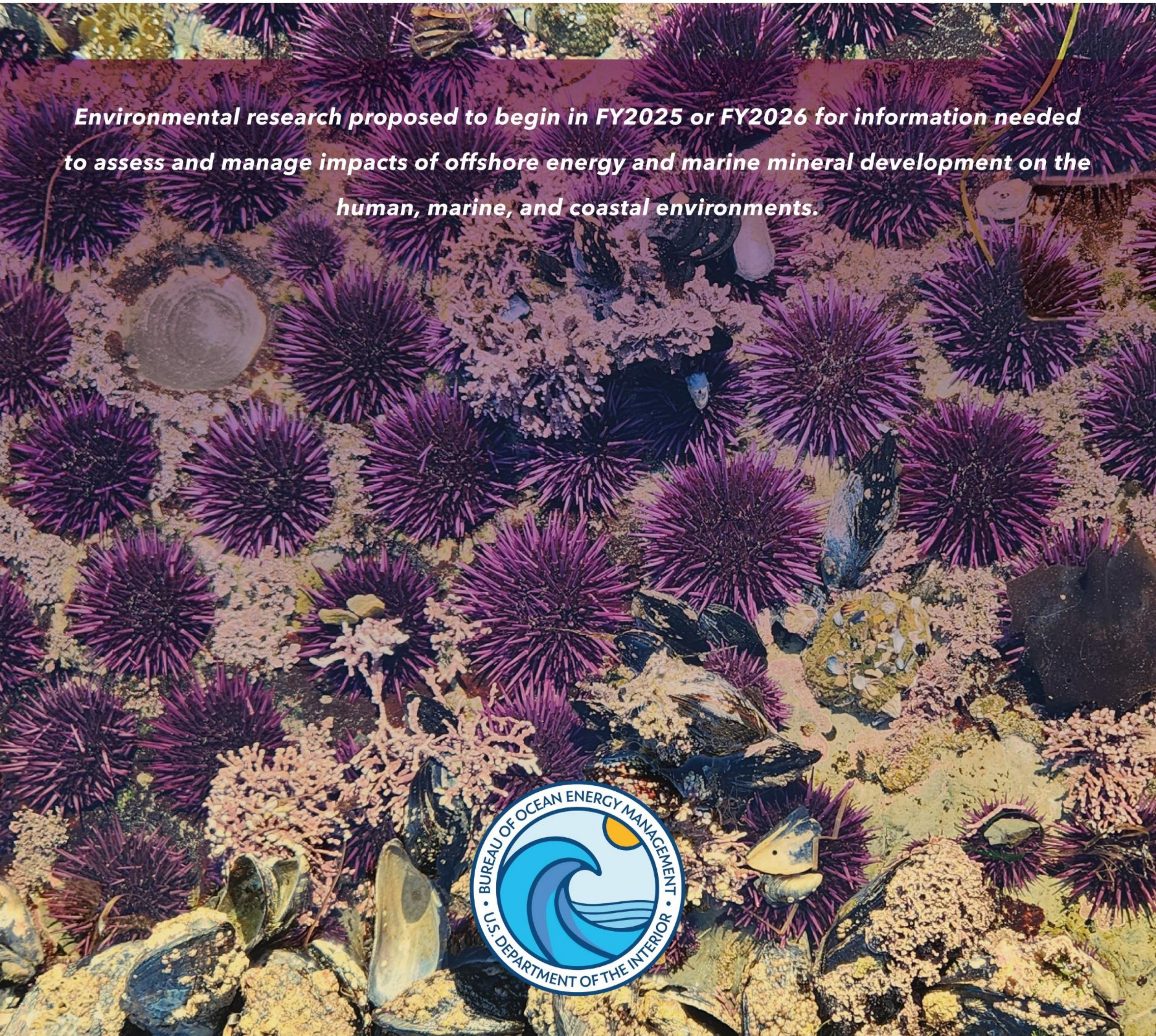
STUDIES DEVELOPMENT PLAN

Environmental research proposed to begin in FY2025 or FY2026 for information needed to assess and manage impacts of offshore energy and marine mineral development on the human, marine, and coastal environments.



BUREAU OF OCEAN ENERGY MANAGEMENT
U.S. DEPARTMENT OF THE INTERIOR

Table of Contents

List of Figures

List of Tables

List of Acronyms

ADEON	Atlantic Deepwater Ecosystem Observatory Network
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
DPEC	Dredging Project Emission Calculator
EA	environmental assessment
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
GHG	greenhouse gas
GOM	Gulf of Mexico
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
NAAQS	National Ambient Air Quality Standards
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

NOSI	National Offshore Sand Inventory
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
PICOC	problem, intervention, comparison, outcome, and context
POWERON	Partnership for an Offshore Wind Energy Regional Observation Network
PSD	Prevention of Significant Deterioration
SDP	Studies Development Plan
SSRA	Significant Sediment Resource Area
SSQ	Strategic Science Questions
TEK	Tribal ecological knowledge
UA	University of Alaska
USCRP	U.S. Coastal Research Program
USGS	U.S. Geologic Survey
WEA	Wind Energy Area

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, mineral, and geological 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. The breadth of ESP research and the efforts of ESP scientists to address needs across BOEM program areas is proving invaluable in addressing BOEM's growing portfolio and the associated information requirements.

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 focusing on the human, marine, and coastal environments:

Baseline studies provide information needed for the assessment and management of impacts from offshore energy and mineral extraction activities Federal and state waters.

Impact studies identify potential impacts on marine resources that may result from offshore energy development or marine mineral extraction.

Monitoring studies provide time series and data trend information for identifying changes in 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 $1.25 billion for research on environmental impacts and monitoring of energy and mineral development ($162 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.

In addition to BOEM's appropriated funds, BOEM and ESP have worked closely with the United States Geological Survey's (USGS's) Ecosystems Mission Area since 1996 to support BOEM science information requirements through a collaborative partnership, which leverages the expertise of scientists from both agencies to provide peer-reviewed scientific information for BOEM decision-makers. Over the past 5 years, USGS has contributed $9.6M to 10 joint studies.

Figure 1 shows how ESP allocated funding by both vendor and discipline between fiscal years (FYs) 2020 and 2024. The USGS OCS funds are captured in the 'Federal' category in the vendor pie chart.

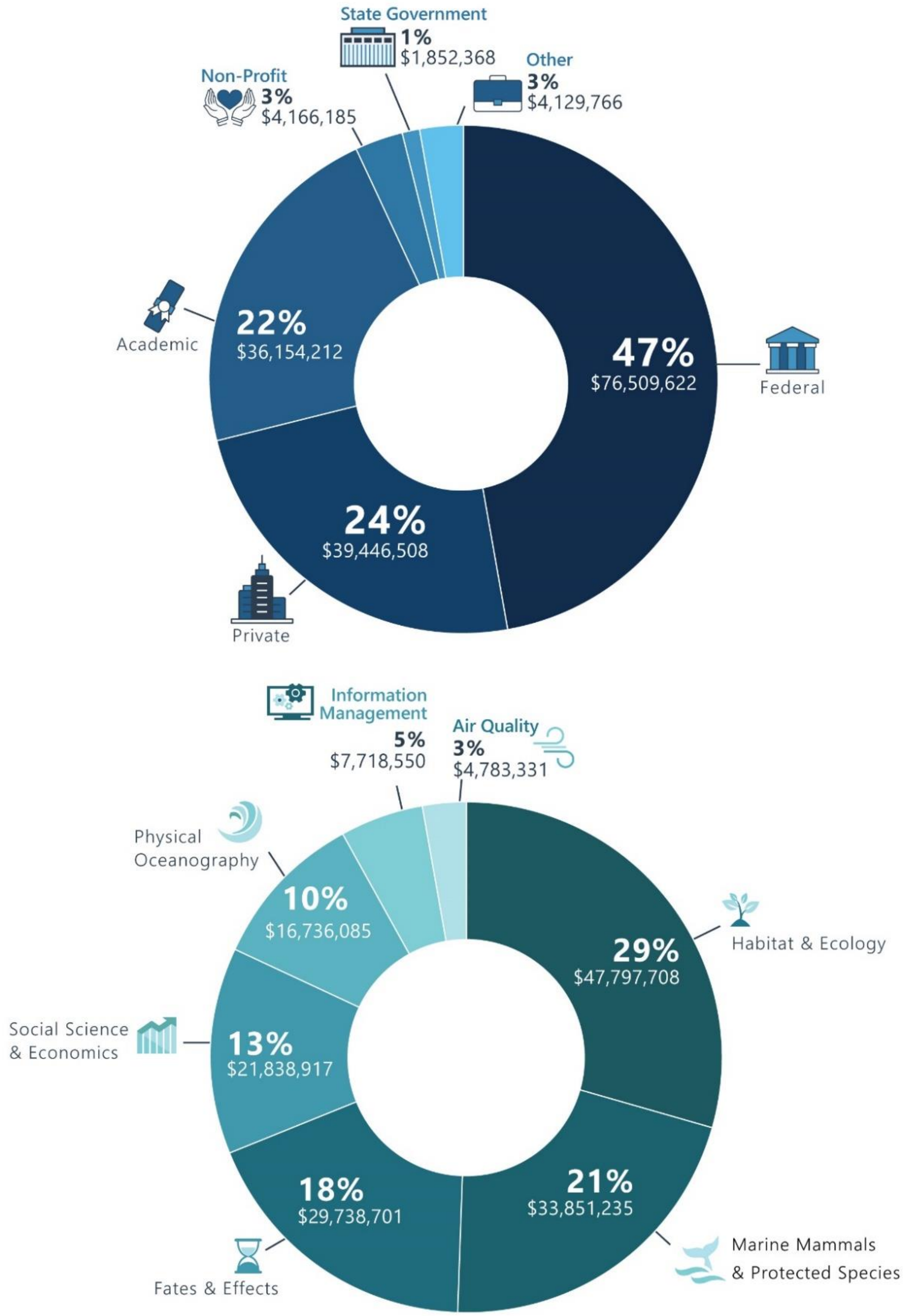


Figure 1. Cumulative ESP expenditures for FY 2020–2024 by vendor type and discipline

1.1.4 ESP Priorities

For the FY 2025–2026 cycle, ESP's main priority will continue to be studies related to renewable energy development, focusing on environmental monitoring and cumulative effects offshore. Further, BOEM is also interested in studies incorporating innovative technologies or techniques.

Effective management of OCS minerals and energy hinges upon cohesive ecological monitoring, which then informs management. Ocean monitoring at the level of detail needed for decision-making is expensive, necessitating timely and innovative solutions. In certain cases, emerging, innovative methods and technologies can more effectively and efficiently monitor the environment over longer periods of time, supplanting the need for intensive monitoring efforts, such as costly and dangerous manned flights and expensive survey vessels, providing better data to BOEM decision-makers at less expense.

Innovative ocean monitoring data and products would be extremely useful for Marine Spatial Planning. To be effective, Marine Spatial Planning requires long-term environmental data as well as innovative technologies that can acquire such data and make it available for Federal, state, local, and Tribal ocean planning.

Innovations supporting BOEM's decision-making might include the following:

- Autonomous and uncrewed monitoring technology and advanced biological and physical sampling technology, such as environmental DNA
- Advanced computing to process and analyze large spatial and temporal data, including high-performance computing with advanced computer hardware and software, as well as artificial intelligence, machine learning, and related advances

Such a suite of tools working together will allow BOEM to tell a more complete story about how the OCS environment is changing—including those changes tied to the environmental impacts of BOEM's decision-making—and why. These technologies also expand BOEM's ability to monitor areas that are otherwise difficult to reach, such as frontier areas and ultra-deep waters where most critical minerals are found.

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, private stakeholders, and Tribes to maximize the utility of results and extend limited budgets.
4. The Bureau will connect regularly with stakeholders and engage in public education and outreach activities to ensure program quality, effective peer review, and data dissemination.

1.2.1 Use-Inspired Science

BOEM embraces the concept of "use-inspired" science in developing ESP studies so that scientific research is designed to both provide answers to specific questions needed for management decisions and advance broader fundamental knowledge. ESP studies 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. BOEM identifies and selects research projects on an annual basis with an emphasis on mission relevance and scientific merit. Upon study completion, the ESP Performance Assessment Tool helps ESP fulfill its mission of providing the best possible scientific information for making decisions concerning our offshore resources. This tool is an internal, online system used to monitor the effectiveness of ESP products in fulfilling the Bureau's information needs and track the program's efficiency in delivering products on time.

1.2.3 Peer Review

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

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

[1] For more information, visit BOEM's webpage on scientific integrity.

ESP evaluates each project for the appropriate level of peer review early in the development stages and through the life of the project to 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 encourages inter- and intra-agency study collaborations with BOEM's Federal partners and has undertaken important and award-winning research efforts in cooperation with agencies such as the National Aeronautics and Space Administration, U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA), and U.S. Navy's Office of Naval Research. BOEM 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). USCRP is a collaboration of Federal agencies, academics, and stakeholders; the program aims to identify coastal research needs, foster research opportunities, enhance funding for academic programs, and promote science translation. 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 leverage their limited resources to accomplish objectives that are beyond the resources and capabilities of any single agency. As a charter member of NOPP, BOEM has funded 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, including the Atlantic Deepwater Ecosystem Observatory Network (ADEON) study, which won the 2023 NOPP Excellence in Partnering Award.

1.2.5 Information Management and Dissemination

BOEM disseminates 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 on the BOEM website. Ongoing research is arranged by BOEM OCS region and discipline and 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. GovInfo houses BOEM's repository of all final reports from ESP-funded studies. The ESP Hub 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 digital magazine *Ocean Science* and quarterly *Science Notes* newsletters.

1.2.6 Outreach and Education

BOEM, like many other Federal agencies, must 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 provides young professionals with opportunities to succeed in their careers. ESP's education goals are to develop 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 contributes to the training and career development of the next generation of marine scientists through the support of undergraduate and graduate research. BOEM also hosts a number of John A. Knauss Marine Policy fellows in both OEP and the Office of Strategic Policy and International Affairs.

ESP has provided financial support to the National Ocean Sciences Bowl (NOSB) to encourage high school students interested in the marine sciences. The NOSB develops links to the pre-college community and to build student awareness of career opportunities in the marine sciences and the Federal Government. The NOSB reaches out to students and communities to increase participation of 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. Regional and Program offices provide substantial input and critical review of the document, which serves as 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 subject matter experts. 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, mineral, and geological 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:** Environmental impacts from activities authorized by BOEM, including how to prevent or lessen potential adverse impacts. 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:** Status, trends, and resilience of potentially impacted socioecological 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 from competing resource use 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, environmental justice communities, and other peoples
3. **Monitoring:** Monitor the environmental impacts of BOEM’s authorizations over the life cycle during which those impacts will occur, including potential future decisions
4. **Cumulative Impacts:** Cumulative environmental impacts of BOEM’s decisions to address the requirements of National Environmental Policy Act (NEPA), OCSLA, and other statutes

5. **Compliance:** 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 to fund a proposed study.

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, which assists BOEM in setting research priorities 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) as well as emerging sectors such as carbon sequestration, critical minerals, and green hydrogen.
2. **Contribution to Existing Knowledge:** Studies must be designed to contribute substantially to existing knowledge; 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 in a succinct yet compelling format that demonstrates the quality of the research design, methodological innovation, and the benefits to BOEM and the public. Proposals should also clearly articulate how data will be archived and how specimens, if collected, are curated.
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, information needs and scientific merit are the basis for determining whether to fund a research proposal.
5. **Leveraging Funds:** Study proposals should explore opportunities for shared funding, which 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) that are meant to provide consistency and guidance to the ESP research portfolio across research areas, balancing the needs of regions and programs. 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 to understand the uncertainty and risk of the socioecological systems under consideration and communicate those risks and uncertainties to decision-makers and the public.

More specifically, ESP needs 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 are these emissions contributing to onshore compliance status 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 manmade 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. 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 March 2024, approximately 12 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

In March 2021, the White House released details of its plan to boost the offshore wind energy industry. As a result, DOI and the Departments of Energy (DOE), Commerce (DOC), and Transportation (DOT) are coordinating their actions to support rapid offshore wind deployment and job creation. DOI, DOE, and DOC announced a shared goal of deploying 30 gigawatts 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 34 active leases along the Atlantic Coast from Massachusetts to South Carolina. BOEM has received 19 Construction and Operation Plans (COPs). Six plans have been approved (Vineyard Wind 1, South Fork, Ocean Wind 1, Revolution Wind, Coastal Virginia Offshore Wind – Commercial, and Empire Wind), and 11 are under active review. The areas for development include Massachusetts, Rhode Island, New Jersey, New York, Delaware, Maryland, Virginia, and North and South Carolina. At the end of 2023, South Fork started delivering electricity to homes in Long Island, NY. Soon after, Vineyard Wind's first turbines delivered electricity to homes in Massachusetts. BOEM auctioned five leases offshore California in December 2022, and the first Gulf of Mexico offshore wind lease sale was held in August 2023, with a second proposed for 2024. In April 2024, BOEM announced two further proposals for offshore wind energy auctions: one off the coast of Oregon and one in the Gulf of Maine.

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. On October 19, 2023, BOEM announced a Draft Wind Energy Area (WEA) in the Gulf of Maine.

1.4.3 Marine Minerals

OCSLA assigns DOI responsibility (delegated to BOEM) 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 69 negotiated agreements and conveyed rights to approximately 195 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 2024). 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 designated 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. Executive Order (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 authorizes 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 trusted voice 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 marine acoustics issues have increased in national and international significance. The CMA science priorities for FY 2025–2026 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
- Understand the potential effects of substrate-borne vibrations produced during renewable energy development on fishes and invertebrates
- Examine potential behavioral 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 jurisdiction now encompasses 3.2 billion acres, compared to 2.3 billion acres prior to 2022. In FY 2025, ESP plans to use funds received through the Inflation Reduction Act to procure environmental studies in both the Caribbean and Pacific Islands.

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; industry is interested 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 or 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). 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 is informed by six cross-cutting principles (ocean health and stewardship; environmental justice (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 OCAP 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. On the Atlantic OCS, the Office of Renewable Energy Programs (OREP) and the Marine Minerals Program (MMP) are actively managing leases. No oil and gas exploratory drilling or development activities currently are taking place as part of the conventional energy program.

Appendix A includes the tables of proposed studies for FY 2025–2026. **Appendix B** provides the profiles for the proposed studies.

2.1.1 Conventional Energy Activities

On September 25, 2020, President Trump issued a memorandum withdrawing certain areas of the OCS from leasing for oil and gas and renewable energy. 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.

As a result, there is no offshore conventional energy development currently occurring in the Atlantic OCS Region. While under this moratorium, BOEM will not be conducting baseline studies in support of oil and gas on the Atlantic OCS, and the Bureau does not anticipate that new information will be needed in FY 2025–2026.

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.

