts/USDHSCG/bulletins/2f0984c

Field	Study Information
Title	Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) II
Administered by	New Orleans Office
BOEM Contact(s)	Timothy White (timothy.white@boem.gov), Hayley Karrigan (Hayley.Karrigan@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2024–2029
Final Report Due	TBD
Date Revised	February 8, 2023
Problem	Long-term data on protected species in the GOM are limited. Collection of these data are essential to understand the potential effects of BOEM-related activities on these species relative to long-term climatological changes and industrial activities.
Intervention	Aerial observations, shipboard observations, oceanographic sampling, telemetry, and passive acoustic monitoring will be used to collect ecological data, covering all major species of interest.
Comparison	Improve discovery of and access to data and study products to compare anthropogenic impacts in living marine resources.
Outcome	Provide important information to inform both BOEM and Bureau of Safety & Environmental Enforcement (BSEE) decisions, including siting of offshore renewable energy and to support the effective management and conservation of Gulf protected species, and to understand and differentiate between the potential effects of changing environmental conditions and BOEM-related activities on offshore species of interest in the Gulf of Mexico.
Context	North Central GOM Region / proposed Wind Energy Areas (WEAs).

BOEM Information Need(s): Improved information is needed on seabird, cetacean, and turtle distribution, abundance, habitat use, and behavior in the GOM to understand better and mitigate the potential impacts of human activities, including those related to all BOEM programs. The next phase of GOMMAPPS science will focus more survey effort on targeting Wind Energy Areas (WEAs) using innovative technologies and traditional surveys to inform pre-and post-construction planning. Collecting multiple layers of information within and outside WEA boundaries will help BOEM better connect the relationships between localized systems with high potential for development and the broader environment. The U.S. GOM Outer Continental Shelf (OCS) is considered critically important to North America's migratory bird, marine mammal, and sea turtle resources during some point of their annual life cycle, and BOEM requires distribution and abundance information about marine protected species for consultations under the Endangered Species Act. Population and distribution assessments are also used to analyze potential interactions with industry activities and quantify take for industry permits. The Outer Continental Shelf Lands Act (OCSLA) and other resource management statutes, including National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Marine Mammal Protection Act

(MMPA), Magnuson-Stevens Fishery Management Act (MSFMA), Migratory Bird Treaty Act (MBTA)) impose requirements for BOEM to analyze and mitigate potential environmental effects of BOEM-authorized activities. The results of this study would provide important information, facilitate effects analyses, and inform BOEM and BSEE regulatory actions.

Background: The GOM is a heavily utilized and industrialized basin, supporting oil and gas exploration and development, commercial and recreational fishing, shipping, military operations, and tourism. GoMMAPPS I was initially conceived as a long-term research and monitoring program and a successful partnership between BOEM, the National Oceanographic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS) that conducted broad-scale surveys to assess the distribution and abundance of marine mammals, sea turtles, and seabirds in the northern GOM. Data collected in association with GoMMAPPS I developed a better understanding of the distribution and density of the species of interest in the Gulf of Mexico, as well as the oceanic environment itself. The first 5-year phase ended in FY2023, and the rapid assimilation of scientific products produced by GoMMAPPS resulted in an updated marine mammal stock assessment by NOAA and informed siting of wind lease areas in the GOM by BOEM (Randall et al., 2022). To address shared regulator and stakeholder information needs, GoMMAPPS II proposes a collaboration among BOEM, NOAA, and a range of Federal and industry stakeholders. Currently, BOEM, NOAA, the Marine Mammal Commission (MMC), and EnerGeo Alliance are exploring shared information needs and methods to address those needs. Additional potential partners are being considered.

Objectives: The objective of this study is to improve abundance, distribution, habitat use, and behavioral information concerning protected living marine resources through multi-year surveys of seabirds, cetaceans, and sea turtles in areas of shared interest. The study is expected to provide updated information on population trends and improve the seasonal coverage of available data. By improving the accuracy and precision of habitat utilization models, this study will generate improved seasonal density maps of seabirds, cetaceans, and sea turtles to inform environmental impact assessments of offshore energy development.

Methods: GoMMAPPS activities by category:

- **Spatial-temporal distribution patterns and abundance estimates** of protected species collected over multiple scales and years to develop models and associated tools that translate these survey data into seasonal, spatially-explicit density estimates incorporating habitat characteristics.
- **Tagging studies** of protected species to develop corrections for availability bias in the abundance survey data and to investigate behavior and ecology of species in areas of interest.
- **Alternative platforms and technologies** to improve population assessment studies (e.g., eDNA).
- **Operationalize cost-efficient remote sensing-and machine learning-based methods** developed on the Atlantic Marine Assessment Program for Protected Species (AMAPPS) to survey and monitor marine wildlife to improve the quality of population estimates and distribution mapping while enhancing personnel safety.
- **Using very high-resolution satellite imagery to detect cetaceans**: Several recent technological advances make this technology on the cusp of operational feasibility: 1) the launch of the Maxar WorldView-3 satellite with 30cm resolution; 2) the planned launch of the Maxar Legion program with dramatically improved revisit rates; 3) proof of concept academic studies; and 4) advances in deep learning tools which enable semi-automated identification and classification of objects.

- **Plankton sampling** to examine potential prey and associations with higher tropic levels.
- **Collaboration** via data sharing with other related observational efforts in the Gulf.

Specific Research Question(s):

1. Can we improve spatially-explicit abundance and distribution models with additional data, in particular, with respect to potential seasonal data gaps (e.g., fall and winter)?
2. Have there been changes in abundance and distribution in marine mammal species in the northern Gulf in recent years? If so, do these changes reflect long-term trends in population size and distribution of these species and others occurring in similar habitats?
3. What proportion of time are turtles spending in the top 2 m of the water column during winter months?
4. What is the distribution of adult leatherbacks, greens, and hawksbills in the GOM?
5. What is the distribution and abundance of sea turtles in the Western Planning Area (WPA)?
6. Can we successfully incorporate imaging into aerial surveys to aid in sea turtle species ID?
7. What spatial scales are required to develop reliable spatially-explicit products of distribution and abundance for the WEAs without sacrificing resolution?
8. How can technologies like eDNA and satellite remote sensing be used most effectively in the larger GOM and the WEAs to resolve species-specific occurrence and ecological community structure?

Affiliated WWW Sites: GoMMAPPS | Bureau of Ocean Energy Management (boem.gov)

References:

Garrison LP, Ortega-Ortiz J. Rappucci G. 2021. Abundance of coastal and continental shelf stocks of common bottlenose and Atlantic spotted dolphins in the Northern Gulf of Mexico: 2017-2018.

Hart KM, Lamont MM. 2021. Discerning behavioral patterns of sea turtles in the Gulf of Mexico to inform management decisions (corrected version). New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 78 p. Report No.: BOEM 2021-088.

Jodice PG, Michael PE, Gleason JS, Haney JC, Satgé YG. 2021. Revising the marine range of the endangered black-capped petrel Pterodroma hasitata: occurrence in the northern Gulf of Mexico and exposure to conservation threats. Endangered Species Research. 46:49–65.

Michael PE, Hixson KM, Haney JC, Satgé YG, Gleason JS, Jodice PG. 2022. Seabird vulnerability to oil: exposure potential, sensitivity, and uncertainty in the northern Gulf of Mexico. Frontiers in Marine Science. 9:880750.

Randall AL, Jossart JA, Matthews T, Steen M, Boube I, Stradley S, Del Rio R, Inzinna D Oos C, Coats L, et al. 2022. A wind energy area siting analysis for the Gulf of Mexico call area. New Orleans (LA):U.S. Department of Interior, Bureau of Ocean Energy Management. National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science. p. 204. Available at: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/GOM-WEA-Modeling-Report-Combined.pdf

Field	Study Information
Title	Gulf of Mexico Region Coastal Ambient Air Quality Monitoring Program: Phase II
Administered by	New Orleans Office
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement, Interagency Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	February 6, 2023
Problem	Concentrations of criteria air pollutants and their precursors are lacking at the Gulf of Mexico's shoreline.
Intervention	Criteria air pollutant concentrations and their precursors will be measured and monitored at a determined site along the coast using federal requirements.
Comparison	Observed criteria pollutants will be compared to the NAAQS.
Outcome	Use the criteria air pollutant concentrations to determination if concentrations are below or above the NAAQS. At low and high concentration events, analyze meteorological conditions to determine if impacts occurred due to onshore or offshore sources. Also, determine appropriate coastal background concentrations to be used in air quality modeling.
Context	Central Gulf of Mexico, Western Gulf of Mexico

BOEM Information Need(s): BOEM needs to determine if activities authorized under the Outer Continental Shelf Lands Act (OCSLA) comply with the National Ambient Air Quality Standards (NAAQS). OCSLA, under section 5(a)(8), requires compliance with the NAAQS pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.), to the extent that activities authorized under the subchapter significantly affect the air quality of any state. Furthermore, monitoring information will support environmental assessments for the National Environmental Policy Act (NEPA) and help validate data from the TEMPO (Tropospheric Emissions: Monitoring of Pollution) and TROPOMI (TROPOspheric Monitoring Instrument) satellites.

Background: NAAQS cover six common criteria air pollutants (Carbon Monoxide [CO], Lead [Pb], Nitrogen Dioxide [NO_2], Ozone [O_3], Particulate Matter (PM), and Sulfur Dioxide [SO_2]) that are considered harmful to the public. Evaluating trends in air quality will help analyze emissions from oil and gas activities, and renewable and carbon sequestration activities before they start. Information from the monitors could also contribute to the State's ambient air monitoring data and U.S. Environmental Protection Agency (USEPA) air quality monitors app used by the public. Measurement data on emissions from OCS activities and their air quality impacts on adjacent States are limited. There are few monitoring stations located near the shoreline of the Gulf of Mexico and those few stations are typically located near major highways or industrial sites which limit their usefulness in analyzing activities authorized under OCSLA. Louisiana's most recent 2021 Annual Monitoring Network Plan shows many of their site monitoring objectives are for high population areas or source oriented. BOEM currently has a mobile

monitoring station in a rural coastal area of Louisiana. The station started collecting ambient air pollutant concentrations in September of calendar year 2021 and will stop collection in September of calendar year 2024, due to the end of an existing contract. The data from this work will help BOEM evaluate air quality modeling predictions, establish background concentrations to demonstrate compliance with the NAAQS, and examine offshore impacts and trends for environmental assessments.

Episodes of high ozone levels (events that occur above the NAAQS) in the GOM overwater have been observed through photochemical modeling (Wilson et al., 2019). The study suggests that "episodes of high ozone over the Gulf are commonly associated with or closely preceded by offshore flow carrying ozone (and presumably ozone precursors) out over Gulf of Mexico waters where, in contrast to ozone over land, the elevated concentrations persist, often into the next day. Additional offshore ozone formation was also observed, both during the initial offshore flow period and on subsequent day(s). We speculate that reduced vertical mixing and a lack of ozone destruction mechanisms result in an environment that can lead to higher ozone concentrations over the Gulf than over land. Elevated ozone over the Gulf was not observed during sustained periods of onshore flow, indicating that interaction with a continental airmass is necessary for development of high ozone over the Gulf." According to photochemical modeling estimates, OCS oil and gas sources in the Gulf of Mexico Region contributed about 43% (30.1 ppb) to the 8-hr ozone NAAQS (Wilson et al., 2019). However, BOEM has learned from past studies that, baseline air concentrations are one source of uncertainty in photochemical models (Biazar et al., 2010). The baseline concentrations in the air may vary-excluding OCS oil and gas sources-thus making it difficult to determine the effect that OCS oil and gas sources have on air quality. Continued deployment of the rural monitoring station equipped with trace level monitors along the Gulf Coast would help to understand baseline air concentrations including ozone concentrations at low and high episodes.

Also, the TEMPO and TROPOMI satellites will provide datasets of atmospheric chemistry measurements. However, remote-sensing measurements from the satellites cannot provide ambient NO_2 concentrations, but the monitors on the mobile monitoring station can. Thus, the data between satellites and the mobile monitoring station will help to examine the relationship between column and ambient NO_2. The mobile monitoring station is equipped with a Pandora Instrument, which is used to measure total column trace gases. BOEM has a current interagency agreement with NASA to assist in validating data from TEMPO and TROPOMI so this separate study can both help fulfil that agreement by validating the satellite data while also helping collect background air column and ambient air data.

The mobile monitoring station could be used for Gulf Coast Community and Cultural impact Baselines Survey study.

Objectives: This study will determine if criteria air pollutants at the monitoring site increased or decreased during onshore (i.e., air flows from sea to land) or offshore (i.e., air flows from land to sea) flows, thus giving BOEM a better idea of air quality conditions at the shoreline from relatively undisturbed air from local onshore emissions. Furthermore, the use of the new Pandora system on the monitoring station will allow BOEM to validate the TEMPO and TROPOMI data at coastal and marine environments so that BOEM can use the satellite data for air quality management.

Methods: This project is special because it will allow us to continue to use BOEM's existing mobile monitoring station that has already been built and paid for by past study efforts. It will allow BOEM to measure baseline coastal air quality without interference from highways or chemical plants. Furthermore, the Pandora instrument on the mobile monitoring station will allow BOEM to continuously

measure total column NO_2 and corroborate with NASA on the validation of the TEMPO and TROPOMI satellite data. BOEM has an interagency agreement with NASA to validate the satellite data, of which NASA is planning to fly over the BOEM monitoring station to compare aircraft, satellite, and monitoring data. The station is equipped to monitor trace level carbon monoxide (CO) by infrared radiation absorbance, nitrogen oxides (NO_x) by chemiluminescence, nitrogen dioxide (NO_2) by chemiluminescence with a photolytic converter, photolysis rate of nitrogen dioxide (jNO_2) by filter radiometer, ozone (O_3) by UV absorption, and total reactive nitrogen (NO_y) by chemiluminescence with a heated molybdenum converter. CO, O_3, and NO_2 are criteria air pollutants, while the other measured pollutants are precursors to criteria air pollutants and/or allow for quality control of the data. Optional particulate matter (PM) monitors could be added to the station. The stations meteorological measurements include wind speed (ultrasonic three-dimensional), relative humidity, barometric pressure, and differential temperature (at 2 and 10 meters) measurements. All data will be imported to the public Air Quality System (AQS) containing ambient air pollution data collected from federal and state control agencies. The AQS system will have both BOEM's monitoring station and existing monitoring station data. The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model would be used to help determine which sources may contribute to low and high polluted days using existing NOAA meteorological datasets such as the North American Mesoscale Forecast System (NAM-12km) or, if available, a higher-resolution dataset for sea/land interactions.

Specific Research Question(s):

1. Using BOEM's monitoring station and existing monitoring stations from EPA's AQS, what are the criteria air pollutants concentrations and temporal and spatial trends at the shoreline?
2. What are the main factors contributing to variability of the monitored pollutants?
3. Are the measured criteria air pollutants above or below the NAAQS?
4. By use of the HYSPLIT model, was the low and high polluted days due to onshore or offshore flow, and which sources possible contributed?

Affiliated WWW Sites: N/A

References:

2021 Louisiana Annual Monitoring Network Plan. Louisiana Department of Environmental Quality Office of Environmental Assessment Air Planning and Assessment Division. Accessed December 20, 2022. Internet website: https://www.deq.louisiana.gov/assets/Air_Data_Sets/LDEQ_2021_Annual_Monitoring_Network_Plan_with_Cover_Letter.pdf.

Biazar AP, McNider RT, Newchurch M, Khan M, Park YH, Wang L. 2010. Evaluation of NASA AURA's data products for use in air quality studies over the Gulf of Mexico. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement. 82 p. Report No.: OCS Study BOEMRE 2010-051.

Wilson D, Stoeckenius T, Brashers B, Do B. 2019. Air quality modeling in the Gulf of Mexico Region. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 655 p. Report No.: OCS Study BOEM 2019-057.

Field	Study Information
Title	Offshore Wind Energy Facilities Impact on Hydrodynamics and Biological Production in the Gulf of Mexico
Administered by	New Orleans Office
BOEM Contact(s)	Mary Kate Rogener-DeWitt (Mary.rogener-dewitt@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, or Cooperative Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 17, 2023
Problem	The Louisiana-Texas shelf is a highly productive, broad continental shelf with complex hydrodynamics due to riverine input from the Mississippi and Atchafalaya Rivers and seasonally varying shelf circulation. Modeling studies from other regions indicate that offshore wind energy facilities may have an impact on local and regional hydrodynamics, raising stakeholder concerns about potential impacts to the northern Gulf of Mexico.
Intervention	A coupled hydrodynamic-biogeochemical model will be used to estimate the potential impacts of offshore wind energy facilities and various wind turbine layouts on the hydrodynamics in the Gulf of Mexico region, specifically within planned Wind Energy Areas.
Comparison	This study will investigate hydrodynamic conditions prior to offshore wind construction, post installation of a single facility, post full build-out of all planned offshore lease areas, as well as various turbine layout scenarios (e.g., spacing, turbine size, layout orientation) in the Gulf of Mexico region.
Outcome	This study will estimate the potential impacts of offshore wind energy facilities, at different stages of development and various turbine layouts, on Gulf of Mexico outer continental shelf hydrodynamics. This information is necessary for mitigation efforts and future NEPA analyses.
Context	Northern Gulf of Mexico

BOEM Information Need(s): Per 30CRF585.101(c), BOEM needs to ensure that renewable energy activities on the Outer Continental Shelf (OCS) are conducted in a safe and environmentally sound manner. To satisfy this obligation and support the sustainable development of offshore wind in the Gulf of Mexico, BOEM needs to understand and predict the potential impact of offshore wind development on local and regional hydrodynamics and resulting impacts on biological productivity.

This study would help BOEM estimate potential impacts of offshore wind energy facilities–during various stages in development and layout scenarios–on the hydrodynamics and productivity of the Gulf of Mexico; provide information to stakeholders through impact assessments and consultations; and guide optimal mitigation measures. These results would be included as part of impact assessments pursuant to the National Environmental Policy Act and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: The Gulf of Mexico is a highly productive, broad continental shelf system with complex hydrodynamics due to multiple river plumes with varying spatial distributions, Loop Current eddies, and seasonally driven shelf circulation resulting in stratification along the shelf (Hetland and DiMarco, 2012). As a result of the complex oceanographic regimes, the Gulf of Mexico is prone to low oxygen conditions. Research in the North Sea, a similar low oxygen prone system, has shown that wind energy facilities further decrease dissolved oxygen concentrations in areas with already low oxygen concentrations (Daewel et al., 2022). Additionally, studies from other regions have shown that offshore wind energy facilities alter regional and local hydrodynamics, surface wind fields, biological productivity, and biogeochemistry (Slavik et al., 2019; van Berkel et al., 2020; Johnson et al., 2021; Christiansen et al., 2022; Daewel et al., 2022; Raghukumar et al., 2022, submitted). However, these regions (North Sea, California Current, and the Mid-Atlantic Bight) have significantly different oceanographic regimes than the Gulf of Mexico. Due to the productive and dynamic nature of the Gulf of Mexico, it is important to understand how offshore wind energy development in the Gulf of Mexico may impact hydrodynamics and biological productivity.

Offshore wind facilities reduce local wind speeds by drawing energy from surface winds, and the turbines alter the turbulence of currents flowing past the structures (Dorrell et al., 2022; Raghukumar et al., 2022). Both effects may alter regional and local hydrodynamics, resulting in impacts to biological productivity. Recently BOEM designated two Wind Energy Areas (WEAs) for offshore wind development on the OCS of Texas and Louisiana. Stakeholders have expressed concern regarding the impacts of large and multiple projects on circulation patterns in response to recently published findings on the impacts of wind energy facilities on hydrodynamics, biological production, and local oxygen concentrations. To date, BOEM has funded studies to analyze the impacts of offshore wind energy facilities on physical and biological oceanographic processes in the California Current, Southern New England, and Mid-Atlantic Bight (Chen et al., 2016; Johnson et al., 2021; BOEM Study AT-22-01A&B; BOEM Study NT-23-09). Conditions in those regions differ from the physical and biological dynamics of the Gulf of Mexico and the locations of the two WEAs. To address the knowledge gaps in the Gulf of Mexico and determine potential mitigations, BOEM needs to estimate the potential effects of wind turbine structures, field structure configurations, and development of multiple wind energy facilities within the WEAs on the surrounding ecosystem. The first wind energy lease sale in the Gulf of Mexico is scheduled for summer 2023 and this study would provide vital information during the development and environmental review of future lessees' Construction and Operation Plans.

Similar to the impacts of offshore wind energy facilities on regional and local hydrodynamics, little is known about the hydrodynamic impacts of various wind turbine layouts (i.e., spacing distance, layout orientation, and turbine size) and how layout design might mitigate potential impacts of altered hydrodynamics as wind turbine size and capacity increase. Thus far, wind turbine siting has focused on minimizing the wind wake between turbines for maximum energy output and providing ample space for navigation of vessels and fishing activities. A recent atmosphere-only modeling study of WEAs in the Mid-Atlantic determined that wind speed, turbulence, friction velocity, and sensible heat fluxes at the surface of the water are slightly reduced in wind farms with turbines 10 MW or larger (Golbazi et al., 2022). These results suggest that there may be impacts to local oceanic circulation patterns from varying sized turbines. By running various model scenarios, this study would help identify optimal turbine orientation, size, and layout to ensure the least amount of local hydrodynamic impact on the environment.

Objectives: The objective of this study is to use model simulations to estimate the potential impacts of offshore wind energy facilities in the Gulf of Mexico on hydrodynamics and biological production.

Various development scenarios and turbine layouts will be investigated and used to evaluate the formation of possible mitigation measures.

This modeling effort would require open-source modeling tools, which would be made publicly available to allow for the transfer of model simulations to other regions as well as to provide code base and configurations for future projects to build upon. This objective aligns with administration priorities to make federally funded research and development accessible to the public in a transparent, reusable, equitable, secure, and trustworthy way (White House memo, 2022).

Methods: A Gulf of Mexico regional modeling approach will be used, and the spatial domain of the model will include the specific WEAs on the Louisiana-Texas OCS. The hydrodynamics of different scenarios will be simulated. Example scenarios include conditions prior to offshore wind farm construction, post installation of a single facility, and a realistic layout of multiple facilities across the WEAs. Additional scenarios may include layouts of varying turbine sizes, spacing, and other characteristics that may impact the hydrodynamics.

This study will build upon existing knowledge, studies, and established models (HYCOM, FVCOM, ROMS, Delft3D, etc.) in the region. No new data or field work will be executed as part of this study due to the richness of data available in the Gulf of Mexico region. This study will start with a synthesis of available empirical data in the region where the wind energy facilities are planned, which may include satellite data, current profiles, meteorological measurements, geophysical surveys, and archived biogeochemical data (macronutrients and other available data). These data would inform an existing coupled hydrodynamic-biogeochemical model that offers the best approach and resolution to complete the objectives and specific research questions.

Specific Research Question(s):

1. How could potential offshore wind energy facilities alter local and regional hydrodynamic processes in the planned WEAs on the Louisiana-Texas OCS? How might these impacts change because of climate change and a warming ocean?
2. How might potential changes in hydrodynamic processes impact biological production throughout the region?
3. How might hydrodynamic processes change over the duration of a build and with different wind turbine layouts?
4. How might alternative siting or turbine layouts act as mitigation efforts and limit impacts on hydrodynamics?

Affiliated WWW Sites: N/A

References:

Bureau of Ocean Energy Management Environmental Studies Program Study Profile on Offshore Wind Impacts on Oceanographic Processes: North Carolina to New York (AT-22-01A&B), https://www.boem.gov/sites/default/files/documents/environment/environmental-studies/Offshore-Wind-Impacts-on-Oceanographic-Processes-North-Carolina-New%20York.pdf

Bureau of Ocean Energy Management Environmental Studies Program Study Profile on Offshore Wind Farm Impacts on Pacific Upwelling, Nutrients, and Productivity (NT-23-09),

https://www.boem.gov/sites/default/files/documents/environment/environmental-studies/NT-23-09.pdf

Chen C, Beardsley RC, Qi J, Lin H. 2016. Use of Finite-Volume Modeling and the Northeast Coastal Ocean Forecast System in Offshore Wind Energy Resource Planning. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 131 p. OCS Study BOEM 2016-050. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/NE-Ocean-Forecast-Model-Final-Report.pdf

Christiansen N, Daewel U, Djath B, Schrum C. 2022. Emergence of large-scale hydrodynamic structures due to atmospheric offshore wind farm wakes. Frontiers in Marine Science, 9:818501. https://doi.org/10.3389/fmars.2022.818501

Daewel U, Akhtar N, Christiansen N, Schrum C. 2022. Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the North Sea. Communications Earth & Environment. 3(1): 1-8. https://doi.org/10.1038/s43247-022-00625-0

Dorrell RM, Lloyd CJ, Lincoln BJ, Rippeth TP, Taylor JR, Caulfield CCP, Sharples J, Polton JA, Scannell BD, Greaves DM, Hall RA and Simpson JH. 2022. Anthropogenic Mixing in Seasonally Stratified Shelf Seas by Offshore Wind Farm Infrastructure. Frontiers in Marine Science. 9:830927. https://doi.org/10.3389/fmars.2022.830927

Golbazi M, Archer CL, Alessandrini S. 2022. Surface impacts of large offshore wind farms. Environmental Research Letters. 17(6): 064021. https://doi.org/10.1088/1748-9326/ac6e49

Hetland RD, DiMarco SF. 2012. Skill assessment of a hydrodynamic model of circulation over the Texas–Louisiana continental shelf. Ocean Modelling. 43: 64-76. https://doi.org/10.1016/j.ocemod.2011.11.009

Johnson T, van Berkel J, Mortensen L, Bell M, Tiong I, Hernandez B, Snyder D, Thomsen F, Peterson P. 2021. Hydrodynamic Modeling, Particle Tracking and Agent-Based Modeling of Larvae in the U.S. Mid-Atlantic Bight. Lakewood (CO): U.S. Department of the Interior, Bureau of Ocean Energy Management. 232 p. Report No.: BOEM 2021-049. https://marinecadastre.gov/espis/#/search/study/100324

Raghukumar K, Chartrand C, Chang G, Cheung L, Roberts J. 2022. Effect of Floating Offshore Wind Turbines on Atmospheric Circulation in California. Frontiers in Energy Research. 660. https://doi.org/10.3389/fenrg.2022.863995

Raghukumar K, Nelson T, Jacox M, Chartrand C, Fiechter J, Chang G, Cheung L, and Roberts J, submitted. Cross-shore changes in upwelling from offshore wind development in California.