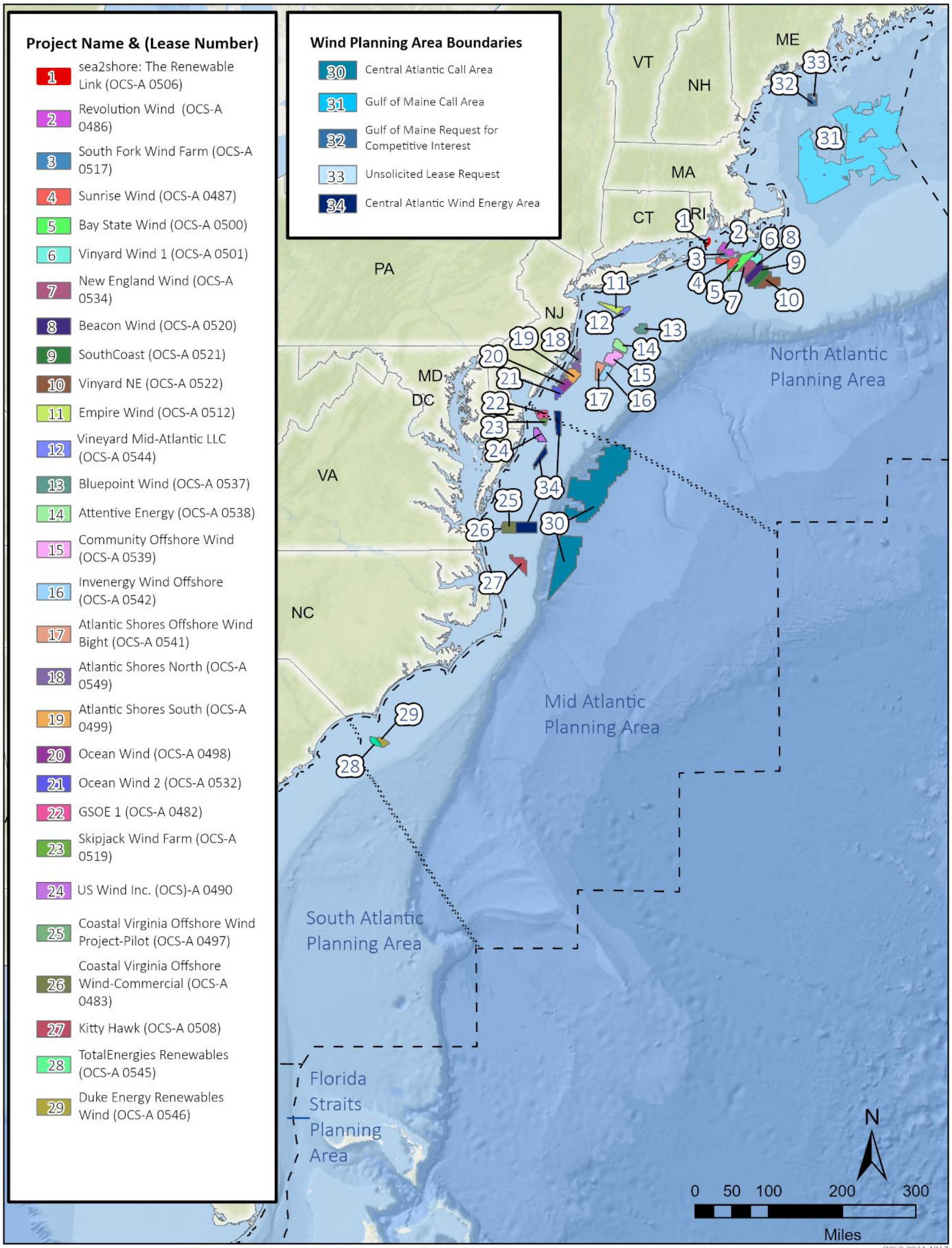


Figure 2. Atlantic Region OCS planning areas for renewable energy and Renewable Energy Areas

2.1.2 Renewable Energy Activities

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 offshore wind projects.

BOEM remains engaged in supporting studies to collect baseline environmental data, as well as modeling studies that integrate various data streams, and empirical fates and effects data to help validate modeling efforts in order to better understand the potential impacts from offshore wind development in the Atlantic. BOEM continues to support the development and expansion of decision-support tools, such as the risk assessment tool to model encounter rates between large whales and vessel traffic from offshore wind energy. 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 actively engaged in research at this location, collecting data on pile driving sound during installation, sound from operating turbines, and development of biological communities on the turbine and surrounding scour protection.

Building on these successful efforts, BOEM is funding studies (RODEO II and Project WOW) to collect empirical data during monopile installations for the Vineyard Wind I and South Fork wind farms, which began in June 2023. Expansion of these efforts is being proposed in this FY 2025 SDP.

2.1.3 Marine Minerals Activities

BOEM continues to evaluate and authorize G&G exploration offshore North Carolina and Florida and lease OCS sand for use in beach nourishment and coastal restoration New Jersey, Maryland, Virginia, North Carolina, South Carolina, and Florida. OCS sand has been used to protect valuable Federal and state assets and infrastructure, such as national seashores along Assateague Island (MD) and Dare County, NC, which was nourished with over 3 million cubic yards over 12.1 miles of shoreline in 2023 (**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. Dare County, NC, before and after restoration

2.2 Decision Context

2.2.1 Current and 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 knowledge and concerns are incorporated in our decision process. BOEM also is investing resources in the issue of the declining population of the highly endangered North Atlantic right whale by allocating staff resources, funding studies, and working with our Federal partners. BOEM continues to address the concerns about visual impacts and 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 (NOSI). The NOSI initiative also supports the *Presidential Memorandum on Ocean Mapping of the United States Exclusive Economic Zone*. 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. For FY 2025, marine minerals studies in the Atlantic are particularly focused on benthic impacts and recovery, emissions outputs per project, and mitigation and minimization of impacts to endangered species. In addition, 18 EO 13817 and EO 14017, there is also increased attention from the Biden Administration on the economic potential of heavy and critical offshore minerals, and our studies also focus on the potential impacts from exploration and development of these minerals.

2.2.2 NEPA and 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. Several profiles propose to examine habitat use and effectiveness of mitigation strategies for several endangered species. In addition, updates are needed to an existing dredge emission calculating program that the MMP utilizes in our NEPA air quality analyses. Finally, a study has been proposed to develop suggested environmental guidelines for exploration and development for critical minerals.

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 Tribes and the public include air quality, benthic habitats, protected species, visual impacts to coastal communities, and use of Tribal ecological knowledge (TEK) and fisher's ecological knowledge (FEK). Many of these issues related to SSQs that address cumulative effects (SSQ 1), existing or emerging technology (SSQ 8), and monitoring (SSQ 9). **Table 1** lists all the renewable energy studies proposed for the Atlantic Region this year and how they address the various SSQs.

Protected Species
Marine mammals on the Atlantic seaboard generally are highly migratory and use a wide area on the OCS. As a result, they may be impacted by all three of BOEM's leasing programs. Existing and innovative technologies are being proposed to better understand protected species migratory habits and movements, as well as their movement around offshore wind farms. BOEM is proposing to partner with industry to use existing fiber optic cable for baleen whale monitoring by applying distributed acoustic sensing technology. BOEM also supports the Partnership for an Offshore Wind Energy Regional Observation Network (POWERON), which aims to deploy extensive acoustic recording devices in strategic areas of interest to BOEM in the Atlantic, as well as better understand seasonal residency and movement of highly migratory fish and sea turtle species in the Mid-Atlantic WEAs by deploying acoustic tags and receivers. Building on existing work funded by BOEM and DOE's Office of Energy Efficiency and Renewable Energy, BOEM will expand baleen whale tagging and environmental data collection during offshore wind farm construction. This year's SDP also will describe BOEM's efforts to conduct expert elicitation to improve behavioral response assumptions and develop a sensitivity analysis on model parameters on an existing bioenergetics model for North Atlantic right whales to better understand the critical model parameters driving population impacts.

Current models to estimate bird fatalities from operating wind turbines are deterministic and do not allow for biological variability. To more accurately estimate bird collisions with turbines, BOEM is proposing to use proxy avian species and relevant high-quality datasets to prepare modeling results that can be integrated into recently developed stochastic models. BOEM also is proposing funding to support access and data updates of the Northwest Atlantic Seabird Catalog.

Socioeconomics
The value of a residential property is determined by a complex set of factors related to the property's amenities and its location. Property owners often raise concerns regarding the effects of offshore wind projects on the value of their property due to potential effects on the visual landscape and other issues. Hedonic regression analysis is a standard revealed-preference methodology to estimate the effects of variables of interest on property values. BOEM is proposing to assess whether offshore wind farms, particularly the viewsheds of offshore wind farms, notably affect property values. If so, additional work will be done to assess factors determining the magnitude of the effects and how these effects evolve over time.

2.3.2 Marine Minerals Activities

Table 2 shows MMP studies proposed for this SDP: four studies are more programmatic and span multiple regions; two studies focus on the Atlantic Region (with both focused on Protected Species); and two studies focus on the GOM Region (see **Section 4.3.2** for a description of these two studies).

Air Emissions
In 2013, MMP developed the Dredging Project Emission Calculator (DPEC) to assess air quality impacts from dredging projects (SSQ 5). BOEM evaluates the potential impacts to air quality under its NEPA mandate and, when relevant, General Conformity Determination provisions of the Clean Air Act. Recent NEPA requirements and guidance require analysis of greenhouse gas (GHG) and climate change effects of proposed actions under NEPA. Estimating a proposed activity's emissions is critical in evaluating the potential effect of the proposed activities on air quality and determining appropriate mitigation. After a decade of use to support environmental analyses, the DPEC needs updating in the following areas: emissions and loading factors; equipment types and use; and the addition of methane and hazardous air pollutants to the estimates.

Habitat
The second MMP study would 1) identify the primary benthic habitat units typically required for EFH consultations and 2) develop 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. 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 third study MMP proposes for this SDP would utilize ecosystem modeling to examine the disruption to primary producers and primary consumers from dredging disturbance or perturbation to habitat (SSQs 1 and 4). This study would leverage existing ecosystem studies funded by BOEM (i.e., Frying Pan Shoals [MM-22-03], 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.

The fourth study would address information that is needed to evaluate the potential effects of exploratory or novel 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.

Protected Species

Two proposed studies would examine the potential impacts to protected species in the Atlantic: 1) a study of smalltooth sawfish presence and movements in proximity to sand resources, and 2) working with the dredging industry to provide recommendations for improved contract plans and specifications for each project that may facilitate operational improvements to reduce take risk for sea turtles and sturgeon (SSQs 1 and 4).

Understanding how smalltooth sawfish activity may overlap with BOEM dredging activities is critical to effective environmental compliance and mitigation measures. BOEM has funded an active acoustic telemetry array at Canaveral Shoals II, an active lease area, since 2013 (Iafrate et al. 2022). From 2016 through 2021, ten total sawfish were detected on Canaveral Shoals, mostly during spring and summer. Their presence along the Atlantic in central Florida is somewhat surprising, therefore warranting further investigation into their movement. The main objective of this study is to characterize the occurrence and movement of smalltooth sawfish near existing and potential sand resources on the OCS to better understand any correlating environmental factors and how BOEM-authorized activities may affect this endangered species and its habitat.

In the second study, BOEM seeks to identify “hot spot” navigation channels and offshore borrow area locations in the Atlantic and Gulf of Mexico regions with the greatest impact to sea turtles and sturgeon. Further, we will collaborate with dredging industry to assess channel and borrow area design factors contributing to the high risk. The results will provide recommendations for improved contract plans and specifications for each project and may facilitate operational improvements to reduce take risk, when considering known, fine-scale behavior patterns from prior studies.

Table 1. Alignment of proposed FY 2025 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	Baleen Whale Behavior and Biological Sampling during Construction of Offshore Wind Farms	-	✓	-	✓	-	-	-	-	-	-	✓	-
2	Applying Distributed Acoustic Sensing Technology to Monitor Large Whales at Atlantic Offshore Wind Areas	-	✓	-	✓	✓	-	-	-	-	-	✓	✓
3	The Effects of Offshore Wind Farms on Property Values in the United States	-	✓	-	-	-	-	-	-	-	✓	-	-
4	Maintenance of the Northwest Atlantic Seabird Catalog	✓	✓	-	✓	-	-	-	-	-	-	-	✓
5	Behavioral Response Workshop for North Atlantic Right Whales	-	✓	-	✓	-	-	-	-	-	-	-	-
6	Seasonal Residency and Movement of Highly Migratory Sea Turtle and Fish Species in Mid-Atlantic Wind Energy Areas Before and After Offshore Wind Construction	✓	✓	-	✓	-	-	✓	-	-	-	✓	✓
7	Integrating High-quality Movement Data from Proxy Species into SCRAM	-	✓	-	✓	-	-	-	-	-	-	✓	✓

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 2025 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	Coastal Marine and Ecological Classification Standard Application: Offshore Energy and Minerals Development	-	-	✓	✓	-	-	✓	-	-	-	-	✓
2	Updating the Dredging Project Emissions Calculator (DPEC) 2024	-	-	✓	-	-	-	-	✓	-	-	-	-
3	Modeling Food Web Effects from Dredging	-	-	✓	✓	-	-	✓	-	-	-	-	-
4	Environmental Evaluation of the Critical and Hard Offshore Mineral Programmatic Reference (EE-CHOMPR)	-	-	✓	✓	-	-	✓	-	-	-	-	-
5	Regional Interconnectivity of Mobile Marine Organisms among Gulf of Mexico Sand Shoals	-	-	✓	✓	-	-	✓	-	-	-	-	✓
6	Baseline Characterization of Communities on Sand Shoals and Nearby Habitats in the Northern Gulf of Mexico	-	-	✓	✓	-	-	✓	-	-	-	-	-
7	The Good, the Bad, the Ugly: A Facilitated Discussion with Dredging Industry to Solicit Recommendations for Low-cost Operational Improvements to Reduce Risk to Protected Species	-	-	✓	✓	-	-	✓	-	-	-	-	-
8	Protected Smalltooth Sawfish Occurrence in BOEM OCS Sand Resource Areas	-	-	✓	✓	-	-	✓	-	-	-	-	-

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

3 Pacific Studies

3.1 Introduction

BOEM's Pacific Region historically included the OCS areas offshore California, Oregon, Washington, and Hawaii (**Figure 4**). With BOEM's recently expanded jurisdiction, the Pacific Region geographic responsibilities also include the OCS associated with the U.S. Territories in the Pacific. 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 2025–2026 SDP, the Pacific Region received and considered 121 study ideas from stakeholders, including Federal and state agencies, Tribal organizations, universities and other research institutions, nonprofit organizations, stakeholder alliances, and private companies. Additionally, eight BOEM staff proposed 15 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 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, 2023, cumulative production was 1.4 billion barrels of oil and 1.9 trillion cubic feet of gas; annual production was 3.0 million barrels of oil and 2.8 billion cubic feet of gas (C. Baver, personal communication). The substantial decline in production since 2015 is due to a number of factors, including 1) the May 2015 break and shut-in of an onshore pipeline that transported oil from offshore (affecting Platforms Harvest, Hermosa, Hidalgo, Harmony, Heritage, and Hondo); 2) relinquishment of five leases in January 2018 (affecting Platforms Gail and Grace); 3) the January–April 2019 shut-in of Platform Irene; 4) the shut-in of Platforms Hogan and Houchin starting in October 2019; 5) the October 2021 break and shut-in through April 2023 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 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.

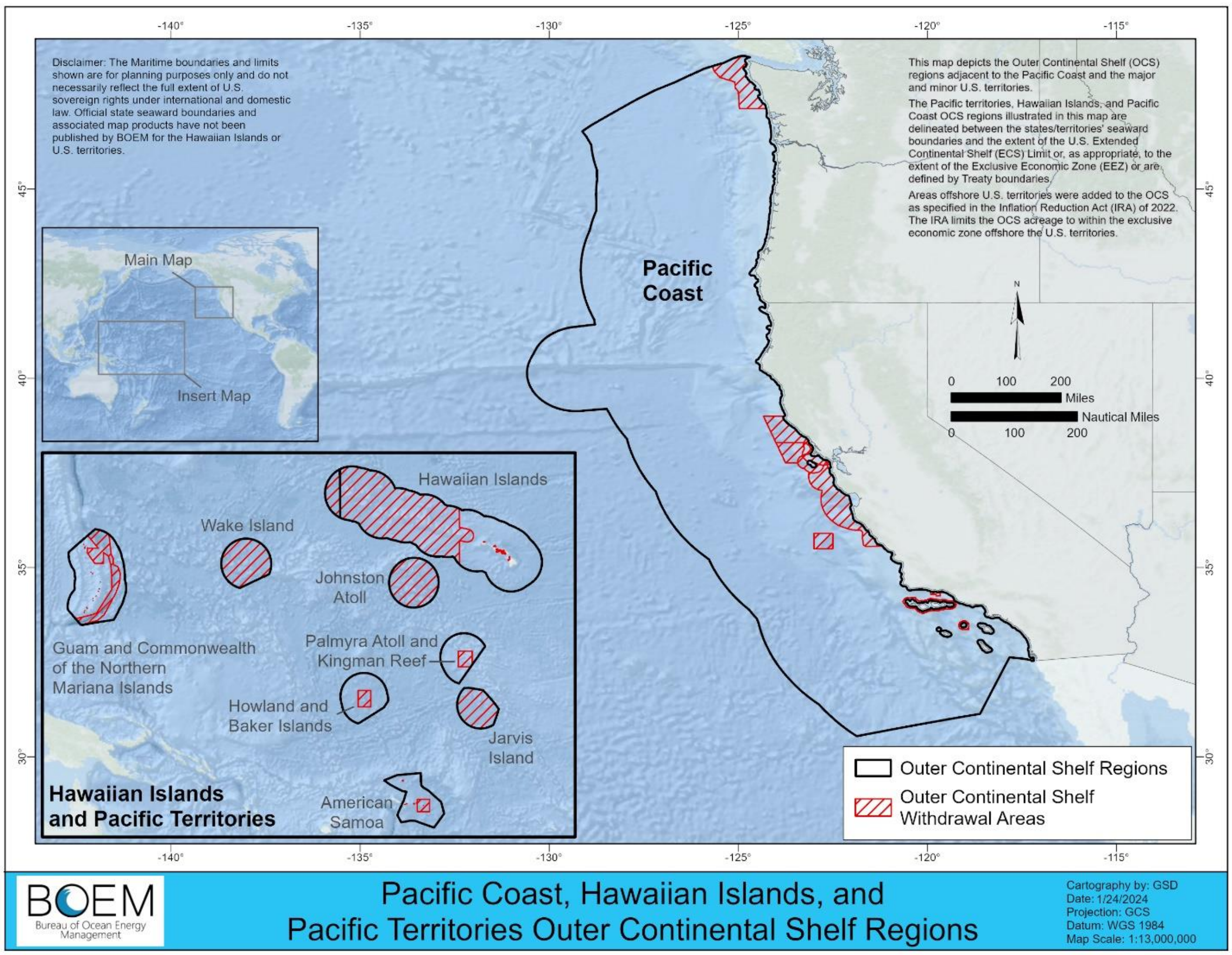


Figure 4. Pacific Coast, Hawaiian Islands, and Pacific Territories

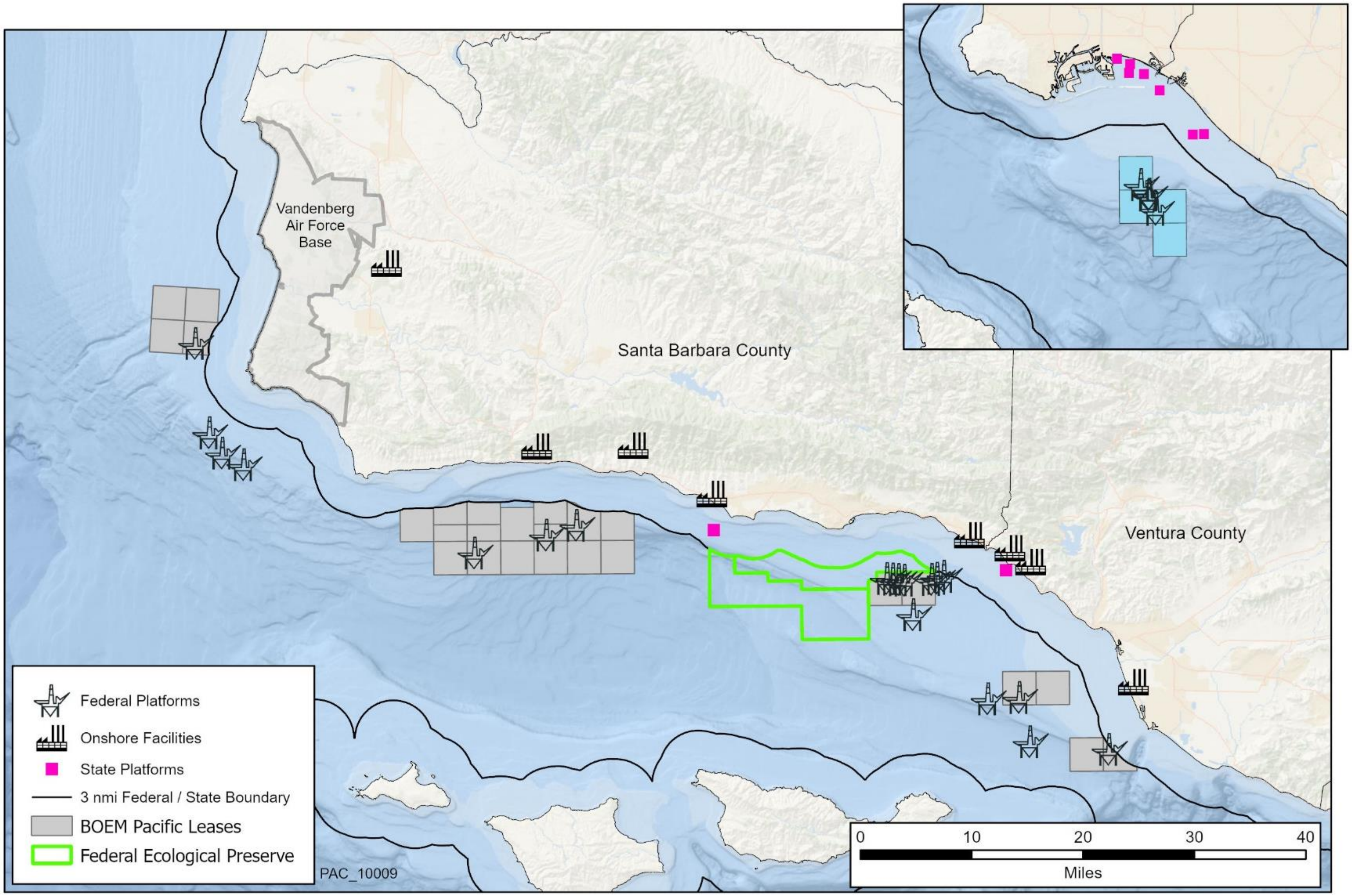


Figure 5. Oil and gas leases and facilities in the Pacific Region

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 research lease to Oregon State University; the PacWave South project, a proposed open ocean wave energy test center, will be located approximately 6 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 designated two final WEAs on February 13, 2024. The potential for wind energy offshore Hawaii has been under consideration since 2016. The recently released Five-Year Offshore Wind Leasing Schedule includes lease sales offshore Oregon in 2024 and California, Hawaii, and possibly Guam in 2028.

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.

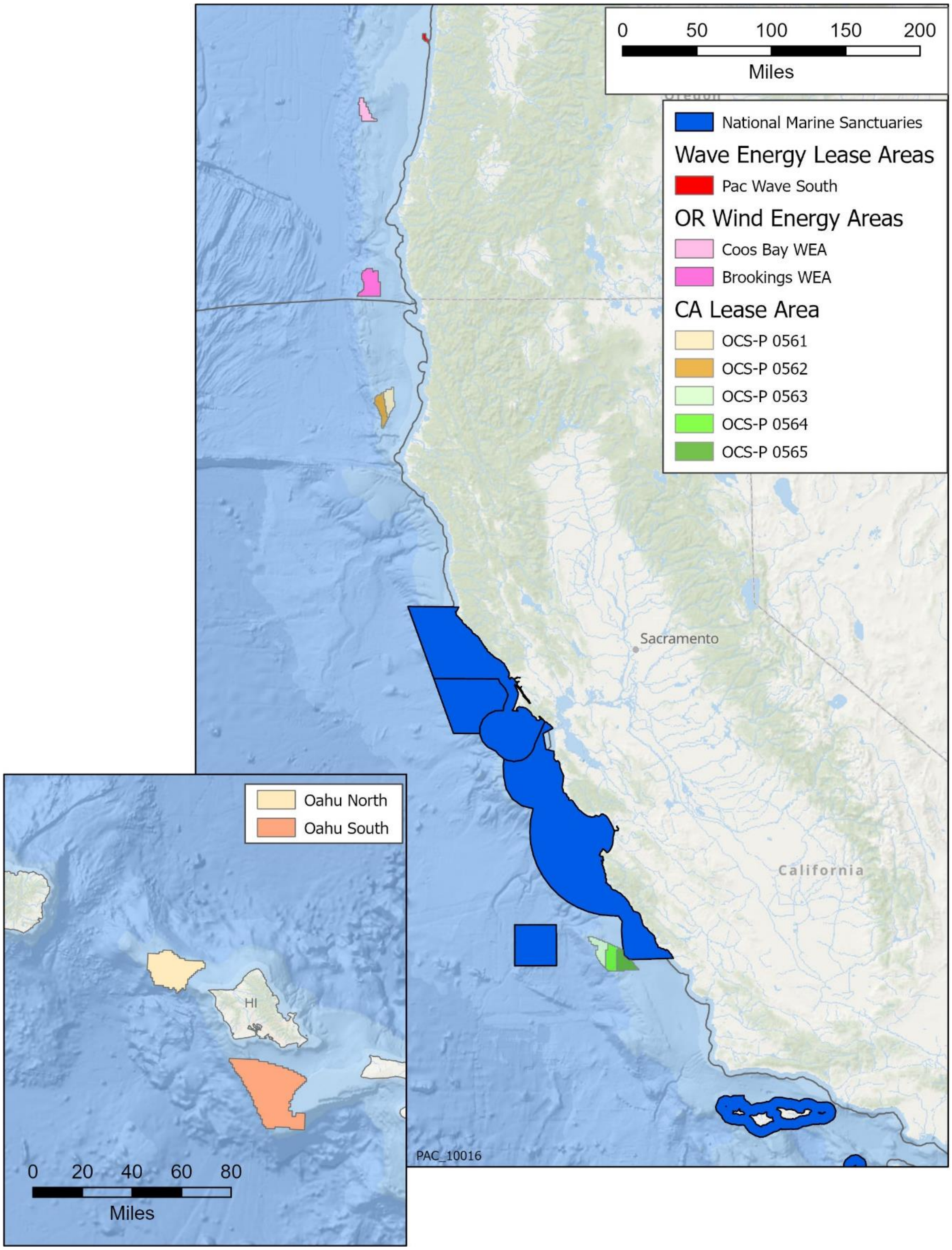


Figure 6. Areas of interest for renewable energy in the Pacific OCS

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 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 California. The MMP and Pacific Region are co-funding several critical marine mineral-related efforts in partnership with USGS's Pacific Coastal and Marine Science Center and NOAA Ocean Exploration. These efforts include scientific expeditions in 2024 and likely 2025 to obtain baseline information about potential abyssal polymetallic nodule resources and the surrounding ecosystems in the OCS in the vicinity of Hawaii, American Samoa, and Guam. Future work in other areas of the Central and Western Pacific is also in discussion.

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, Hawaii, and U.S. Pacific Territories. 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, Hawaii, and Guam
  - Potential environmental and socioeconomic impacts of wind energy development offshore the West Coast, Hawaii, and Guam, 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, BOEM Pacific marine mineral-related activities are focused on resource evaluation efforts 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 associated with abyssal nodules in areas of high resource potential are the current focus, the Pacific Region, in partnership with the MMP, tries to organize 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 model is being implemented for preliminary resource and environmental work in areas south of Hawaii as well as east of American Samoa and east of Guam.

3.3 Alignment With SSQs

Current and forecasted activities in the Pacific Region (**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 eight Pacific Region studies proposed for FY 2025, two would inform conventional energy, eight 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 (2 studies)
- Determining effects of habitat or landscape alteration (5 studies)
- Determining how future ocean conditions and dynamics may mask effects of OCS activities (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 (1 study)

Table 3. Alignment of proposed FY 2025 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	Guidance on Compensatory Mitigation to Achieve Net Positive Impacts of Offshore Wind Energy to Seabirds	-	✓	-	✓	-	-	✓	-	-	-	-	-
2	Probability Analysis of Derelict Fishing Gear Interactions with Floating Offshore Wind Mooring Systems Offshore California	-	✓	-	-	-	-	✓	-	-	-	-	-
3	Ichthyoplankton Entrainment Assessment for HVDC Cooling Systems	-	✓	-	-	-	-	✓	-	-	-	-	-
4	Impacts of Floating Offshore Wind Subsurface Infrastructure to Hydrodynamics, Biogeochemistry, and Primary Productivity in the Pacific OCS	-	✓	-	-	-	-	-	-	✓	-	✓	✓
5	Comprehensive Vulnerability of Marine Birds to Inform Offshore Wind Energy Development Throughout Waters Surrounding Pacific Offshore Continental Shelf of Hawaiʻi	-	✓	-	-	-	-	✓	-	-	-	-	-
6	Updating Climate Science Integration into BOEM Pacific Decision-making	✓	✓	✓	✓	-	-	-	-	✓	-	✓	-
7	Potential Environmental Effects from Impressed Current Cathodic Protection Systems	-	✓	-	-	-	-	✓	-	-	-	-	-
8	Testing a Next Generation Tagging 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 moving ahead with offshore renewable energy leasing and development in the GOM after completing the regions first offshore wind sale in 2023.

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 within a collaborative network of member Federal and state agencies, universities, and research and environmental groups.

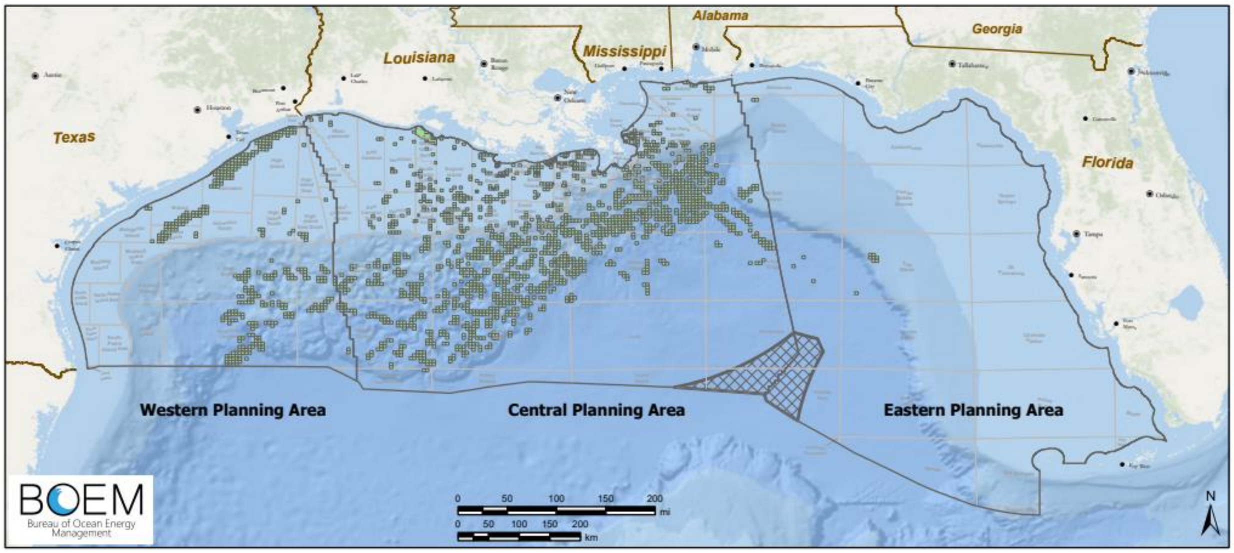
The INVEST in America Act of 2021 granted BOEM the authority to manage carbon sequestration and storage in subsea oil and gas reservoirs of the OCS. BOEM's current rulemaking efforts are working toward developing new regulations that will be needed to support development of this new program. Much attention 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. Green hydrogen production using offshore wind-generated electricity is another component of renewable energy that is under consideration for addition to the GOMR's portfolio.

Appendix A includes the tables of proposed studies for FY 2025–2026. **Appendix B** provides the profiles for the proposed studies.

4.1.1 Conventional Energy Activities

As of February 1, 2024, there are nearly 2,200 active oil and gas leases on the GOM OCS (**Figure 7**). Within active leases, there are currently 1,399 platforms making substantial contributions to the Nation's energy supply. BOEM published the Proposed Final Program in September 2023 covering a five-year period from July 1, 2024, to June 30, 2029. The program was approved by the Secretary of the Interior in December 2023. During this five-year period, three oil and gas lease sales are scheduled with one lease sale each to be held in 2025, 2027, and 2029. GOMR currently provides approximately 15% of U.S. domestic oil production and 1% 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, visit the [region's web page](#).

BOEM Gulf of Mexico OCS Region
Blocks and Active Leases by Planning Area
February 1, 2024



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	384	2,112,082
Central	12,409	66,446,351	1,790	9,552,763
Eastern	11,537	64,357,859	13	74,880
Sub-Totals	29,186	159,381,023	2,187	11,739,725
CPA / EPA Shared Blocks*	(86)		0	
Totals	**29,100**	**159,381,023**	**2,187**	**11,739,725**

Planning Area Boundary
Extended Continental Shelf (ECS area)
Active Leases

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

Office of Leasing and Plans, Mapping and Automation Section | MAS2024-72 | 1 February 2024

Figure 7. GOM OCS Region planning areas and active oil and gas leases (February 2024)

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 (SSRAs), such as the Ship Shoal Area and others, that may also be optimum sites for oil and gas platforms and associated pipelines, as well as offshore wind infrastructure (**Section 4.1.3**) (**Figure 8**). These challenges are becoming more complex and deserving of rigorous and integrated environmental study, monitoring, and management.

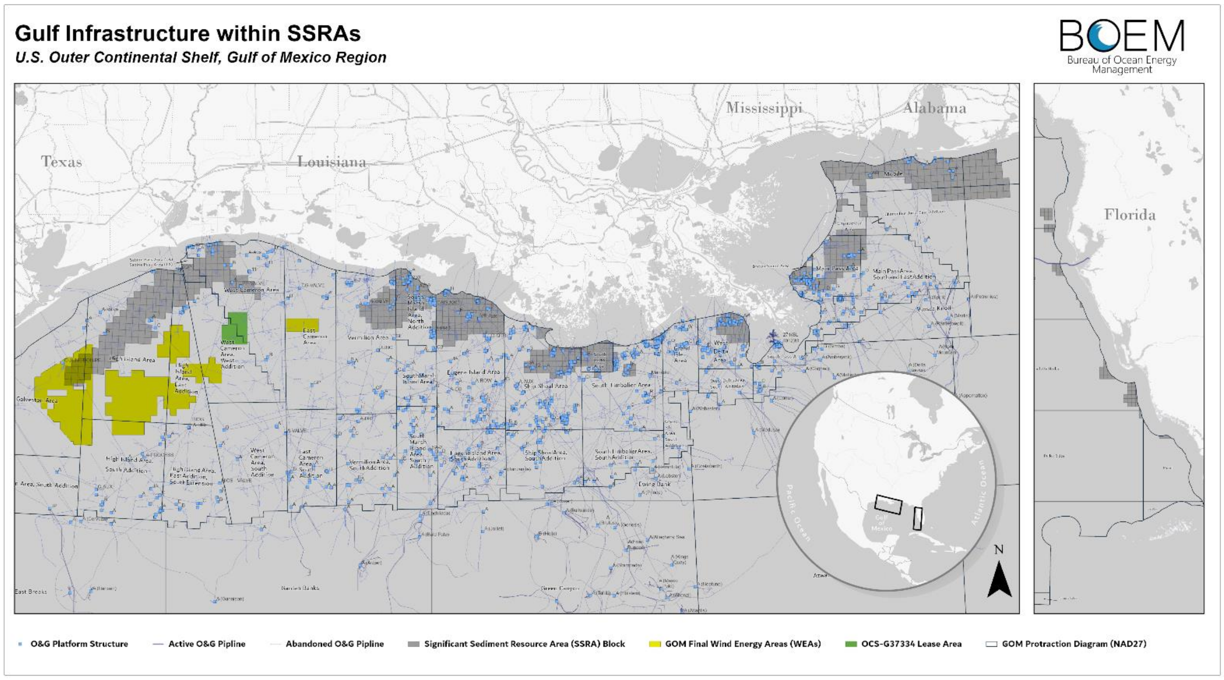


Figure 8. Complex, competing-use challenges in the GOM (updated in February 2024)

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).

Two other studies conducted by the National Renewable Energy Laboratory in FY 2023; *Renewable Energy Hurricane Risk Assessment* (Mudd et al.2023) and *Assessment of Offshore Wind Energy Opportunities and Challenges in the U.S. Gulf of Mexico* (Fuchs et al.2023)

In August 2020, the Governor of Louisiana signed EO JBE2020-18 to establish a Climate Initiatives Task Force and set GHG 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. Few more Task Forces were held subsequently in FY 2022 and 2023. BOEM published a Request of Interest in June 2021 and a Call for Information and Nominations (Call) in November 2021. The final WEAs were finalized on October 31, 2022. BOEM published 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. On May 25, 2023, BOEM announced the final environmental assessment (EA) and published the Final Sale Notice on July 21, 2023. On August 29, 2023, BOEM held the first-ever offshore wind energy auction for the GOM region resulting in the Lake Charles Lease Area being awarded to RWE Offshore US Gulf, LLC. On October 27, 2023, BOEM announced it has finalized four WEAs in the GOM for a potential sale. **Figure 9** shows the renewable energy planning areas in the GOM, and **Figure 10** displays the final WEAs.

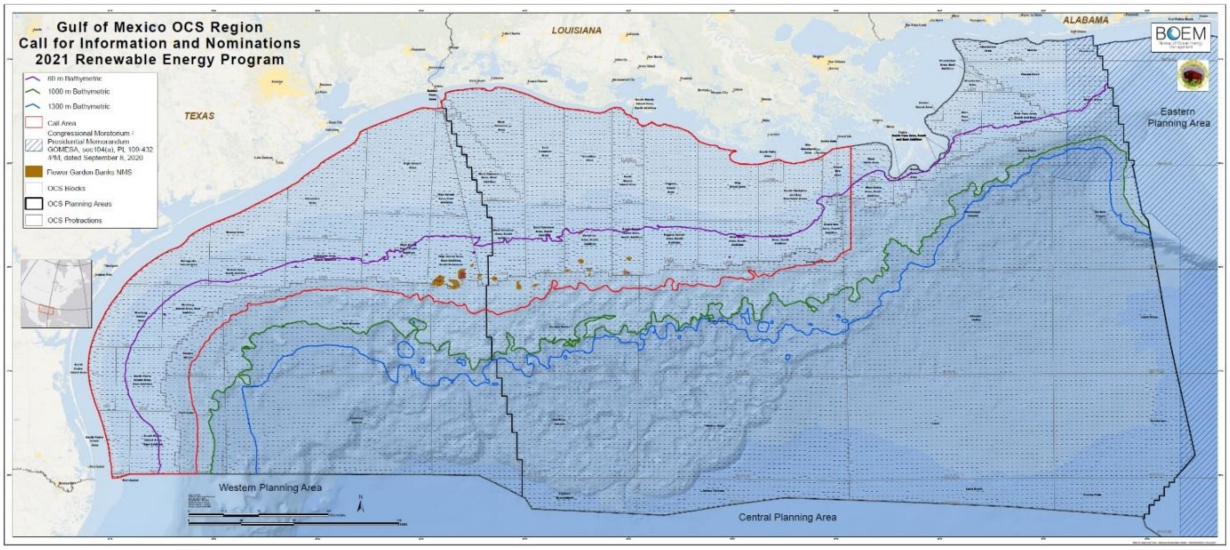


Figure 9. GOM renewable energy planning areas

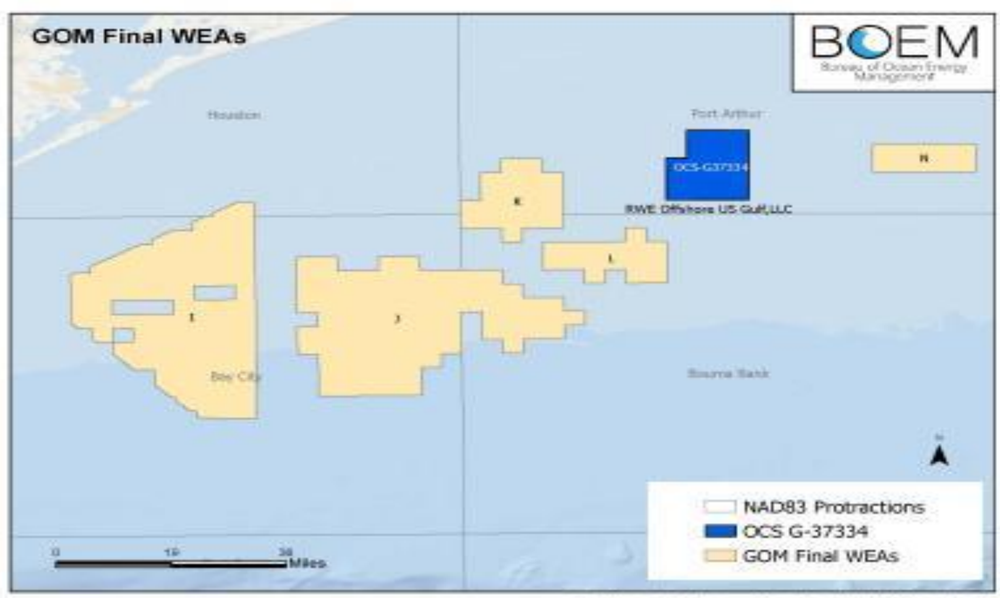


Figure 10. GOM final WEAs

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. In addition, air quality modeling updates and new air pollutant measurement surveys will inform decision-making regarding ongoing conventional energy production and their cumulative impacts.