Slavik K, Lemmen C, Zhang W, Kerimoglu O, Klingbeil K, Wirtz KW. 2019. The large-scale impact of offshore wind farm structures on pelagic primary productivity in the southern North Sea. Hydrobiologia. 845(1): 35-53. https://doi.org/10.1007/s10750-018-3653-5

van Berkel J, Burchard H, Christensen A, Mortensen LO, Svenstrup Petersen O, and Thomsen F. 2020. The effects of offshore wind farms on hydrodynamics and implications for fishes. Oceanography 33(4): 108–117, https://doi.org/10.5670/oceanog.2020.410.

White House memo on Multi-Agency Research & Development Priorities, 22 July 2022, https://www.whitehouse.gov/wp-content/uploads/2022/07/M-22-15.pdf

Field	Study Information
Title	Seismic Survey Mitigation Measures and Protected Species Observer Report
Administered by	New Orleans Office
BOEM Contact(s)	Beth Nord (beth.nord@boem.gov), Tre Glenn (tre.glenn@boem.gov), Hayley Karrigan (hayley.karrigan@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2026
Final Report Due	December 2026
Date Revised	February 8, 2023
Problem	Marine mammals depend on sound to perform various life functions. Noise generated during geological and geophysical activities can interfere with these behaviors through masking, physiological effects, and animal response to the noise.
Intervention	This study will increase BOEM's knowledge of impacts from noise generated during geologic and geophysical surveys and knowledge into the effectiveness and/or synthesis of the current suite of National Marine Fisheries Service (NMFS) mitigations in use to reduce impacts to these species.
Comparison	The study will investigate the effectiveness of the current oil and gas program area seismic mitigation measures for the 2016–2023 data set and compare that information with the data evaluated in two previous studies. The study will determine compliance levels of the 2016–2023 data set and compare those compliance levels with the data evaluated in the two previous studies. Study results would also be used to propose revisions to current NMFS mitigations (e.g., Protected Species Observer [PSO] reporting) and support annual reporting associated with the 2020 Biological Opinion for Outer Continental Shelf Oil and Gas activities in the Gulf of Mexico (hereafter 2020 BiOp).
Outcome	Expand BOEM's understanding of mitigation effectiveness and potentially inform development of new or revised mitigation measures. This information would be utilized for future National Environmental Policy Act (NEPA) assessments and Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) consultations or coordination activities for the Oil and Gas program area and the ongoing implementation of 2020 BiOp. Information about mitigation effectiveness specific to high resolution geophysical sources could have applications to surveys conducted for the Renewable Energy and Marine Mineral program areas.
Context	Northern Gulf of Mexico

BOEM Information Need(s): Specific information is needed on current GOM oil- and gas-related seismic survey mitigation effectiveness, mitigation compliance evaluation, types of geological and geophysical surveys and sources, and protected species (e.g., marine mammal and sea turtle) detections and responses. This information will be used to develop improvements to mitigations, as applicable, and

supplement reporting provided for the 2020 Biological Opinion (BiOp). BOEM has responsibilities through NEPA, the ESA, and the MMPA to update protected species impact analyses and determinations; reduce and avoid impacts; and to consider and adopt new mitigation. This study would contribute to BOEM responsibilities under ESA, OCSLA, NEPA, and MMPA. This study could also have applicability to mitigations developed for the Renewable Energy and Marine Mineral program areas.

Background: This study will use information acquired between 2016 and 2023 during BOEM-authorized geological and geophysical seismic surveys and continue the analyses conducted under BOEM 2012-015 and BOEM 2019-012 which were conducted on PSO data available up to 2015. The original studies were developed to address information needs on seismic survey mitigation effectiveness and compliance, along with protected species detections and responses. These studies have contributed substantially to BOEM's understanding of visual and acoustic mitigation effectiveness; compliance levels; and the characterization of seismic survey activity levels, species occurrence, distribution, behavior, and observer effort. As result of past efforts, BOEM/BSEE have utilized recommendations made on reporting and data collection and gained an evaluation of PSO datasets over time. This new study would update and expand BOEM's understanding of mitigation measures' effectiveness and continue to document the ongoing application of mitigation measures assigned to reduce or eliminate noise impacts from seismic geological and geophysical surveys on marine mammals and sea turtles.

Objectives: The objective of this study is to analyze, synthesize, and summarize the monitoring data acquired during BOEM-authorized geological and geophysical activities conducted between 2016 and 2023, verify compliance with mitigations, evaluate mitigation effectiveness, evaluate behavioral responses, and analyze data for trends in survey types and sources, and species detections and responses by conducting comparisons of data from previous BOEM studies (BOEM 2012-015 and BOEM 2019-012). This study would inform other geological and geophysical survey monitoring and reporting conducted as part of the 2020 BiOp and the MMPA Rule for Taking Marine Mammals Incidental to Geophysical Surveys Related to Oil and Gas Activities in the Gulf of Mexico (*Federal Register* 86 January 19, 2021).

Methods: The study will use the PSO observational report data (and seismic survey cumulative reports per MMPA) gathered between January 2016 and December 2023 in the Gulf of Mexico to meet monitoring and reporting requirements for BOEM-authorized geological and geophysical activities. An analysis of PSO data submitted between January 2016 and December 2023, including three types of reports (observer effort, survey, and sightings) will be completed. The data will be summarized, synthesized and analyzed to answer the research questions below. Characterizations of seismic survey activity levels (e.g., survey noise characterization and species present), species occurrence and behavior, and observer effort are among the types of data that will be analyzed. The new data will be compared against data evaluated in two previous data synthesis reports (BOEM 2012-015 and BOEM 2019-012).

Specific Research Questions:

1. What is the effectiveness of G&G survey mitigation measures?
2. How do the results of the observational data from 2016–2023 compare with the results of the previous (i.e., 2009–2015 and 2002–2008 data? Are there any long-term trends in species detected or species behavioral responses, or short-term trends (e.g., during COVID-affected years).
3. What are the sound sources and survey methods for the 2016–2023 observational data? How do the sound sources and survey methods for the observational data from 2016–2023 compare

with those sound sources and survey methods used in the activities evaluated in the previous data sets? Are there any long-term trends associated with sound sources or survey methods?

4. Are there any discernable differences in animal behavioral responses associated with different equipment types? Are there any discernable differences in animal behavioral responses associated with new and unusual sound source technologies including *Wolfspar* utilized during any of the evaluation periods?
5. What is the effectiveness of the mitigation measures applicable to the 2016–2023 data? How does the mitigation effectiveness for the observational data from 2016–2023 compare with the mitigation effectiveness for the activities evaluated in previous data sets? Can effectiveness ultimately be determined or are there other parameters more meaningful?
6. Based on the effectiveness review of the mitigation measures, are there recommendations as to modifications of those mitigation measures and/or recommendations on types of information that could be collected to improve the ability to determine effectiveness of mitigation measures?
7. How do mitigation compliance levels for the 2016–2023 data compare with compliance levels for the previous data sets?

Affiliated WWW Sites: N/A

References:

Barkaszi MJ, Kelly CJ. 2019. Seismic survey mitigation measures and protected species observer reports: synthesis report. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 220 p. Report No.: OCS Study BOEM 2019-012.

Barkaszi MJ, et al. 2012. Seismic survey mitigation measures and marine mammal observer reports. New Orleans (LA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 28 p. Report No.: OCS Study BOEM 2012-015.

Field	Study Information
Title	Spatial Ecology of Black-capped Petrels: Marine Spatial Planning and Species Conservation
Administered by	New Orleans Office
BOEM Contact(s)	Tre Glenn (tre.glenn@boem.gov), Timothy White (timothy.white@boem.gov)
Procurement Type(s)	Contract or Interagency Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	May 17, 2023
Problem	Data that adequately describe the movement patterns and habitat use of the globally endangered black-capped petrel in U.S. waters are limited. The species is currently considered for listing as Threatened under the Endangered Species Act.
Intervention	Develop habitat models, update range maps, migration pathways, Planning Area 'residency' and transit times, and marine-terrestrial connectivity for this species to inform marine spatial planning, species conservation plans, and Species Status Assessments.
Comparison	Compare spatial data with other pelagic seabirds in relevant BOEM Planning Areas in both the Atlantic and Gulf of Mexico regions.
Outcome	Fill data gaps for a globally endangered seabird that can subsequently inform both BOEM and BSEE regulatory needs.
Context	Atlantic and Gulf of Mexico Wind Energy Areas.

BOEM Information Need(s): Additional information is needed to assess the potential for reducing negative effects to seabirds due to various impacting factors associated with oil and gas activities in the Gulf of Mexico (GOM) Outer Continental Shelf (OCS), as well as interest in offshore wind energy development in the GOM and Atlantic regions. Information derived from the study would be useful in environmental analyses and consultations accompanying the evaluation of future renewable energy construction and operations plans in the Atlantic and GOM. Tracking movements of black-capped petrels will provide information for input into Endangered Species Act (ESA) Section 7 consultations (e.g., the proposed listing of the black-capped petrel) and to BOEM for use in National Environmental Policy Act analyses, Exploration Plans, Development Operations Coordination Documents, and BOEM's Oil Spill Risk Assessment model. Further, data collected from this effort would greatly assist BOEM and the U.S. Fish and Wildlife Service (USFWS) as they work cooperatively in drafting a new migratory bird Memorandum of Understanding).[1] This study in concert with results from Russell (2005) and the ongoing Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) project provide

[1] The existing MOU can be found at: https://www.boem.gov/sites/default/files/renewable-energy-program/MMS-FWS_MBTA_MOU_6-4-09.pdf

the necessary nexus for implementation (delivery) of regulations, policies, or stipulations to reduce mortality risks to migratory birds associated with proposed actions.

Background: The black-capped petrel is currently considered for listing as Threatened under ESA by the USFWS. More is known on distribution data in the Atlantic, but data gaps still exist related to colony connectivity and movement patterns. Individual-based tracking data from the proposed study would greatly enhance understanding of marine habitat use, movement patterns, and residency times in and transit times through BOEM Planning Areas.

Objectives: The proposed study will identify use areas and movement patterns for the black-capped petrel in the Atlantic and Gulf of Mexico. This would benefit greatly from partnerships, methodologies, protocols, and lessons learned from the GoMMAPPS and recent research activities in the Atlantic. This effort could potentially be folded in to the proposed GoMMAPPS II effort.

- Determine daily (diurnal versus nocturnal) and seasonal movements of the black-capped petrel in the ATL and northern GOM.
- Analyze movements in relation to state versus federal waters, BOEM's administrative areas (Planning Areas/Wind Energy Areas), and existing and planned OCS infrastructure (wind turbines, platforms).
- Assess the population size of the species at regional scales and develop models and associated tools to translate these data into seasonal, spatially-explicit range maps incorporating habitat characteristics.

Methods: This study would use bio-logging, physiological markers, and pre-existing survey data in the ATL and GOM.

Specific Research Question(s):

1. How do marked black-capped petrels use the ocean environment year-round within a given region?
2. Do marked black-capped petrel movements and habitat use within a given BOEM region vary as a function of season, time-of-day, and in response to oceanographic and environmental conditions?
3. From a marked population of black-capped petrels, is it possible to delineate hotspots (temporal and seasonal variation) within a given BOEM region?
4. Do marked black-capped petrels spend disproportionate amounts of time in certain BOEM Planning Areas within a given region?
5. Where do marked black-capped petrels that use the Atlantic and northern Gulf of Mexico breed?

Affiliated WWW Sites:

https://ecos.fws.gov/ecp/species/4748

https://www.fws.gov/species/black-capped-petrel-pterodroma-hasitata

https://www.birdscaribbean.org/our-work/working-groups/black-capped-petrel-wg/

https://www.boem.gov/gommapps

https://gomamn.org/wp-content/uploads/2020/02/chapter6-1.pdf

https://www.biorxiv.org/content/10.1101/2022.06.02.491532v3

https://www.biorxiv.org/content/10.1101/2021.01.19.427288v1

References:

Jodice PGR, Adams EM, Lamb J, Satgé Y, Gleason JS. 2019. GoMAMN Strategic Bird Monitoring Guidelines: Seabirds. Pages 129-170 in Wilson RR, Fournier AMV, Gleason JS, Lyons JE, Woodrey MS. Eds. Strategic Bird Monitoring Guidelines for the Northern Gulf of Mexico. Mississippi Agricultural and Forestry Experiment Station Research Bulletin 1228, Mississippi State University. 324pp. Available at: https://gomamn.org/wp-content/uploads/2020/02/chapter6-1.pdf

Jodice PGR, Tavano J, Mackin W. 2013. Marine and coastal birds and bats. Pages 475-587 *in* Michel J. Ed. South Atlantic information resources: data search and literature synthesis. New Orleans (LA) U.S. Department of the Interior, Minerals Management Service. Report No.: OCS Study BOEM 2013-01157.

Michel J. Ed. 2013. South Atlantic information resources: data search and literature synthesis. New Orleans (LA) U.S. Department of the Interior, Minerals Management Service. Report No.: OCS Study BOEM 2013-01157.

Russell RW. 2005. Interactions between migrating birds and offshore oil and gas platforms in the northern Gulf of Mexico: final report. New Orleans (LA) U.S. Department of the Interior, Minerals Management Service. 348 p. Report No.: OCS Study MMS 2005-009.

Field	Study Information
Title	Understanding Impacts of Offshore Carbon Sequestration on the Marine Environment: Informing Operational Management Needs Through Focused Literature Review and Synthesis
Administered by	New Orleans Office
BOEM Contact(s)	Melissa Batum (melissa.batum@boem.gov), Mark Mueller (mark.mueller@boem.gov), Michelle Bromschwig (michelle.bromschwig@boem.gov), Stephanie Sharuga (stephanie.sharuga@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2025
Final Report Due	December 2025
Date Revised	May 10, 2023
Problem	BOEM has new regulatory authority to lease and manage sub-seabed carbon dioxide (CO_2) sequestration (CS) on the Outer Continental Shelf (OCS). Information on potential environmental impacts to the human, marine, and coastal environment from CS activities and best available monitoring methods and protocols is needed to inform leasing and management decisions.
Intervention	Perform an extensive, global literature review and synthesis for each BOEM region on the potential impact producing factors from CS activities; the potential impacts on the human, marine, and coastal environment; and the monitoring that will be required during each phase of a CS project.
Comparison	Prior BOEM-funded research on CS detailed recommendations for best management practices for CS in OCS sub-seabed, but with a focus on operational considerations like reservoir selection and CO_2 transportation.
Outcome	Region-specific information to aid BOEM's ongoing program development and various operational needs.
Context	Nationwide, with a focus on the Gulf of Mexico (GOM) due to the higher likelihood of initial activity in that region.

BOEM Information Need(s): The INVEST in America Act (i.e., Bipartisan Infrastructure Law) of 2021 amended the Outer Continental Shelf Lands Act's (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 (CS) in sub-seabed reservoirs on the OCS. Rulemaking efforts are currently under way to establish regulations to implement a nationwide OCS CS Program.

BOEM needs environmental information to inform its rulemaking, program development, and national and regional policy. The new CS Program will cover all aspects of a full program from pre-leasing activities through site closure including pre-lease geological and geophysical exploration, leasing, planning, site characterization, drilling, installation, injection operations, risk management, monitoring,

and decommissioning. BOEM needs information on the potential impact producing factors from CS activities; the potential impacts to the human, marine, and coastal environment; the monitoring that will be required during each phase of a CS project; and the most effective monitoring methods and protocols for each potentially impacted environmental resource during each project phase.

The only prior BOEM-funded study on the topic (Smyth and Hovorka 2018) details recommendations for best management practices (BMPs) for CS in sub-seabed reservoirs, but with a focus on operational considerations like reservoir selection and CO_2 transportation. The BMPs report does not provide sufficient detail on potential environmental impacts including direct, indirect, and cumulative effects that are needed to inform the OCS-wide NEPA and other environmental analyses needed at every decision point along this program from rule promulgation to pre-lease resource analysis, lease planning, leasing, plan approvals, and permit approvals. This environmental information is also needed to inform lease stipulations, conditions of approval for plans and permits, risk management and monitoring strategies, national programmatic policy, and region-specific program/operational guidance.

Background: Carbon dioxide (CO_2) is the most commonly produced, atmospheric greenhouse gas. Carbon sequestration is the process of capturing, transporting, and storing atmospheric carbon dioxide. It is an important method of reducing the amount of CO_2 in the atmosphere with the goal of reducing global warming (climate change) impacts created by the greenhouse gas effect. CO_2 capture and storage is an essential part of current climate mitigation models (IPCC 2005, NAS 2019, NAS 2021, IEA 2021, US State Dept 2021) and the United States' goal to mitigate the climate change crisis and reach net-zero carbon emissions by 2050. The 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 CO_2 capture, utilization, and storage (CCUS) projects and CO_2 pipelines, and to support their efficient, orderly, and responsible deployment (87 FR 8808). BOEM needs the environmental information from this research to implement the CEQ recommendations and conduct adequate NEPA analyses. The development of this study's scope and deliverables will be coordinated with an anticipated Gulf Region CS EIS analysis to maximize both regional and national utility.

Objectives: To conduct a literature review and synthesis from a variety of vetted sources with relevant, up-to-date, and state-of-the-science information on potential impact producing factors from CS activities; the potential impacts to the human, marine, and coastal environment; the monitoring that will be required for each environmental resource during each phase of a CS project; and the most effective monitoring methods and protocols for each potentially impacted resource.

A summary will be provided for each OCS region (total 2.5 billion acres) that will aid BOEM's ongoing program development and various operational needs. In addition to the environmental information in the above paragraph, each regional summary will also provide sufficient detail on potential environmental impacts including direct, indirect, and cumulative effects specific to each region. The summary will also include region-specific recommendations for mitigation measures to minimize potential impacts to each environmental resource, as appropriate. This information is needed at the region-specific level to inform the NEPA and other environmental analyses needed at every decision point along this program from pre-lease resource analysis and lease planning, leasing, plan approvals, and permit approvals. This environmental information is also needed to inform lease stipulations, conditions of approval for plans and permits, risk management and monitoring strategies, national programmatic policy, and region-specific program guidance. The summaries will also identify knowledge gaps that will provide clear need and direction for future field and laboratory-based studies.

Methods: The study will compile existing global knowledge via literature review and synthesis on potential impact producing factors from CS activities; the potential impacts to the human, marine, and coastal environment; the monitoring that will be required during each phase of a CS project; and the most effective monitoring methods and protocols for each potentially impacted resource. Resources may include existing laws, regulations, guidance, best management practices, scientific literature, etc. Sub-seabed CS has already taken place in Norway, Australia, and Brazil and is under consideration in U.S. State waters. The Federal government (e.g., Department of Energy), industry, and academia are currently performing new, relevant research on the topic. Relevant information from current onshore projects that may translate to the offshore, may also be included.

This study will entail compiling, vetting, and analyzing available information on CS impacts in human, marine and coastal environments, then synthesizing it to create useful resources that address BOEM's needs programmatically and across all regions. Appropriate SME input will be included throughout development of the statement of work and duration of the project to maximize utility of the final deliverables. Future potential study needs will also be identified and recommended to address identified knowledge gaps via field, laboratory, or modeling analyses.

Specific Research Question(s):

1. What information and data are currently available on the potential impact producing factors associated with offshore CS activities?
2. What information and data are currently available on the potential environmental impacts from offshore CS activities to the human, marine, and coastal environments?
3. What information and data are currently available on the potential scale and impacts of leakage from sub-seabed CO_2 sequestration reservoirs and pipelines? Are there any known impacts of this CO_2 leakage on air quality?
4. What are the known impacts of induced seismicity from sub-seabed CO_2 sequestration activities to benthic biota and other components of the marine environment?
5. What information and data are currently available regarding potential environmental impacts from CS activities in the onshore environment that can be translated to the offshore environment?
6. What are the most effective monitoring methods and protocols for each potentially impacted environmental resource for each phase of a CS project (pre-injection, during injection, and post-injection) for each OCS region (Atlantic, Gulf of Mexico, Pacific, Alaska)?
7. What are region-specific recommendations for mitigation measures to minimize potential impacts to each environmental resource from each phase of CS activities?
8. What are region-specific BMPs for monitoring each environmental resource during each phase of a CS project?
9. What are the gaps in understanding that may affect the efficacy of monitoring protocols and methods for the environmental resources of the OCS?

Affiliated WWW Sites: N/A

References:

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. 2005. Carbon Dioxide Capture and Storage. Cambridge University Press (UK). 431 p. https://ipcc.ch/report/carbon-dioxide-capture-and-storage/

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.

National Academies of Sciences, Engineering, and Medicine. 2021. A Research Strategy for Ocean-based Carbon Dioxide Removal and Sequestration. Washington, DC: The National Academies Press. https://doi.org/10.17226/26278.

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

U.S. State Department and Executive Office of the President. 2021. The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050. 65p. https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf

Field	Study Information
Title	Adaptation of a Cook Inlet Circulation Model and Calculations
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	February 8, 2023
Problem	The Bureau of Ocean Energy Management (BOEM) uses current and sea ice data from an ice-ocean circulation model, together with wind data in its Oil-Spill-Risk Analysis (OSRA). However, existing data for Cook Inlet are only available through 2009, and the adjacent Gulf of Alaska has experienced a series of marine heatwaves in the past decade. Additional hindcasts are needed to adequately evaluate if the marine heatwaves have changed the ice and ocean circulation compared to the known historical variability.
Intervention	This study will be conducted using an existing coupled ice-ocean model. The latest information on bathymetry, river inflows, and meteorological fields will be incorporated into the model and its forcing fields.
Comparison	An updated 10–20 year hindcast simulation for the Gulf of Alaska and Cook Inlet, with accurate bathymetry and enhanced forcing fields, will elucidate changes from previous simulation.
Outcome	The output of this study will be used in the BOEM OSRA applications. The improved currents and meteorological forcing fields will enhance the accuracy of OSRA model results and help us understand the impact of spatial resolution on the performance of the OSRA model.
Context	Cook Inlet and the Gulf of Alaska.

BOEM Information Need(s): Oil-Spill Risk Analysis (OSRA) is a cornerstone foundation for evaluating potential oil spill impacts from Outer Continental Shelf oil and gas leasing in National Environmental Policy Act analyses, and oil spill response plans. The results of this study will be used by BOEM to create the OSRA estimates of oil-spill trajectories. This study will result in a time-series of simulated current and wind fields that will be compared to field projects that have been conducted in the Cook Inlet and the Gulf of Alaska; these results will be used in the OSRA calculations.

Background: Ocean currents in Cook Inlet are forced by winds and river runoff, as well as very large tidal amplitude and extreme tides. The Alaska Coastal Current that flows into Lower Cook Inlet and continues out through Shelikof Strait is an important element of the nearshore circulation of the northern Gulf of Alaska (Johnson 2021). In the Gulf of Alaska, a large area of unusually warm ocean water (marine heatwave) formed from 2014-2019 (Litzow et al. 2020). Sea ice forms in Cook Inlet, but its effect on the overall circulation pattern has not been studied in detail.

The circulation of Cook Inlet has been studied through previous model simulations, with funding by National Oceanographic and Atmospheric Administration (NOAA), BOEM, U.S. Army Corps of Engineers, and others (Danielson et al. 2016, 2020; Shi 2020; Zhang 2022). The models were subjected to a range of sensitivity calculations and skill was assessed by teams of oceanographers. The models demonstrated significant skill in simulating the ocean surface currents. Many field programs that may provide observational data for assimilation and validation have also been conducted in this area.

Objectives: The objective of this study is to adapt and maximize the utility of an existing, coupled ice-ocean circulation model in order to obtain simulations of the circulation in Cook Inlet and portions of the Gulf of Alaska for use in OSRA. Specific objectives include:

- Ensuring the simulations have significant skill in reproducing the near-surface currents, compared to drifting buoy data, fixed current meters, acoustic Doppler current profilers (ADCPs), high-frequency radar data, and other data sets.
- Providing BOEM with 10–20 years of relevant modeled fields, such as gridded wind, surface water, ice velocity, ice cover, and other modeled fields to use as input into the OSRA trajectory calculations.