With the momentum moving forward on renewable energy development and captured carbon sequestration, and the potential for green hydrogen production in the Gulf, new information needs have been identified to help inform the development and management of these programs. A literature search and synthesis study focusing on green hydrogen will additionally conduct a gap analysis to help inform future environmental analyses and mitigation development. A second study relating to green hydrogen and wind energy will compile a database of cultural resources along the Gulf Coast and assess their viewsheds and the potential visual impacts of offshore infrastructure construction. Another study will use a coupled hydrodynamic-biogeochemical model to estimate the hydrodynamic conditions prior to, during, and after construction of offshore wind energy facilities.

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. Information provided by these studies would enable BOEM to conduct more comprehensive and informed environmental impact assessments, associated NEPA analyses, and Tribal and EJ consultations. For example, a 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. EJ continues to be a topic of concern for BOEM, and compiling an EJ Fact Book will better identify and characterize these communities to inform environmental impact analyses moving forward. Lastly, a newly proposed study will evaluate the vessel strike risk for Rice's whales, sperm whales, and other protected whale species in the GOM.

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 2025 would inform cumulative impacts analyses. 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 eight study profiles for the FY 2025 SDP and no profiles for FY 2026 and beyond. All profiles address at least one national SSQ, while several of the profiles address two or more questions (**Table 4**). Five of the 10 studies would inform the conventional energy program, six would inform the renewable energy program and/or carbon sequestration in the GOM, and three would additionally inform the MMP. Out of the eight studies proposed, two would inform all program areas in the GOM.

Five profiles address cumulative effects. Three are concentrated in the social sciences, with a focus on cultural resources. Three profiles focus on air emissions while three others address effects of habitat or landscape alterations. Two profiles relate to future ocean conditions and dynamics, one profile addresses exposure to hydrocarbons or other chemicals, and one profile will inform long-term monitoring.

4.3.2 Marine Minerals Activities

Habitat

MMP has two new study profiles proposed in the GOM for FY 2025 (**Table 2**). The first study would focus on developing a regional understanding on the interconnectivity and differences of shoal species occurrence and distribution in the northwestern GOM by establishing a telemetry array on Sabine Bank, TX, and monitoring and maintaining an existing array on Ship Shoal, LA. Data of habitat and shoal species (e.g., sea turtles, sharks) occurrence, distribution, and movement on Sabine Bank is necessary to establish an environmental baseline prior to anticipated dredging of the shoal in the near future for coastal restoration projects within Louisiana and Texas, and to accurately assess future post-dredging animal and habitat impacts (SSQs 1, 4, 9). Results from this study would help inform dredging windows as well as NEPA effects analysis, particularly related to fisheries species. This study would leverage the existing Ship Shoal ecosystem study (MM-19-01) funded by BOEM.

The second study would focus on understanding 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 and understanding the baseline communities of sand shoal and non-shoal habitats, including species preferences (both biotic and abiotic) and food web interactions, is needed to understand their ecological value. This study would characterize the communities, production, and abiotic factors present on sand shoal and nearby non-shoal areas in Sabine Bank, TX, and Ship Shoal, LA, by examining metrics—such as species composition, abundance, richness, diversity, food web interactions—to understand the importance of shoals more fully to the ecosystem. The results of this study would provide valuable baseline data on sand shoal ecosystems of the central GOM that could be used to improve existing mitigation strategies for reducing the effects of dredging on marine resources, including protected species (SSQs 1, 4). This information would also be important for BOEM to comply with NEPA and Section 7 consultations for sediment dredging and the eventual installation of renewable energy structures.

4.3.3 Renewable Energy Activities

GOMR is proposing six studies that would inform wind energy development in the Gulf. Three studies focus on social science topics: 1) developing an inventory of submerged historic aircraft inventory (mentioned above), 2) compiling a database of cultural resources along the Gulf Coast and assessing their viewshed and potential visual impacts, and 3) identifying and characterizing EJ communities to develop an EJ-focused Fact Book, which also would inform BOEM's conventional and marine minerals programs. A fourth 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. A fifth study will address vessel strike risk to Rice's and other whales from oil and gas-related vessel traffic, but the results will also inform renewable energy development in the region. Lastly, a sixth study will conduct a literature search and synthesis focusing on green hydrogen production but will additionally inform renewable energy development.

Table 4. Alignment of proposed FY 2025 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**
-	A Data Inventory and Assessment of Submerged Aircraft Loss Records on the Gulf of Mexico Outer Continental Shelf	✓	✓	✓	-	-	-	-	-	-	✓	-	-
-	Air Quality Modeling in the Gulf of Mexico Region - 2025 Update	✓	-	-	✓	-	-	-	✓	-	-	-	-
-	Airborne Air Emission Surveys of Oil and Gas Activities in the Gulf of Mexico Region	✓	-	-	✓	-	-	-	✓	-	-	-	-
-	Green Hydrogen (GH2) Production from Offshore Wind Energy: Informing Management Needs Through a Focused Literature Review, Information Synthesis, and Gap Analysis	-	✓	-	✓	-	✓	✓	✓	✓	-	-	-
-	Gulf of Mexico Environmental Justice Fact Book: Coastal Communities Affected by Activities on the Outer Continental Shelf	✓	✓	✓	✓	-	-	-	-	-	✓	-	-
-	Offshore Wind Energy Facilities Impact on Hydrodynamics and Primary Production in the Gulf of Mexico	-	✓	-	-	-	-	✓	-	✓	-	-	-
-	Oil and Gas Vessel Strike Risk Analysis: Cetaceans in the Northern Gulf of Mexico with a Focus on the Endangered Rice's and Sperm Whale	✓	✓	-	✓	-	-	-	-	-	-	-	-
-	The Value of View: Visual Impact Analysis from Green Energy Development on Cultural Resources Along the Gulf of Mexico	-	✓	-	-	-	-	✓	-	-	✓	-	-

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

5 Alaska Studies

5.1 Introduction

The Alaska OCS encompasses 15 planning areas in the Arctic, Bering Sea, and Gulf of Alaska (**Figure 11**). Through its Alaska Regional Office, BOEM oversees more than one billion acres on the Alaska OCS. 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 11. 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 with partnerships and non-federal matching funds from more than 50 different organizations. Completed study reports are posted on the BOEM website and on BOEM's Alaska regional website.

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 and continuing through the 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.

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 the availability of these resources 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. Additionally, changes in sea ice conditions and permafrost require industry to adapt their activities.

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 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 2025–2026. **Appendix B** provides the profiles for the proposed studies.

5.2 Decision Context

5.2.1 Current/Relevant Issues

A recent BOEM-funded study (Meadows et al. 2023) identified two wind energy locations and one hydrokinetic energy location in the Lower Cook Inlet OCS as having the highest potential in providing ocean-based renewable power. The result of this study, along with industry interest in renewable energy activities in Cook Inlet, has resulted in BOEM focusing data collection in this area to identify potential resources that could be affected by renewable energy activities. As renewable energy gains momentum in Lower Cook Inlet, there will continue to be new information needs crucial for guiding the program's development and management. BOEM also needs sea ice data for use in oil spill risk analyses to support both renewable and conventional energy activities on the OCS.

BOEM Alaska also needs to understand the potential impacts of tidal and wind energy within Cook Inlet to inform future decisions about site selection and development. Data are required to facilitate appropriate engineering design and to investigate potential impacts related to avian collisions and marine mammal interactions. BOEM is proposing the following studies for funding in FY 2025 to address these data needs: 1) occurrence, seasonal distribution, and density of marine mammals to assess the potential impacts of renewable energy activities; 2) assessment and minimization of avian collision risk associated with renewable energy infrastructure; 3) distribution and abundance of threatened Steller's Eiders in Cook Inlet; and 4) geographic coverage, duration, and type of sea ice in Cook Inlet, Alaska.

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 will be used to help to identify potential hydrothermal vents and will be useful for initial exploration and evaluation of mineral resources, and for understanding the surrounding habitats, ecosystems, and the potential impacts of any future seafloor disturbing activities.

Presidential Memoranda signed in 2016 and 2023 withdrew all unleased areas in the Beaufort and Chukchi Seas from future oil and gas leasing. As a result, BOEM is focusing study efforts on the Lower Cook Inlet.

5.2.2 NEPA/Consultation Information Needs

BOEM needs data to better understand and disclose the potential for impacts to biological resources from OCS-related activities. Three of the studies in **Table 5** provide the information for a better understanding of the effects of renewable energy activities on marine mammals and migratory birds. BOEM is prioritizing research in Cook Inlet to gain information on the distribution, population abundance, habitat use and movements, productivity, and health of marine mammals, migratory birds, fish, and invertebrates. Due to the traditional, cultural, and nutritional importance of fish, marine mammals, migratory birds, and other resources to Alaska Native peoples, BOEM must address the potential effects of OCS actions on subsistence activities and harvest patterns. The growing interest in renewable energy in Alaska requires more specific information on how wind and hydrokinetic energy development in the Alaska OCS could impact resources. Information provided by these studies would enable BOEM to conduct more comprehensive and informed environmental analyses, prepare NEPA documents, and coordinate environmental and Tribal consultations. In addition to supporting the preparation of NEPA documents, information on impacts to vulnerable marine species is required for compliance with other environmental statues, regulations, and EOs, including the MMPA, MSFCMA, MBTA, EFH, and EJ.

The effects of climate change, particularly increasing ocean temperatures and marine heat waves, likely will 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 and affect OCS infrastructure?
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 has identified information needs related to potential impacts from renewable energy activities. The information gathered would identify direct, indirect, and cumulative impacts, inform the analysis required for the preparation of NEPA documents, and focus environmental and Tribal consultations. Most of the studies in **Table 5** would inform both cumulative impacts and long-term monitoring efforts.

BOEM is gaining a better understanding of Arctic and subarctic offshore environments in Alaska. Most investigations collect baseline data on resources of the Lower Cook Inlet. BOEM also supports research on fates and effects of oil, ocean circulation models, sedimentation rates in unique habitats, and sea ice coverage in Lower Cook Inlet. 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 the list of studies proposed for FY 2025; no studies currently are proposed for FY 2026. The studies proposed for the Alaska Region represent diverse research needs and address SSQs. **Table 5** aligns studies and specific SSQs.

Although the currently proposed studies were developed in the context of BOEM’s renewable energy program in Lower Cook Inlet, the proposed studies will also address information needs associated with conventional energy development.

Table 5. Alignment of proposed FY 2025 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	Assessment and Minimization of Avian Collision and Displacement Risk Associated with Renewable Energy Infrastructure in the Cook Inlet Planning Area, Alaska	✓	✓	-	✓	-	-	✓	-	-	-	✓	✓	-	-	-
2	Occurrence, Seasonal Distribution, and Density of Mysticete Cetaceans in Lower Cook Inlet, Alaska	✓	✓	-	✓	-	-	✓	-	-	-	-	✓	-	-	✓
3	Distribution and Abundance of Threatened Steller's Eiders in the Cook Inlet Planning Area: Use of Photographic Monitoring and Satellite Telemetry	✓	✓	-	✓	-	-	✓	-	-	-	✓	✓	-	-	-
4	Geographic Coverage, Duration and Type of Sea Ice in Cook Inlet, Alaska: Informing Site Selection for Renewable and Conventional Energy	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	✓	✓	✓
5	University of 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, marine mineral exploration and leasing activities, and the developing carbon sequestration program. 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. 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 environmental 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 (e.g., autonomous and uncrewed monitoring technology, environmental DNA (eDNA), machine learning, and, per EO 14110, artificial intelligence) 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 sequestration, and EJ.

Appendix A includes the tables of proposed studies for FY 2025–2026. **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 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 (e.g., a study focusing on species found in multiple regions or issues that transcend a specific region or program); are demonstrative in nature (e.g., to determine whether new or improved technology may be acceptable for monitoring biological resources); or fulfill a national stakeholder outreach or education need.

6.2.1 Upcoming Decisions

- Programmatic and project-specific MMPA, ESA, NHPA, and similar consultations across BOEM programs for decisions related to permitting and mitigation measures
- Offshore wind energy leasing and development in the Atlantic, Pacific, and GOM Regions, as well as gauging interest in the U.S. Territories
- Developing the offshore geologic carbon sequestration program
- Enhancing outreach and engagement for Tribes and EJ communities

6.2.2 Current/Relevant Issues

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. For FY 2025, OEP is proposing two studies that will analyze potential impacts of sound generation and carbon dioxide leakage from carbon sequestration activities. Though these studies will not be completed in time to provide input into the new regulations, the information will be a useful starting point for future BOEM research into carbon sequestration.

Understanding the acoustic impacts of offshore development activities continues to be a priority for BOEM, and OEP is proposing for FY 2025 six other studies (in addition to the above-mentioned carbon sequestration study) related to sound in the marine environment. One study will look to address recent concerns raised by fishing communities regarding the potential impacts of substrate-borne vibration on benthic fishes and invertebrates, many of which are commercially important. Another study will look at potential acoustic impacts of vessels’ dynamic positioning systems. The remaining four studies focus on potential acoustic impacts to whales, seals, and sea turtles.

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 five ambitious strategic 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 in June 2020 to coordinate agency policy and actions needed to achieve the goals and it serves as the senior-level mechanism for Federal interagency and White House coordination. 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 co-chairs the IWG-OEC, and Bureau staff serve on the NOMEC Council and on each IWG. In coordination with the NOMEC Council and IWGs, the ESP is continuing to support NOMEC Strategy implementation by funding many different studies focused on BOEM-needed mapping, exploration, and characterization efforts, such as *Facilitating Interagency Partnerships in Support of the Presidential Memo on Ocean Mapping, Exploration, and Characterization* (NT-21-01). BOEM continues to collaborate regularly with multiple interagency partners and provide 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.

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 rebuilding the economy through support of small businesses and investment in jobs of the future. In BOEM's case, the plan enables growth of the blue economy and the sustainable development of ocean resources, resulting in economic expansion, 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 is proposing two studies related to EJ. One study will look to develop artificial intelligence capabilities for informing EJ community characterizations to supplement ongoing EJ efforts, and the second proposes a cross-regional comparison of subsistence activities.

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, marine mammals, and sea turtles). To improve our understanding of the impact of climate change on the OCS, as well as human activities on the OCS, OEP proposes a study to compile, synthesize, and evaluate existing information on climate change in OCS environments, particularly those impacts associated with sensitive species and habitats.

Air quality and GHG emissions remain an important area of study for the Bureau. To effectively manage emissions, BOEM needs to evaluate the accuracy of its Outer Continental Shelf Air Quality System (OCS AQS) activity-based inventory with measured data. One study proposed by OEP this year seeks to verify

BOEM's OCS AQS activity-based inventory, quantify the uncertainties, and develop a modern framework for monitoring and quantifying air emissions to incorporate atmospheric-based measurements.

As noted in **Section 1.4.5**, the Inflation Reduction Act amends OCSLA to expand the definition of the OCS to include the EEZs of the inhabited U.S. territories: Puerto Rico, Guam, American Samoa, U.S. Virgin Islands, and the Northern Mariana Islands. With this expanded jurisdiction, the Bureau needs to better understand the U.S. territorial marine and coastal environments, including environmental characterization, archaeological and cultural resources, and socioeconomic and sociocultural contexts. For FY 2025, OEP is proposing three studies that focus on increasing BOEM's knowledge of the U.S. territories. One study will look to develop an inventory of coastal and submerged archaeological and historical sites in the U.S. Caribbean, a second plans to investigate potential hydrodynamic and biogeochemistry impacts of offshore wind in Puerto Rico and the U.S. Virgin Island, and a third study will contribute to the buildout of an integrated marine-life-observing capability for U.S. Territorial waters.

Lastly, OEP is proposing four studies that seek to improve BOEM's monitoring capabilities. **Section 1.1.4** lists environmental monitoring as a priority for ESP this year, particularly if such monitoring activities can incorporate innovative technologies or techniques. Two proposed monitoring studies will look to incorporate such innovative technologies. One study will seek to use eDNA to develop a reliable biological monitoring system of important species that may be impacted by present and future offshore energy activities, and the other will look to harness the power of artificial intelligence and machine learning to improve aerial imagery monitoring. The other two monitoring studies will investigate the efficacy of fish aggregating devices for ecological monitoring of floating offshore wind and support the development of national infrastructure for large-scale monitoring of wildlife movements.

6.2.3 NEPA/Consultation Information Needs

OEP requires robust, up-to-date data to fully analyze and disclose the potential for impacts to humans and 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, renewable energy development, as well as carbon sequestration activities. BOEM needs data and information about resources in and around the U.S. territories to support potential OCS development. Often, ESP acquires data to support 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, BOEM needs information to examine the effectiveness of current and proposed mitigation and minimization measures that can lessen or eliminate impacts from offshore energy, carbon sequestration, or marine and critical mineral activities.

For this FY 2025–2026 SDP, OEP's NEPA and consultation needs focus on ecological concerns for marine mammals, sea turtles, and fishes; EJ; commercial fishing; carbon sequestration; climate change; and Tribal relations.

6.3 Alignment With SSQs

The suite of studies proposed by OEP primarily seek to answer SSQs related to the acute and chronic effects of sound from BOEM-regulated activities on marine species and their environment (SS2); how BOEM can better use existing or emerging technology to achieve more effective or efficient scientific results (SSQ 8); and what the best resources, measures, and systems are for long-term monitoring (SSQ 9).

Six proposed studies address concerns about sound in the marine environment. OEP is interested in learning more about the potential impact of sound generated by both renewable and conventional energy development and proposed studies focus on a range of subject species, including whales, seals, turtles, fish, and shellfish.

Unsurprisingly, there is a significant amount of overlap between the proposed OEP studies that look to utilize emerging or innovative technologies and those that relate to long-term monitoring efforts, with five studies addressing both these science questions. To be cost effective, many long-term monitoring programs will require the use of innovative technologies, which are often cheaper than traditional methods (e.g., using machine learning to analyze satellite images of birds rather than trained observers to conduct ariel transects). These five studies will utilize a variety of technologies such as eDNA, instrumented fish aggregating devices, and high-performance computing to monitor a range of species.

In addition to the above studies, OEP is also proposing two studies that will use social science to assess the impact of OCS activities on the human environment (SSQ 7). These studies will address a range of issues pertaining to coastal and submerged archaeological and historical sites in the Caribbean, as well as subsistence activities in Alaska, the GOM, and the Gulf of Maine. Two studies will look at possible habitat or landscape changes from BOEM-regulated activities (SSQ 4). One of these studies will investigate impacts on hydrodynamics and biogeochemistry from offshore wind development in Puerto Rico and the U.S. Virgin Islands, and the other will look at the potential impacts from carbon dioxide leakage from carbon sequestration projects.

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

Table 6. Alignment of proposed FY 2025 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	Vibroacoustic Sensitivity and Subacute Biological Effects of Economically Important Fishes and Shellfishes from Marine Renewable Energy Development	-	✓	-	-	✓	-	-	-	-	-	-	-
2	Marine Mammal Hearing Temporary Threshold Shift and Auditory Recovery from Complex Noise Exposure	✓	✓	-	-	✓	-	-	-	-	-	-	-
3	Behavioral and Physiological Responses of Sea Turtles to Sound	✓	✓	-	-	✓	-	-	-	-	-	-	-
4	High performance Computing and Technical Support for BOEM's Aerial Imagery Monitoring Surveys	-	✓	-	-	-	-	-	-	-	-	✓	✓
5	Developing a Reliable Biosurveillance Monitoring System for Offshore Energy Activities Using Environmental DNA (eDNA)	✓	✓	-	-	-	-	-	-	-	-	✓	✓
6	Sound Source Characterization of Dynamic Positioning Systems: Field Verification	-	✓	-	-	✓	-	-	-	-	-	-	-
7	Inventory and Assessment of Coastal and Submerged Archaeological and Historical Sites along the U.S. Caribbean Territories	-	✓	-	-	-	-	-	-	-	✓	-	-
8	Combining Machine Learning and Novel Tagging Techniques to Improve the Accuracy of Data Used to Model Leatherback Density, Distribution, and Reproductive Productivity	✓	✓	✓	-	-	-	-	-	-	-	✓	-
9	Building an Integrated, Sustained, Marine-life-observing Capability for U.S. Territorial Waters	✓	✓	-	-	-	-	-	-	-	-	✓	✓
10	Relationships with Land and Resources: A Cross Regional, Comparative Study of Subsistence Activities	✓	✓	-	-	-	-	-	-	-	✓	-	-

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	Modeling Carbon Dioxide Leakage and Potential Environmental Impacts from Carbon Sequestration Projects on the Outer Continental Shelf (OCS)	✓	-	-	-	-	-	✓	-	-	-	-	-
12	Offshore Wind Farm Impacts on the Hydrodynamics and Biogeochemistry in Puerto Rico and the U.S. Virginia Islands	-	✓	-	-	-	-	✓	-	-	-	-	-
13	Building National Infrastructure for the Monitoring of Wildlife Movements	✓	✓	✓	-	-	-	-	-	-	-	✓	✓
14	Development of an Instrumented Fish Aggregating Device (iFAD) for Ecological Monitoring of Floating Offshore Wind	-	✓	-	-	-	-	-	-	-	-	✓	✓
15	All Impacts Are Not Equal: Artificial Intelligence Approaches for Understanding Impacts of BOEM Permitted Activities on Sperm Whale Vocal Clans	-	✓	-	-	✓	-	-	-	-	-	✓	-
16	Very Low-frequency Hearing in Bearded Seals	✓	✓	-	-	✓	-	-	-	-	-	-	-
17	Verification of OCS AQS and Development of a Satellite-based Top-down Emissions Inversion System	✓	-	-	-	-	-	-	✓	-	-	-	-

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

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APPENDIX A: Tables of Proposed Studies for FY 2025–2026

Table A-1. Atlantic (OREP) studies proposed for FY 2025, alphabetized by title

Profile Page #	Discipline	Study Title
61	MM	Applying Distributed Acoustic Sensing Technology to Monitor Large Whales at Atlantic Offshore Wind Areas
65	MM	Baleen Whale Behavior and Biological Sampling During Construction of Offshore Wind Farms
69	MM	Behavioral Response Workshop for North Atlantic Right Whales
72	HE	Integrating High-quality Movement Data from Proxy Species into SCRAM
75	IM	Maintenance of the Northwest Atlantic Seabird Catalog
77	MM	Seasonal Residency and Movement of Highly Migratory Sea Turtle and Fish Species in Mid-Atlantic Wind Energy Areas Before and After Offshore Wind Construction
80	SE	The Effects of Offshore Wind Farms on Property Values in the United States

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 2025, alphabetized by title

Profile Page #	Discipline	Study Title
84	MM	Baseline Characterization of Communities on Sand Shoals and Nearby Habitats in the Central Gulf of Mexico
88	IM	Coastal Marine and Ecological Classification Standard Application: Offshore Energy and Minerals Development
92	MM	Environmental Evaluation of the Critical and Hard Offshore Mineral Programmatic Reference (EE-CHOMPR)
95	HE	Modeling Food Web Effects from Dredging
99	HE	Regional Interconnectivity of Mobile Marine Organisms among Gulf of Mexico Sand Shoals
103	HE	Protected Smalltooth Sawfish Occurrence in BOEM OCS Sand Resource Areas
106	MM	The Good, the Bad, the Ugly: A Facilitated Discussion with Dredging Industry to Solicit Recommendations for Low-cost Operational Improvements to Reduce Risk to Protected Species
109	AQ	Updating the Dredging Project Emissions Calculator (DPEC) 2024

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 2025, alphabetized by title

Profile Page #	Discipline	Study Title
112	HE	Comprehensive Vulnerability of Marine Birds to Inform Offshore Wind Energy Development Throughout Waters Surrounding Pacific Offshore Continental Shelf of Hawaiʻi
116	FE	Guidance on Compensatory Mitigation to Achieve Net Positive Impacts of Offshore Wind Energy to Seabirds
120	HE	Ichthyoplankton Entrainment Assessment for HVDC Cooling Systems
123	PO	Impacts of Floating Offshore Wind Subsurface Infrastructure to Hydrodynamics, Biogeochemistry, and Primary Productivity in the Pacific OCS
127	FE	Potential Environmental Effects from Impressed Current Cathodic Protection Systems
130	FE	Probability Analysis of Derelict Fishing Gear Interactions with Floating Offshore Wind Mooring Systems Offshore California
133	HE	Testing a Next Generation Tagging Technology for Sea Otters (Enhydra lutris)
136	IM	Updating Climate Science Integration into BOEM Pacific Decision-making

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 2025, alphabetized by title

Profile Page #	Discipline	Study Title
140	SE	A Data Inventory and Assessment of Submerged Aircraft Loss Records on the Gulf of Mexico Outer Continental Shelf
143	AQ	Air Quality Modeling in the Gulf of Mexico Region - 2025 Update
147	AQ	Airborne Air Emission Surveys of Oil and Gas Activities in the Gulf of Mexico Region
150	IM	Green Hydrogen (GH2) Production from Offshore Wind Energy: Informing Management Needs Through a Focused Literature Review, Information Synthesis, and Gap Analysis
154	SE	Gulf of Mexico Environmental Justice Fact Book: Coastal Communities Affected by Activities on the Outer Continental Shelf
158	PO	Offshore Wind Energy Facilities Impact on Hydrodynamics and Primary Production in the Gulf of Mexico
163	MM	Oil and Gas Vessel Strike Risk Analysis: Cetaceans in the Northern Gulf of Mexico with a Focus on the Endangered Rice's and Sperm Whale
167	SE	The Value of View: Visual Impact Analysis from Green Energy Development on Cultural Resources Along the Gulf of Mexico

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 2025, alphabetized by title

Profile Page #	Discipline	Study Title
170	HE	Assessment and Minimization of Avian Collision and Displacement Risk Associated with Renewable Energy Infrastructure in the Cook Inlet Planning Area, Alaska
174	HE	Distribution and Abundance of Threatened Steller's Eiders in the Cook Inlet Planning Area: Use of Photographic Monitoring and Satellite Telemetry
178	PO	Geographic Coverage, Duration, and Type of Sea Ice in Cook Inlet, Alaska: Informing Site Selection for Renewable Wave and Tidal Energy
181	MM	Occurrence, Seasonal Distribution, and Density of Mysticete Cetaceans in Lower Cook Inlet, Alaska
185	PO	University of Alaska Coastal Marine Institute

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 2025, alphabetized by title

Profile Page #	Discipline	Study Title
188	MM	All Impacts Are Not Equal: Artificial Intelligence Approaches for Understanding Impacts of BOEM Permitted Activities on Sperm Whale Vocal Clans
192	MM	Behavioral and Physiological Responses of Sea Turtles to Sound
196	HE	Building an Integrated, Sustained, Marine-life-observing Capability for U. S. Territorial Waters
199	HE	Building National Infrastructure for the Monitoring of Wildlife Movements
203	MM	Combining Machine Learning and Novel Tagging Techniques to Improve the Accuracy of Data Used to Model Leatherback Density, Distribution, and Reproductive Productivity
207	HE	Developing a Reliable Bio surveillance Monitoring System for Offshore Energy Activities Using Environmental DNA (eDNA)
211	HE	Development of an Instrumented Fish Aggregating Device (iFAD) for Ecological Monitoring of Floating Offshore Wind
215	HE	High-performance Computing and Technical Support for BOEM's Aerial Imagery Monitoring Surveys
218	SE	Inventory and Assessment of Coastal and Submerged Archaeological and Historical Sites along the U.S. Caribbean Territories
222	MM	Marine Mammal Hearing Temporary Threshold Shift and Auditory Recovery from Complex Noise Exposure
226	FE	Modeling Carbon Dioxide Leakage and Potential Environmental Impacts from Carbon Sequestration Projects on the Outer Continental Shelf (OCS)
230	PO	Offshore Wind Farm Impacts on the Hydrodynamics and Biogeochemistry in Puerto Rico and the U.S. Virginia Islands
234	SE	Relationships with Land and Resources: A Cross Regional, Comparative Study of Subsistence Activities
239	FE	Sound Source Characterization of Dynamic Positioning Systems: Field Verification
243	AQ	Verification of OCS AQS and Development of a Satellite-based Top-down Emissions Inversion System
247	MM	Very Low-frequency Hearing in Bearded Seals
250	HE	Vibroacoustic Sensitivity and Subacute Biological Effects of Economically Important Fishes and Shellfishes from Marine Renewable Energy Development

Discipline Codes

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

Background: DAS is a relatively new sensing technology that can be used to monitor undersea vibroacoustic disturbances, either in the water column or within the seabed, over a large (~ 100 km) distance (Wilcock et al., 2023). The approach is to attach the shore terminal of the fiber-optical cable to an interrogator, which sends a series of short laser pulses through one of the spare fibers (a.k.a., dark fiber) to measure the phase shift from the backscattering of the pulse along the cable. The backscattering of the laser pulse, caused by the nanometer-scale deformation of the fiber, is used inversely to get information on the vibroacoustic waves, such as acoustic pressure and particle motion in the water column or substrate-borne vibration, in the marine environment (Hartog, 2017; Lindsey and Martin, 2021).

Based on experimental settings, such as the distance of phase shift being measured (called gauge length), the spacing segments of scattered pulse (called channel), DAS can be used to monitor undersea vibroacoustic waves from under 0.001 Hz to above 1 kHz with a spatial resolution of a few meters (Guo et al., 2023; Wilcock et al., 2023). Over the past several years, DAS has been successfully demonstrated to monitor a variety of ocean environments, ranging from seismic activities, ocean dynamics, shipping noises, and marine life (e.g., Lindsey et al., 2019; Sladen et al., 2019; Landrø et al., 2020; Williams et al., 2019; Rivet et al., 2021; Bouffaut et al., 2022; Douglass et al., 2023; Wilcock et al., 2023) and to conduct shallow water passive geotechnical imaging (Williams et al., 2021).

Using an existing fiber optical submarine telecommunication cable that was buried in soft sediments at 0–2 m below the seafloor from Longyearbyen to Ny-Ålesund in Svalbard, Norway, Landrø et al. (2020) were able to continuously collect DAS data over 44 days with a sampling rate at 645.16 Hz. Their study detected whale calls along the 120 km of the cable with a 3D position localization of vocalizing whales for density estimation (Bouffaut et al., 2022). In another study, Wilcocks et al. (2023) used the two submarine cables operated by the Ocean Observatories Initiative Regional Cable Array off Pacific City to detect and localize blue (*Balaenoptera musculus*) and fin whale (*B. physalus*) calls as well as vessel traffic over four days in November 2021. The ship track results from DAS showed close agreement with that from the ship's automatic information system.

Because large whale detection and localization can be achieved using existing fiber optical cables on and below the seafloor, DAS technology provides a great opportunity to monitor these animals' distribution, movement, and potential behavior at a lower cost than current PAM systems.

Objective(s): The objectives of this study are: (1) Validate DAS-based baleen whale acoustic detection with those using traditional PAM in the Atlantic offshore wind energy areas (WEAs); (2) Supplement the Atlantic Regional PAM Network with DAS technology to enhance baleen whale detection and localization in the offshore WEAs; and (3) Establish an operational protocol for long-term baleen whale monitoring using DAS technologies for environmental assessments of offshore wind development.

Methods: The proposed research will first conduct a feasibility study to identify the offshore wind developers that own fiber optical cables that can be used for DAS monitoring and investigate the logistics on accessing necessary hardware and sites for the study. Interrogator(s) will then be installed to the shore terminal of the dark fiber(s) to measure backscattering of laser pulses that are emitted into the cable. DAS data collected will then be analyzed to derive information on baleen whale (in particular, NARWs) distribution, movement, and possibly behavioral status.

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more years, from 2025–2026. Because a large number of bird-tagging projects are planned through industry-sponsored projects, this proposal focuses on continued funding of the baleen whale monitoring components of Project WOW including tagging, passive acoustic monitoring, co-variate data collection, and analysis.

The WOW team represents a multi-institution consortium that brings together internationally recognized principal investigators in the areas of statistical and ecological modeling (University of St. Andrews), geospatial data analysis and modeling (Duke University), marine megafauna research (Duke, Syracuse, TetraTech, Florida State, Wildlife Conservation Society [WCS], New England Aquarium), avian and bat ecology (Biodiversity Research Institute, TetraTech, SUNY Stonybrook), bioacoustics (Cornell University, Duke, Southall Environmental Associates, Syracuse University, Woods Hole Oceanographic Institution [WHOI], Pacific Northwest National Lab [PNNL]), behavioral ecology (Duke, SUNY, Syracuse, WCS), biological oceanography (Rutgers), and technology development (PNNL, WHOI, Scientific Innovations). The project team will also focus on a stakeholder engagement process organized with relevant regional entities such as the Northeast Regional Ocean Council (NROC), Mid-Atlantic Regional Council on the Ocean, Environmental-Technical Working Group, NYSERDA State of the Science Workgroups, and the Regional Wildlife Science Collaborative. Critically, the consortium has extensive experience in research, monitoring and risk assessment associated with offshore energy development, including deep relationships with wind energy developers and extensive experience collaborating with stakeholders, as well as State and Federal agencies.

Thus far, whales have been tagged during construction of the South Fork Wind and Vineyard Wind projects. Several new projects are also expected to start construction over the next couple years. This work will leverage the research and OREC completed under the existing interagency agreement and extend the tagging, passive acoustic monitoring, co-variate data collection, and analysis focused on increasing sample sizes to better understand baleen whale responses during OSW construction activities. These data will help to reduce uncertainty and will result in more robust data to inform environmental impact assessments in the region and, potentially, renewable energy development in U.S. waters more broadly.

Continued data collection would be aligned with current methods and the study area approved under the work plan approved by DOE and BOEM. Additional data would also meet the recommendations of the National Academies of Sciences, Engineering, and Medicine report (2023) on hydrodynamics and Nantucket Shoals to conduct research to better understand how North Atlantic right whales are using the habitat in this area.

Objective(s): Collect additional data to monitor baleen whale responses (behavior, movement, distribution, hormones) to OSW construction to supplement current datasets collected through Project WOW to inform impact assessments.

Methods: The proposed research will conduct continued baleen whale research during construction of offshore wind farms. Biological sampling from a research vessel outfitted with a suite of oceanographic sampling equipment, biopsy data collection, locating and tracking of whales. Biological sampling will be conducted to assess the physiology of baleen whales occurring around wind farms under construction. In particular, the effects of underwater human-generated noise have been shown to produce physiological responses in whales (i.e., elevations in stress hormones). Fecal samples will be collected opportunistically after defecation; blubber samples will be collected using remote biopsy darting; and blow samples will be collected non-invasively from targeted individual whales. Non-invasive drone

Field	Study Information
Title	Behavioral Response Workshop for North Atlantic Right Whales
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov), James Price (james.price@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	February 12, 2024
Problem	A sensitivity analysis on model parameters needs to be conducted on an existing bioenergetics model for North Atlantic right whales to better understand the critical model parameters driving population impacts. An expert elicitation needs to be conducted to improve behavioral response assumptions in the model that direct the energetic consequences of disturbance in the model.
Intervention	Convening a sensitivity analysis and behavioral response workshop for a recently developed predictive model for the bioenergetic consequences of behavioral disturbance, and identifying future research and monitoring needs will address improve the model.
Comparison	Compare the population model parameters to the most current information and expert elicitation on model parameters.
Outcome	A review of a recently developed predictive bioenergetic model will improve the model and provide a sensitivity analysis of the most important variables in the model.
Context	Atlantic

BOEM Information Need(s): BOEM needs to synthesize the state of the science for behavioral responses in rights whales and conduct an expert elicitation on some key model parameters as they relate to offshore wind. This will help BOEM make the requisite environmental impact assessments and mitigation recommendations and/or requirements as mandated by the National Environmental Policy Act and help BOEM meet its requirements under the Endangered Species Act and the Marine Mammal Protection Act as applied to critically endangered North Atlantic right whales *(Eubalaena glacialis)*.

Background: Disturbance to wildlife populations can have repercussions on individuals. These non-lethal disturbances could result in effects that potentially have population-level consequences on marine mammals (Booth et al. 2014; Farmer et al. 2018; King et al. 2015; Natural England 2017; Pirotta et al. 2015; Costa 2012; Noren et al. 2009; Pirotta et al. 2019; Van der Hoop et al. 2017; Villegas-Amtmann et al. 2015). In 2022, an online expert elicitation exercise was carried out under BOEM contract 140M0121C0008 to estimate a dose-response function for critically endangered North Atlantic right whales exposed to pile-driving noise during offshore wind farm construction. The behavioral response function quantifies the probability that an individual right whale will cease foraging for the duration of pile driving activities. This function was applied to a model built on the population consequences of multiple stressors (PCoMS) framework. These behavioral response assumptions drive the energetic consequence calculations of the model. However, the elicitation that resulted in the development of this function highlighted information gaps in our understanding of the behavioral responses of right whales to impulsive noise sources. Although much of this uncertainty is driven by a lack of empirical data, the elicited dose-response function may be improved through expert opinion on certain model parameters. While BOEM works on closing these information gaps, the model would benefit from the following additional work, including but not limited to:

- Response scenarios for foraging disturbance based on the project design envelope of likely constructions scenarios.
- The "average" response of an individual during different behavioral states during noise exposure regardless of where on the behavioral response curve exposure occurs.
- Differences in behavioral response between different age classes or health condition.
- Changes in behavioral response over time or number of exposures.
- Other factors identified in coordination with BOEM.