Methods: This study will adapt an existing operational or community ocean model (e.g., CIOFS, ROMS, or MOM6) to produce a hindcast of the current fields in Cook Inlet, using data assimilation methods whenever practical. The model shall have sufficiently high-resolution to resolve important features of the circulation field. The selected model will be coupled with an ice model to produce appropriate ice fields. The hindcast period will be determined by data availability but shall be at least 10 years. The tidal current must be accurately reproduced. The wind forcing will be derived from the products of an atmospheric model. Skill assessment comparisons against historical field observations, i.e., current meters and drifting buoy velocities, will be performed.

Specific Research Question(s):

1. What is the significance of different model grid resolutions to the simulation of tide rips and other dynamic processes in Cook Inlet?
2. How can the subsurface information from high resolution modeling be used in BOEM's Oil Spill Risk Analysis?

Affiliated WWW Sites: N/A

References:

Danielson SL, Hedström KS, Curchitser E. 2016. Cook Inlet circulation model calculations. Anchorage (AK): Prepared by University of Alaska Fairbanks for USDOI, BOEM Alaska OCS Region. OCS Study BOEM 2015-050. 149 p. https://espis.boem.gov/final%20reports/5561.pdf

Danielson SL, Hill DF, Hedström KS, Beamer J, Curchitser E. 2020. Demonstrating a high-resolution Gulf of Alaska ocean circulation model forced across the coastal interface by high-resolution terrestrial hydrological models. Journal of Geophysical Research: Oceans. 125(8): e2019JC015724.

Johnson MA. 2021. Subtidal surface circulation in lower Cook Inlet and Kachemak Bay, Alaska. Regional Studies in Marine Science 41: 101609. https://doi.org/10.1016/j.rsma.2021.101609

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

Shi L, Lanerolle L, Chen Y, Cao D, Patchen R, Zhang A, Myers EP. 2020. NOS Cook Inlet operational forecast system: model development and hindcast skill assessment. Silver Spring, MD: USDOC, NOAA, Coast Survey Development Laboratory. NOAA Technical Report NOS CS 40. 77 p. https://repository.library.noaa.gov/view/noaa/27560/noaa_27560_DS1.pdf

Zhang A. 2022. Implementation of the Cook Inlet operational forecast system (CIOFS) and the nowcast/forecast skill assessment. Silver Spring, (MD): USDOI, NOAA. NOAA Technical Report NOS CO-OPS 096. 59 p.

Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Alaska Coastal Marine Institute
Administered by	Alaska Regional Office
BOEM Contact(s)	Eric J. Taylor (eric.taylor@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2028
Final Report Due	TBD
Date Revised	May 16, 2023
Problem	The BOEM Environmental Studies Program needs applied scientific studies to provide information for making responsible decisions for managing energy and marine mineral resources on the Alaska Outer Continental Shelf (OCS).
Intervention	Research faculty at the University of Alaska provide scientific information to inform leasing, exploration, and development decisions in the Alaska OCS.
Comparison	Through the Alaska Coastal Marine Institute (CMI), BOEM will obtain scientific research to address multiple stakeholder interests including the state of Alaska, Department of Interior, industry, conservation organizations and the public.
Outcome	University of Alaska research faculty with expertise in physical oceanography, wildlife and fisheries ecology, air quality, human dimensions and social science, climate, and other disciplines are available to design, collect and disseminate environmental information needed for OCS energy and marine mineral decisions; address local and regional OCS-related environmental and resource issues of mutual interest; and strengthen the BOEM-State partnership.
Context	All Alaska OCS Planning Areas.

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

Background: The CMI is cooperative program between BOEM and the University of Alaska, with State of Alaska participation, began in 1993 with the goals of updating and expanding our understanding of OCS environmental information and addressing future needs related to the offshore energy and marine program in Alaska. Scientific research is guided by framework issues related to potential future lease sales and other energy related actions in the Alaska OCS Region. CMI project awards require a 1:1 cost share.

Objectives: The Framework Issues which guide the CMI are:

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

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

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

Specific Research Question(s): N/A

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

References: None

Field	Study Information
Title	Early Detection Plan for Marine Non-native Species in Cook Inlet, Alaska
Administered by	Alaska Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	February 9, 2023
Problem	The potential for introductions of marine Non-Native Species (mNNS) in the Alaska Region is increasing as a result of a changing climate coupled with increased shipping and other human activities. No protocols are in place to provide guidance for early detection, containment, and/or removal of invasive species as the result of energy assessment and extraction activities on the Alaska OCS.
Intervention	This study will create a baseline record of the current planktonic, benthic, and attached organism communities to provide a benchmark comparison to detect mNNS and develop early detection monitoring and response plans for any mNNS that are deemed invasive for Cook Inlet.
Comparison	This study complements planned and ongoing efforts by multiple organizations in Alaska to establish a baseline record of plankton, attached, and benthic communities, including those currently associated with existing infrastructure in state waters.
Outcome	This study will provide baseline data and a monitoring plan for the early detection of mNNS and an associated response plan aimed at containment and eradication of detected invasive species.
Context	Cook Inlet Planning Area

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

Background: The definition of a non-native species is any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to a particular ecosystem; while the definition of an invasive species is a non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112). Increased ship traffic and other activities in the Alaska Outer Continental Shelf (OCS), as well as new OCS infrastructure create new opportunities for the establishment of mNNS. Together with climate change,

the potential for the introduction of mNNS in the Alaska OCS is significant. The detection of mNNS is the first step towards identifying and preventing the establishment of invasive species.

Monitoring for mNNS has not been a primary focus in relation to energy assessment and extraction in Alaska. This project will develop a standardized monitoring plan for mNNS to guide future energy assessment and extraction activities within the Cook Inlet Planning Area. Results from this project will complement other BOEM-supported efforts in Cook Inlet (NT-17-x10) and the Arctic (AK-15-01; AK-20-07), help to extend the reach of PlateWatch (a citizen science network in southeast Alaska).

Objectives:

- Establish a baseline dataset of benthic and planktonic species associated with key habitat types in Cook Inlet to use as a comparison benchmark for future monitoring.
- Establish a monitoring plan for detection of benthic and planktonic mNNS covering key habitat types in the vicinity of current and potential future energy assessment and extraction activities in Cook Inlet.
- Record local and traditional knowledge (LTK) for comparison and inclusion into biological assessments, as well as incorporate citizen science in the monitoring plan, where practical.
- Develop an early detection response plan to be executed in the event mNNS are detected and become considered invasive and include protocols for evaluation, potential containment, and eradication.

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

A monitoring plan will be developed for detecting mNNS in Cook Inlet near areas of existing State of Alaska oil and gas installations and potential future OCS activity. The monitoring plan will include a sampling design that covers the necessary temporal and spatial scales needed to identify the introduction of mNNS based on known pathways of introduction. Species distribution models will also be considered to highlight species with broad environmental tolerance that would be considered likely invaders as the climate changes. This study also will develop an early detection response plan that includes containment and eradication protocols in the event mNNS are detected and deemed invasive. Protocols for containment and/or eradication will be based on current best practices used in analogous habitats, when possible, or analogous taxonomies.

Specific Research Question(s):

1. What do planktonic, benthic, and attached communities look like near areas of current and potential future oil and gas installations in Cook Inlet?

2. Are artificial substrates and habitats created from installations facilitating the establishment of mNNS in Cook Inlet?
3. How can LTK inform mNNS monitoring and management?
4. What is an appropriate response plan for notification, containment, and eradication if an invasive species is identified?

Affiliated WWW Sites: https://platewatch.nisbase.org

References:

Executive Order 13112 on Invasive Species, Executive Orders. February 3, 1999. Code of Federal Regulations, title 3 (2000):159-163. https://www.invasivespeciesinfo.gov/executive-order-13112.

Field	Study Information
Title	Improving Modeling of Oil Spill Weathering in Ice
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	March 30, 2023
Problem	The Arctic Maritime Spill Response Modeling (AMSM) Workshop and Work Groups identified key unresolved issues to improve modeling of oil spill weathering in ice.
Intervention	BOEM will enhance existing working relationships with National Oceanic and Atmospheric Administration (NOAA), Office of Restoration and Response, by establishing financial cooperation, data sharing agreements, and logistical support agreements to enhance and improve modeling of oil weathering in ice -algorithms and their availability using the General NOAA Operational Modeling Environment (GNOME) Suite.
Comparison	BOEM and others (NOAA, BSEE, and/or USCG) will partner on collaborative research, leveraging expertise across one or more organizations to address oil-in-ice weathering modeling needs for the Alaska North Slope or Cook Inlet region.
Outcome	This project will support mutually identified information needs to improve oil-in-ice algorithms and implement them in open-source weathering models such as GNOME Suite and make the results widely available to stakeholders in a web-based application.
Context	Beaufort Sea Planning Area, Cook Inlet Planning Area.

BOEM Information Need(s): BOEM conducts oil weathering modeling in Arctic and subarctic areas where sea ice forms during the winter to assist in the development of oil spill scenarios for National Environmental Policy Act (NEPA) analyses. BOEM uses the propriety SINTEF oil weathering model which requires a yearly license for its use. Improved oil-in-ice algorithms would refine oil weathering estimates used in NEPA assessments and open-source software would provide for greater transparency to stakeholders.

Background: Oil weathering modeling is fundamental for providing insight and answering questions on oil spill fate and persistence and/or oil spill response. Oil interactions with mobile sea ice or immobile landfast ice involve several processes that affect oil fate (French-McCay et al. 2017). These interactions include spreading in broken ice; movement on, under, and through ice; and adsorption to snow.

BOEM, previously MMS, funded studies to improve modeling of oil weathering in ice (Reed et al. 2005; Reed et al. 1998). In December 2019, the Center for Spills and Environmental Hazards (CSE) and Arctic

Domain Awareness Center (ADAC) hosted the Arctic Maritime Spill Response Modeling (AMSM) workshop (ADAC and CSE 2019; Manning, 2021, Verfaillie 2021). The AMSM workshop gathered expert advice on information needs for oil spill modeling and weathering in ice. Information needs include: (1) scaling the effects of oil weathering based on a percent of ice cover beyond the currently used 80/20% rule and (2) developing algorithms as a function of different types of ice (e.g., fresh, one year, frazil ice), oil in ice interactions (e.g., dissolution, dissolve), and physical properties of oil (e.g., pour point, wax content) when hot oil reaches a cold environment. Recent investigations have shown that improvements to the ice algorithms translated to improvement in oil spill weathering model performance.

The GNOME Suite is built on a collection of open-source software tools developed by the Emergency Response Division (ERD) of National Oceanic and Atmospheric Administration, Office of Response and Restoration (NOAA, 2023). Currently the sea ice weathering capacity is in the PyGNOME core code if input from a coupled ice-ocean model is used. Sea ice weathering is not yet accessible from WebGNOME for the general user. Additionally, the ability to run GNOME in just weathering mode (similar to ADIOS2) with ice is not available.

Objectives: The goal of this project is to implement improved oil weathering algorithms for pack or landfast ice into a readily available open-source modeling software accessible to BOEM staff and the public in a web-based application. Specific objectives include:

- Evaluate needs of BOEM and others for modeling oil spill weathering in ice for NEPA and oil spill response.
- Evaluate AMSM workshop information need recommendations and implement two to three algorithm enhancements that can be readily executed to improve oil weathering algorithms for pack or landfast ice.
- Evaluate and implement the use of open-source modeling software (WebGNOME Suite, or others) and web-based applications for oil-in-ice weathering.
- Evaluate and implement longer weathering times, up to 30 days, for use in future NEPA scenario analysis.

Methods: This study will enhance open-source modeling software available to a broad variety of users for calculating oil weathering estimates, including in ice. A coordinated effort will identify mutual oil-in-ice modeling needs for agencies (BOEM, BSEE, USGC, NOAA) to support research and development of oil-in-ice algorithms in updated open-source models. The study will advance oil-in-ice algorithms in oil weathering models and advance web-based applications for modeling fate and weathering results that could help enhance informed decision-making on the oil spill weathering modeling. Researchers will develop standardized processes and tools to facilitate and implement the development of open-source software and a web-based application.

Specific Research Question(s):

1. How can oil-in-ice algorithms that are used in oil spill or oil-spill weathering models be improved?
2. What recommendations from the AMSM Workshop can be implemented to improve modeling of oil spill weathering in ice?

3. How can improved oil weathering in ice be made available to the modeling, spill response, and NEPA practitioner community?

Affiliated WWW Sites: N/A

References:

Arctic Domain Awareness Center (ADAC) and Center for Spills and Environmental Hazards (CSE). 2019. Arctic Maritime Spill Response Modeling (AMSM) Workshop Report December 3–5, 2019. 450 pp. https://unh.app.box.com/s/8q5hgf1boe53uvsu2pzolq4jo04hp1ka

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

Manning J, Verfaillie M, Barker C, Berg C, MacFadyen A, Donnellan M, Everett M, Graham C, Roe J, Kinner N. 2021. Responder Needs Addressed by Arctic Maritime Oil Spill Modeling. Journal of Marine Science and Engineering. 9(2):201. https://doi.org/10.3390/jmse9020201

NOAA, Office of Restoration and Response. 2023. GNOME suite for oil spill modeling. https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/gnome-suite-oil-spill-modeling.html#:~:text=The%20GNOME%20%28General%20NOAA%20Operational%20Modeling%20Environment%29%20suite,broader%20academic%2C%20response%2C%20and%20oil%20spill%20planning%20communities. [Last updated Tuesday, January 3, 2023 2:57pm PST. Accessed March 28, 2023]

Reed M, Johansen Ø, Brandvik PJ, Daling P, Lewis A, Fiocco R, Mackay D (SINTEF Applied Chemistry, Trondheim, Norway). 1998. Revision of MMS offshore continental shelf oil-weathering model: evaluation. Anchorage (AK): U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region. 137 p. Report No.: OCS Study MMS 98-0058. https://espis.boem.gov/final%20reports/4197.pdf

Reed M, Daling P, Moldestad MØ, Brandvik PJ, Resby J, Leirvik F, Johansen Ø, Skognes K, Hetland B, Schrader TJ (SINTEF Materials and Chemistry, Trondheim, Norway). 2004. Revision of the OCS oil-weathering model: phases II and III. Anchorage (AK): U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region. 17 p. Report No.: OCS Study MMS 2005-020. https://espis.boem.gov/final%20reports/5088.pdf

Verfaillie M. 2021 Oil spill modeling for improved response to Arctic maritime spills: the path forward. Thesis. Durham, NH: University of New Hampshire, Coastal Response Research Center and Center for Spills and Environmental Hazards. 380 p. https://unh.app.box.com/s/r0b67786aodoeo5shwb017ktirme3gbe

Field	Study Information
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, Cooperative Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	March 30, 2023
Problem	Synthesized sea ice data for Cook Inlet is dated, and environmental 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, provide data to validate 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 understanding of modern changes in type, geographic extent, and persistence of sea ice is needed to provide context for interpretation of changing ecosystem patterns and inform environmental reviews and decision-making regarding energy development. In addition, BOEM needs updated information about the type and geographic extent of sea ice coverage over time, to validate coupled ice-ocean circulation models used to support OSRA and to characterize tidal resources for renewable energy development.

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 more than twenty years ago by Mulherin et al. (2001). Information about the geographic coverage, shorefast ice persistence, and seasonality of sea ice is important for understanding the fate of spilled oil and to characterize tidal energy resource potential. 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 oil and gas and renewable energy and to better understand where sea ice occurs and how it may affect oil and gas or renewable activities.

Objectives:

- Assess and document sea ice type, area, thickness, other physical properties, 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 summarize current relevant information and 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 2026. 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 literature, 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 at least one seasonal cycle. Researchers will compile a time-series of physical parameters to evaluate any correlations between ice extent, ice type, and physical parameters. Researchers will identify future research topics including when and where the conditions for frazil ice formation occur and the existence, size, and frequency of occurrence of submerged ice blocks (laden with sand/gravel/mud) in Cook Inlet.

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 changed in recent decades and what can be inferred about ecosystem changes and how might these changes affect potential future oil and gas and renewable energy activities?
3. What is the best sea ice metric for use in OSRA model validation or accurate tidal energy resource characterization?
4. Are there unique physical properties of the sea ice in Cook Inlet which may cause ice to submerge?

Affiliated WWW Sites: N/A

References:

Laidre K, Hobbs R, Ferrero R. 2017. Summer, fall, and early winter behavior of beluga whales, Delphinapterus leucas, satellite-tagged in Cook Inlet, Alaska, in 1999 and 2000 (KEW Shelden, editor). Seattle (WA): U.S. Department of Commerce, National Oceanic and Atmospheric

Administration, National Marine Fisheries Service. 33 p. Report No.: AFSC Processed Report 2017-08.

Mulherin ND, Tucker WB III, Smith OP, Lee WJ. 2001. Marine ice atlas for Cook Inlet, Alaska. Hanover (NH): U.S. Army Engineer Research and Development Center Cold Regions Research and Engineering Laboratory. 155 p. Report No.: ERDC/CRREL Technical Report 01-10.

National Weather Service. 2022. NWS Alaska Sea Ice Program (ASIP). Anchorage (AK): U.S. Department of Commerce, National Oceanic and Atmospheric Administration; [accessed 2022 Feb 3]. https://www.weather.gov/afc/ice.

Nelson WG, Whitney JW. 1996. A description of summer and winter environmental conditions within Cook Inlet, Alaska. In: Proceedings Western Regional Meeting; 1996 May 22–24; Anchorage, AK. Society of Petroleum Engineers. 14 p.

Nelson WG. 1995. Sea ice formation in Cook Inlet Alaska: a high energy environment. In Proceedings of the 14th Conference on Offshore Mechanics and Arctic Engineering, Volume IV, Copenhagen, Denmark, June 18-22, 1995. American Society of Mechanical Engineers, Offshore Mechanics & Engineering Division. 9 p.

Parker D, Jacobs J. 2018. Cook Inlet ice guidelines a best practice for stakeholder engagement. Proceedings of the Marine Safety & Security Council, the Coast Guard Journal of Safety at Sea. 75(2):64–68.

U.S. National Ice Center. 2022. Arctic ice products. Suitland (MD): U.S. National Ice Center; [accessed 2022 Feb 3]. https://usicecenter.gov/Products/ArcticHome.

Wang T, Yang Z. 2020. A tidal hydrodynamic model for Cook Inlet, Alaska, to support tidal energy resource characterization. Journal of Marine Science and Engineering. 8(4):254. https://doi.org/10.3390/jmse8040254

Field	Study Information
Title	Updating Lower Cook Inlet Seabird Colony Counts
Administered by	Alaska Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 16, 2023
Problem	Locations, species composition, and sizes of seabird colonies in Lower Cook Inlet (LCI) and associated regions are important to guide prudent development of energy resources. Large fluctuations in seabird breeding distribution and abundance are occurring at multiple seabird colonies. A comprehensive population survey of seabird colonies in LCI is necessary to update baseline data to assess the potential effects of current and future stressors.
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. In addition to highlighting new colony locations, results will be evaluated with historic colony estimates to document differences in seabird abundance and breeding distribution.
Outcome	This study will produce defensible estimates of breeding bird populations in the Cook Inlet Planning Area.
Context	Lower Cook Inlet and Shelikof Strait.

BOEM Information Need(s): A better understanding of seabird population distributions, relative abundance and species compositions in LCI is needed to evaluate potential impacts from oil and gas activities. Colony surveys provide important data needed to assess and mitigate potential effects of oil and gas activities, vessel traffic, oil spills, disturbance, and Highly Pathogenic Avian Influenza (HPAI) on seabird populations. Updating population estimates of breeding seabirds and colony locations in LCI will help to inform the effects of climate change and improve the assessment of potential 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 potential impacts from future lease sales and exploration plans, and development and production plans. The study will provide information about ongoing trends related to

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

Background: Alaska supports North America's greatest concentration of seabirds with an estimated 40 to 50 million individuals breeding in Alaska, or roughly 75% of North America's seabirds (USFWS 2009; Stephensen and Irons 2003). An additional 40 to 45 million seabirds that breed outside Alaska spend the austral winter feeding in Alaska waters with Alaskan-breeding birds. Seabirds are long-lived, conspicuous, and feed near the top of marine food web making them ideal biological indicators of marine health. 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) support approximately 325 seabird colonies totaling over a half million breeding birds. Traditionally, breeding seabird populations are estimated from colony-based censuses, though seabirds from these colonies forage offshore (up to 200 km; Boersma and Wheelwright 1979) and diverse survey methods are needed to minimize undercounting these populations. Funding for surveys has been largely unavailable over the past three decades. Information currently archived in the North Pacific Seabird Colony Register (NPSCR) for the LCI, and associated regions is nearly 40 years old; the average year of the "Best Current Estimate" in the NPSCR, managed by the U.S. Fish and Wildlife Service, is 1982. 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 Gulf of Alaska, where massive seabird die-off events occurred and populations at many colonies experienced complete reproductive failure (Piatt et al. 2020). In 2022, the occurrence of HPAI in Alaska created another potential impact to seabirds; however, negative effects have been largely limited to scavengers (e.g., gulls, jaegers) and have not caused any known widespread mortalities at breeding colonies. However, HPAI strains are now evolving with unknown risks to migratory birds. Efforts to fully assess the impacts of these events are once again hampered by the lack of updated baseline information.

Objectives:

- Establish current estimates of distribution, species composition, and abundance of seabirds in approximately 325 known LCI colonies and identify any new colony locations to determine potential changes that have occurred over the past 40–50 years.
- Evaluate alternative survey methods and emerging technologies to estimate seabird abundance and develop a protocol that balances statistical confidence, repeatability, feasible methods, and reasonable costs.
- Provide information to BOEM on important marine bird areas based on number of individuals and species of conservation concern that will allow the Bureau to develop a more accurate Oil Spill Risk Assessment and inform an appropriate and feasible oil spill response strategy in the event of an oil spill.
- Update the North Pacific Seabird Colony Register used in the National Ocean and Atmospheric Administration's online Environmental Response Management Application tool (ERMA).

Methods: An array of field methods is 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 the U.S. Geological Survey (USGS) to develop and apply emerging technology protocols to estimate abundance 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 population 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 current population indices and the current population estimates, locations, and species composition of seabird colonies in LCI and adjacent coastlines?
2. How does seabird breeding distribution, composition and estimates of abundance differ from 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)?

Affiliated WWW Sites: N/A

References:

Boersma PD, Wheelwright NT. 1979. Egg neglect in the Procellariiformes: reproductive adaptations in the fork-tailed storm-petrel. Condor 81(2):157-165.

Ford G, Bonnell M, Varoujean D, Page G, Carter H, Sharp B, Heinemann D, 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, Kuletz KJ, Bodenstein B, Garćia-Reyes M, Duerr RS, 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.

Stephensen SW, Irons DB. 2003. Comparison of colonial nesting seabird in the eastern Bering Sea and Gulf of Alaska. Marine Ornithology 31(2):167-173.

U.S. Fish and Wildlife Service. 2009. Alaska Seabird Conservation Plan. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK. 136 p.

Field	Study Information
Title	Assessing the Effectiveness of Offshore Wind Lease Sale Stipulations on Improving Engagement
Administered by	Office of Environmental Programs
BOEM Contact(s)	Laura Mansfield laura.mansfield@boem.gov), Meghan Cornelison (meghan.cornelison@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Performance Period	2024-2029
Final Report Due	TBD
Date Revised	May 15, 2023
Problem	There is a lack of understanding on the effect of policy mechanisms BOEM has implemented to make engagement with those potentially affected by BOEM activities more meaningful and less burdensome for all parties.
Intervention	Evaluate the effect of lease sale stipulations on improving meaningful engagement.
Comparison	The study will develop an understanding of perceptions about meaningful engagement and the effect of enhanced engagement activities, specifically due to lease sale stipulations, over time.
Outcome	A better understanding of the effect of engagement-related lease sale stipulations on achieving more meaningful and less burdensome engagement, and recommendations on how to improve future stipulations to meet the needs of affected groups, environmental reviews, and projects.
Context	One area without an enhanced engagement lease stipulation compared with an area with a recent lease stipulation requiring enhanced lessee engagement.

BOEM Information Need(s): There is a robust body of literature evaluating the role of meaningful engagement in identifying and mitigating impacts (Ottinger 2013), assessing the value of meaningful engagement in decision-making (Bidwell 2016; Elmallah & Rand 2022), and providing recommendations on methods of engagement to yield meaningful outcomes (Firestone et al. 2018; Klain et al. 2017). However, there is a lack of understanding on the effect of policy mechanisms BOEM has implemented (as well as those it could implement) to make engagement more meaningful and less burdensome for all parties.

BOEM's recent inclusion of lease stipulations requiring that offshore wind lessees submit progress reports to BOEM on their engagement activities is a step BOEM took to advance equity goals, and a study would be required in order to gauge effectiveness. Specifically, a longitudinal study starting with the collection of regional baseline data is essential to develop an assessment of the effect of lease stipulations on engagement. This is of particular importance as BOEM ramps up its offshore wind leasing activities to meet ambitious federal targets and continually revisits and refines lease stipulations in advance of upcoming lease sales.

Background: In January 2022, BOEM included a first-of-its-kind stipulation in the Final Sale Notice for Atlantic Wind Lease Sale 8 for Commercial Leasing for Wind Power on the Outer Continental Shelf (OCS) in the New York Bight. The new stipulation is an effort to require early and regular engagement with Tribes and ocean users, underserved communities, and other stakeholders (collectively ‘‘Tribes and parties’’) that may be potentially affected by the project activities on the OCS. The stipulation requires lessees to submit a semi-annual progress report to BOEM including 1) identification of those potentially affected by proposed activities; 2) updates on engagement activities; 3) identification of impacts or benefits due to proposed activities; 4) how, if at all, a project has been informed or altered to address those challenges or benefits; and 5) planned engagement activities during the next reporting period. The stipulation also requires to the maximum extent practicable, that Lessees coordinate with one another on engagement activities with specific recognition of the intent to reduce engagement burden on Tribes and parties. This stipulation also linked and incorporated a separate lease requirement for the development of communication plans for fisheries (Fisheries Communication Plan (FCP)), Tribes (Native American Tribes Communication Plan), and agencies (Agency Communication Plan), which serve to guide engagement activities with those groups.

After inclusion in the New York Bight lease sale, this stipulation has been included in following offshore wind lease sales including Carolina Long Bay, California, and Gulf of Mexico. It is essential that the efforts to meet these stipulations are evaluated to assess whether they are meeting intended goals and determine next steps to maximize coordination, communication, and meaningful engagement while reducing engagement burdens on all parties. Reduction of engagement burden, specifically highlighted as a goal of the lease stipulation, refers to the burden communities face when asked to engage on multiple processes and by multiple entities. For example, the same few individuals in a given community (Tribe, underserved community, commercial fishing group) are often asked to provide input on multiple projects within their area of interest. This generates a burden on individuals' time and capacity, and often is requested on top of their main job or responsibilities. Furthermore, communities may have varying levels of capacity to engage on BOEM's processes, which can generate higher burdens and lead to barriers for engagement for some groups such as tribes and underserved communities. Assessments of the effect of stipulations requiring lessees enhance engagement will help BOEM ensure intended goals are achieved and develop more equitable approaches through improved stipulations or implementation guidance.

Objectives: The objectives of this study are to:

- Gain an understanding of how lessee engagement activities and reporting, required by BOEM lease sale stipulations, affects underserved communities.
- Determine whether engagement-related lease sale stipulations improve meaningful engagement or reduce burdens as intended.
- Develop recommendations for future lease stipulations or improved practices for implementation.

Methods: The study will be a longitudinal assessment conducted in two phases. It will be based on a targeted literature review and utilize both iterative survey and interview methodologies. In phase one, the study team will first conduct a targeted literature review on engagement related to energy planning, leasing, development on federal lands and waters; offshore decision making; and industrial-scale resource development projects. This literature review will answer questions such as: What are the main critiques or common problems of engagement activities and their effectiveness? What worked and what didn’t, and why? This literature review will help inform questions for phase one focus groups in an area

with existing engagement activities before enhanced engagement stipulations have been introduced. After the research garners a basic understanding of perceptions of engagement without activities associated with lease sale stipulations around enhanced engagement, the study will move to phase two.

During phase two, surveys will be conducted in an area where an enhanced engagement lease stipulation applies. The surveys will be conducted yearly following a lease sale for three years. Following the initial survey, quarterly focus groups will be held in the same area over the same time period. The questions asked during surveys and focus groups will be centered around gathering information that would help determine the level of effectiveness of the enhanced engagement lease stipulation on improving previously identified problems or critiques of engagement. The interview methodology for the focus groups will be semi-structured. The study team will work with BOEM to determine and prioritize what types and level of information is most helpful, and the study team will design questions that are open-ended and unstructured though delivered in a way where the researcher controls the line of questions in order to maximize usefulness to the research. The number of participants in each focus group shall be more than four and less than ten. The information gathered from focus groups should be representative of different perspectives. The number of focus groups required shall reflect the context of the geographic area and diversity in perspectives. BOEM assumes between one and six focus groups would be sufficient, with the final number dependent on final methodology, area chosen, complexity of the socio-cultural context, and scope of the proposed activity.

Survey and focus group results will be summarized and provided to BOEM in interim reports as results are available, and a final report on the longitudinal study will describe any changes in perceptions over time. Finally, this report will evaluate whether there are indications of improvements in meaningful engagement or reductions in engagement burdens due to lease stipulation related activities. The report will also provide recommendations for future lease stipulations and identify any practices to improve implementation of current lease stipulations.

Specific Research Question(s):

1. What is the effect of engagement-related lease stipulations on perceptions of process fairness and meaningfulness, inclusiveness in decision-making processes, and trust in processes or projects?
2. Are engagement-related lease sale stipulations and associated activities decreasing burdens and increasing efficiencies?
3. What effect do engagement-related lease stipulations have on perceptions of potential impacts and opportunities from offshore wind development over time?
4. Are there any improvements BOEM can make to lease sale stipulations to better achieve intended goals?
5. Are enhanced engagement requirements in offshore wind lease stipulations relevant to other BOEM-authorized or related activities such as oil and gas, marine minerals, carbon sequestration, or hydrogen?

Affiliated WWW Sites: N/A

References:

Bidwell D. 2016. Thinking through participation in renewable energy decisions. Nature Energy. 1:16051. https://doi.org/10.1038/nenergy.2016.51.

Firestone J, Hoen B, Rand J, Elliott D, Hübner G, Pohl J. 2018. Reconsidering barriers to wind power projects: community engagement, developer transparency and place. Journal of Environmental Policy Planning. 20:370–386. https://doi.org/10.1080/1523908X.2017.1418656.

Elmallah S, Rand J. 2022. 'After the leases are signed, it's a done deal': exploring procedural injustices for utility-scale wind energy planning in the United States. Energy Research & Social Science. 89:102549. https://doi.org/10.1016/j.erss.2022.102549.

Klain SC, Satterfield T, MacDonald S, Battista N, Chan KMA. 2017. Will communities "open-up" to offshore wind? Lessons learned from New England islands in the United States. Energy Research & Social Science. 34:13–26. https://doi.org/10.1016/j.erss.2017.05.009.

Ottinger G. 2013. Changing knowledge, local knowledge, and knowledge gaps: STS insights into procedural justice. Science, Technology, and Human Values. 38:250–270. https://doi.org/10.1177/0162243912469669

Field	Study Information
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	May 11, 2023
Problem	Sounds produced by BOEM-authorized projects may impact sea turtles. BOEM requires more information about the behavioral and physiological impacts of sound on sea turtles.
Intervention	Gather behavioral and physiological data on the impacts of sound exposure on targeted species to better inform Endangered Species Act (ESA) consultations.
Comparison	Estimates of acoustic impacts on sea turtles are currently 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): BOEM is required to estimate potential acoustic impacts on sea turtles from industry sound sources. In 2021, BOEM convened a workshop to develop a methodological framework for studies focused on sea turtle behavioral and physiological (stress/hormone) responses to sound. An incomplete understanding of the physiological and behavioral impacts of sound across species and life stages of sea turtles may lead to incorrect 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 potential impacts of noise on a sea turtles.

Background: The impact of sound-generating events is a substantial factor that needs to be considered when addressing environmental impacts of offshore energy activities. However, limited data are available to accurately assess these impacts for sea turtles, therefore, current regulatory practice uses auditory thresholds derived from fishes, despite very different hearing anatomy. In addition, behavioral response thresholds are derived from limited data: the responses of two individual turtles when exposed to airguns in open-water pens (Department of Navy 2017, McCauley et al. 2000). And no data are available to assess the potential impacts of sound on physiological (stress) responses. In the biological opinion on geological and geophysical 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 (Harms et al. 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. Thus, there is a pressing need for increased investment in research to fill those gaps, particularly given the overlap between offshore energy areas and habitats 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). Since hearing sensitivity varies with age and between species, it is reasonable to assume that behavioral and physiological responses to anthropogenic sounds would also vary throughout a turtle's lifetime. For example, breeding adult females may be less sensitive to noise-induced stress than other life-history stages, 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 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.

While several studies have examined physiological responses of sea turtles to physically 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 acoustic exposure. 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 and one loggerhead sea turtle in an open-water pen increased 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

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

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 a significant behavioral response to an airgun array but did observe responses to the presence of large seismic vessels, and Hazel et al. (2007) found that sea turtles avoided small vessels, depending on vessel speed. O'Hara and Wilcox (1990) observed that loggerhead sea turtles avoided a 30m area around an airgun firing with a compressor pressure at 140 kg/cm^2 in a canal, however behaviors were not consistent, with some turtles approaching the airguns and the studies conducted have largely focused on loggerhead or green sea turtle responses to airguns, 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 of species and age classes of sea turtles.

Objectives: Use the most-up-to date information about sea turtle hearing and sea turtle response to sound to perform a behavioral and physiological response study of sea turtles to anthropogenic sounds. Use new data gathered from hearing sensitivity tests and behavioral studies to determine which sounds (frequency and received 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 (Harms et al. 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 an option.

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?

Affiliated WWW Sites: N/A

References:

DeRuiter SL, Doukara KL. 2012. Loggerhead turtles dive in response to airgun sound exposure. Endangered Species Research. 16:55–63.

Harms CA, Nowacek, DP, Piniak WED (North Carolina State University, Morehead City, NC). *In prep*. Workshop Report: Methods to Examine Behavioral and Physiological Responses of Sea Turtles to Sound. City (ST): U.S. Department of the Interior, Bureau of Ocean Energy Management. Report No.: OCS Study BOEM 20xx-xxx. Contract No.: M20AC10008-02

Hazel J, Lawler IR, Marsh H, Robson S. 2007. Vessel speed increases collision risk for the green sea turtle *Chelonia mydas*. Endangered Species Research. 3:105–113.

Hildebrand JA. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series. 395:5-20.

Lavender AL, Bartol SM, Bartol IK. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta)* using a dual testing approach. Journal of Experimental Biology. 217:2580–2589.

Martin KJ, Alessi SC, Gaspard JC, Tucker AD, Bauer GB, Mann DA. 2012. Underwater hearing in the loggerhead turtle (*Caretta caretta*): a comparison of behavioral and auditory evoked potential audiograms. Journal of Experimental Biology 215(17):3001–3009.

McCauley RD, Fewtrell J, Popper AN. 2003. High intensity anthropogenic sound damages fish ears. The Journal of the Acoustical Society of America. 113:638-642.

Moein S, Musick J, Keinath J, Barnard D, Lenhardt M, George R. 1994. Evaluation of seismic sources for repelling sea turtles from hopper dredges. Final report submitted to the U.S. Army Corps of Engineers, Waterways Experiment Station. Gloucester Point (VA): Virginia Institute of Marine Science (VIMS), College of William and Mary. 42p.

Nelms SE, Piniak WE, Weir CR, Godley BJ. 2016. Seismic surveys and marine turtles: an underestimated global threat? Biological Conservation. 193:49–65.

O'Hara J, Wilcox JR. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. Copeia. 2:564–567.

Piniak WE, Mann DA, Harms CA, Jones TT, Eckert SA. 2016. Hearing in the juvenile green sea turtle (*Chelonia mydas*): a comparison of underwater and aerial hearing using auditory evoked potentials. PloS ONE. 11(10).

Richardson WJ, Greene CR Jr, Malme CI, Thomson DH. 1995. Marine Mammals and Noise. San Diego, CA: Academic Press.

U.S. Department of the Navy. 2017. Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis (phase III). San Diego (CA): Space and Naval Warfare System Command, Pacific. 194 p.

Weir CR. 2007. Observations of marine turtles in relation to seismic airgun sound off Angola. Marine Turtle Newsletter. 116:17–20.

Field	Study Information
Title	Building National Infrastructure for the Monitoring of Wildlife Movements
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Contract/Interagency Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 23, 2023
Problem	All regions and programs within BOEM as well as other DOI agencies such as USGS, USFWS, BLM and NPS depend on animal telemetry for managing the nations land and waters. However, no coordinated investment across DOI or the wider U.S. government exists to support national telemetry infrastructure. Historical distribution models are not predictors of future distribution, particularly due to climate-driven changes. Animal telemetry is a critical tool to inform our understanding of distribution, movements, and behaviors. Without a means to coordinate data, ensure data is accessible for analysis, and a robust U.S. infrastructure, understanding the national/regional impacts to fisheries and protected species will be incomplete.
Intervention	Expand national infrastructure for animal movement analysis consisting of expanded data repository and analytical tools via the Animal Telemetry Network to capture the larger array of deployed tags, contribute towards national telemetry infrastructure, for monitoring movements across the OCS in priority areas.
Comparison	Change is measured by: 1) enabling long-term analysis of animal movements in the U.S.; 2) an increase in non-Federal participants in telemetry networks, such as stranding organizations and academia; and 3) reduced long-term costs and reliability.
Outcome	Improved access to monitoring data of marine life, enabling BOEM studies to focus on specific issues and species, and not the infrastructure needed.
Context	All regions

BOEM Information Need(s): BOEM requires robust information on fishes and Endangered Species Act-listed species movement in and around areas identified for energy development and mineral extraction. Animal telemetry can provide vital information to inform environmental analysis and consultations across program areas such as offshore wind (OSW) placement locations, oil/gas leasing, and sand/mineral extraction (Bangley et al. 2020, Cooke 2008, Crossin et al. 2017, Hardin & Fuentes 2021). A need for improved data on animal movement, habitat use, behavioral, and foraging ecologies are routinely identified in regional wildlife science collaborative, public and consulting agency comments related to energy development and marine mineral extraction. Telemetry is an important tool to support animal movement and behavior studies to supplement survey efforts. Additionally, animal telemetry can be used to understand behavioral and spatial changes related to BOEM-regulated

activities in the OCS, such as turbine installation, construction, operation, and decommission (Block et al. 2016, Roquet et al. 2017).

Background: This study proposes continued support of national infrastructure for animal telemetry across Federal, State, and non-government organizations as well as international partnerships.

Acoustic telemetry networks–fixed acoustic receivers and mobile acoustic transmitters, usually attached to wildlife in the form of a tag–are largely established on a project-by-project basis and are maintained by researchers only for the duration of each project, sometimes just a few seasons. This results in detrimental temporal and spatial gaps in coverage and leads to inconsistent data quality and an inability to understand movements over longer terms and broader spatial scales.

Such *ad hoc* approaches are not cost-effective for long-term, regionally comprehensive monitoring. There are high upfront installation and maintenance costs that are ultimately borne by the granting agency. For acoustic telemetry studies in the United States, this cost largely falls to BOEM, Fish and Wildlife Service, United States Geological Survey, National Oceanic and Atmospheric Administration and the National Science Foundation and results in institutions and granting agencies absorbing the frequent expense of installing new receivers. These agencies would be far better served by permanently fixed receivers that are maintained independently of a discrete research project.

A centrally managed, standardized network of acoustic and radiofrequency receivers can replace our current, haphazard telemetry networks with increased and long-term animal monitoring to match the extended timeframe necessary to detect changes as a result of BOEM-authorized actions. Tagged marine life could be tracked across the entirety of their range (potentially beyond the hypothesized range fixed by a limited transmitter network). There would be a greater choice in the selection of deployment locations that would improve study designs and increase the statistical rigor of resulting analyses. The higher upfront costs of installing a standardized, long-term, regional network would be offset by reduced long-term costs. Maintaining such a system would be far less expensive than repeated reinstallation of assets driven by the fluctuating priorities of researchers, funding agencies, and public interest. Data could be serviced via a variety of human and autonomous solutions, including the use of oceanographic gliders to download and transmit data from the receivers to centralized data archives and ultimately to diverse users. (Cimino et al. 2018). This would decrease the logistical and financial burden of independent research groups coordinating data recovery.

A long-term telemetry network would also open partnership opportunities with offshore wind, fishers, and other ocean stakeholders. It would present a data equity solution, as researchers and other ocean stakeholders, including Tribal groups, would have access to useable telemetry data without bearing the financial burden of maintaining an inconsistent network of independently deployed receivers. Additional marine life telemetry infrastructure support, data management, analytical tools, and public accessibility for satellite, acoustic, and archival tags, would be maintained through the existing Animal Telemetry Network.

The need for up-to-date movement/distribution information and supporting collection methods is particularly important in the face of climate change-driven shifts in species distribution and biogeography.

Through the implementation of this project, BOEM and partners would develop vital infrastructure for the responsible development of offshore energy resources.

Objectives:

- Support the continued development of national infrastructure for large scale monitoring of wildlife movements.
- Through the Animal Telemetry Network (ATN), ensure data is delivered consistently for environmental impact analysis and long-term monitoring and that data is discoverable across agencies and private sector.
- Improve upon the participation of non-federal data holders by developing a user-friendly interface for the animal telemetry community to extend the user network beyond federal entities.

Methods:

1. Conduct feasibility studies: evaluate the technical feasibility of deploying and maintaining the telemetry network in the Outer Continental Shelf; conduct a power analysis to determine appropriate sample size for determining impact from energy operations; and consider factors such as oceanographic condition impact on transmission range, depth, equipment requirements, and data transmission capabilities.
2. Assess existing pilot studies or smaller-scale deployments to test and refine the system
3. Convene stakeholders to develop minimum data standards and submissions for long term discoverability.
4. Develop a comprehensive deployment and operations plan to build on the existing ATN. This includes selecting appropriate tracking technologies (e.g., acoustic, satellite, or GPS), determining deployment strategies (e.g., fixed or mobile receivers), and establishing protocols for data collection and management. Considering such factors as scalability, redundancy, and long-term sustainability.

Specific Research Question(s): N/A

Affiliated WWW Sites: N/A

References:

Bangley CW, Curtis TH, Secor DH, Latour RJ, Ogburn MB. 2020. Identifying important juvenile dusky shark habitat in the Northwest Atlantic Ocean using acoustic telemetry and spatial modeling. Marine and Coastal Fisheries. 12(5):348–363. https://doi.org/10.1002/mcf2.10120.

Block BA, Holbrook CM, Simmons SE, Holland KN, Ault JS, Costa DP, Mate BR, Seitz AC, Arendt MD, Payne JC, et al. 2016. Toward a national animal telemetry network for aquatic observations in the United States. Animal Biotelemetry. 4(1):6. https://doi.org/10.1186/s40317-015-0092-1.

Cimino M, Cassen M, Merrifield S, Terrill E. 2018. Detection efficiency of acoustic biotelemetry sensors on Wave Gliders. Animal Biotelemetry. 6(1):16. https://doi.org/10.1186/s40317-018-0160-4.

Cooke S. 2008. Biotelemetry and biologging in endangered species research and animal conservation: Relevance to regional, national, and IUCN Red List threat assessments. Endangered Species Research. 4:165–185. https://doi.org/10.3354/esr00063.

Crossin GT, Heupel MR, Holbrook CM, Hussey NE, Lowerre-Barbieri SK, Nguyen VM, Raby GD, Cooke SJ. 2017. Acoustic telemetry and fisheries management. Ecological Applications. 27(4):1031–1049. https://doi.org/10.1002/eap.1533.

Hardin EE, Fuentes MMPB. 2021. A systematic review of acoustic telemetry as a tool to gain insights into marine turtle ecology and aid their conservation. Frontiers in Marine Science. 8:765418. https://doi.org/10.3389/fmars.2021.765418.

Roquet F, Boehme L, Fedak M, Block B, Charrassin J-B, Costa D, Hückstädt L, Guinet C, Harcourt R, Hindell MA, et al. 2017. Ocean observations using tagged animals. Oceanography, 30(2):139–139. https://doi.org/10.5670/oceanog.2017.235.

Field	Study Information
Title	Establishing a Baseline Offshore Monitoring Program of Birds, Cetaceans, Turtles in Puerto Rico and the Virgin Islands
Administered by	Office of Environmental Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov), Mike Rasser (michael.rasser@boem.gov), Jake Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2024–2029
Final Report Due	TBD
Date Revised	February 10, 2023
Problem	BOEM currently has jurisdiction of the waters adjacent to the U.S Territories; however, no contemporary at-sea surveys exist (within the last 20 years) concerning the marine abundance and distribution of seabirds, cetaceans, and turtles in the vicinity of Puerto Rico and the Virgin Islands. BOEM requires updated and expanded data for environmental assessments.
Intervention	High-resolution imagery aerial surveys off Puerto Rico, St. John St. Croix, and St. Thomas islands. Tagging and tracking seabirds at colony locations. Utilization of the NEXRAD weather surveillance station on Puerto Rico to better characterize migratory songbird migration and flight height of flocks.
Comparison	Baseline spatial characterization of seabird, sea turtle and marine mammal aggregations and migratory songbird aeroecology.
Outcome	Analytical products that will quantify spatial, temporal, and density gradients of offshore wildlife distributions for planning wind energy development.
Context	Northern Caribbean Sea

BOEM Information Need(s): Baseline offshore surveys to characterize densities and distributions of seabirds, marine mammals, sea turtles and migratory movements of neotropical migratory songbirds off Puerto Rico and the Virgin Island are spatially and temporally limited and insufficient for ecological assessment of these important wildlife resources for offshore energy planning and development. Neotropical migratory songbirds that winter in the Caribbean migrate through the Gulf of Mexico to breed in North America. Section 50251(b) of the IRA amends definitions of the OCS in the Outer Continental Shelf Lands Act to include specified submerged lands adjacent to U.S. territories.

Background: Puerto Rico is the U.S. territory with the largest human population, and its offshore waters are BOEM's jurisdiction under the Offshore Wind for Territories Act. Puerto Rico and the U.S. Virgin Islands are important stopover, breeding sites, and offshore foraging areas for a variety of migratory songbirds, seabirds, marine mammals, and sea turtles. Every year, hundreds of species of migratory songbirds travel through Puerto Rico and the U.S. Virgin Islands as part of their annual migration. Over twenty years ago, the U.S. Navy and NOAA's Southeast Fisheries Science Center conducted limited assessments of seabirds, marine mammals, and sea turtles around the Caribbean Islands. Significant changes are suspected to have occurred since then, but existing data is too limited to allow for an

accurate understanding of how the ecology may have changed. Songbirds that nocturnally migrate in large flocks each spring and fall across these waters are a particularly vulnerable wildlife resource, but flight height and intensity of migratory songbird movements have yet to be studied with data collected by the NEXRAD weather surveillance station in Puerto Rico, which also covers the islands of St. John, St. Croix, and St. Thomas. Information concerning migratory birds' movements and flight heights is critical for understanding potential avian interactions with offshore wind energy installments (Cohen et al. 2022). This study proposes to fill species-specific information gaps through baseline surveys, data collection, and modeling of marine wildlife distributions and neotropical migratory bird movements to inform offshore wind energy assessment and risk modeling.

Objectives:

- Estimate vertical profiles of migratory songbird density, speed and direction for the weather surveillance radar station Puerto Rico (station TJUA). Develop an initial analytical pipeline using WSR-88D imagery at locations nearest to the coast and for locations with heavy bird traffic rates during migration.
- Collect seasonally targeted high-resolution aerial imagery of the distribution and abundance of seabirds, marine mammals, and sea turtles off the islands of Puerto Rico, St John, St. Croix and St. Thomas and create spatially-explicit maps of species assemblages and density estimates for priority species.
- Track individual seabirds across multiple species to facilitate assessment of fine-scale horizontal and vertical space use, which are important variables to include in collision risk assessments and identification of foraging areas.

Methods:

1. Using weather surveillance radar to map migratory bird movements: Estimate vertical profiles of bird migration to characterize bird density, speed, direction, altitude, and phenology for the radar station in Puerto Rico (TJUA) for the full duration of the WSR-88D archive. Create spatial maps of bird migration to characterize bird density, speed, direction, altitude, and phenology for this radar station during this period. For this site, employ correction layer to quantify migration traffic over water to estimate how many birds migrate over water. Create forecasts for how many, when, where birds are over water by modifying existing BirdCast forecast models by Cornell University and BOEM study and BOEM study GM-22-02. To understand migratory connectivity between the Caribbean and the United States apply this suite of activities to the radar station in Puerto Rico (TJUA) and integrate with 20-25 stations that sample over water in the Gulf of Mexico and Atlantic Ocean regions under ongoing BOEM study GM-22-02.
2. Photogrammetric aerial surveys of marine mammals, turtles, and seabirds: High-resolution aerial imagery surveys and use of automated detection algorithms to map the seasonal distribution and abundance of seabirds, marine mammals, and turtles in the vicinity of Puerto Rico and the Virgin Islands.
3. GPS tracking of seabirds from colonies: vertical and horizontal space-use of seabirds at sea with satellite telemetry from seabird colonies on Puerto Rico and the Virgin Islands networking with Birds Caribbean.

Specific Research Question(s):

1. What is the at-sea distribution and abundance of seabirds, sea turtles and marine mammals in the vicinity of Puerto Rico and the U.S. Virgin Islands?
2. Which seabird species are best to track with GPS surveillance technologies to determine fine-scale foraging patterns and central place foraging from Puerto Rico and the U.S. Virgin Islands?
3. What are the vertical profiles of bird density, speed and direction from the weather surveillance radar station in Puerto Rico?