A follow-up elicitation should therefore be conducted to address limitations, and where solutions are identified, produce a revised dose-response function that better reflects the complexities of right whale behavior and the range of scientific opinions on their sensitivity to piling noise. A combination of virtual and in-person elicitations should be conducted over multiple sessions to provide experts ample time for deliberation and function development. The revised dose-response function could readily be integrated into the existing predictive bioenergetic model to expand on previous BOEM funding investment.

Objective(s): The objective of this study is to conduct a sensitivity analysis of the existing predictive bioenergetic model and conduct an expert elicitation workshop on behavioral responses in North Atlantic right whales.

Methods: The analysis and elicitation workshop should be developed through the best available information from peer reviewed literature, gray literature, and expert elicitation. This model must be peer-reviewed and developed collaboratively with partners such as BOEM, NOAA, marine mammal physiologists, and population modelers.

Specific Research Question(s):

1. How much bioenergetic disturbance is required to result in an individual fitness-level impact during migration, feeding, displacement, or nursing of calves?
2. How can non-lethal impacts of disturbance be incorporated into existing population models to assess a population-level consequence?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: https://boem-wind.wp.st-andrews.ac.uk/

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Field	Study Information
Title	Integrating High-quality Movement Data from Proxy Species into SCRAM
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (david.bigger@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	United States Geological Survey
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	February 14, 2024
Problem	SCRAM (Stochastic Collision Risk Assessment for Movement) uses movement data from the Motus network as inputs to estimate number of ESA birds colliding with offshore wind turbines. The temporal data gap and the coarseness of the spatial data creates high uncertainty and obvious challenges in estimating the number turbine collisions.
Intervention	Use existing high-accuracy tracking data (e.g., GPS) from proxy species.
Comparison	Comparison of monthly offshore movements using Motus derived data and high-accuracy data from proxy species.
Outcome	A series of high-accuracy movement maps and data to be integrated into SCRAM
Context	Atlantic

BOEM Information Need(s): BOEM has a responsibility under the Endangered Species Act (ESA) to assess the risks of offshore wind energy development to listed species. The red knot, piping plover, and roseate tern are listed species that can migrate through areas developed for offshore wind. Information from this effort will be used to inform ESA consultations with the US. Fish & Wildlife Service and NEPA analyses on the risk of offshore wind development projects to the red knot, piping plover, and roseate tern.

Background: Collision Risk Models are frequently used to estimate bird fatalities from operating wind turbines. The Band Model (2012) is widely used in Europe for common species and was recently used in the US (e.g., Virginia Offshore Wind Technology Advancement Project BA and Vineyard Wind BA). However, the Band Model is deterministic and does not allow biological variability (e.g., number of birds, flight heights, etc.) to be incorporated into input parameters, thus creating uncertainty in the interpretation of the model outputs (e.g., estimated number of collisions). The recently developed Stochastic Collision Risk Assessment for Movement (SCRAM) addresses these short comings (Adams et al. 2022).

However, the usefulness of the SCRAM model is hobbled by the temporal gaps and spatial coarseness and low quality of the species movement data on the Outer Continental Shelf. The movement data is key input used to estimate the number of birds that could encounter offshore wind turbines and is currently derived from data collected by a handful of shore based Motus towers. There are several shortcomings with the current approach. The Motus dataset for the three species is relatively small, confined to a handful of studies. Most Motus datasets cover only the fall migration and consequently SCRAM can provide only collision estimate collisions for fall migration. Currently, the Motus data from a single tower is inherently coarse with a spatial resolution of 20km. The Motus tracking stations are shore based and are only capable of detecting birds some 20 km away–falling well short of most wind farms.

Although it would be ideal to tag listed species, there are constraints (permits, proof that it can be done without harm, limits on number of animals to tag etc.). That said, a few offshore wind developers have taken the initiative to put GPS tags on red knots with some success and there is a recent graduate study in Oregon that put GPS tags on a few roseate terns last year in Maine, but no such efforts with piping plovers. Though these efforts are underway, there is a need to look at existing data to fill these gaps.

An alternative approach is to pool together high-quality movement data (e.g., GPS) from proxy species that are taxonomically and ecologically similar to the three ESA species. Most examples in the literature use substitute species as proxies for others to predict habitat usage (Loman et al 2021) or for predicted population responses to stressors. However, demographic data from proxy species are commonly used as inputs for population viability analyses when there are no data from the target species. This study would be similar filling in a gap in input data for a population viability analysis.

Objective(s): The objectives are: 1) use high-quality tracking data to describe movements of proxy species for roseate tern, piping plover, and red knot, spanning land and ocean in a way that can be integrated into the SCRAM model; 2) provide relevant biological data from non-listed species to expand the utility of SCRAM for other migrating species; and 3) develop approaches to validate SCRAM model predictions at land-based turbines.

Methods: Identify list of proxy species and relevant high quality data sets. Potential species (but not limited to) include American golden-plover *Pluvialis dominica*, black-bellied plover *P. squatarola*, Hudsonian godwit *Limosa haemastica*, common tern *Sterna hirundo*, least tern *Sternula antillarum*, American oystercatchers *Haematopus palliatus*. Acquire access to data sets by reaching out to The Shorebird Science and Conservation Collective (Shorebird Science and Conservation Collective | Smithsonian's National Zoo and Conservation Biology Institute (si.edu)) and others. Model overland and ocean movements. Prepare movement modeling results in a format to be integrated into SCRAM.

Specific Research Question(s): This study will test the efficacy of using data from proxy species over data specific to federally listed species.

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Adams EM, Gilbert A, Loring P, Williams, KA. 2022. Transparent modeling of collision risk for three federally listed bird species in relation to offshore wind energy development: Final Report. U.S. Department of the Interior, Bureau of Ocean Energy Management. 9 p. Report No.: OCS Study BOEM 2022-071. https://espis.boem.gov/Final%20Reports/BOEM_2022-071.pdf

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Loman ZG, Deluca WV, Harrison DJ, Loftin CS, Schwenk WS, Wood PB. 2021. How well do proxy species models inform conservation of surrogate species? Landscape Ecol. 36:2863–2877. https://doi.org/10.1007/s10980-021-01294-8.

Field	Study Information
Title	Maintenance of the Northwest Atlantic Seabird Catalog
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger (David.bigger@boem.gov), Timothy White (timothy.white@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	National Oceanic and Atmospheric Administration (NOAA), National Centers for Coastal Ocean Science
Total BOEM Cost	TBD
Performance Period	FY 2025–2030
Final Report Due	NA
Date Revised	January 26, 2024
Problem	Continued support for developing and maintaining the integrity of databases housing marine bird data is needed to support the review energy development projects.
Intervention	Acquire and integrate new avian datasets into database.
Comparison	N/A
Outcome	Database that is accessible to the public.
Context	Atlantic OCS

BOEM Information Need(s): The development of offshore renewable energy facilities has the potential to impact bird species. Compiling data collected by marine bird surveys is key for making the decisions related to offshore energy proposal reviews. Continued support for developing and maintaining the integrity of databases housing marine bird data, in addition to conducting the analyses and syntheses necessary to support the review of offshore energy proposals, will allow BOEM to use the most recent and best available information for decision-making.

Background: With the passage of the Energy Policy Act of 2005, BOEM was delegated responsibilities for alternative energy activities on the Outer Continental Shelf (OCS). This responsibility includes offshore wind energy projects. Experience from onshore wind development suggests that the careful siting of facilities is critical to minimizing impacts to bird species. Over the past 15 years, BOEM, the U.S. Geological Survey, NOAA, and other organizations, have generated a vast array of marine bird biological data.

Resource stewardship and public accountability obliges the BOEM to reap the full benefits of these investments, for use both internally and by our conservation partners. However, the full benefit can only be achieved with effective and efficient long-term data management, including data sharing, as well as the capacity to conduct data analyses. Furthermore, there is demand for access to this data, both within BOEM and by our agencies' partners, all of whom are having to make decisions about offshore energy projects and fulfill their responsibilities under the National Environmental Policy Act, the Endangered Species Act, the Migratory Bird Conservation Act and other legal requirements. Meeting these needs will require sustained institutional support of data management and data syntheses and organizational commitments to developing a culture that fully embraces knowledge management, data sharing, and collaboration with partners.

Since 2007, BOEM funded a series of studies to compile existing observational datasets of seabirds and shorebirds. These efforts provided the foundation to develop predictive models that describe past and future the distribution and abundance of almost 50 species on the Atlantic. The current geospatial database represents the most comprehensive accumulation of observations available along the Atlantic coast and is invaluable as a foundation for future field efforts. However, the database is most valuable if it is readily accessible to the public, maintained, and annually updated. BOEM is already incorporating the requirement that investigators submit their data to the catalog as a repository for sharing and compiling observations. The long-term maintenance requires dedicated funding to ensure that it is maintained. This study will establish an agreement with the National Center for Coastal Ocean Science (NCCOS) to maintain the database for the next five years.

Objective(s): Provide access to and updating of the Northwest Atlantic Seabird Catalog to support energy siting decisions and other seabird research activities along the Atlantic coast and OCS, as well as expansion into other regions.

Methods: NCCOS will be the primary source for the database and responsible for maintaining and updating the database and ensuring the valuable datasets are available to the public for the next five years. Tasks associated with this responsibility include:

- Acquiring and integrating new avian tabular datasets with surveys of the OCS into the database. This includes the expansion of the geographic scope to include the Caribbean and other U.S. regions (e.g., Gulf of Mexico).
- Conducting QA/QC and standardization of legacy datasets, especially auxiliary information like flight height, etc.
- Providing public access to the data, including documentation.
- Standardizing legacy datasets as needed.
- Maintaining and updating or create a new segmentation algorithm.

Specific Research Question(s): N/A

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: [Offshore Wind Archives - NCCOS Coastal Science Website (noaa.gov)]

References: None

Field	Study Information
Title	Seasonal Residency and Movement of Highly Migratory Sea Turtle and Fish Species in Mid-Atlantic Wind Energy Areas Before and After Offshore Wind Construction
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker (kyle.baker@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement, Purchase
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	May 10, 2024
Problem	Numerous acoustic tagging studies of highly migratory sea turtles and fish species have occurred or are occurring in the Mid-Atlantic. However, coordinated tag and receiver deployment and data management and analysis of baseline and post-construction data are needed to understand seasonal movement and residency patterns of individuals in Mid-Atlantic Wind Energy Areas.
Intervention	Implement a rigorous tagging program of sea turtle species and coordinate expanded deployment of sonic receivers to detect tagged species.
Comparison	Assess movement and residency patterns for multiple species in different geographic areas of wind development and compare data before and after offshore wind farm construction.
Outcome	Improved understanding of sea turtle and fish habitat use in and around the Mid-Atlantic Wind Energy Areas that will help determine the magnitude and extent of beneficial or adverse impacts wind farm construction (e.g., noise)) may have on these migratory species. Improved density surface models for sea turtles in the Mid-Atlantic.
Context	Mid-Atlantic Wind Energy Areas

BOEM Information Need(s): Offshore wind is quickly developing in the Atlantic and construction and operation levels will quickly ramp up. BOEM needs information on sea turtle and fish species distribution not only to understand the pre-construction baseline conditions, but also to monitor any resulting ecosystem changes that construction and operation of offshore wind farms may have on the marine environment. There is a need to better understand sea turtle movement, habitat use, and seasonal residency in offshore wind energy areas. Highly migratory sea turtle and fish species presence, movement, and habitat use changes with season and water temperature, yet sea turtle use in many offshore wind energy areas is not well understood. For example, it is believed Kemp's ridley use many offshore wind areas, but the species is often not detected during surveys due to their small size. The low availability of all sea turtle species to be sighted provides an incomplete ecological story of sea turtle movement and seasonal residency in wind energy areas that tagging efforts would inform. Numerous acoustic tagging studies of highly migratory fish species have or are occurring in the Mid-Atlantic, and by coordinating efforts and adding receivers through this study, we can expand these data collection efforts in Mid-Atlantic wind energy areas of interest to BOEM. Consistent and long-term collection of rigorous tagging data would provide vital information to help determine the magnitude and extent of beneficial or adverse impacts from offshore wind development from Area ID through construction and operations, and eventually decommissioning, as well as improve data availability to inform current sea turtle density models (https://seamap.env.duke.edu/models/NUWC/EC/). These data would be important to developers and other stakeholders concerned with development on the Outer Continental Shelf, and assist BOEM's National Environmental Policy Act analyses, and consultations under the Magnuson Stevens Act and the Endangered Species Act.

Background: The use of sonic tags has been very successful in tracking the movement of large marine vertebrates (Baker et al. 2014; Barco and Lockhart 2017). Numerous acoustic tagging studies of highly migratory fish species have or are occurring in the Mid-Atlantic (https://matos.asascience.com/project). Sonic tags transmit a specific coded signal that is used to identify individuals as they move within the range of the receivers. Sonic tags can also emit a signal that indicates the approximate depth of the turtle. A sonic tagging program will provide crucial data on fish and sea turtle migratory movements, habitat use, residency patterns, and changes over time in wind energy areas. A goal is to establish a larger “sonic net” to capture a wider range of movement of individuals. A secondary goal of the study would be to increase the longevity of tag attachment. A study has shown that the duration of tag attachment varies greatly by species (Smith et al. 2019), but in many cases the tag life is much longer than the attachment life resulting in a shorter data series for the individuals. The improvement of the longevity of tag attachment will provide better and more cost-efficient data collection under the tagging program.

Objective(s): The overall objective of the project is to increase the understanding of highly migratory fish and sea turtle species in offshore wind energy areas in the Mid-Atlantic by strategically deploying moored sonic receivers throughout wind energy areas and tagging large numbers of sea turtles that move throughout the Atlantic at different times of year. A secondary objective would be to improve existing tagging methods to increase the longevity of tag attachment on animals for overall improvement of data, efficiency, and cost savings.

Methods: Conduct tagging trips to tag turtles and/or coordinate with existing studies to attach sonic tags on sea turtles, and tag turtles released from stranding networks. Strategically deploy moored sonic receivers and/or attach receivers to existing moorings in wind energy areas. Data would be integrated into existing databases. Current tag attachments for sea turtles will be evaluated and improved upon to increase their longevity.

Specific Research Question(s):

1. What are highly migratory sea turtle and fish species residency and movement patterns in wind energy areas before and after construction begins?
2. What months and/or seasons do highly migratory sea turtle and fish species appear in different wind energy areas?
3. How long do highly migratory sea turtle and fish species remain in wind energy areas?
4. How can the longevity of sea turtle tag attachments be improved?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Baker LL, Jonsen ID, Mills Flemming JE, Lidgard DC, Bowen WD, Iverson SJ, Webber DM. 2014. Probability of detecting marine predator-prey and species interactions using novel hybrid acoustic transmitter-receiver tags. PLoS One. 9(6):e98117.

Barco S, Lockhart G. 2017. Turtle tagging and tracking in Chesapeake Bay and coastal waters of Virginia: final contract report. Prepared for US Fleet Forces Command. Norfolk (VA): Naval Facilities Engineering Command Atlantic, Norfolk. Obligation No.: N62470-10-3011, Task Order 50.

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Field	Study Information
Title	The Effects of Offshore Wind Farms on Property Values in the United States
Administered by	Office of Renewable Energy Programs and Office of Strategic Resources
BOEM Contact(s)	Mark Jensen (mark.jensen@boem.gov), Sindey Chaky (sindey.chaky@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	April 3, 2024
Problem	BOEM needs information about the effects of offshore wind farms on property values. This issue is of interest to coastal property owners and to local governments that depend on property tax revenue. This study may also provide information regarding the distributional impacts of offshore wind farms, such as potential impacts on environmental justice communities.
Intervention	The study will use hedonic regression analysis.
Comparison	The analysis will compare changes in property values among properties that are at varying distances from offshore wind farms. It will also assess how these changes relate to the life-cycle stage of a wind farm.
Outcome	This study will provide information about whether there are any notable effects of offshore wind farms on property values and, if there are, what the locational and time dimensions of these effects are.
Context	The analysis will be performed on up to five property markets along the Atlantic Coast that are, or will be, near offshore wind farms.

BOEM Information Need(s): BOEM needs information about the empirical effects of offshore wind farms on residential property values. This information will be used in both project-specific and programmatic environmental impact statements and will be responsive to a question that is often raised by the public in various forums.

Background: The value of a residential property is determined by a complex set of factors related to the property's amenities and its location. Property owners often raise concerns about the effects of offshore wind projects on the value of their property due to potential effects on the visual landscape and other issues. Hedonic regression is a revealed-preference statistical methodology that attempts to identify the effects of a treatment variable (e.g., installation of a nearby wind farm) by obtaining data on, and controlling for, factors other than wind farms that affect property values. A substantial amount of prior research using hedonic regression has been conducted on the effects of onshore wind turbines on property values (Parsons and Heintzelman 2022). These studies typically find either no statistically significant effects from wind turbines or that the effects are limited to a particular distance away from the turbines (Parsons and Heintzelman 2022). Brunner et al. (2024) is a recent, large-scale study of the effects of onshore wind farms on property values in the U.S. This study found that the negative effects on property values primarily occur within one mile of the installed turbines and that property values gradually recover in the years following construction.

There have been two studies of the effects of offshore wind farms on property values. Jensen et al. (2018) analyzed the effects of two wind farms offshore of Denmark, while Dong and Lang (2022) analyzed the effects of the Block Island wind farm on property values on both Block Island and the Rhode Island mainland. Both of these studies found that property values were not significantly impacted by the wind farms. However, further research is needed to assess whether this finding holds in the contexts associated with the development of wind farms along the U.S. Atlantic seaboard because they will be taller (and thus more visible), will have more turbines, may have different locational features (e.g., being near beaches), and face different local opinions regarding offshore wind.

Objective(s): To assess whether offshore wind farms, particularly the viewsheds of offshore wind farms, notably affect property values. If so, this study will also assess what determines the magnitude of the effects and how these effects evolve over time.

Methods: The study will use a hedonic regression framework to assess the effects of offshore wind farms on residential property values. The offshore wind farms and the most relevant nearby property markets that could be assessed are:

- Vineyard Wind 1 - Martha’s Vineyard and Nantucket Island in Massachusetts
    - Note that some additional projects (e.g., Sunrise Wind, Beacon Wind, SouthCoast Wind, New England Wind) may be built in the general vicinity of Vineyard Wind 1 in the next few years, although these projects are at similar or further distances from shore.
- Revolution Wind and South Fork Wind (adjacent projects) - Nearby coastal areas in Massachusetts and Rhode Island
- Empire Wind 1 and 2 - Nearby coastal areas in New York and northern New Jersey
- Atlantic Shores North and South - Coastal New Jersey
- Maryland Offshore Wind (MarWin and Momentum Wind) - Nearby coastal areas in Maryland and Delaware

The Coastal Virginia Offshore Wind project is estimated to be only faintly visible on the clearest of days and thus is not expected to be included in this study. The hedonic regression framework will take relevant elements from Brunner et al. (2024), Dong and Lang (2022), and Jensen et al. (2018). The contractor will develop a measure of turbine visibility and will collect various data on properties’ amenities and location in order to isolate the effects of turbine visibility. The contractor will explore whether distributional or environmental justice questions can also be answered. The analysis will be conducted for the aggregate property market surrounding each offshore wind farm. If the methods used are comparable, the analysis will also be performed on the entire dataset (i.e., for all studied wind farms). The analysis will likely be published in one final BOEM study report. However, depending on how the timing of offshore wind projects and the study evolve, BOEM may choose to pursue a two-phase study design (corresponding to the early projects and later projects). Some key issues that will be resolved as this study advances are discussed below.