Affiliated WWW Sites: N/A

References:

Cohen EB, Buler JJ, Horton KG, Loss SR, Cabrera-Cruz SA, Smolinsky JA, Marra PP. 2022. Using weather radar to help minimize wind energy impacts on nocturnally migrating birds. Conservation Letters. https://doi.org/10.1111/conl.12887.

Field	Study Information
Title	Evaluating Community Benefit Provisions for Offshore Renewable Energy
Administered by	Office of Environmental Programs
BOEM Contact(s)	Meghan Cornelison (meghan.cornelison@boem.gov), Laura Mansfield laura.mansfield@boem.gov)
Procurement Type(s)	Contract
Performance Period	2024-2027
Final Report Due	TBD
Date Revised	May 15, 2023
Problem	BOEM needs a better understanding of established community benefit provisions to respond to calls for community benefits and communicate BOEM's role surrounding community benefits provisions.
Intervention	An assessment of existing community benefits provisions related to renewable energy and the development of a framework of good practices related to community benefits.
Comparison	N/A: this study concept is not an experimental design.
Outcome	An enhanced BOEM understanding of extant community benefit programs and good practices for community benefit provisions related to offshore renewable energy.
Context	All OCS regions

BOEM Information Need(s): As offshore renewable energy planning, leasing, and development expand in the U.S., stakeholders continue to highlight the importance of ensuring affected communities, including environmental justice and underserved communities, benefit from development. BOEM often receives public comments through planning and environmental review processes broadly expressing the need for communities to benefit from renewable energy projects. Additionally, participants in the environmental justice engagement meetings for the New York Bight Programmatic Environmental Impact Statement repeatedly expressed a need for increased transparency around community benefit strategies. As renewable energy planning continues, BOEM would gain from a deepened understanding of how directed benefit provisions affect communities, including avenues for selecting benefit mechanisms and selecting recipient communities, the efficacy of various mechanisms, and potential equity considerations. Examining extant community benefit provisions and establishing a framework of good practices BOEM can make available for developers and communities would help advance BOEM's role in supporting a just energy transition.

Background: BOEM considers beneficial impacts of projects in environmental reviews by analyzing changes in employment, revenues, and indirect economic effects. However, community benefit provisions are typically negotiated between developers and local or state entities or are provided voluntarily by developers as part of their corporate social responsibility portfolios. These arrangements

are often not tied directly to impacts of specific projects and are therefore not included in environmental analyses.

BOEM's role and statutory authority in facilitating community benefit provisions is narrow. However, as the federal agency responsible for managing offshore energy development across the U.S. Outer Continental Shelf (OCS), BOEM is well-situated to serve in a convening role to help provide resources to lessees and communities considering development of community benefit provisions. An understanding of the various types of benefits mechanisms and their implementation in other contexts will help BOEM respond to inquiries about benefits, articulate BOEM's role in the community benefits arena, incorporate applicable information into environmental reviews, and provide a set of good practices for community benefit provisions for U.S. OCS renewable energy developments. For example, the Scottish government published "Good Practices Principles for Community Benefits from Offshore Renewables Developments" as a resource during development of its offshore wind industry. BOEM needs an enhanced understanding of extant community benefit efforts to articulate good practices related to community benefit provisions and help BOEM engage in a convening or supporting role on topics around community benefits.

Community benefits provisions have become an important element of development processes for offshore wind as a way to mitigate social conflicts around development (Bristow, Cowell, and Munday 2012). A range of mechanisms for directing benefits toward communities have been applied in the U.S. and abroad. Bristow, Cowell, and Munday (2012) define community benefits as "some form of additional, positive provisions for the area and people affected by major development Community benefit provisions in the context of this study proposal include financial or in-kind benefits provided by lessees and developers to local and regional entities, but do not include project-related *beneficial impacts* such as jobs, tax revenues, or indirect benefits. BOEM has used its regulatory toolset to advance community benefits provisions for recent offshore wind lease sales. Bidding credits related to community benefit agreements were included in the California lease sale in 2022. The mechanisms for providing community benefits vary across projects, areas, and communities; therefore, an exploration of aspects of community benefit provisions that can be generalized across regions, and aspects that would need to be considered on a case-by-case basis, would be a beneficial element of BOEM's assessment of good practices related to community benefits provisions.

Objectives:

- Provide BOEM a comprehensive understanding of the content of community benefit provisions and the process by which they have been implemented for offshore renewable energy in the U.S. and abroad.
- Enhance BOEM's understanding of the nature of community benefit mechanisms, including key themes, issues of concern, typical benefits, potential lessons learned, and good practices.
- Provide information on impacts of community benefits provisions that can be incorporated into NEPA reviews.
- Inform BOEM's analysis of potential regulatory tools within BOEM's legal authority to develop and implement for delivering benefits to underserved communities, and help BOEM better communicate its role and authority in response to calls for community benefits during engagement with impacted communities.
- Develop a document of good practice principles for community benefits provisions for BOEM to make available as a resource for developers and communities.

Methods: The first step of the study would include a broad literature review of existing research on corporate social responsibility and good governance related to energy and resource development. Literature would likely include research around offshore industrial activities, including oil and gas, and onshore activities as appropriate. Researchers would use the information from the literature review to inform parameters for the next phase of the study examining established community benefits programs related to renewable energy development. The investigation would include a targeted review of available renewable energy benefit provision materials, and related information on their outcome, supplemented with a subset of focus groups, to produce a findings report and to inform a synthesis of good practices related to community benefits provisions.

The contractor would work with BOEM to recommend an analytical approach to systematically review established community benefit provisions to identify typical mechanisms, assess efficacy, describe benefits, and provide information on other parameters agreed to by BOEM and the contractor. The researcher would engage with companies and local entities to explain the study and request information to support the analysis, building off of existing studies if applicable. The scope of the review would include renewable energy projects in the U.S. and other areas, including the United Kingdom and Europe. The review would aim to identify broad similarities between various benefits programs and any lessons learned from previous and existing programs. To help "ground-truth" the findings from the review of extant community benefits provisions, the study would include an element of direct targeted engagement with individuals from applicable communities who can speak to the outcomes from community benefits provisions. The contractor would work with BOEM to identify a small subset of one or two communities that were party to benefit provision(s) for discussions or focus groups to gather input on the outcomes of the provision(s).

Information learned from review of extant community benefit programs would be synthesized in a review document that includes the types of community benefits provisions often utilized for renewable energy projects, mechanisms for their development, outcomes, and lessons learned. The information would then inform a "principles of good practices" document BOEM can make available as a resource to communities, developers, and other parties exploring community benefits provisions for BOEM-authorized renewable energy activities.

Specific Research Question(s):

1. What sorts of equity benefits programs have been implemented to-date in the U.S. and abroad? What are the lessons learned from existing efforts?
2. What are the pathways by which benefits mechanisms get developed (e.g., direct negotiations between communities and developers, agreements tied to power purchases, lease-related benefits mechanisms)?
3. How do community benefit provisions and the pathways by which they are developed affect the outcomes, perceptions of effectiveness and fairness, and other metrics of results?
4. Should community benefit provisions be considered in environmental analyses of renewable energy projects? If so, how?
5. What principles or good practices can BOEM identify related to community benefit provisions that can be provided to BOEM's stakeholders?

Affiliated WWW Sites: N/A

References:

Bristow G, Cowel, R, Munday M. 2012. Windfalls for whom? The evolving notion of 'community' in community benefit provisions from wind farms. Geoforum. 43(6):1108–1120. https://doi.org/10.1016/J.GEOFORUM.2012.06.015

Department of Energy, Office of Minority Business & Economic Development. 2017. Guide to advancing opportunities for community benefits through energy project development. Community Benefit Agreement (CBA) Toolkit | Department of Energy.

Klain SC, Satterfield T, MacDonald S, Battista N, Chan KMA. 2017. Will communities "open-up" to offshore wind? Lessons learned from New England islands in the United States. Energy Research & Social Science. 34:13–26. https://doi.org/10.1016/j.erss.2017.05.009.

Rudolph D, Haggett C, Aitken M. 2015. Community benefits from offshore renewables: good practice review. https://www.climatexchange.org.uk/media/1536/full_report_-_community_benefits_from_offshore_renewables_-_good_practice_review.pdf

Tyler G, Bidwell D, Smythe T, Trandafir S. 2022. Preferences for community benefits for offshore wind development projects: a case study of the Outer Banks of North Carolina, US. Journal of Environmental Policy & Planning. 24(1):39–55.

Tyler JG. 2020. Offshore wind and community benefits in Kitty Hawk, NC. University of Rhode Island Master's Thesis. Open Access Master's Theses. Paper 1846. https://digitalcommons.uri.edu/theses/1846.

Field	Study Information
Title	Future Directions of Physical Oceanography Research on Offshore Renewable Energy Development at the Bureau of Ocean Energy Management
Administered by	Office of Environmental Programs and Office of Renewable Energy Programs
BOEM Contact(s)	Zhen Li (Zhen.Li@boem.gov), Tom Kilpatrick (Thomas.Kilpatrick@boem.gov), Jeff Ji (Jeff.Ji@boem.gov), Jennifer Draher (Jennifer.Draher@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2025
Final Report Due	TBD
Date Revised	May 12, 2023
Problem	The development of offshore renewable energy could potentially change the physical characteristics and processes in the lease areas of the Outer Continental Shelf (OCS), resulting in changes in the bio-geo-chemical processes and having implications on marine ecosystems, fisheries, and marine mammals.
Intervention	Understanding the impacts of offshore renewable energy development on Physical Oceanography (PO) is the foundation for understanding the potential environmental impacts on other oceanographic processes and is crucial for writing the environmental impact statements and environmental assessments as a requirement for the National Environmental Policy Act (NEPA) prior to any renewable energy lease sales in the OCS.
Comparison	A workshop to address the challenges and opportunities that BOEM's PO research encounters in the emerging needs of assessing the impacts of the offshore renewable energy development on physical and other oceanographic processes in the OCS leasing areas.
Outcome	A workshop and synthesis report to help BOEM better strategize its approach in addressing the emerging short-term and long-term physical oceanography information needs for offshore renewable energy development NEPA assessment.
Context	All OCS regions

BOEM Information Need(s): As one of the three federal departments (U.S. Departments of the Interior, Energy, and Commerce) responsible for deploying 30 Gigawatts of offshore wind energy by 2030, BOEM has established an ambitious goal of completing at least 16 Construction and Operations Plans by 2025, generating about 19 GW of clean energy (FS, 2021). BOEM conducted several offshore wind energy lease sales in the Atlantic and Pacific OCS and is planning to conduct lease sales in the Gulf of Mexico (GOM) OCS in the near future. BOEM assesses the potential environmental impacts of commercial scale offshore wind farms as part of Bureau's responsibilities under the National Environmental Policy Act (NEPA). The impact of these wind farms on the physical processes is the first and most important factor to consider, because physical processes (temperature, salinity, density, pressure, etc.) and water

movements determine stratification of water columns, vertical mixing, transports of phytoplankton, larval dispersal, primary production, sound speed, and other oceanographic processes.

In 2021, BOEM completed a study, "Hydrodynamic Modeling, Particle Tracking and Agent-Based Modeling of Larvae in the U.S. Mid-Atlantic Bight (Johnson et al., 2021), which evaluated how, and to what extent, offshore wind farms affect the physical and biological processes in the Mid-Atlantic. However, a similar study conducted by NOAA Northeast Fisheries Science Center (Chen et al. 2021) has shown a much broad scale effect that wind farms have on the physical and oceanographic processes in the Mid-Atlantic Bight. NOAA Fisheries thus raised concerns over BOEM's 2021 study. BOEM has subsequently requested the National Academies establish a committee of experts to assess the potential impacts from offshore windfarms on marine hydrodynamics in the Nantucket Shoals region. The NASEM study on the Nantucket Shoals region will likely be completed in the fall of 2023. Rather than seeking the expert advice from NASEM for each individual OCS renewable energy lease sale, BOEM needs to develop a strategy and optimize its approach going forward. BOEM needs expert advice on how to use the best available information and conduct both modeling and observation studies to understand and define the extent of offshore wind farms effect on the physical and biological processes in potential lease areas within different OCS regions. BOEM needs to engage and partner with other federal, state agencies, non-profit organizations, private industry, and academies to address this challenge.

Background: BOEM and its predecessor Minerals Management Service (MMS) has a long history of conducting physical oceanography research through the Environmental Studies Program (ESP) since the ESP was first established in 1973. BOEM's physical oceanography has made substantial contributions to the scientific community as well as fulfilling BOEM's mission throughout the years (Li et al 2022; Lugo-Fernández, 2015) The last comprehensive review of BOEM's (MMS) physical oceanography research program was conducted by NASEM in 1990 (NRC, 1990). The current scientific consensus regarding the impacts of offshore wind energy development on oceanographic processes can be summarized as follows:

- North Sea: Satellite imagery analysis shows that turbid wakes of individual turbines are 30-150 m wide, a few km long, and aligned with tidal currents that could impact sediment transport (Vanhellemont and Ruddick, 2014). A review article by van Berkel et al. (2020) categorized wind farms in the North Sea and the Irish Sea into five dynamics regimes and summarized the findings on the impacts of offshore wind farms on hydrodynamics and wind field. The impacts can be local or regional depending on the regime. A recent modeling study shows that wind wakes can cause up to 10% changes in annual primary production at the offshore wind farms and extended to a larger region (Daewel et al., 2022). Another study also found that large-scale offshore wind farms can significantly reduce the air-sea heat fluxes with a net cooling of the lower atmosphere in the wind farm areas down to more than 2.0 Wm^{-2} on an annual mean basis (Akhtar et al., 2022). Several other studies, both modeling and observational, indicate that offshore wind farms (OSW) have impacts on the ocean dynamics , primary production, and marine ecosystems (Christiansen et al., 2022; Dorrell et al., 2022; Floeter et al., 2022).
- U.S. Atlantic Wind Energy Areas (WEAs): One high-resolution modeling study simulated in the summer of 2018 indicates a reduction of 3%-4% near-surface wind speed downstream of the wind farms (Golbazi et al., 2022). The authors suggested that future studies are needed to explore the offshore wind turbine effects in other seasons. There are no studies published so far on the effects of wind farms on primary production or ecosystems.

- U.S. Pacific WEAs: One modeling study, funded by the California Energy Commission, suggests a modest impact of OSW on coastal upwelling and nutrient supply (Raghukumar et al., 2022; Raghukumar et al., in review), which in turn has implications for ecosystem dynamics and fisheries. Because each OSW area is oceanographically and ecologically unique, scientific studies are needed for each OSW area within each OCS region (Lloret et al., 2022).

Objectives:

- Establish the consensus of state-of-the-art approach to address the impacts of the renewable energy development on physical and other oceanographic processes in the OCS lease areas that are unique to each OCS region.
- Identify research needs and limitations in the numerical modeling to evaluate the impacts and establish a network for sub-mesoscale observations of ocean currents, hydrography, and winds via Gliders, Lagrangian drifters and other instruments to validate high-resolution ocean models.
- Develop a strategy for BOEM's PO research on the development of renewable energy, including necessary modeling tools and ocean observations for model validation.
- Foster collaboration among federal and state government agencies, academic researchers, non-profit organizations, private industry, and other interested entities.

Methods: The NASEM will conduct a workshop in their facility in Washington, D.C. by inviting experts (domestic and international) from academia, federal and state government agencies, non-profit organizations, private industry, and other entities to present the relevant topics. BOEM's PO team will provide input in selecting the experts, attend the workshop, and participate in discussions. OEP managers will participate and present the overview of ESP at the workshop. The workshop is planned for 2-3 days with both in-person and virtual attendance. The NASEM should publish a peer reviewed synthesis report of the workshop that highlights the presentations of these speakers and provides recommendations for the path forward of BOEM's PO research.

Specific Research Question(s):

1. What is the status of research (domestic and international) on assessing impacts of offshore renewable energy development (e.g., offshore wind farms) on hydrodynamic and biogeochemical processes that could potentially lead to impacts on marine ecosystems, fisheries, and marine mammals?
2. What is the future approach that BOEM should adopt to improve current modeling efforts and to determine the sub-mesoscale observations needed to validate the high-resolution numerical models?
3. What physical oceanography research should BOEM conduct to protect BOEM's offshore renewable energy development as a result of climate change?
4. How to build BOEM's Physical Oceanography Research Program to be a leader in conducting research on development of offshore renewable energy to serve BOEM's mission?

Affiliated WWW Sites: N/A

References:

Fact Sheet (FS): Biden Administration jumpstarts offshore wind energy projects to create jobs. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/

Johnson TL, van Berkel JJ, Mortensen LO, Bell MA, Tiong I, Hernandez B, Snyder DB, Thomsen F, Svenstrup Petersen O. 2021. Hydrodynamic modeling, particle tracking and agent-based modeling of larvae in the U.S. mid-Atlantic bight. Lakewood (CO): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-049. 232 p. https://marinecadastre.gov/espis/#!/search/study/100324

Chen C, Zhao L, He P, Beardsley R, Stokesbury K. 2021. Assessing potential impacts of offshore wind facilities on regional sea scallop laval and early juvenile transports (Report No. NA19NMF450023). Report by Woods Hole Oceanographic Institution. Report for National Oceanic and Atmospheric Administration (NOAA).

Li Z, Smith C, DuForec C, Zaleski SF, Auad G, Johnson W, Ji Z-G, O'Reilly SE. 2021. A multifaceted approach to advance oil spill modeling and physical oceanographic research at the United States Bureau of Ocean Energy Management. Journal of Marine Science and Engineering. 9(5):542. https://doi.org/10.3390/jmse9050542

Lugo-Fernández, A. 2015. A temporary bonanza of ocean research funds in the Gulf of Mexico. Mar. Technol. Soc. J. 49(3):84–87.

National Research Council (NRC). 1990. Assessment of the U.S. Outer Continental Shelf Environmental Studies Program: I. Physical Oceanography. Washington, DC: The National Academies Press. https://doi.org/10.17226/1609. (accessed on Dec 15, 2022).

Vanhellemont Q, Ruddick K. 2014. Turbid wakes associated with offshore wind turbines observed with Landsat 8. Remote Sensing of Environment, 145, 105-115. https://doi.org/10.1016/j.rse.2014.01.009

Van Berkel J, Burchard H, Christensen A, Mortensen LO, Petersen OS, Thomsen F. 2020. The effects of offshore wind farms on hydrodynamics and implications for fishes. Oceanography. 33(4):108–117. https://doi.org/10.5670/oceanog.2020.410

Daewel U, Akhtar N, Christiansen N, Schrum C. 2022. Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the North Sea. Communications Earth & Environment. 3:292. https://doi.org/10.1038/s43247-022-00625-0.

Akhtar N, Geyer B, Schrum C. 2022. Impacts of accelerating deployment of offshore windfarms on near-surface climate. Scientific Reports. 12:18307. https://doi.org/10.1038/s41598-022-22868-9

Christiansen N, Daewel U, Djath B, Schrum C. 2022. Emergence of large-scale hydrodynamic structures due to atmospheric offshore wind farm wakes. Frontiers in Marine Science. 9:818501. https://doi.org/10.3389/fmars.2022.818501

Dorrell RM, Lloyd CJ, Lincoln BJ, Rippeth TP, Taylor JR, Caulfield C-cP, Sharples J, Polton JA, Scannell BD, Greaves DM, et al. 2022. Anthropogenic mixing in seasonally stratified shelf seas by offshore wind farm infrastructure. Frontiers in Marine Science 9. https://doi.org/10.3389/fmars.2022.830927

Floeter J, Pohlmann T, Harmer A. Möllmann C. 2022. Chasing the offshore wind farm wind-wake induced upwelling/ downwelling dipole. Frontiers in Marine Science 9:884943. https://doi.org/10.3389/fmars.2022.884943

Golbazi M, Archer CL, Alessandrini S. 2022. Surface impacts of large offshore wind farms. Environmental Research. Letters. 17:064021. https://doi.org/10.1088/1748-9326/ac6e49

Raghukumar K, Chartrand C, Chang G, Cheung L, Roberts J. 2022. Effect of Floating Offshore Wind Turbines on Atmospheric Circulation in California. Frontiers in. Energy Research. 10:863995. https://doi.org/10.3389/fenrg.2022.863995

Lloret J, Turiel A, Solé J, Berdalet E, Sabatés A, Olivares A, Gili J-M, Vila-Subirós J, Sard R. 2022. Unravelling the ecological impacts of large-scale offshore wind farms in the Mediterranean Sea. Science of the Total Environment. 824:153803. https://doi.org/10.1016/j.scitotenv.2022.153803

Field	Study Information
Title	Integrating Dimethyl Sulfide (DMS) Gradients into Dynamic Management to Predict North Atlantic Right Whale Occurrence in the Northeast
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 13, 2022
Problem	BOEM planning and mitigation currently relies on acoustic and visual methodologies to detect and/or anticipate the occurrence of North Atlantic right whales (NARW) 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 the Northeast. 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 whales to DMS gradients relative to species movements, and aggregate 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 baleen whale species.
Context	Gulf of Maine

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 ESA-listed species. These needs can be met more efficiently if BOEM can support the development of a method to predict when and where NARW aggregates 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 quieter 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). Data collected during pilot studies over the last two years show the relationship between DMS and large whales. For right whales we have shown the relationship in three different foraging grounds (Cape Cod Bay, George's Bank and south of Martha's Vineyard. We have also demonstrated the relationship with two zooplankton feeding species: NARW and sei whales.

Savoca and Nevitt 2014 showed that in an assemblage of southern ocean seabirds, response to DMS is an adaptation for locating krill. Other southern ocean krill specialist such as chinstrap penguins and whale sharks have also been shown responsive to DMS (Amo et al. 2013 and Dove et al. 2015). With the exception of negative findings for humpback whales (Bouchard et al. 2019), baleen whales have not been well studies relative to DMS. However, they have functional olfactory systems (Godfrey 2013) indicating that finding food via DMS is possible. In addition, Savoka (2018) suggested a novel roll for DMS, which is attracting or "recruiting" marine top predators such as large whales, that recycle iron, thereby fertilizing the ocean and stimulating primary productivity.

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 EK60 echosounder data of *Calanus* zooplankton and shipboard and aerial surveys of NARW abundance.
- Identify DMS thresholds that predict NARW occupancy of Cape Cod Bay Critical Habitat (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. 2021) sampled in the immediate path of a focal NARW and in the wider oceanscape, assessed by surveying a 2 km "cloverleaf" pattern around aggregation locations. to document the DMS levels available to whales. This will enable us to test our hypothesis that NARW will aggregate in areas with higher levels of DMS. Data collection will be augmented by autonomous vessel using standardized transects for DMS February to May; designed to capture low-high-low DMS concentrations, measured in nanomoles (nmol) per liter (L) of seawater. DMS data will be combined with right whale aerial surveys conducted by the Center for Coastal Studies during this same period. If Autonomous vehicles are used, we will also use acoustic detection capability (Baumgartner et al. 2020) to quantify the relative arrival and departure of right whales from CCBCH relative to DMS concentrations. The spatial and temporal DMS data collected will be used by our remote sensing team as the basis for identifying direct measurements or correlates of DMS levels, and to groundtruth metrics for identifying DMS concentrations at the scale needed for management. Such data do not currently exist, which handicaps remote sensing investigations. Data on zooplankton levels relative to DMS will be collected with an EK60 echosounder, measuring densities along shipboard transect lines (Owen et al. 2021). Specifically, the following tasks will be accomplished:

- In situ measurements of DMS and prey fields in Cape Cod Bay right whale critical habitat.
- Comparison of right whale distribution, abundance and behavior relative to DMS concentration.
- Identification of DMS thresholds associated with NARW site occupancy of Cape Cod Bay (i.e., arrival, maximum abundance and departure).
- Remote sensing to identify DMS levels from space.

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

Affiliated WWW Sites: N/A

References:

Bouchard B, Barnagaud J-Y, Poupard M, Glotin H, Gauffier P, Torres Ortiz S, et al. 2019. Behavioural responses of humpback whales to food-related chemical stimuli. PLoS ONE 14(2):e0212515. https://doi.org/10.1371/journal.pone.0212515.

Baumgartner MF, Lysiak NSJ, Schuman C, UrbanRich J, Wenzel FW. 2011 Diel vertical migration behavior of Calanus finmarchicus and its influence on right and sei whale occurrence. Mar. Ecol. Prog. 423:167–184.

Goldbogen JA, Calambokidis J, Oleson E, Potvin J, Pyenson ND, Schorr G, Shadwick RE. 2011. Mechanics, hydrodynamics and energetics of blue whale lunge feeding: efficiency dependence on krill density. J. Exp. Biol. 214:131–46.

Kowalewsky S, Dambach M, Mauck B, Dehnhardt G. 2006. High olfactory sensitivity for dimethyl sulphide in harbour seals. Biol. Lett. 2:106–109. https://doi.org/10.1098/rsbl.2005.0380.

Okane D, Koveke EP, Tashima K, Saeki K, Maezono S, Nagahata T, Hayashi N, Owen K, Zitterbart DP, Ohira S-I, et al. 2019. High sensitivity monitoring device for onboard measurement of dimethyl sulfide and dimethylsulfoniopropionate in seawater and oceanic atmosphere. Anal. Chem. 91:10484–10491.

Nielsen MLK, Bejder L, Videsen SKA, Christiansen F, Madsen PT. 2019. Acoustic crypsis in southern right whale mother–calf pairs: infrequent, low-output calls to avoid predation? Journal of Experimental Biology. 222(13). https://doi.org/10.1242/jeb.190728.

Cusano DA, Conger LA, Van Parijs SM, Parks SE. 2019. Implementing conservation measures for the North Atlantic right whale: considering the behavioral ontogeny of mother-calf pairs. Animal Conservation 22(3):228-237.

Parks SE, Cusano DA, Van Parijs SM, Nowacek DP. 2019. Acoustic crypsis in communication by North Atlantic right whale mother–calf pairs on the calving grounds. Biol. Lett. 15:20190485. http://doi.org/10.1098/rsbl.2019.0485.

Savoca MS, Nevitta GA. 2014. Evidence that dimethyl sulfide facilitates a tritrophic mutualism between marine primary producers and top predators. PNAS. 111(11):4157–4161.

Field	Study Information
Title	Marine Mammal Hearing Temporary Threshold Shift and Auditory Recovery from Complex Noise Exposure
Administered by	Office of Environmental Programs
BOEM Contact(s)	Shane Guan (shane.guan@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	January 9, 2023
Problem	Information on marine mammal hearing threshold shift (TS) is only limited to effects from purely impulsive and non-impulsive sound exposure. Additionally, information is lacking regarding potential recovery from auditory fatigue after one noise-exposure event within 24 hours or during noise-gaps from intermittent noise exposure. Therefore, it is often difficult for BOEM to accurately assess the effects of marine mammal noise exposures in real-world situations, which are often complex and dynamic.
Intervention	This study will investigate temporary threshold shift (TTS) and auditory recovery on select captive marine mammal species (e.g., mid- and high-frequency cetaceans, pinnipeds, sirenians, and sea otters) that are exposed to complex sounds with different impulsiveness for different exposure durations 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 threshold matrices on select marine mammal functional hearing groups when exposed to anthropogenic sounds similar to those in real-world situations that have different impulsiveness and temporal characteristics. It would also establish guidance to quantify cumulative sound exposure that considers auditory recovery functions.
Context	Nation-wide relevance for activities involving offshore wind construction, seismic exploration, subsea drilling and dredging, etc.

BOEM Information Need(s): Current noise impact assessments on marine mammal noise-induced threshold shift (NITS) from noise exposure uses a binary approach by classifying the noise sources into two mutually exclusive categories: impulsive and non-impulsive (Finneran 2016). But in real-world situations, animals are often exposed to complex noise fields, i.e., those that include both impulsive and non-impulsive components from various anthropogenic sources (e.g., concurrent impact and vibratory pile driving). Currently there is no information on marine mammal NITS when exposed to a noise field that contains both impulsive and non-impulsive sources. Additionally, variations in noise duration and intervals between noises can have a large influence on the effects on hearing (especially TTS and

permanent threshold shift, or PTS). Information is lacking regarding potential recovery from auditory fatigue after one noise-exposure event within 24 hours or during noise-gaps from intermittent noise exposure. Therefore, it is often difficult for BOEM to accurately assess the effects of marine mammal noise exposures in real-world situations, which are often complex and dynamic.

Background: Marine engineering activities (e.g., offshore renewable energy facility construction and operation, offshore oil and gas exploration, subsea drilling and dredging, and structure removal) generate intense and/or long-lasting noises that are known to impact marine life. In addition, noise fields from these activities are often complex and dynamic, including both impulsive and non-impulsive sources with dynamic temporal variations in exposure levels. For example, impact pile driving (impulsive source) for offshore wind construction may be conducted from a barge operating a dynamic positioning (DP) system (non-impulsive source). The duty cycle of impact hammer striking the pile may allow exposed marine mammal to recover from auditory fatigue between noise pulses.

However, current marine mammal noise exposure injury criteria are based on laboratory studies of animals exposed to controlled sound sources typically not seen in real-world conditions. These sound sources were either purely impulsive pulses, short tone bursts, or long-duration band noise (Finneran 2015). Noise that contains both impulsive and non-impulsive structures is called complex noise (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 underwater (Guan and Brookens, 2021). Studies applying human and terrestrial mammal NITS modeling approach for marine mammals showed that adjusted PTS thresholds from complex noise exposure fell somewhere between the thresholds of purely impulsive and purely non-impulsive exposures, and the values depended on impulsiveness of the received noise (Guan, 2022).

Additionally, very few studies have investigated potential auditory recovery function during noise gaps when animals are exposed to intermittent sound sources, such as impact pile driving. Studies in human and terrestrial psychoacoustics showed that intermittent noise exposure caused less damage to hearing than does continuous noise of the same intensity (Schmidek et al., 1975). However, a later study by Sataloff et al. (1983) on humans showed that long-term intermittent exposure to intense noise caused severe loss in high frequencies but little or no hearing loss in the lower frequencies, even after many years of exposure. A recent study on zebrafish exposed to random noise of different temporal variation also showed different levels of NITS (Wong et al., 2022).

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 assist BOEM decision-making using scientific knowledge that is first in class. Furthermore, the results from this work could be used to establish appropriate standards for classifying noise types based on metrics of impulsiveness and intermittence from different noise sources under general operating conduction. It could also be used to update or revise current marine mammal noise exposure criteria. The study may eventually lead to a paradigm shift in the way we regulate underwater noise, if the results indicate that marine mammals respond differently to complex noises and that there is auditory recovery when exposed to intermittent noises.

Objectives: The objectives of this study are to:

- Obtain NITS on select marine mammal species that are exposed to complex noise at different impulsiveness settings.
- Acquire knowledge on potential auditory recovery on select marine mammal species that are exposed to intermittent noise as compared to continuous noise

Methods: The study would conduct noise exposure experiment on select marine mammal species (e.g., mid- and high-frequency cetaceans, pinnipeds, sirenians, and sea otters) using behavioral or auditory evoked potential procedures to obtain NITS thresholds under different intensity, impulsiveness, and duty cycle. Based on the results, the researchers would develop appropriate metrics to characterize impulsiveness and intermittence of the noise sources, which, in turn, could 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?
    a. If so, what are the thresholds for a given species or functional hearing group?
    b. If so, do marine mammals show lower NITS when exposed intermittent noise vs. continuous noise that have the same exposure energy?
2. Do marine mammals exhibit different NITS thresholds when exposed to complex noise that have different impulsiveness and/or duty cycle but the same exposure energy?
3. How can we predict threshold shift in time varying acoustic exposures?
4. What is/are the appropriate standard(s) to classify and characterize noise types and their potential to cause a threshold shift based on metrics of impulsiveness and intermittence?
5. 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?
6. Do current NITS thresholds based on pure impulsive and non-impulsive noise exposure need to be updated or revised for BOEM's environmental assessment?

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.

Finneran JJ. 2015. Noise-induced hearing loss in marine mammals: a review of temporary threshold shift studies from 1996 to 2015. J Acoust Soc Am. 138:1702–1726.

Finneran JJ. 2016. Auditory Weighting Functions and TTS/PTS Exposure Functions for Marine Mammals Exposed to Underwater Noise. SSC Pacific, San Diego, CA, USA. Technical Report 3026.

Guan S. 2022. A simple approach for marine mammal noise-induced threshold shift prediction from down-the-hole piling noise exposure. J Acoust Soc Am. 152:A108.

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. doi:10.3390/jmse9050507.

Hamernik RP, Qiu W, Davis B. 2003. The effects of the amplitude distribution of equal energy exposures on noise-induced hearing loss: the kurtosis metric. J Acoust Soc Am. 114:386–395.

Hamernik RP, Qiu W, Davis B. 2007. Hearing loss from interrupted, intermittent, and time varying non-Gaussian noise exposure: the applicability of the equal energy hypothesis. J Acoust Soc Am. 122: 2245–2254.

Qiu W, Davis B, Hamernik RP. 2007. Hearing loss from interrupted, intermittent, and time varying Gaussian noise exposures: the applicability of the equal energy hypothesis. J Acoust Soc Am. 121:1613–1620.

Qiu W, Hamernik RP, Davis RI. 2013. The value of a kurtosis metric in estimating the hazard to hearing of complex industrial noise exposures. J Acoust Soc Am. 133:2856–2866.

Sataloff J, Sataloff RT, Gore RP. 1983. Intermittent exposure to noise: Effects on hearing. Ann Otol Rhinol Laryngol. 92:623–628. doi:10.1177/000348948309200618.

Schmidek M, Margolis B, Henderson TL. 1975. Effects of the level of noise interruptions on temporary threshold shift. Am Ind Hyg Asso J. 36:351–357.

Wong MI, Lau IH, Gordillo-Martinez F, Vasconcelos RO. 2022. The effect of time regime in noise exposure on the auditory system and behavioural stress in the zebrafish. Sci Rep. 12:15353 doi:10.1038/s41598-022-19573-y.

Xie H, Qiu W, Heyer NJ, Zhang M, Zhan, 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.

Field	Study Information
Title	National Outer Continental Shelf (OCS) Oil Spill Occurrence Rates
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jeff Ji (jeff.ji@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2025
Final Report Due	TBD
Date Revised	May 10, 2023
Problem	OCS petroleum hydrocarbon spill data for analyses—including the number, volume, and rate of such petroleum hydrocarbon spills—is needed to support the assessment of potential impacts under the National Environmental Policy Act (NEPA).
Intervention	Updated OCS petroleum hydrocarbon spill data will be collected into a systematic collation of data for mathematical analyses.
Comparison	A suite of objective statistical methodologies will provide estimates of petroleum hydrocarbon spill rates to use in oil spill risk analysis (OSRA), offshore environmental costs model (OECM) and NEPA analyses.
Outcome	This study will deliver National estimates of the occurrence of OCS oil spills for a range of spill volume size classes.
Context	All OCS planning areas.

BOEM Information Need(s): The Bureau of Ocean Energy Management (BOEM) needs up-to-date quantifications of spill occurrence for the OCS to perform oil spill risk analysis (OSRA). OCS oil spill occurrence rates are essential for analyzing potential oil spills and their impacts in NEPA documents and oil spill response plans. The general trend is that these spill rates have been decreasing over the past decades (ABS Consulting, 2016). To reflect the progress of the technology and the improvement of safety regulations, it is critical to calculate the spill rates using the most recent 15-years of available data. The previous study (ABS Consulting, 2016) used the data between 2000-2014. This proposed study will use the data between 2010-2024 and replace two thirds (10 years out of the 15 years) of the data from the previous study.

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

Currently, the Bureau of Safety & Environmental Enforcement (BSEE) maintains OCS spill data related to oil and gas activities on the OCS. BSEE receives these data from operators, who are required to submit offshore incident reports to the agency for various safety and environmental events, including spills of chemicals or crude oil (30 Code of Federal Regulations [CFR] 250.187, 30 CFR 254.46, and BSEE Notice to Lessees [NTL] 2019-N05). Spills may include crude or refined petroleum, drilling fluids, other chemicals, or mixtures thereof. BOEM uses these spill data and derived spill rates to assess and disclose oil spill risks to help inform leasing and plan decisions . The BSEE spill data and BOEM analyses have also been used to support BSEE responsibilities, principally oil spill response planning, drilling permitting, and rulemaking. Both bureaus have an interest in ensuring oil spill data and spill rate analyses are updated regularly. Since 1975, a series of spill rate analyses have been conducted by BOEM or its predecessors (e.g., Anderson et al., 2012), where spill rates were determined in terms of the volume of oil produced or handled. The most recent by ABS Consulting, Inc. (2016) collated data through as late as 2015. The ABS studies collated data through 2021 but are not designed to analyze National OCS spill rates (ABS Consulting, 2018; https://marinecadastre.gov/espis/#!/search/study/100250; ABS Consulting, 2021, https://espis.boem.gov/final%20reports/BOEM_2021-065.pdf). This study proposes to Nationally update OCS spill data and spill rate analyses through calendar year 2024 (1964–2024).

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

Specific objectives are:

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

Methods: The investigators will update National OCS oil spill occurrence estimates previously calculated for OCS (ABS Consulting Inc., 2016). They will collect, examine, and reconcile crude and refined oil spill records and cleanup reports for the OCS for spills ≥1 bbl from industry, U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), U.S. Department of the Interior (DOI), BOEM, BSEE, U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (USDOT, PHMSA), state (e.g., Alaska Department of Environmental Conservation [ADEC]), and other datasets through 2022. The investigators will also calculate accident frequencies for small spills and perform appropriate statistical analyses, including trend analysis. Results will be collated into an electronic database in a standard format.

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

Affiliated WWW Sites: N/A

References:

Anderson CM, Mayes M, LaBelle RP. 2012. Update of occurrence rates for offshore oil spills. Herndon (VA): U.S. Department of the Interior Bureau of Ocean Energy Management. 76 p. Report No.: OCS Report 2012-069.

ABS Consulting, Inc. 2016. 2016 Update of occurrence rates for offshore oil spills. 95 p.

ABS Consulting, Inc. 2018. US Outer Continental Shelf oil spill statistics. Anchorage (AK): U.S. Department of the Interior Bureau of Ocean Energy Management. 44 p. Report No.: OCS Study BOEM 2018-006.

ABSG Consulting, Inc. 2021. Alternative oil spill occurrence estimators for determining rates for the Atlantic Outer Continental Shelf. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 97 p. Report No.: OCS Study BOEM 2021-065.

Field	Study Information
Title	Next Generation of Animal Telemetry: Space Flight Testing
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Interagency Agreement/Contract
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	December 19, 2023
Problem	Spatial and temporal coverage limitation of telemetry receiving stations lead to data loss and cost ineffectiveness for animal movement studies.
Intervention	Leveraging the growing small satellite industry, anticipated to be as many as 18,000 orbiting assets by 2028, to augment current telemetry limitations. Change is measured by increased accuracy and bandwidth available to telemetry needs.
Comparison	This is measured against existing telemetry spatial quality.
Outcome	Improved data quality with reduced costs for animal telemetry needs.
Context	All OCS areas.

BOEM Information Need(s): This study implements BOEM's Outer Continental Shelf (OCS) Lands Act mandate to monitor the marine environment adjacent to U.S. OCS operations. Understanding animal movement in the OCS is required for nearly everything under BOEM's purview. Telemetry is an important tool to support animal movement and behavior studies to supplement survey effort. Additionally, animal telemetry can be used to infer movements related to activities in the OCS, such as geophysical surveys, construction and demolition. Animal telemetry can provide relevant information for National Environmental Policy Act, Marine Mammal Protection Act, Magnuson-Stevens Fishery Conservation and Management Act, and Endangered Species Act consultations across program areas such as wind and hydrokinetic placement locations, oil/gas leasing and even used in monitoring impacts of climate change. Internal reports, such as BOEM's Effects of Offshore Energy Sound Producing Activities on Fish and Invertebrates (Normandeau Associates, Inc. 2012) as well as public comments on a variety of EIS, from the Arctic to Atlantic, call for a need for improved data on animal movement, behavioral, and foraging ecologies.

Background: Tracking of highly mobile marine megafauna is typically accomplished by Argos satellites. This study proposes development of supplemental/alternative method of OCS marine animal tracking by leveraging NASA's CubeSat Launch Initiative low-earth orbiting small satellite programs.

Animal movement studies face several technological challenges due to proprietary technology, limited radio transmission range, overhead satellite time limitations and most importantly, cost. Cumulatively, these factors limit opportunity to gather information on animal movements throughout the U.S. Exclusive Economic Zone. An open-source receiving network, which does not depend on the Argos

satellite system significantly lowers costs by enabling use of a constellation of low cost, open-source data relay CubeSats.

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

Marine mammals, fishes, sea turtles, birds and invertebrates are all 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 be physically recovered, these tags can be deployed on animals not suitable for archival tags alone (such as sea turtle hatchlings and red knots).

Objectives: Demonstrate low earth orbit constellation of receivers able to relay animal telemetry information with sub 10m accuracy.

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

- Develop and launch CubeSats for data link characterization.
- Convene a workshop of the CubeSat community as well as ocean telemetry engineering experts to establish a standardized communication platform for low orbital pico-satellites.
- Convene a public competition to create a coding algorithm for managing big data associated with visualizing movements accurately.
- Ground-truth CubeSat animal tags in diverse scenarios.

Specific Research Question(s): Can CubeSats be used to improve the accuracy and diversity of taxa, compared to the existing Argos system.

Affiliated WWW Sites: https://www.nasa.gov/directorates/heo/home/CubeSats_initiative

References:

Normandeau Associates, Inc. 2012. Effects of noise on fish, fisheries, and invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. Herndon (VA): U.S. Dept. of the Interior, Bureau of Ocean Energy Management. 72 p. plus appendices. Report No.: OCS Study BOEM 2013-300.

Field	Study Information
Title	Non-Physiological Effects of Marine Vibroseis on Baleen Whales: Field Study of Behavioral Responses
Administered by	Office of Environmental Programs
BOEM Contact(s)	Sam Denes (samuel.denes@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2025
Final Report Due	TBD
Date Revised	May 11, 2023
Problem	Seismic airgun surveys produce high levels of acoustic energy that can lead to harassment of marine life. Marine vibroseis technology may provide the ability to replace some of the airgun survey activity. However, the response of marine life to these devices is relatively unstudied. As vibroseis produce most of their energy below 100 Hz, the effects on animals that communicate and are expected to hear at those frequencies are of most concern, particularly, baleen whales.
Intervention	Behavioral response of baleen whales to vibroseis may be observed through coordinated monitoring of the whales in proximity to active vibroseis surveys. Visual and acoustic observations, along with animal borne tags would be used to document behavior.
Comparison	The behavioral responses of baleen whales to three exposure regimes will be compared: a) exposure to operational marine vibroseis; b) exposure to vibroseis vessels without the vibroseis signal; and c) no exposure.
Outcome	This study will demonstrate that behavioral response of baleen whales to vibroseis activity is context dependent. The response will depend on the individual, species, behavioral state, acoustic environment, and operational condition of the vibroseis. These results will allow BOEM to make more informed estimates of the effects of vibroseis activities on baleen whales.
Context	Gulf of Mexico Western and Central Planning Regions

BOEM Information Need(s): It is unknown whether, how, and under what circumstances marine mammals are likely to respond to exposure of acoustic energy from vibroseis surveys. Understanding these effects will allow proper assessment of potential impacts, which is critical to ensure that adequate mitigations are employed once marine vibroseis is fully operational.

Background: Exposure to sounds generated by seismic surveys can lead to both physiological and behavioral effects on marine mammals. Under the marine mammal protection act, exposure that leads to permanent hearing loss is considered to be a “Level A take,” while behavioral impacts and temporary hearing loss is called a ‘Level B take.” Marine vibroseis, which is an emerging technology, may be able to replace some portion of typical airgun surveys associated with oil and gas exploration and production on the outer continental shelf (Feltham et al 2018; Laws et al 2019; Teyssandier and Sallas 2019). It is

expected that because of the nature of the acoustic signal, the impact from the vibroseis will have significantly lower likelihood of Level A takes of marine mammals. Conversely, a desktop study showed that the criteria used to determine Level B takes from acoustic disturbance of marine vibroseis signals will result in larger numbers of predicted takes when compared to seismic airgun surveys based on current regulatory criteria (Matthews et al 2021).

Objectives: The proposed study will determine the behavioral response, if any, of baleen whales exposed to marine vibroseis surveys.

Methods: The proposed study would utilize full scale marine vibroseis to expose baleen whales to the acoustic energy emitted by these devices. The study would take place in an area expected to have baleen whales. These target species have low frequency vocalizations that overlap with vibroseis signals and are assumed to be most likely to be affected. To determine the behavioral response, controlled exposure experiments will be conducted. Target individuals will be monitored before, during, and after treatments. Monitoring may be conducted through a variety of techniques including animal borne tags, focal follows, acoustic monitoring methods, and shore-based observations. Monitored individuals (or groups) will be exposed to either acoustic energy from vibroseis operations or a control. The behavioral responses of baleen whales to three exposure regimes will be compared: a) exposure to operational marine vibroseis; b) exposure to vibroseis vessels without the vibroseis signal; and c) no exposure.

Specific Research Question(s):

1. Is there a measurable response from baleen whales when exposed to marine vibroseis in realistic field conditions?
2. What factors contribute to the likelihood of behavioral response to marine vibroseis surveys?
3. Can the severity of response be predicted (e.g., based on equipment, survey characteristics, environment, species, behavioral state, life stage, health of individual)?

Affiliated WWW Sites: N/A

References:

Feltham A, Girard M, Jenkerson M, Nechayuk V, Griswold S, Henderson N, Johnson G. 2018. The Marine Vibrator Joint Industry Project: four years on. Exploration Geophysics. 49(5):675–687. https://doi.org/10.1071/EG17093.

Laws RM, Halliday D, Hopperstad J-F, Gerez D, Supawala M, Özbek A, Murray T. Kragh E. 2019. Marine vibrators: the new phase of seismic exploration. Geophysical Prospecting, 67:1443–1471. https://doi.org/10.1111/1365-2478.12708.

Matthews MR, Ireland DS, Zeddies DG, Brune RH, Py´c CD. A modeling comparison of the potential effects on marine mammals from sounds produced by marine vibroseis and air gun seismic sources. 2021. J. Mar. Sci. Eng. 9(12). https://dx.doi.org/10.3390/jmse9010012.

Teyssandier B, Sallas JJ. 2019. The shape of things to come — development and testing of a new marine vibrator source. The Leading Edge. 38:680–690.

Field	Study Information
Title	Non-Physiological Effects of Marine Vibroseis on Bearded Seals: Lab Study on Masking Effects
Administered by	Office of Environmental Programs
BOEM Contact(s)	James Price (james.price@boem.gov)
Procurement Type(s)	Cooperative Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 11, 2023
Problem	Seismic airgun surveys produce high levels of acoustic energy that can lead to harassment of marine life. Marine vibroseis may provide the ability to replace some of the airgun survey activity due to lower source levels and low frequency content. However, the response of marine life to marine vibrators is relatively unstudied. As marine vibrators produce most of their energy below 100 Hz and produce a significantly longer signal than an airgun pulse, acoustic masking may be a pervasive concern for low frequency sensitive species, such as seals and baleen whales.
Intervention	Expose low-frequency communicators (bearded seals) in a calibrated test tank to determine detection thresholds for marine vibroseis stimuli. Use auditory parameters within an established masking model to test masking predictions. Measure auditory thresholds and response times in off-band listening experiment designed to evaluate the potential cognitive effects of marine vibroseis stimuli at higher frequencies.
Comparison	Hearing tests for masking performed in a tank using simulated marine vibroseis sound will be compared with model-derived masking thresholds.
Outcome	This study will determine the hearing thresholds of bearded seals to marine vibroseis signals, and the efficacy of a masking model to predict how much marine vibrators could mask their communication. Reasonable inferences could be made about the masking effect of marine vibrators on other marine mammals that are also low frequency vocalizers, such as baleen whales.
Context	All planning regions

BOEM Information Need(s): Much effort has been made in developing the technology of marine vibrators (the technology, not the devices themselves, is called marine vibroseis). Compared to airguns used in marine seismic surveys, marine vibrators performing the same task, emit lower energy overall with most the energy concentrated at lower frequencies. As such, they offer a potential alternative to airguns surveys, which can cause hearing damage or other injurious impacts to marine mammals nearby, if their downsides are not great. One of the possible downsides to marine vibroseis is its potential to mask communication among low-frequency vocalizing marine mammals. BOEM needs to evaluate the possible masking effects of marine vibroseis in order to assess the mitigative value of this technology with respect to airgun use.

Background: Low-frequency sound is generated by airguns and marine vibrators during geophysical exploration to find oil and gas deposits in the sea floor. Airguns additionally produce high amplitude, high frequency sound that is an extraneous by product and one that can potentially cause hearing loss in several species of marine animals. The interest in marine vibrators as a substitute to airguns is in their lower frequency, more continuous output that poses a lower risk to hearing loss in marine mammals. Whether the alternative use of marine vibrators will reduce harmful effects to marine life or create other problems is yet undetermined. Acoustic modeling efforts indicate that marine vibroseis sources, although longer in duration and lower in frequency, may provide improved acoustic conditions for marine mammals relative to airguns due to their lower source levels and lower frequency content. As marine vibroseis sources are developed for marine applications and approach operational testing and deployment stages, information concerning their possible environmental effects is needed.

Unfortunately, there are no available data to show received levels and spectra at known distances from actual marine vibroseis sources deployed in realistic environments. Desktop models based on nominal signal output parameters indicate lower received peak pressure and sound exposure level (SEL) at frequencies < 150 Hz and substantially less high-frequency content than impulsive seismic sources. While it is possible to model the potential behavioral and auditory effects of marine vibroseis sources on marine mammals based on these assumptions, in the absence of field measurements the accuracy of such predictions is unknown. Even more importantly, none of the animal data upon which modeled effects are based have been obtained at low frequencies or with sounds of similar composition. Thus, using modeled results to anticipate the environmental impacts of low-frequency marine vibroseis sources on marine mammals is speculative at best.