- **Project timing**. The Vineyard Wind 1 and South Fork projects will be operational in 2024 and Revolution Wind will likely be operational in 2025. There is more uncertainty regarding the timing of the Empire Wind 1, Atlantic Shores South, and Maryland Offshore Wind projects; it appears they will be operational in the 2026-2027 timeframe. The Empire Wind 2 and Atlantic Shores North projects will likely be built even later. The exact approach to dealing with the timing of available projects will be resolved as the timing of the study itself becomes clearer. At a minimum, the study will analyze the effects of the Vineyard Wind 1 and Revolution Wind/South Fork projects. Note that one can analyze the effects of offshore wind farms on property markets before a project is operational because offshore wind farm plans are publicly announced well in advance and thus could affect property values in advance of construction. However, one would prefer some post-construction data if possible because certain information about the windfarms (and their visibility) may not be widely known before construction.
- **Measuring Viewshed Impacts**. The study will need to define a measure of viewshed impacts. Jensen et al. (2018) and Dong and Lang (2022) defined yes/no measures of whether the turbines are visible from a particular location. If this approach is used, the measure would use available software and data to account for elevation and obstructions to visibility. Brunner et al. (2024) used distance bands from a wind farm (e.g., 0–1 miles, 1–2 miles, etc.) as their impact measure. One could also attempt to create a visual impact scale based on a set of factors along the lines developed by Sullivan et al. (2013).
- **Life-Cycle of Offshore Wind Farms**. Hedonic regressions create measures of the extent to which, including the timing of when, properties are impacted by wind farms. In most of the literature related to wind farms, the date of the completion of construction is the date at which a property is defined to be affected by a wind farm. This was the approach taken by Jensen et al. (2018) and Dong and Lang (2022). However, offshore wind farms go through a multi-year process from obtaining a lease all the way through project construction. Since various information is made public throughout this process, it will be important to carefully consider how the timing of any impacts from offshore wind farms evolve. Brunner et al. (2024) used the project announcement date as the relevant date it its analysis. Brunner et al. (2024) also performed an "event study" analysis that explored the dynamics of property values on an annual basis relative to the project announcement date. This could be a relevant approach for analyzing the effects of offshore wind farms in the U.S. The contractor could also develop a non-year-based timing measure based on milestones (e.g., the Notice of Intent to prepare a project-specific EIS, the publication of a Draft EIS, BOEM's approval of the project, etc.).

Specific Research Question(s):

1. What factors affect the extent to which offshore wind farms affect property values?
2. Do the viewsheds of offshore wind farms in the United States affect nearby property values? If so, at what distance between a wind farm and coastal properties does this effect disappear?
3. What are the time dynamics of the impacts of offshore wind farms on property values?

Current Status: N/A

Publications Completed: N/A

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Field	Study Information
Title	Baseline Characterization of Communities on Sand Shoals and Nearby Habitats in the Northern 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 or Cooperative Agreement (CESU)
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	May 23, 2024
Problem	BOEM needs to better understand relationships of marine species using sand shoal, which are sources for dredging sediments used for coastal restoration projects.
Intervention	Characterize the communities, production, and abiotic factors present on sand shoal and nearby non-shoal areas by examining such metrics as species composition, abundance, richness, diversity, food web interactions, etc.
Comparison	Compare the ecological communities present on Sabine Bank and surrounding non-shoal areas (i.e., mud bottoms) to find the extent to which various species use shoals over non-shoal areas. Data from Ship Shoal reference sites could be compared to examine inter-shoal variability.
Outcome	Valuable baseline data on sand shoal ecosystems of the northern Gulf of Mexico (GOM), for informing management strategies designed to reduce the effects of dredging on marine resources, including protected species.
Context	Northern GOM predominantly, but this information could be used for future studies comparing shoal habitats across the GOM OCS and the East Coast for marine minerals and renewable energy activities.

BOEM Information Need(s): BOEM is responsible for overseeing non-energy mineral exploration, leasing, and production. Sand shoals are a primary area for dredging in order to restore areas along the GOM coast. 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 study will provide information to establish baseline use, support analysis of affected resources, monitoring, cumulative effects, and compliance for dredging in the OCS by understanding the roles sand shoals have in the ecosystem compared to surrounding non-shoal habitats. This study would characterize the communities present on sand shoal habitats on shoals and non-shoal habitats (i.e., mud bottoms). Due to a lack of baseline data in the Sabine Bank, the collected data would later inform the food web model analysis created in the proposed "Modeling food web effects from dredging" study. Comparison of the shoal habitat to the shoal habitat could assist in quantifying the effects of dredging on Ship Shoal in the

Ecological Study on Ship Shoal, LA (M19AC00015; Nelson et al., ongoing; Xue et al. ongoing). Essentially, if the community structure is similar from Ship Shoal and Sabine Bank, then the effects of dredging found at Ship Shoal would be better understood for Sabine Bank. The results would support the improved management of fish, benthos, and endangered species such as sea turtles. This data would support National Environmental Policy Act (NEPA) documents, Coastal Zone Management Act (CZMA) requirements for necessary data and information to conduct an adequate consistency review, and Endangered Species Act (Section 7) and Essential Fish Habitat consultations.

Background: 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. About 4M cubic yards of sediment is proposed to be dredged from Sabine Bank for Texas Point Refuge within the next year. This study would extend BOEM's knowledge beyond current ongoing studies that is 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 one to two, or more, years 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 proposed study would build upon this information, using data from the reference areas (non-dredged) from the ongoing study to compare with the proposed shoal sampling on Sabine Bank to understand inter-shoal variability. The dredging comparison from the ongoing study could then be used to understand the dredging effects on Sabine Bank. It is known that certain species are found on or around shoals, the relationship between species and their use of shoal vs. non-shoal habitat are not fully understood. For example, a species of particular interest is the blue crab, as 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 a contributing factor for a high degree of site fidelity of sea turtles on both Ship Shoal and Sabine Bank (Fujisaki 2020). However, predator-prey relationships between sea turtles and blue crabs have not been confirmed on sand shoals; this study would further investigate and characterize this potential relationship. This study would also allow data collection to support shoalMATE (Pickens and Taylor, 2020). ShoalMATE is a software developed to help evaluate project footprints for Essential Fish Habitat. BOEM needs to understand major predator-prey relationships on shoals and non-shoal habitat to determine if species are using the shoals or nearby non-shoals, for foraging, breeding, or as a travel corridor to another location such as artificial reefs and oil and gas infrastructure.

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 (Rutecki et al. 2014). 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. Studies suggest that the sand shoals provide habitat for many nekton and benthic species [Nelson et al. (ongoing); Xue et al. (ongoing); Pickens and Taylor (2020)]. The information gathered through this study will inform BOEM's decision making regarding the issuance of sediment leases and dredging mitigation measures. It will also provide additional information which could be useful for NEPA, ESA, and CZM purposes for not only marine minerals activities, but also oil and gas, offshore wind, and carbon capture and storage activities managed by BOEM.

Objectives:

1. Conduct an existing data review of common nekton and benthos diversity and abundance and predator-prey relationship data within the shoals of the Northern GOM.
2. Collect baseline nekton and benthos data on Sabine Bank to compare species diversity, abundance, and usage of shoal vs. non-shoal habitats.
3. Characterize the ecological communities on shoals using the newly collected data on Sabine Bank and that from the Ecological Recovery study (Nelson et al. ongoing) to understand inter-shoal variability.
4. Determine if there is any correlation of the diversity and abundance or predator-prey relationship by physical aspects, such as dissolved oxygen, water temperature, grain size, sedimentation, etc.
5. If additional funding is available following the collection of and analyses of data, a study could be proposed like the food web dynamics study among these abundant species along the Sabine Bank to determine the predatory-prey relationships between these two habitats.

Methods: A data review would be conducted that will provide BOEM with some background data and gap analysis for select shoals in the Northern GOM. Species abundance and predator-prey relationships for the more abundant taxa should be assessed for shoals and surrounding non-shoal habitat. The sampling design should allow for a strong statistical evaluation of shoal, and non-shoal habitats, with adequate replication for statistical analysis. Multiple shoal stations should be used on Sabine Bank and non-shoal habitats to see if there is any variation in abundance, biomass, diversity, and food web dynamics. This study would also use reference data (non-dredged) from the ongoing Ecological Recovery study on Ship Shoal to evaluate inter-shoal variability. The methods used would have to be similar enough in order to be compared with the Ecological Recovery study. The presence and abundance of species could be assessed with traditional methods such as trawls, longlines, crab traps, benthic cores, grab samples, etc. Cost effective techniques and new technology should be considered, such as isotopes, telemetry, high-resolution sonar, video, long-term continuous environmental instruments, and any others identified during study design. These new data could be compared to that from previous studies to determine any trends or comparisons between these two habitats. Comparison of the food web dynamics in these two habitat types would help BOEM establish a baseline understanding to inform analysis of dredging effects. It would also build on the work conducted by Pickens and Taylor (2020) for the creation of ShoalMATE. 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 (GOMMAP), U.S. Geological Survey (USGS), ShoalMATE, etc. Environmental parameters should be sampled and then taken into consideration when comparing communities at the shoal and non-shoal habitats.

Specific Research Question(s):

1. How does the abundance, biomass, diversity, and predator-prey relationship of common nekton and benthic species compare from shoal and non-shoal habitats?
2. What is the inter-shoal variability, between Ship Shoal and Sabine Bank, of the abundance, biomass, diversity, and predator-prey relationships of common nekton and benthic species?
3. Are there key shoal characteristics and environmental parameters that influence variations in species abundance and predatory-prey relationships between shoal and non-shoal habitats?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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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), Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	TBD
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	February 7, 2024
Problem	The Coastal and Marine Ecological Classification Standard (CMECS) provides a system for coastal and marine environment characterization, comprising 1) components to define the attributes of environmental units and 2) a framework for synthesizing this information. Codified workflows for applying CMECS to survey data that is tailored to BOEM requirements is needed to overcome complex inconsistencies in data interpretation when classifying seafloor and categorizing habitats for offshore wind and offshore dredging environmental consultations. In practice, developers and scientists largely use expert opinion, rather than a common standard, to interpret research and offer insight. If not provided consistently, data may not be universally understood to support BOEM pre-development baselines and post-development analysis. For example, CMECS uses “mud” as a sediment description which is not a term in geotechnical work.
Intervention	Develop specific protocols (guidance) and crosswalk classifications to help BOEM and its stakeholders to interpret and translate relevant energy and mineral site characterization survey data into the more widely known and defined CMECS units. Doing this will enable geophysical and/or geotechnical engineers standards to better reconcile often competing standards.
Comparison	N/A
Outcome	Guidance documents that support BOEM and its stakeholders in meeting the requirements of consultations with consistent and standardized characterization for our impact assessments. This aids decisions on future sites for wind and dredging events. These may include specific methods analysis, decision-based workflows, an image gallery with examples of CMECS classifications, crosswalk practitioners (e.g., engineers) and scientists' definitions, and training aids.
Context	Atlantic, Pacific, Gulf of Mexico, and Alaska Outer Continental Shelf

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 stakeholders 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 that 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. 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 information is needed to inform environmental consultations.

Objective(s):

- Develop documents that will assist BOEM in operationally applying mapping standards to classify and categorize habitats, to inform offshore wind and offshore dredging environmental consultations with consistent and standardized characterizations within the substrate and geoform components (water column and biotic components to be included in a follow-on phase). Create crosswalks and explanatory guides to help BOEM bridge the language and methods between planners, development, scientists, and engineers.
- Compile, adapt, and disseminate BOEM-attuned protocols, guidelines and standards to increase efficiencies and improve the status quo in survey mapping and characterization products.
- Embody FAIR Principles ("FAIR Principles" www.go-fair.org/fair-principles/) in the data deliverable review process and enable data serviceability further enabling data to be findable, accessible, interoperable and reusable in the long-term.

Methods:

- Coordinate and leverage with other non-BOEM CMECS venues and/or meetings to increase collaboration opportunities and minimize duplication.
- Convene and facilitate workshops 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 interpretation and mapping and 2) gather recommendations for the development and dissemination of protocols and guidance resources (e.g., endorsement of CMECS by NOMEC/IWG, etc.).

- Identify study areas that include offshore energy and mineral sites in the Outer Continental Shelf (Atlantic, Gulf of Mexico, Pacific, Alaska and /or U.S. Territories) as reference sites.
- Describe the geoform and substrate environment in a consistent and repeatable way with NOAA National Marine Fisheries consultations, developers, engineers, and the broader coastal communities to improve discussions and analysis of potential environmental risk discussed.
- Use the existing source data and derived data products for those sites.
- Use CMECS as the classification framework and review existing classification systems and guidelines not limited to the references 1 through 9 to supplement as needed.
- Identify variables to characterize wind energy and marine minerals sites. Establish a crosswalk of geoform and substrate classification scheme structure for offshore wind energy and marine mineral site planning and activities.
- Apply and test scheme within an energy and mineral site with engineers and scientists.
- 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) as a reference 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); 5) a hierarchical diagram of CMECS scheme for substrate and geoform components associated with offshore energy and mineral activities; 6) a data sharing protocol; and 7) training aids.
- Verify, validate, and document.

Specific Research Question(s):

1. What are the scientific and engineering setting and/or cross walk within the CMECS geoform and substrate component needed to ensure consistent information for consultation use and assessment?
2. At which scale (e.g., 1:24k, 1:100k, etc.) should features or bodies be mapped to sufficiently meet the needs of a consultation from developers (e.g., infrastructure, energy, critical minerals) and engineers (e.g., marine minerals lease and/or borrow area design)?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Environmental Evaluation of the Critical and Hard Offshore Mineral Programmatic Reference (EE-CHOMPR)
Administered by	Marine Minerals Program
BOEM Contact(s)	Shannon Cofield (shannon.cofield@boem.gov); Jennifer Le (Jennifer.le@boem.gov); Donna Schroeder (donna.schroeder@boem.gov) ; Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	Cooperative Agreement or Interagency Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	January 17, 2024
Problem	The U.S. lags behind other developed nations in domestic Critical Minerals (CM) planning and investments. A series of recent Executive Orders recognize this issue and direct Federal agencies to take actions to bolster development of domestic CM resources. BOEM has just recently received an unsolicited request for lease sale along with multiple inquiries about Bureau regulations governing CM leasing and the types of environmental information needed to support such decisions on the Outer Continental Shelf (OCS).
Intervention	Successful management of CM activities is reliant on comprehensive environmental information so that potential impacts may be understood, avoided, minimized, or offset. Potential impacts will vary according to the phase of the life cycle of a development project, which includes prospecting and exploration, site characterization, construction and operations, and post-operations and decommissioning.
Comparison	Most deep-sea environments where CM (i.e., nodules) are found remain relatively unknown, yet a sufficient understanding is legally necessary for National Environmental Policy Act (NEPA) and other statutory requirements. Without adequate baseline information, BOEM won't be able to conduct defensible analyses to inform pre-leasing decisions and apply appropriate post-leasing environmental mitigations and monitoring.
Outcome	Based on this study's findings, develop suggested environmental guidelines for exploration and development for critical minerals.
Context	Deep sea CM (primarily polymetallic nodules) in all U.S. Federal waters but with emphasis on Pacific Ocean locations where nodules are most abundant.

BOEM Information Need(s): Critical mineral (CM) resources under BOEM jurisdiction with the most prevalent industry interest lie in deep water (>500m water depth) on outer continental shelves. These remote resources have vastly different extraction requirements and procedures than traditional sand and gravel resources. Likewise, deep sea CM likely lie in unique environments, which remain relatively unstudied across large spatial regions. Therefore, deep sea critical mineral activities increase the probability of activity in frontier areas, specifically in Pacific islands and Atlantic locations.

This study was originally designed as Phase 2 of a recently completed MMD Critical Minerals Resource Evaluation (Phase 1) study. Phase 1 was a desktop study synthesizing current information for known offshore CM resources, with a primary focus on polymetallic nodules. Phase 1 also included CM economic information, and an industry overview for exploration, extraction, and refining. Phase 2 is designed to be a complementary desktop study that identifies known information of environments associated with the idented offshore CM resources in Phase 1. The two phases are not dependent on each other, but they are intended to complement each other.

This study aims to provide environmental guidelines within the scope of NEPA to assist BOEM's evaluation for future regulatory requests. In particular, in February 2024 BOEM received an unsolicited request for lease sale to harvest nodules off American Samoa; such guidelines will be crucial to assisting BOEM's future reviews and decision-making.

Background: The U.S. is lagging behind other developed nations in domestic CM planning and investments. A series of recent Executive Orders (EO 14017, EO 13953, and EO 13817) recognize this issue and direct Federal agencies to take actions to bolster development of domestic CM resources. BOEM has received inquiries about Bureau regulations governing CM leasing and the types of environmental information needed to support such decisions on the Outer Continental Shelf (OCS).

The International Seabed Authority (ISA) is the intergovernmental body that oversees mineral activities on the seafloor beyond national jurisdiction. It is charged with both development of seabed mineral resources and protection of the marine environment. The ISA is currently developing regulations, including those related to the environment, for the exploitation phase of seabed mining; those for the exploration phase already exist (i.e., ISA, 2020). This international "Mining Code" provides a starting point for this study to adapt relevant pieces to a domestic perspective, especially as the U.S. continually provides feedback on the developing regulations.

Successful management of CM activities is reliant on comprehensive environmental information so that potential impacts may be understood, avoided, minimized, or offset. Potential impacts will vary according to the phase of the life cycle of a development project, which includes prospecting and exploration, site characterization, construction and operations, and post-operations and decommissioning. Prospecting and exploration is the first stage to locate CM deposits and is usually performed over a wide area. Techniques include remote sensing technologies and spot sampling to search for, sample, study, and analyze CM deposits to investigate whether those minerals can be commercially exploited. Site characterization includes the description of any environmental component necessary to assess the site for development. Construction and operations includes all activities associated with the extraction and removal of CM deposits for commercial purposes including operations, mineral processing, and transportation to land. Post-operations and decommissioning include the final phase when CM extraction operations cease and includes removal of infrastructure, site clearance, and rehabilitation (where possible).

Objective(s):

- Compile, assess, and summarize best practices and standards for deep-sea environmental data and sample collection, analysis, and curation.

- Identify, compile, consolidate, and summarize existing governmental, industry, academic, and non-governmental data and information needed to assess and monitor impacts associated with each lifecycle phase of a CM project (prospecting; exploration and site characterization; construction and operations; decommissioning) and the associated habitats, ecological patterns, and environmental baselines against which impacts can be analyzed.
- Based on this study's findings, develop suggested environmental guidelines for analysis of exploration and development for critical and other hard minerals, with a focus on prospecting of polymetallic nodules.

Methods: Desktop study based on current literature, review of analogue industries, and international policies that may be adapted for NEPA-related assessments.

Specific Research Question(s):

1. What are best practices for deep-sea data collection, sampling, and sample preservation?
2. What information is already published on existing environmental conditions proximal to critical mineral resources within BOEM jurisdictions?
3. What are the Impact Producing Factors (IPFs) for each phase of a critical mineral project (1) prospecting and exploration; (2) site characterization; (3) construction and operations; and (4) post-operations and decommissioning)?
4. What modifications are necessary to adapt existing processes, whether external or internal, to environmental assessment?
5. What modifications are necessary to adapt existing processes for monitoring of the deepwater seabed and the overlying and proximally adjacent water column?

Current Status: N/A

Publications Completed: Phase 1 was completed December 2023, and the final report is currently under review for publication.