The most pervasive auditory effect of marine vibroseis noise is likely to be masking, in which an animal's ability to hear and respond to a signal of interest is reduced by the presence of overlapping noise. Masking is a concern for all marine mammals that rely on sound during orientation, conspecific communication, foraging, or predator avoidance. To understand and predict masking from any source, data are needed to parameterize the auditory capabilities of potential listeners. However, this need is often overlooked or oversimplified, either due to the difficulty of acquiring auditory data or the complexity of applying it in realistic listening scenarios. In the absence of necessary auditory data, assessments of masking are inaccurate. For example, while it has often been assumed that impulsive noise from seismic airguns has low potential to mask biologically relevant sounds, this has recently been demonstrated experimentally to not be the case (Sills, et al. 2017). Audiometric studies of living, listening animals are needed to identify key parameters of masking at low frequencies, to inform and validate masking models, and to generate realistic estimates of masking potential in the presence of specific noise sources.

Objectives: Determine the hearing thresholds and masking potential of low-frequency communicators to marine vibroseis signals.

Methods: This study will employ the behavioral response method in a well calibrated test tank to determine the hearing thresholds of low-frequency communicators. This study will:

- Use the best available masking model auditory parameters to test for masking associated with a representative marine vibroseis stimuli.
- Measure the auditory detection thresholds of a low-frequency communicator for representative marine vibroseis stimuli, obtained from a complementary field effort conducted by Southall Environmental Associates, Inc.

- Measure auditory detection thresholds and response times in off-band listening trials designed to evaluate the potential cognitive effects of marine vibroseis stimuli at higher frequencies.

Since seals have the best demonstrated low-frequency hearing ability among marine mammals, they are the best available candidates for the proposed studies of auditory masking by low-frequency sound.

Specific Research Question(s):

1. Does masking by marine vibroseis stimuli significantly interfere with seal communications?
2. What are the detection thresholds of representative marine vibroseis stimuli?
3. What are the auditory thresholds and response times with off-band sound exposure?

Affiliated WWW Sites: N/A

References:

Sills JM, Southall BL, Reichmuth C. 2017. The influence of temporally varying noise from seismic air guns on the detection of underwater sounds by seals. The Journal of the Acoustical Society of America. 141: 996. doi: 10.1121/1.4976079.

Field	Study Information
Title	Relationships with Land and Resources: A Comparative Study of Subsistence Activities in the United States
Administered by	Office of Environmental Programs
BOEM Contact(s)	John Primo (john.primo@boem.gov), Jeffrey Brooks (jeffrey.brooks@boem.gov), Sindey Chaky (sindey.chaky@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Performance Period	FY 2024–2028
Final Report Due	TBD
Date Revised	May 15, 2023
Problem	Knowledge about subsistence practices and cultural land uses is inconsistent and lacking in areas of the country. This information is needed to support the Department's responsibilities for environmental justice, ecosystems, climate change, and Native American Tribes.
Intervention	Document and compare subsistence activities in three regions of the United States to provide enhanced understandings of subsistence activities and insights into similarities and differences between regions.
Comparison	Compare subsistence activities in communities from three regions.
Outcome	Enhance understanding of subsistence in terms of its cultural importance and role in maintaining group identity. Inform decision-making on the OCS, coastal areas, and the nation's interior and develop methods for future research in the Pacific and Atlantic regions.
Context	One or more communities in the Southcentral Alaska, the Northern Rocky Mountains of Colorado, and the Gulf of Mexico including indigenous, non-Indigenous, low income, and other environmental justice communities.

BOEM Information Need(s): The Department of the Interior is developing an Order to implement environmental justice mandates for which subsistence activities and traditional land uses are of primary concern. The Secretarial Order would require Bureaus to proactively collect, analyze, and apply information on subsistence activities and harvest patterns while making decisions regarding federal stewardship of public lands and waters. The Secretarial Order would remove barriers for underserved populations to access subsistence resources, understand the cultural connections to harvesting and sharing subsistence foods, and how these populations may use nonedible subsistence resources for making and selling handicrafts. Subsistence is important to the Department as it has been a topic of concern for NEPA assessments for years and wise management of the associated resources supports the Nation's Trust responsibilities to Tribal Nations.

Comprehensive data on subsistence activities and associated phenomena are lacking for much of the United States. Federal managers and decision makers require up-to-date information about the sociocultural and socioeconomic dimensions of subsistence for public lands and waters to meet environmental justice mandates and better serve environmental justice populations. This research

would provide insights about what methodologies are applicable and potentially successful for studying subsistence harvest patterns and cultural land uses for all regions of the United States.

One would expect cultural, social, economic, and geographical differences in patterns of subsistence harvest across regions of the United States (i.e., the Gulf of Mexico region; the northern Rocky Mountains in Colorado; Southcentral Alaska). There may also be important similarities. A set of three ethnographic case studies would allow BOEM to make these comparisons and better understand if there is a changing pattern of subsistence uses at a multi-regional scale.

Background: Resource professionals recognize the importance of traditional lands and waters in supporting food security, community resilience, and cultural identity for Indigenous and non-indigenous peoples, including minority, low income, and underserved communities. Traditional lands are those lands that form part of the traditional territory of a people or community, and which they have traditionally used and occupied and continue to use and occupy, and to which a people or a community has asserted Aboriginal Rights and Title (Law Insider, 2022). Tribal consultation in Alaska indicates adverse impacts to subsistence from climate change and reduced availability of and access to subsistence resources for harvest, sharing, and other cultural activities (BIA, 2022). The Bureau of Land Management conducted stakeholder interviews in the San Luis Valley, Colorado in preparation of a resource management plan. Emphasis was placed on capturing the voices of environmental justice populations (e.g., Hispanic, low-income, tribal members living on ancestral lands). Several respondents mentioned the importance of fish and game to supplement their diets and the existence of a multigenerational connection to the land for hunting, fishing, and cultural purposes. Research in the Gulf of Mexico revealed a diverse range of subsistence harvesters and activities (e.g., gardening, hunting, shrimping, fishing, gathering) that take place in Louisiana coastal areas and offshore (Regis and Walton, 2022). Changes in the environment, shifts in climate, land uses, and land ownership have impacted access to resources. The Louisiana study highlighted the importance of the social and cultural aspects of subsistence such as sharing, the passing of identity and heritage, and the skills to provide for self and family.

For much of the contiguous United States, up-to-date formal documentation of subsistence is sparse. Some state and tribal wildlife agencies may have records related to subsistence harvests that could be used to compile baseline data. Both Alaska and the San Luis Valley are showing signs of climate change impacts with extreme weather patterns and reduced water availability that adversely affect subsistence activities. Coastal areas in the Gulf of Mexico and Alaska are undergoing subsidence, erosion, and sea level rise, reducing the size of coastal areas. Initial reports indicate deleterious impacts on the subsistence practices of local communities as their access to resources diminishes. To serve environmental justice populations and provide continued opportunities for subsistence and other cultural and traditional land uses, the Department of the Interior must account for these changes and challenges in its decisions for land use management.

Objectives: The purpose of this proposed research is to enhance the Department's understanding of subsistence harvest patterns and traditional land uses for three regions of the United Sates. There are four specific objectives:

- Gain a more robust understanding of cross-regional subsistence and improve the Department's environmental assessments by establishing a baseline for subsistence practices in three different regional ecosystems.

- Understand the social and cultural significance of subsistence activities and other traditional land uses in each community and region.
- Learn and document the similarities and differences in subsistence activities between communities and between regions.
- Provide recommendations and lessons learned for how to conduct further baseline and primary research on subsistence practices and traditional land uses.

Methods: This study will involve both primary and secondary data collection and analyses and build on previous research sponsored by BOEM (e.g., Kofinas et al., 2016; Regis and Walton, 2022; SRBA, 2010, 2013). To establish the baseline, researchers would conduct literature reviews and archival research to compile and synthesize information about subsistence activities and other traditional land uses. Baseline research would be used to 1) document environmental justice populations and communities and their traditional use areas and 2) assist the research team in vetting and selecting communities for primary data collection. Researchers would use purposive, convenience, and snowball or referral sampling for this targeted and largely qualitative descriptive study. In a case study approach, primary data collection would use ethnographic techniques, including open-ended conversations, key informant and small group discussions, mapping exercises, and participant observation, drawing on secondary information collected for the baseline. Community selection and identification would be guided by potential federal planning and environmental assessment needs in each region.

Specific Research Question(s):

1. What are the spatial, temporal, and physical parameters and cultural dimensions of subsistence activity in each region and community; who is harvesting what resources when and where, by what means, and for what reasons?
2. What is the sociocultural role played by subsistence and other traditional land uses (e.g., hunting, fishing, small-scale farming, community gardens, mariculture, visits to sacred sites or places of special use or ritual and ceremony)?
3. How does subsistence vary between communities, Tribes, and underserved populations, with particular attention to environmental justice populations?
4. What role does subsistence play in community cohesion, community resilience, and in preservation and passing on of cultural heritage and identity?
5. What and how much subsistence foods are of primary importance for ensuring food security?
6. Are subsistence practices related to social structure and organization (e.g., whaling crews)?
7. What subsistence resources and practices are impacted by environmental change (e.g., climate change, land use changes)?
8. Does risk management play a role in subsistence? Do practitioners consider the possibility of poor production or poor harvest years? Do they make efforts to address this? What strategies have they, or might they use (e.g., diversification of harvests (rabbits as opposed to deer, seals as opposed to other marine species, etc.)?

Affiliated WWW Sites: N/A

References:

[BIA] Bureau of Indian Affairs. 2022. Federal subsistence policy consultation summary report. June 14, 2022. Available at https://www.bia.gov/sites/default/files/dup/tcinfo/final-subsistence-consultation-summary-report_6.10.22_508.pdf

Kofinas G, BurnSilver SB, Magdanz J, Stotts R, Okada M. 2016. Subsistence sharing networks and cooperation: Kaktovik, Wainwright, and Venetie, Alaska. OCS Study BOEM 2015-023. Fairbanks, AK: University of Alaska Fairbanks, School of Natural Resources and Extension, 263 pp.Law Insider. 2022. Traditional lands definition. https://www.lawinsider.com/dictionary/traditional-land

Regis H, Walton S. 2022. Subsistence in coastal Louisiana Volume 1: An exploratory study. OCS Study BOEM 2022-0XX (four volumes). Baton Rouge and Thibodaux, LA: Louisiana State University and Nicholls State University, 167 pp.

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

SRBA. 2013. COMIDA: Impact monitoring for offshore subsistence hunting, Wainwright and Point Lay, Alaska. OCS Study BOEM 2013-211. Anchorage, AK: Stephen R. Braund and Associates, 268 pp.

Field	Study Information
Title	Socio-Cultural and Economic Impacts of Changing Energy Trends
Administered by	Office of Environmental Programs
BOEM Contact(s)	Laura Mansfield (laura.mansfield@boem.gov), Kristen Strellec (kristen.strellec@boem.gov), Doleswar Bhandari (doleswar.bhandari@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 15, 2023
Problem	BOEM has limited information about the socio-cultural and economic impacts of a large shift away from oil and gas leasing activities. BOEM's current methods of analysis are not systematic or human-centered and have limited capability to assess impacts that cannot be reliably quantified or estimated.
Intervention	Develop economic scenarios, focused on employment patterns, and conduct a social impact assessment (SIA) specifically considering changing energy trends and the impacts of reduced or no oil and gas leasing on social systems including economics and cultural considerations.
Comparison	Without this study, BOEM has a reduced capacity to fully analyze changing energy trends and the impacts of future leasing decisions on the human environment.
Outcome	Improve socio-cultural and economic considerations in the no action alternative analysis for the National Program Environmental Impact Statement. This improved analysis would provide stronger science and knowledge-based rationale behind decisions about whether, when, or how many oil and gas lease sales to hold given current energy needs and socio-cultural implications.
Context	Gulf of Mexico OCS Region

BOEM Information Need(s): Changing trends in energy are likely to have transformative impacts on society. A reduction in Outer Continental Shelf (OCS) oil and gas leasing is likely given ambitious goals to increase offshore wind activities and advance a transition to an equitable clean energy future. BOEM has limited information about the socio-cultural and economic implications of these changing energy trends and the impacts of reducing leasing or decisions not to lease OCS areas for oil and gas development.

This study will look at multiple energy outlooks that capture both industry trends and policy changes to develop potential economic scenarios, especially considering employment patterns, related to declining levels of oil and gas activity over time. These employment scenarios will serve as informational input for a social impact assessment (SIA) of a reduction of oil and gas activities. This information could improve the human dimensions discussion of the "no action" alternative in NEPA documents. This study would focus on understanding the impacts of no new oil and gas leasing and would not provide a comprehensive analysis on potential impacts of substitute energy activities. The study will describe how

the energy transition would look and document the impacts of no new leasing as the energy sector changes. For example, the study will describe which job skills may be transferrable and analyze the difference in social impact should an employee lose their job or transition their job skills to a different job as a result of no new leasing. This study would enable BOEM to look more deeply at the socio-cultural and economic impacts of changing energy trends and better understand the implications of key decisions during the energy transition.

Background: The No Action Alternative in the current Draft Programmatic Environmental Impact Statement (PEIS) for the 2023–2028 National OCS Oil and Gas Program states there would be no new oil and gas development or associated impacts from the 2023–2028 Program, but there could be impacts from energy substitutions. The PEIS further summarizes potential impacts: "employment, income, and related revenues will be impacted in the Western and Central GOM Planning Areas if no new leasing were to occur, given the longstanding history and well-established oil and gas industries and economies that have developed there. Any explicit economic benefits associated with OCS activities in the other regions may also be forgone. Impacts from energy substitutions due to increased tankering of imported oil may occur in the Pacific, GOM, and Atlantic Regions. There may be the potential for cross-boundary effects related to oil tankering, especially if oil spills occur. Limited impacts are expected in the Alaska Region." The resource-level analysis associated with the No Action Alternative generally describes very high-level impacts to the human environment of no new leasing or does not discuss impacts of no new leasing and describes solely impacts associated with substitution. For example, the cultural section broadly describes a change in personal or community identity. The analysis focuses on employment, income, and revenues, and mentions high-level potential impacts such as disruption, losses, and change. As the energy transition accelerates, a better understanding of a changing economic baseline is necessary. Additionally, more systematic methods of analysis and the production of a more nuanced understanding of socio-cultural and economic considerations of a large shift away from oil and gas leasing will become more important for decision-making and public engagement. A human-centered methodological design is needed to provide this level of nuance for socio-cultural impacts.

This study would use existing in-house models and analyses as a starting point and ensure integration of any new approaches with existing guidance and needs. For example, any economics related analyses will use or build from BOEM's economic approaches including Cumulative Impact Model (CIM) and Lifecycle Cumulative Impact Model (LCIM) for potential employment changes associated with different scenarios. This study would provide additional non-monetized social and cultural considerations to discuss in the context of overall costs and benefits of leasing decisions, both quantifiable and non-quantifiable.

This study will rely on a large body of literature associated with the SIA field to inform methodological choices. In the United States, we typically use NEPA approaches to cover social impacts. However, in the field of SIA, especially in the international development context, there are more comprehensive human-centered approaches to evaluating decisions that are not always possible within the constraints of NEPA. SIAs are sometimes described as applied anthropology and require team approaches that require experts from various sub-fields of social science and often varied methodological approaches depending on the reason for conducting the SIA. The International Association for Impact Assessment regularly updates a list of key citations for books and journal articles in the SIA field. The "International Principles for Social Impact Assessment" is often cited as the leading guide on implementing SIAs (Vanclay, 2003).

Objectives:

- Characterize the changing economic baseline associated with the energy transition.
- Describe the social, economic, and cultural impacts of reduced oil and gas activity resulting from reduced lease sales or no sale decisions.
- Provide stronger science- or knowledge-based rationale concerning the human environment to decision-makers as they consider whether, how often, and how many lease sales to hold.
- Ensure BOEM is more informed about potential socio-cultural and economic impacts to more meaningfully engage with potentially affected populations.

Methods: The first part of the study will develop potential economic scenarios based on declining levels of oil and gas activity over time. The scenario development will rely on multiple energy outlooks that capture both industry trends and policy changes. Economic scenarios will be developed with input from BOEM economists and will provide a picture, especially focused on employment patterns, of what the economy could look like given changing energy trends.

The second part of the study would be based on existing best practices to conduct a Social Impact Assessment. A first step would be to conduct a literature review of SIA practices, especially focusing on approaches best suited for offshore considerations. This would inform the development of a SIA methodological framework that best sets the study up for understanding potential impacts of a no new oil and gas leasing context.

The literature review and framework development process will determine the methods chosen to best collect information that will form the basis of analysis concerning potential socio-cultural and economic impacts of no new leasing. Specific social categories included in the study will be determined through the SIA framework development. Categories may include those BOEM typically analyzes such as land use, recreation and tourism, and economics; and it may go beyond or more in depth into specific categories to develop the most comprehensive SIA possible with information that could serve both the No Action Alternative for the National OCS Oil and Gas Program and objectives outlined above.

Common elements of an SIA that would be part of the framework include: (1) identification of interested and affected groups; (2) documentation of the setting and context including the understanding of values and perceptions; (3) identification of social categories of relevance and associated indicators and data sources; (4) collection of baseline data; (5) stakeholder engagement to understand concerns of different groups, including contribution to the skills and capacity of communities to engage; and (6) impact identification, including perception of impacts.

Specific Research Question(s):

1. What are the social, cultural, and economic impacts of no new OCS oil and gas leasing?
2. Which areas and populations would be most impacted by no new OCS oil and gas leasing?
3. Are there any important socio-cultural or economic distinctions with different levels impacts at different levels of leasing activity?
4. Are there any impacts that would occur at higher levels in environmental justice populations or underserved communities?

Affiliated WWW Sites: N/A

References:

Vanclay F. 2003. International principles for social impact assessment. Impact Assessment and Project Appraisal 21(1):5–11.

International Association for Impact Assessment (2014). Social Impact Assessment Key Citations. https://www.iaia.org/pdf/Key%20Citations_SIA%2014%20Apr.pdf.

Field	Study Information
Title	Synthesis of Climate Change Sensitivity and Information Gaps in Priority Management Areas of the Outer Continental Shelf (OCS)
Administered by	Office of Environmental Programs
BOEM Contact(s)	Stephanie Sharuga (stephanie.sharuga@boem.gov), Mark Mueller (mark.mueller@boem.gov), Nellie Elguindi (nellie.elguindi@boem.gov), Jake Levenson (jacob.levenson@boem.gov), Tim White (timothy.white@boem.gov), Christina Bonsell (christina.bonsell@boem.gov), John Schiff (john.schiff@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	May 10, 2023
Problem	Climate change is altering abiotic conditions throughout the OCS including for sensitive habitats and species of special interest to all BOEM programs and regions. It is challenging for environmental assessments to thoroughly evaluate potential climate change impacts in the deeper waters of the OCS where less information is readily available.
Intervention	This study will compile, synthesize, and evaluate existing information on climate change-related changes and impacts in OCS environments within the BOEM management context, particularly impacts associated with sensitive species and habitats.
Comparison	Without this study, BOEM's subject matter experts (SMEs) will not have access to the proposed "one-stop," easily accessible, synthesized and relevant information resources designed to support BOEM assessment and management needs related to climate change-related effects and impacts in OCS environments.
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 several specific resource deliverables SMEs can use for management decision making and planning of future research.
Context	The scope and results of this study span all BOEM regions and programs with results useful for all BOEM-managed activities. The focus will be on OCS environments where these activities occur, with particular emphasis on deeper waters that are relatively understudied by climate change scientific research.

BOEM Information Need(s): Climate change has far-reaching impacts that can have a variety of consequences for marine environments. Information on climate change is needed to inform BOEM's assessments and evaluations of impacts in areas of BOEM-managed activities and for sensitive species and habitats of interest. The study will focus on the OCS and directly address areas and resources of concern for BOEM. This 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. 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 impacts of climate changes need to be better understood for BOEM analyses, including to better assess proposed actions, evaluate appropriate alternatives and mitigation measures, accurately assign impact levels, and inform future operational management decisions.

The information collected and synthesized will allow for more informed resource-management decisions for BOEM-regulated offshore wind, oil and gas, marine minerals, and carbon sequestration activities throughout the OCS. It will inform numerous national and/or programmatic efforts, a variety of National Environmental Policy Act sections, Tribal consultations, and Coastal Zone Management Act consistency determinations. The study will also contribute to BOEM's ability to meet its responsibilities under the Federal Ocean Acidification Research and Monitoring Act (FOARAM 2009) and Executive Order 14008.

Background: Climate change and its effects are a growing concern for marine environments, and such effects are increasingly being observed in deeper ocean waters (Sweetman et al. 2017) such as those 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 indirect and direct impacts on fauna and sensitive habitats, with effects on individual species populations and wider ecosystem integrity and connectivity. Climate change can disproportionately affect certain sensitive marine species, prey, and habitats. Ecologically important biogenic habitats such as those formed by cold-water corals (actively protected by BOEM) are at risk because climate change affects their environmental conditions. Cold-water coral habitats are being increasingly exposed to acidified conditions, with live corals showing reduced calcification and coral skeletons becoming eroded (Maier et al. 2008, Lunden et al. 2014, Hennige et al. 2020). Deeper marine areas serve as global carbon reservoirs, accumulating carbon from ocean uptake of anthropogenic carbon dioxide (CO_2) at the surface and subsequent circulation to deep water. This is leading to shifts of the aragonite saturation horizon, which is the depth at which corals may be vulnerable to dissolution (Zheng and Cao 2014, Perez et al. 2018). Withifn the century, most current cold-water coral habitats could be beneath the aragonite saturation horizon (Guinotte et al. 2008). Regional- or global-scale climate change impacts on foundational, 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 to:

- Identify habitats and/or species of concern in areas of the OCS where BOEM-managed activities occur that may potentially be affected by climate change. Identify types and extent of climate change potential impacts on those habitats or species and associated prey based on the current state of knowledge.
- Compile and synthesize information on climate change effects in areas of BOEM-managed activities and for sensitive habitats/species 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.
- Provide recommendations on how climate change information can be incorporated into BOEM environmental analyses and assessments. Provide recommendations for future study needs and BMPs related to climate change, within the specific context of BOEM-managed areas.

Methods: This study will enable a better understanding of the data and information that are available related to climate change effects in the OCS, as well as potential impacts to ecosystems. 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. 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 written synthesis report about climate change in relation to key resources in OCS environments where BOEM-managed activities occur. 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 OCS habitats; approaches for measuring parameters and effects; best practices; and more. The scope will be guided by BOEM and other federal SMEs.
- 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 for BOEM to better understand climate change in OCS environments in the BOEM management context, 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 for BOEM's assessment and operational considerations related to climate change with the goal of integrating information into existing BOEM SME resources.

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 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 deeper waters of the OCS (e.g., specific recommended future field work and BMPs)?

Affiliated WWW Sites: N/A

References:

Guinotte JM, Orr JC, Cairns S, Freiwald A, Morgan L, George RY. 2006. Will human-induced changes in seawater chemistry alter the distribution of deep-sea scleractinian corals? Front. Ecol. Environ. 4:141–146. doi: 10.1890/1540-9295(2006)004[0141:whcisc]2.0.co;2

Hennige SJ, Wolfram U, Wickes L, Murray F, Roberts JM, Kamenos NA, Schofield S, Groetsch A, Spiesz EM, Aubin-Tam M-E, et al. 2020. Crumbling reefs and cold-water coral habitat loss in a future ocean: evidence of "coralporosis" as an indicator of habitat integrity. Front. Mar. Sci. 7. https://doi.org/10.3389/fmars.2020.00668

IPCC. 2021. Climate Change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte V, Zhai P, Pirani A, Connors SL, Péan C, Berger S, Caud N, Chen Y, Goldfarb L, Gomis MI, et al. editors]. Cambridge University Press. In Press.

Lawman AE, Dee SG, DeLong KL, Correa AMS. 2022. Rates of future climate change in the Gulf of Mexico and the Caribbean Sea: implications for coral reef ecosystems. JGR Biogeosciences. 127(9). https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2022JG006999

Levin L. 2021. IPCC and the deep sea: a case for deeper knowledge. Front. Clim. 27. https://doi.org/10.3389/fclim.2021.720755

Lunden JJ, McNicholl CG, Sears CR, Morrison CL, Cordes EE. 2014. Acute survivorship of the deep-sea coral Lophelia pertusa from the Gulf of Mexico under acidification, warming, and deoxygenation. Front. Mar. Sci. 19(1). https://doi.org/10.3389/fmars.2014.00078

Maier C, Hegeman J, Weinbauer MG, Gattuso JP. 2009. Calcification of the cold-water coral *Lophelia pertusa,* under ambient and reduced pH. Biogeosciences. 6:1671–1680. https://doi.org/10.5194/bg-6-1671-2009

Perez F, Fontela M, García-Ibáñez M, Mercier H, Velo A, Lherminier P, Zunino P, de la Paz M, Alonso-Pérez F, Guallart EF, et al. 2018. Meridional overturning circulation conveys fast acidification to the deep Atlantic Ocean. Nature. 554:515–518. https://doi.org/10.1038/nature25493

Sweetman AK, Thurber AR, Smith CR, Levin LA, Mora C, Wei C-L, Gooday AJ, Jones DOB, Rex M, Yasuhara M, et al. 2017. Major impacts of climate change on deep-sea benthic ecosystems. Elementa: Science of the Anthropocene 5(4). doi: https://doi.org/10.1525/elementa.203

United Nations (2021). The Second World Ocean Assessment, United Nations. https://doi.org/10.18356/9789216040062

Zheng M-D, Cao L. 2014. Simulation of global ocean acidification and chemical habitats of shallow- and cold-water coral reefs. Adv. Climate Change Res. https://doi.org/10.1016/j.accre.2015.05.002

Field	Study Information
Title	Using Coast Guard's AIS Vessel and Federal Aviation Administration's NextGen Helicopter Data to Track BOEM-Authorized Activities
Administered by	Office of Environmental Programs
BOEM Contact(s)	Holli Wecht (Holli.Wecht@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 10, 2023
Problem	BOEM requires a better understanding of the environmental impacts from the numerous vessel and helicopter trips conducted in support of BOEM's oil and gas (O&G) program in the Gulf of Mexico (GOM).
Intervention	By using the U.S. Environmental Protection Agency's Automatic Identification System (AIS) emissions dataset and the Federal Aviation Administration's (FAA) NextGen data, vessels and helicopter data for BOEM's O&G sources could be tracked, spatially allocated, and emissions calculated for calendar year 2023 in the GOM.
Comparison	In 2017, AIS and NextGen data were used to calculate and spatially allocate vessel and helicopter emissions in the GOM. By analyzing 2023 AIS emissions data, BOEM can allocate vessel emissions into BOEM's O&G categories and analyze activity density and emissions trends.
Outcome	Improved activity density and gridded emissions for BOEM's tools and reports.
Context	Gulf of Mexico OCS planning areas.

BOEM Information Need(s): BOEM needs to analyze the environmental impacts from the numerous vessel and helicopter trips in support of BOEM's oil and gas (O&G) activity in the GOM for required impact assessments under the National Environmental Policy Act (NEPA) and the Outer Continental Shelf Lands Act (OCSLA), to generate emissions factors for the Offshore Environmental Cost Model (OECM), and for the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) consultation reporting requirements per the 2020 National Marine Fisheries Service (NMFS) Biological Opinion (BiOP) for O&G activity (NMFS 2020).

Background: BOEM's mission is to manage development of OCS energy and mineral resources in an environmentally and economically responsible way. In 2021, there were approximately 1,738 oil and gas facilities in the Gulf of Mexico (GOM), along with exploratory drilling activities. BOEM last conducted a comprehensive vessel and helicopter analysis for air quality impact assessments in the GOM under the *Year 2017 Emissions Inventory Study* (Wilson, et. al, 2019). Figure 1 shows activity density maps for oil and gas activity support vessels and helicopters. In addition, vessel and helicopter emissions data was calculated and spatially allocated for future modeling efforts.

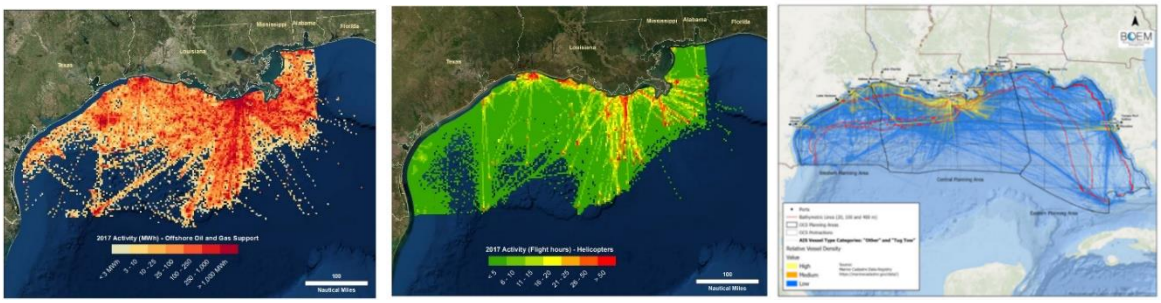

Figure 1. 2017 Support Vessel (on left) and Helicopter Activity (in center) in the GOM (Wilson, et al., 2019), with Vessel Density Map between March 2020-2021 (on right) (NMFS, 2020).

The U.S. Environmental Protection Agency (EPA) has calculated vessel emissions data for calendar year (CY) 2020 in the GOM using an Automatic Identification System (AIS). However, the EPA's oil and gas source categories do not match source categories of the past BOEM's inventory efforts or that of OECM. Therefore, BOEM needs mapping of the EPA's offshore oil categories into the OECM categories (pipelaying, support, survey, drilling, etc.). The EPA will be calculating vessel emissions data using AIS for CY2023 in the GOM with the same format as their CY2020 emissions. BOEM can use the EPA's CY2023 vessel emissions data, map into our O&G categories, and form CY2023 density and emissions maps by area/block in the GOM. In addition, BOEM needs detailed vessel and helicopter emissions factors for BOEM's OECM model, which supports the national oil and gas program, and an additional source category for tankers and barges for oil transport. This effort would tie into BOEM's 2023 emissions inventory. BOEM would have a comprehensive CY2023 oil and gas emissions inventory in the GOM, and not just facility emissions, included in BOEM's emissions reporting tool, the Outer Continental Shelf Air Quality System (OCS AQS), for impact assessments (future cumulative modeling efforts).

This effort would also tie into BOEM's BiOP reporting requirements to annually summarize vessel and aircraft traffic data associated with O&G activities. The 2020 NMFS BiOP on the Federally Regulated Oil and Gas Program Activities in the GOM 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 oil and gas 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" (NMFS 2020).

The past BiOP efforts used broad source categories that overestimated the vessel impacts. Having a specific O&G source category as EPA has defined will led to more accurate vessel impacts. Vessel track mapping will be used for the annual report (Figure 1) as well as a summary of vessel size, vessel speed, vessel draft, port of origin/transit, and OCS destination. O&G-related helicopter flight track mapping and summary of activity will also be included. In addition, this vessel traffic information could be used to develop more informed vessel interaction/strike and noise impact analyses, and vessel traffic characterization in NEPA documents.

Objectives:

- Collect CY2023 AIS vessel emissions data from the EPA datasets, form monthly activity density maps, calculate and spatially allocate those monthly emissions in a form for upload to OCS AQS by BOEM's vessel source category.
- Collect monthly CY2023 FAA NextGen data, form activity density maps, calculate and spatially allocate those emissions in a form for upload to OCS AQS by helicopter source category.
- Provide a final report detailing the methodology and calculation of emissions including final emissions factors for the OECM model, plus final vessel and helicopter EPA National Emissions Inventory (NEI) datasets.
- Perform emission trends analysis for vessel and helicopter (density and emissions).
- Provide AIS vessel data activity density maps and summary information (including speed data), plus a trends analysis of the vessel activity.
- Provide FAA NextGen helicopter data activity maps and summary information, plus a trends analysis of the helicopter activity.

Methods: The contractor would acquire CY2023 EPA's AIS emissions dataset and FAA's NextGen data (or perhaps use the FAA NextGen data from BOEM's 2021-047, if possible). Using this data and other necessary sources, the contractor will generate O&G activity density and gridded emissions (temporally and spatially) that can be incorporated into OCS AQS for air quality impact assessments, plus provide the helicopter data in the format of the EPA's NEI ACCESS database. Vessels to be considered relative to O&G activities include Survey, Drilling, Pipelaying, Support, Well stimulation, etc. Specific to O&G in the GOM, the contractor will provide activity density shapefiles (temporally and spatially), port counts, OCS destination counts, and information on vessel size, draft, and speed. In addition, the final report will include a statement of procedure (SOP) for creating the end result, including mapping of the sources into OECM categories.

Specific Research Question(s):

1. At what locations and what months in the GOM receive high amount of BOEM O&G vessel traffic (spatially and temporally allocate)?
2. At what locations and what months in the GOM receive high amount of BOEM O&G helicopter traffic (spatially and temporally allocate)?
3. What are the emissions from vessels and helicopters supporting BOEM's O&G program (spatially and temporally allocate)?
4. What are the updated OECM emissions factors for CY2023?
5. What are the characteristics of the O&G vessels conducting activities authorized by BOEM?
6. What are the vessel and vessel emissions trends? What are the helicopter and helicopter emissions trends?

Affiliated WWW Sites:

https://www.boem.gov/environment/environmental-studies/ocs-emissions-inventories

https://www.boem.gov/about-boem/biological-opinions-evaluations-endangered-species-act-section-7-consultations#:~:text=The%20Biological%20Opinions%20identify%20non,and%20conducting%20the%20proposed%20action.

https://gaftp.epa.gov/air/nei/2020/doc/supporting_data/nonpoint/CMV/2020%20C3%20Marine%20Emissions%20Tool%20%20Documentation.pdf

https://www.boem.gov/sites/default/files/documents/environment/environmental-assessment/nepa/BOEM%20Helicopter%20Report.pdf

References:

NMFS. 2020. Biological opinion on the federally regulated oil and gas program activities in the Gulf of Mexico. FPR-2017-9234. March 13, 2020.

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

Field	Study Information
Title	Using Very High-Resolution Satellite Imagery to Detect Cetaceans
Administered by	Office of Environmental Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2024–2027
Final Report Due	TBD
Date Revised	May 15, 2023
Problem	Data on cetacean distribution are needed at spatial and temporal scales that are challenging to collect using existing methods. Satellite imagery has the potential to provide the required information but there are a number of barriers that need to be overcome before this approach can be operationalized.
Intervention	Work with collaborators to create an effective whale detector. Package together libraries of high-resolution satellite imagery annotations for each species of interest that are currently under development into a publicly available web-based interface for detecting objects of interest from very high-resolution satellite imagery.
Comparison	Vessel and aerial surveys are challenging to implement over large spatial scales, in remote areas, and during seasons with poor weather. While passive acoustic monitoring provides valuable information on species occurrence in specific locations or time periods, extrapolating to overall distribution is challenging, and inference is limited to vocalizing animals.
Outcome	Further the development of using very high-resolution satellite imagery to detect cetaceans.
Context	North Atlantic wind planning areas and Alaska lease areas.

BOEM Information Need(s): Information on cetacean abundance and distribution is needed to assess overlap between key species and potential oil and gas activities in Alaska waters and BOEM wind energy areas throughout the U.S. east coast. Vessel and aerial surveys have long been used to provide information on marine mammal density and distribution. Still, they are challenging to implement over large spatial scales, in remote areas, and during seasons with poor weather. While passive acoustic monitoring provides valuable information on species occurrence in specific locations or time periods, extrapolating to overall distribution is challenging, and inference is limited to vocalizing animals. The use of satellite imagery has the potential to provide information on abundance and distribution during seasons and in areas that are currently challenging, or prohibitively expensive, to survey and are needed to meet regulatory requirements under the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and National Environmental Policy Act (NEPA). Focal species for this study include endangered cetaceans in Alaska (Cook Inlet beluga whales, bowhead whales) and the North Atlantic (North Atlantic right whales) as well as humpback whales in both areas. These cetaceans are of critical interest due to their status under the Endangered Species Act and the overlap of their range with areas

of increased anthropogenic impact such as oil and gas exploration, fishery entanglement, and development of offshore wind farms; bowhead whales are an important cultural resource to Alaska Natives.

Background: Information on cetacean distribution is needed at a temporal and spatial scale that is not currently achievable using existing methods. Several recent publications have demonstrated that it is technologically feasible to identify whales in very high-resolution (VHR) satellite imagery. The availability of VHR imagery is expected to dramatically increase in the coming years with the launch of the new Maxar's Legion constellation of satellites in 2023 that have the ability to capture 5 million sq km a day (~3% of the earth) at a resolution of 31 cm and a revisit rate up to 15 times a day. However, there are significant barriers to using these data in an operational capacity to understand cetacean distribution, including access to satellite imagery, wind, cloud cover, and availability of the animals at the surface. This study outlined here is part of an ongoing collaboration between BOEM, NOAA/NMFS and NOAA's Alaska Fisheries Science Center (Khan et al. 2023). Several recent technological advancements have brought the use of VHR satellite imagery to the cusp of operational feasibility:

1. The launch of the Maxar WorldView-3 satellite with 30 cm resolution.
2. The planned launch of the Maxar Legion program with dramatically improved revisit rates.
3. Proof of concept academic studies.
4. Advances in deep learning tools enable semi-automated identification and classification of objects.

Much of the work in this field is being led by the Geospatial Artificial Intelligence for Animals (GAIA) initiative, which brings together an extraordinary coalition of organizations to tackle the challenge of designing a large-scale operational platform to detect whales from earth-orbiting satellites, including government agencies (National Oceanic and Atmospheric Administration (NOAA), U.S. Naval Research Laboratory (NRL), the Bureau of Ocean Energy Management (BOEM), and the U.S. Geological Survey (USGS)), academia (British Antarctic Survey (BAS), University of Edinburgh), and the private sector (Microsoft AI for Good Research Lab, MAXAR). GAIA has received support over the past few years in the amount of $275,000 from various grants to NOAA Fisheries, and $60,000 from the Naval Research Laboratory under sponsorship by ONR Marine Mammal Biology Program. Preliminary analyses associated with these exploratory projects helped to advance the basic understanding of the workflow required for an Artificial Intelligence/ Machine Learning (AI/ML) framework to detect whales from space. Over the past three years, this investment has supported numerous efforts, including :

- The development of software (Picterra) for annotating satellite imagery.
- A statistical hypothesis test on surface whales, submerged whales, and background pixels on VHR imagery as a proof-of-concept, resulting in an analysis of whale detections based on spectral signature.
- The leveraging of anomaly-based detection methods used for vessels in VHF imagery for the detection of large marine mammals. These methods proved to be successful for detecting large marine mammals, highlighting current capabilities and pipelines that could be used for this effort.
- The development of a neural network-based detection algorithm for whales. A total of 730 whale signatures and 9,300 background signatures were extracted to provide training and testing data. This work is ongoing and will support GAIA development.

- Maxar GeoHIVE crowdsourcing annotation and the development of an annotation workflow for satellite imagery using ArcMap and ArcPro.
- The integration of detection algorithms into an end-to-end, Marine Mammals from Space tool suite to support GAIA efforts. This will allow users to upload satellite imagery, pre-process imagery for likely whales using automated algorithms, present likely whales for users for verification, and store whale chips in a database. This part of the project will feed into a classification tool that for identifying whales to the species level.

As is the case with the annotated reference library, the detection models are still preliminary, and classification models have not been developed. Further work is needed to create this workflow to build the library and systems required for an operational framework.

Objectives:

1. Development of an automated pipeline for routine identification of cetaceans in VHR satellite imagery for key species including the development of an annotated image library including infrastructure support for cloud computing and/or on-premises GPU machines and software.
2. Development of a database (including the development and maintenance of a web-based interface) where users can upload, view, and train sample images of marine mammals for algorithm development and storage of marine mammal detections.

Methods: Efforts to create an effective whale detector will be pursued by multiple collaborators, including Microsoft and NRL. Creating an extensive library of high-resolution satellite imagery annotations for each species of interest is underway with three different methodologies (Maxar GeoHIVE crowdsourcing campaign, in-house manual annotation, and via an online annotation tool that serves up image chips resulting from an anomaly detector). These components will be packaged together into a publicly available web-based interface for detecting objects of interest from VHR satellite imagery, allowing users to connect with their cloud computing resources (image storage containers and machine learning servers). Annotations will be used to refine machine learning models in an active learning process. These algorithms will be made opensource as much as possible and integrated into the operational system for whale detection. Funding will support staff to operationalize this AI/ML annotation system including project management and annotation labor at NOAA Fisheries, and scientific and software engineering support at NRL. Funding will also be used to host an interagency working group to meet in person to scope out the vision for the operational system and workflow bringing together expertise from BOEM, NOAA, NRL, Microsoft, BAS, and others.

Specific Research Question(s):

1. Can population estimates and localized space use be effectively assessed using satellite imagery and what might limit the effectiveness of this approach?
2. What is the best way to operationalize the detection of cetaceans from VHR satellite imagery to expand our ability to monitor marine mammal presence, especially in areas of interest to oil and gas exploration, offshore wind energy, fishing gear entanglement and aquaculture?

Affiliated WWW Sites:

Geospatial Artificial Intelligence For Animals | NOAA Fisheries

GitHub - microsoft/whales: An active learning pipeline for identifying whales in high-resolution satellite imagery.

References:

Cubaynes HC, Clarke PJ, Goetz KT, Aldrich T, Fretwell PT, Leonard KE, Khan CB. 2023. Annotating very high-resolution satellite imagery: a whale case study. MethodsX. 10:102040.

Khan CB, Goetz KT, Cubaynes HC, Robinson C, Murnane E, Aldrich T, Sackett M, Clarke PJ, LaRue MA, White T, at al. 2023. A biologist's guide to the galaxy: leveraging artificial intelligence and very high-resolution satellite imagery to monitor marine mammals from space. Journal of Marine Science and Engineering. 11(3):595.

Field	Study Information
Title	Vibrational Sensitivity in Mobile Benthic Organisms
Administered by	Office of Environmental Programs
BOEM Contact(s)	Erica Staaterman (erica.staaterman@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	Jan 24, 2023
Problem	The majority of hearing sensitivity studies within animal bioacoustics typically focus on detection of acoustic pressure, rather than particle motion. For marine fishes and invertebrates, particle motion is the more salient cue, since for most species it is the only component of a sound wave that they can detect. Many terrestrial organisms, particularly invertebrates, sense their world through substrate vibrations, but we currently lack a basic understanding of vibrational sensitivity in marine taxa. This information is necessary in order to understand potential acoustic impacts of BOEM's activities on marine fishes and invertebrates.
Intervention	The proposed study will develop an experimental apparatus that can measure hearing sensitivity of fishes and aquatic invertebrates in terms of both water-borne and substrate-borne particle motion detection. Selected fish and aquatic invertebrate species will be tested for their baseline particle motion detection thresholds. Histological studies will be performed on the mechanosensory structures to understand the mechanisms of sound detection in the tested species.
Comparison	The results of the study will provide important information on particle motion detection sensitivity by fishes and aquatic invertebrates and will help BOEM to assess whether certain water-borne and substrate-borne anthropogenic vibroacoustic waves could be detected by these species.
Outcome	This study will build an experimental apparatus and will provide foundational knowledge on vibrational hearing sensitivity in marine invertebrates and fishes. This work will pave the way for future research efforts to establish acoustic criteria, i.e., thresholds at which anthropogenic sounds would be disturbing to these taxa.
Context	Relevant to all BOEM programs and regions.

BOEM Information Need(s): BOEM is required to assess the potential impacts of underwater sound from BOEM-regulated activities on marine species. Historically, most of the concern has been on impacts to marine mammals, but we now know that many fishes and invertebrates are sensitive to underwater sound as well. The fishing community has voiced concerns over potential detrimental impacts, especially given the expected increase in noise during both construction and operations of offshore wind farms (Popper et al 2020). Since all fish species and likely all aquatic invertebrates respond to particle motion – rather than acoustic pressure, which is the focus of studies concerning

marine mammals - a renewed research paradigm is needed. There is a paucity of data regarding basic vibrational sensitivity in marine fishes and invertebrates. Without such critical information, it will be difficult for BOEM to assess the potential impacts of particle motion generated by its regulated activities (e.g., offshore renewable energy development).

Background: The majority of bioacoustics research has typically focused on acoustic pressure because it is a relevant stimulus for almost all tetrapod species. Long-term studies on human psychoacoustics have provided solid understanding on mammalian ears and auditory pathways concerning sound detection, perception, and noise-induced hearing loss (NIHS). Across the animal kingdom, however, it's likely that particle motion is the most common means of acoustic detection; indeed, *all* fishes and likely all invertebrates are sensitive to it (Popper and Hawkins, 2018). Nevertheless, knowledge concerning particle motion detection, perception, and potential effects across species is severely lacking. The reason for that lies partly in the lack of research on the mechanosensory organs, and partly in the fact that there is such a large diversity of species that detect sound in this way. Information from a handful of "representative species" is simply insufficient.

The term "particle motion" can refer to oscillatory movements of water particles or sediment particles associated with a propagating sound wave. "Substrate vibration" encompasses several types of waves: compressional and shear waves that propagate within the sediment, as well as interface (Scholte) waves that travel along the seabed (Miller et al., 2016). Many terrestrial species, especially invertebrates, are able to glean key information from their surroundings (e.g., weather events, approaching predators, presence of mates) by detecting substrate vibrations – transmitted through plant stems, the forest floor, or nests, for example (Roberts and Wickings 2022). Substrate vibration detection in aquatic invertebrates is a particularly challenging research topic because these animals often live at the interface of water and saturated sediment (e.g., sand or mud mixed with water), so teasing apart the detection of water-borne particle motion vs. pure substrate-borne vibration is quite difficult (Roberts and Wickings 2022).

This study aims to develop an experimental apparatus that will allow for basic tests of sensitivity to both water-borne and substrate-borne vibrations in marine invertebrates and fishes. There are several methodological approaches to this type of work, each with tradeoffs. BOEM plans to convene an expert workshop in FY23 to gather insights about different potential experimental designs. The outcomes of the workshop will help inform the experimental design that is developed in this study.

While this study will test vibrational sensitivity in several species as a proof-of-concept, the larger aim of this study is to create an experimental apparatus that can be used again and again to test many more species, which will greatly expand our understanding across benthic taxa. In addition to testing more species, follow-on work should consider exposing animals to higher sound levels – to measure the *onset of a significant behavioral response to anthropogenic signals*, rather than just the onset of detection. This type of research is critical for establishing acoustic criteria for invertebrates, and for providing additional data for fishes (Popper et al. 2014). Many researchers in the bioacoustics community have stated that the fish acoustic criteria should be revisited, and that the next iteration should be presented in terms of particle motion to better reflect the sensitivity of the species at hand; this project will be critical for that line of work. There is an interagency working group currently revisiting the fish interim criteria; in addition to adding particle motion, this group hopes to identify data gaps, i.e., which species still need to be tested to provide a more holistic understanding of hearing sensitivity in these taxonomic groups. Advice from that working group could inform the next batch of species to be tested.

Objectives:

- Develop a calibrated experimental apparatus that can create and measure vibrations in the water and in the sediment and can effectively test vibrational sensitivity in a range of fish and invertebrate species.
- Produce written protocols for using the experimental apparatus such that future work can easily adopt the same methods.
- Conduct proof-of-concept tests on several species to determine baseline vibrational sensitivity (i.e., audiograms/vibrogram).
- Describe potential mechanosensory mechanisms for sound detection (through dissections and/or electron microscopy).

Methods:

- After considering the recommendations from the particle motion workshop, build the experimental apparatus. This will likely require either a mesocosm or large tank, equipped with sensors in both the water and in the sediment. To generate water-borne particle motion, the entire tank can be vibrated (likely by placing the tank on a "shaker table", see Casper and Mann 2007). To generate vibration through the sediment, another mechanism needs to be developed and tested.
- Conduct a suite of experiments on particle-motion sensitive species, in which the animals are exposed to vibrations of different frequencies and amplitudes, and the onset of response is recorded.
- After the study specimens have been tested, use histological work to describe the mechanosensory systems.

Specific Research Question(s):

1. What is the lowest level of sound (at each frequency tested) that each focal species can detect (in terms of both water-borne and substrate-borne particle motion)?
2. Are any of the species tested sensitive to *only* water-borne particle motion or *only* substrate vibration?
3. What are the proposed mechanisms for sound detection in each species tested (e.g., statocyst, mechanosensory hairs, lateral line.)?

Affiliated WWW Sites: N/A

References:

Casper BM, Mann DA. 2007. The directional hearing abilities of two species of bamboo sharks. Journal of Experimental Biology. 210(3):505–511. doi:10.1242/jeb.02677

Miller JH, Potty GR, Kim HK. 2016. Pile-driving pressure and particle velocity at the seabed: quantifying effects on crustaceans and groundfish. Adv Exp Med Biol. 875:719–728. doi:10.1007/978-1-4939-2981-8_87

Popper, AN, Hice-Dunton, L, Williams, K., Jenkins, E. 2020. Workgroup report on sound and vibration effects on fishes and aquatic invertebrates. State of the Science workshop on Wildlife and

Offshore Wind Energy 2020: Cumulative Impacts. https://www.nyetwg.com/_files/ugd/78f0c4_275f9f2ac5e84b07ae420e0cf5b5b2eb.pdf

Popper AN, Hawkins AD. 2018. The importance of particle motion to fishes and invertebrates. J Acoust Soc Am. 143:470–488.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, Coombs S, Ellison WT, Gentry RL, Halvorsen MB, et al. 2014. Sound exposure guidelines for fishes and sea turtles: a technical report prepared by ANSI-accredited standards committee S3/SC1 and registered with ANSI (ASA S3/SC1.4 TR-2014). Retrieved from Melville (NY).

Roberts L, Wickings K. 2022. Biotremology: tapping into the world of substrate-borne waves. Acoustics Today. 18(3). doi:10.1121/at.2022.18.3.49