Affiliated WWW Sites: N/A

References: N/A

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)	Intraagency Agreement
Conducting Organization(s)	United States Geological Survey
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	February 8, 2024
Problem	Primary producers and primary consumers are a critical component in coastal and shelf food webs. The effects of dredge-related reduction or 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 OCS, <30-m depths

BOEM Information Need(s): Dredging assumes complete removal of primary producers and primary consumers within the relatively small dredge footprint (Michel et al. 2013). This depletion of the base of the food web is well documented, but the effects to higher trophic levels is harder to detect (e.g., Iafrate et al. 2022). In addition to existing field-based evidence, modeling the effect of the removal of a prey base on higher trophic levels would help elucidate whether the effect exists yet is difficult to measure, or whether the effect does not meaningfully transfer to higher trophic levels. This study would attempt to link the small-scale (space and time) perturbation with the potential for scalable ecosystem effects (e.g., Lewis et al. 2021). This information would be used by BOEM analysts in NEPA and EFH documents, and by resource management agencies (e.g., Fishery Management Councils), when considering how the removal of primary producers and primary consumers affects marine benthivores and piscivores.

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 such as fishes, crustaceans, and birds (Lewis et al. 2021). Benthic primary producers and primary consumers are typically found in MMP 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 and/or settled detritus could be lost by either removal by the dredge or relocated by mobilization into currents, potentially having a large effect on the food web. As primary consumers, like infauna and echinoderms, recolonize an area, if they lack a prey source, the habitat may be unsuitable. 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. Because these scenarios are difficult and expensive to measure in the field, a model based on existing data would allow BOEM to simulate different scenarios, timeframes, and seasons and then estimate the outcome (i.e., effects and resilience).

Objectives: Leverage existing datasets to quantify effects of removal of primary producers due to dredging, and how that affect primary consumers and higher trophic-level fishes in two environments. Test scenarios over different timeframes (days to months) and seasons when possible.

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 [NSL# MM-19-01] and Natural habitat associations and the effects of dredging on fish at the Canaveral Shoals, East-Central Florida). These recent and ongoing studies include field data on primary production, as well as primary consumers and higher trophic level fishes, in two different environments. 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., east-central Florida and Gulf of Mexico). Alternatively, if they are static, a new model or Ecological Network Analysis may re-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 scales, timeframes, and seasons, as the data allow. Spatial scales should seek to represent both the perturbation (i.e., dredge footprint) as well as different foraging ranges. This may include inshore coastal or estuarine areas. When the removal of benthos from a simulated perturbation is 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.

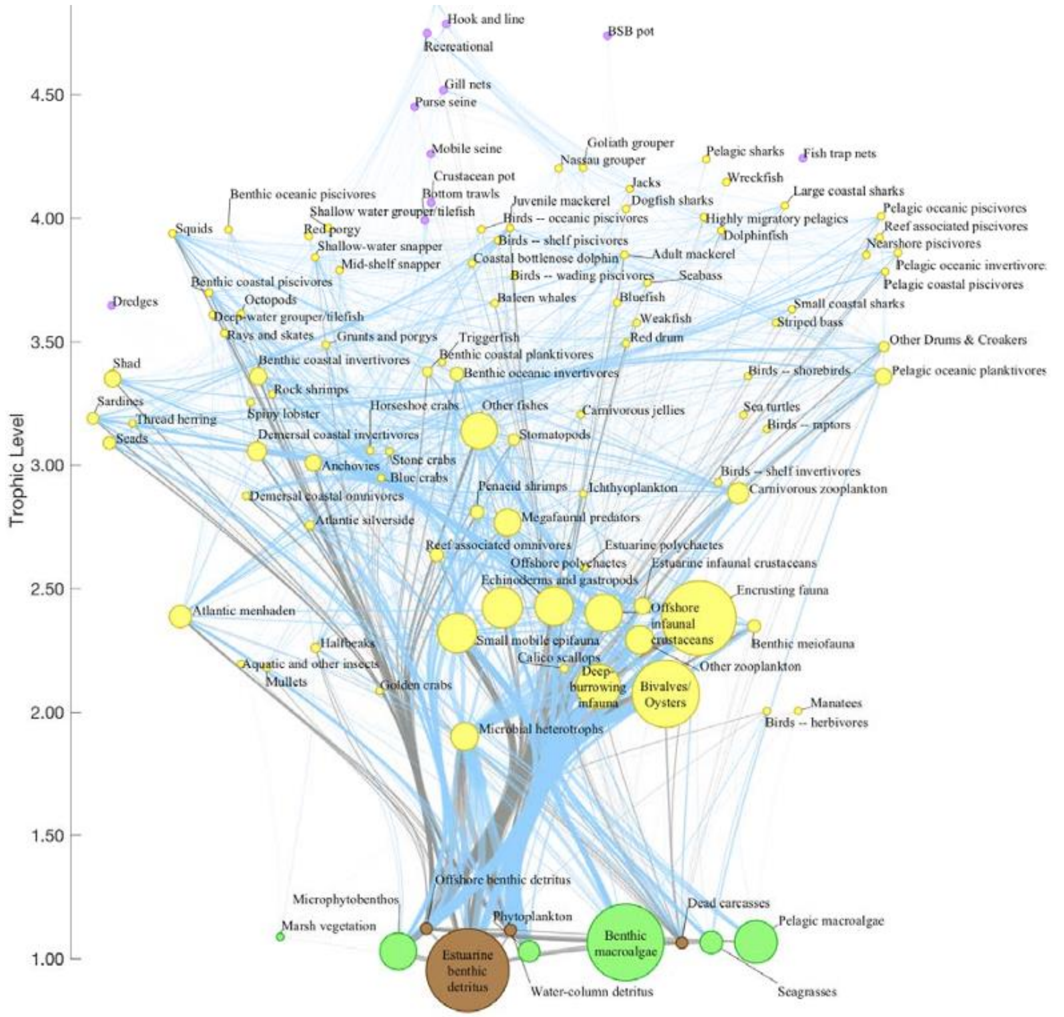

Figure 1. South Atlantic Bight Food web. Nodes are colored based on type (green = producer, brown = detritus, yellow = consumer, purple = fleet). Blue for all edges except flows to detritus, which are grey (SAFMC 2016).

Specific Research Question(s):

1. How does a decrease or removal of primary producers and/or primary consumers (e.g., from dredging) affect energy flow to other parts of a food web? What is the spatial scale, timeframe, and seasonality of this effect?
2. At what trophic level or guild is an effect to energy flow due to decreased or removal of primary producers and/or primary consumers no longer measurable?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Iafrate JD, Reyier EA, Ahr BJ, Watwood SL, Scheidt DM, Provancha JA, Holloway-Adkins KG, DiMatteo A, Greene J, Krumholz J, Carroll A. 2022. Behavior, seasonality, and habitat preferences of mobile fishes and sea turtles within a large sand shoal complex: habitat connectivity, ocean glider surveys, and passive acoustics. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. 160 p. Report No.: OCS Study BOEM 2022-018.

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

Field	Study Information
Title	Regional Interconnectivity of Mobile Marine Organisms among Gulf of Mexico Sand Shoals
Administered by	Marine Minerals Program
BOEM Contact(s)	Ana Rice (ana.rice@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement and/or Interagency Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	February 8, 2024
Problem	Data of habitat and shoal species (e.g., sea turtles, sharks) occurrence, distribution and movement on Sabine Bank, Texas and knowledge of shoal interconnectivity and/or differences in the northwestern Gulf of Mexico (GOM) region is necessary to establish an environmental baseline prior to dredging in near future anticipated coastal restoration projects within Louisiana and Texas, and to accurately assess future post dredging animal and shoal habitat impacts in the northwestern GOM.
Intervention	Establish and maintain an acoustic telemetry array in the northwestern GOM, particularly on Sabine Bank, Texas to acquire baseline shoal species occurrence and distribution. Monitor and maintain an active telemetry array on Ship Shoal, Louisiana. Compare and assess species interconnectivity between the two sites.
Comparison	Conduct movement and habitat occurrence analyses at Sabine Bank and Ship Shoal to gain understanding on shoal species occurrence, distribution and movement, and shoal species interconnectivity in the northwestern GOM.
Outcome	Regional understanding of interconnectivity and/or differences of shoal species occurrence and distribution in the northwestern GOM, including potential impacts to the shoal species from future development activity within the Lake Charles renewable energy lease area.
Context	GOM OCS.

BOEM Information Need(s): The Marine Minerals Program at BOEM needs to collect baseline data on Sabine Bank, Texas to help understand long term use of the shoal, particularly by sea turtles and sharks, in near-future anticipated coastal restoration projects within Louisiana and Texas that will use the shoal as a borrow area. Moreover, a regional understanding of shoal interconnectivity and/or differences in the northwestern GOM is essential for accurately assessing future post dredging animal and habitat impacts in the region. This study will inform broad spatial and temporal species occurrence, distribution and movement patterns on Sabine Bank, and through monitoring and maintenance of an established and active telemetry array on Ship Shoal, Louisiana (funded by BOEM as part of MM-19-01 and operated since 2021) BOEM will gain regional understanding of shoal species occurrence, distribution and movement, and shoal interconnectivity/differences in the northwestern GOM. Results from this study will help inform dredging windows as well as NEPA effects analysis, particularly related to fisheries species. This study will also benefit OREP because the Sabine Bank study region is near the site of the first wind energy lease in the GOM. Acquiring baseline data will be used to better understand potential impacts of future marine minerals dredging and renewable energy projects.

Background: Several of the largest shoals and shoal complexes in the northern GOM are located on the inner shelf of Louisiana and north Texas (i.e., Sabine Bank, Trinity Shoal, Ship Shoal) and are as a primary source of sand for coastal restoration projects. However, knowledge of how mobile marine organisms, such as sea turtles and sharks, occur and are distributed along these shoals is relatively limited. Sea turtles are protected species capable of basin wide migration and are particularly vulnerable during marine minerals activities, such as dredging, as they risk injury or mortality through dredge entrainment. Traditionally, information on the distribution of marine animals within shoal habitats has relied on trawl and/or longline samples, which are subject to gear selectivity and represent a snapshot in time, limiting the ability to evaluate seasonal, and interannual occurrence of mobile taxa. In contrast, acoustic telemetry represents a potentially powerful tool to continuously examine animal occurrence and movement patterns at higher resolution over extended temporal scales. Acoustic telemetry use has increased dramatically over the past two decades, due in part to cheaper costs relative to satellite telemetry, and recent technological advances that allow researchers to passively collect movement data across a variety of spatial (meters to 1,000s of km) and temporal scales (days to > 10 years). As a result of the relatively small size of acoustic transmitters, the technology can be used on a wide range of marine organisms (and life stages) from benthic invertebrates to highly mobile bony fishes, turtles, and even large sharks. Acoustic receivers (data logging hydrophones) can be deployed in various configurations to address questions of interest related to habitat occurrence, distribution, site fidelity, connectivity, and characterization of migratory patterns, while also recording environmental data such as water temperature and ambient noise. Animal detection data can then be combined with environmental/physical data to characterize species-habitat relationships and develop predictive models (and maps) of species occurrence.

The proliferation of passive acoustic arrays across the Atlantic and Gulf (e.g., the Atlantic Cooperative Telemetry network, Integrated Tracking of Aquatic Animals in the Gulf of Mexico) has also facilitated development of large-scale cooperative networks which link arrays maintained by different research groups and have greatly improved the utility of acoustic telemetry for migratory species. Long term funding of these cooperative networks is necessary to enable data sharing across research groups and allows for continued detection of tagged animals that move beyond the initial study area. In this vein, acoustic telemetry has recently been used to evaluate long term patterns of habitat occurrence and distribution of mobile marine fauna on sand shoals in both the U.S. Atlantic and GOM. A recent study on Canaveral Shoals (NT-14-x14) on the Atlantic Ocean (Reyier et al. 2023) investigated movement and use patterns of a variety of species to determine seasonal patterns of occupancy on the shoal and habitat associations for species over a multi-year period. In addition to the species tagged in the Reyier et al. 2023 study, the study documented the presence of animals tagged by other researchers in nearby array networks. In the future, these cooperative networks can be used to further leverage other research and agency partnerships (i.e., NOAA, U.S. Fish and Wildlife Service, and USGS). Similar efforts are now underway at the Ship Shoal array in the GOM, where tagging efforts have mostly focused on blacktip sharks due to their common occurrence in that shoal. Before the establishment of the telemetry array, BOEM funded study NT-16-07 tagged a number of sea turtles on Ship Shoal to understand their movement, distribution and habitat use on the shoal.

Goal/Objectives: The overall goal is to establish and maintain an acoustic telemetry array on Sabine Bank, Texas for three years and fund additional monitoring and maintenance for a duration of three years (no additional tagging) of a previously deployed array on Ship Shoal, Louisiana. Specific objectives include:

- Tag and characterize shoal habitat occurrence, distribution and movement patterns for sea turtles, and a coastal migratory species (e.g., blacktip shark). Combine acquired environmental data (e.g., water temperature, ambient noise) with animal detection data to characterize species-habitat relationships and movement for tagged species. Use all recorded species data (e.g., bull sharks, Atlantic tarpon, red drum) between Sabine Bank and Ship Shoal to understand potential interconnectivity and differences in species distribution between the shoals.

Methods:

1. Set up a skeleton telemetry array (i.e., 5–7 acoustic receivers) on fixed structures around Sabine Bank, with a subset of acoustic release receivers deployed on open bottom habitat of the shoal (3–5). Installing receivers on fixed energy infrastructure will allow evaluation of potential loss of equipment from trawling activities and keep a subset of receivers in reserve, as replacements for receivers that are lost. Installation of receivers in open bottom habitat within the shoal will allow to fill any noticeable gaps in the array. Service receivers 2–3 times per year.
2. Deploy a number of transmitters (about 50 total) at Sabine Bank on sea turtles and a model migratory species (e.g., blacktip shark) common to the region and known to utilize shoal habitats. Field deployments to tag species is recommended to occur 1–2 times per year over multiple years.
3. Provide maintenance funds to service receivers and data downloads 2–4 times per year for the pre-established telemetry array at Ship Shoal.
4. Conduct movement and habitat data analyses at Sabine Bank and Ship Shoal to evaluate seasonal use patterns and habitat associations of sea turtles and a model migratory species on the shoals, while also monitoring/documenting timing and occurrence of other tagged animals that use the features.

Specific Research Question(s):

1. What is the regional spatial/temporal occurrence, distribution and movement of sea turtles and a model migratory species (i.e., blacktip shark) on Sabine Bank?
2. What is the occurrence and variability of other tagged animals in the study area?
3. What is the interconnectivity and/or differences of species occurrence and distribution between Sabine Bank and Ship Shoal?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Reyier E, Ahr B, Lafrate J, Scheidt D, Lowers R, Watwood S, Back B. 2023. Sharks associated with a large sand shoal complex: community insights from longline and acoustic telemetry surveys. PLoS One. 18(6):e0286664. https://doi.org/10.1371/journal.pone.0286664.

Field	Study Information
Title	Protected Smalltooth Sawfish Occurrence in BOEM OCS Sand Resource Areas
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (deena.hansen@boem.gov); Doug Piatkowski (douglas.piatkowski@boem.gov); Victoria Brady (victoria.brady@boem.gov)
Procurement Type(s)	Interagency Agreement or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	April 8, 2024
Problem	Recent evidence indicates that the endangered smalltooth sawfish is present in BOEM OCS lease areas. However, BOEM lacks a full investigation of the extent of endangered smalltooth sawfish overlap with BOEM Marine Minerals activities, and potential impact to the species.
Intervention	Existing telemetry and tagging data will be analyzed for occurrence of smalltooth sawfish at different spatial and temporal scales near OCS sand resources (from proven to unverified). If the data analysis determines that certain OCS areas have sufficient presence of smalltooth sawfish, then a tagging effort may be pursued to identify site-specific habitat occurrence and movements.
Comparison	Smalltooth sawfish overlap with sand resources on the OCS may be compared to presence at other habitat types.
Outcome	Determine environmental correlates, including sand resource characteristics, that influence smalltooth sawfish distribution. Results will not only improve BOEM's leasing and mitigation recommendations, but they may inform resource managers' species conservation decisions.
Context	Florida's east coast, from coastal waters to 50-m depths.

BOEM Information Need(s): Little is known about smalltooth sawfish use of the Outer Continental Shelf (OCS), where marine minerals are managed by BOEM. Smalltooth sawfish, listed under the Endangered Species Act (ESA), have been detected by an acoustic array at Canaveral Shoals, an active dredge lease area. Not only do these detections of 21 individuals indicate a need for further site-specific analysis but on a broader scale, overlap with other sand resources (whether proven or unverified) is understudied. This study would help establish a baseline and fill data gaps about the habitat use and movement patterns of smalltooth sawfish on the OCS to help inform future BOEM decisions. Specifically, ESA Biological Assessments and National Environmental Policy Act (NEPA) documents would integrate findings into analyses and conclusions.

Background: Smalltooth sawfish, listed as endangered under the ESA since 2003, faces habitat loss as one of the biggest threats to recovery. The species historically ranged from Texas to North Carolina, but now the primary population is known to inhabit the waters of southwest Florida (Brame et al. 2019). Recent studies suggest management efforts have been successful in stabilizing the population, and the population may be increasing (Wiley and Brame 2018), though a 2024 rise in deaths linked to unexplained circling behavior in shallow waters near the Florida Keys may complicate this species' recovery (Staletovich 2024). A growing population may partially explain a rise in smalltooth sawfish detections in coastal Atlantic acoustic arrays; the increase may also be due to more tags at-large. Most studies on smalltooth sawfish have focused efforts on juveniles and southwest Florida which serves as critical habitat for the species. Tagging efforts show that some adult sawfish display site fidelity to Florida Bay in southwest Florida, while others may migrate north during the summer. One particular study tagged sawfish in Florida Bay and observed three males migrating north in the GOM, but the study was limited due to tag retention issues (Papastamatiou et al. 2015).

BOEM has funded an active acoustic telemetry array at Canaveral Shoals II, an active lease area, since 2013 (Iafrate et al. 2022). From 2016 through 2023, 21 total sawfish were detected on Canaveral Shoals, mostly during spring and summer. The sawfish were originally tagged and released hundreds of kilometers from the shoals, mostly from Florida's Gulf coast through the Keys, with some individuals returning for up to four consecutive years. The active array continues to opportunistically detect individuals that are tagged by other researchers; the current study (MM-20-x04a), however, includes neither robust data analysis nor additional field efforts specific to this protected animal. Their presence along the Atlantic in central Florida is somewhat surprising, therefore warranting further investigation into their movement. Understanding how smalltooth sawfish activity may overlap with BOEM dredging activities is critical to effective environmental compliance and mitigation measures.

Objective(s): The main objective of this study is to characterize the occurrence and movement of smalltooth sawfish near existing and potential sand resources on the Florida - Atlantic OCS to better understand any correlating environmental factors and how BOEM-authorized activities may affect this endangered species and its habitat.

Methods: The study will achieve the objective by taking a two-phase approach.

- Phase 1: Analyze existing telemetry data for smalltooth sawfish occurrence at different spatial and temporal scales around Florida - Atlantic OCS sand resources (e.g., Canaveral Shoals II). This may include both BOEM-funded and other acoustic arrays, depending on cooperation throughout the tagging and array network. Additionally, data from fishery-dependent and fishery-independent surveys will be supplemented with interviews with researchers, fishermen, and other stakeholders to obtain information that may not be published in the literature, and in areas where telemetry data are limited. (Estimate 1 year/$150,000 of effort.)
- Phase 2: If the data analysis determines that certain OCS areas have sufficient presence of smalltooth sawfish, then a tagging effort may be carried out. These data would be integrated and reanalyzed with the original Phase 1 dataset to identify site-specific habitat occurrence and movements, and any correlating environmental factors. (Estimate 3 years/$450,000 of effort.)

Specific Research Question(s): How do smalltooth sawfish spatially and temporally overlap with potential sand resources on the OCS? What environmental factors correlate with their occurrence?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Brame A, Wiley T, Carlson J, Fordham S, Grubbs R, Osborne J, Scharer R, Bethea D, Poulakis G. 2019. Biology, ecology, and status of the smalltooth sawfish *Pristis pectinata* in the USA. Endanger Spec Res. 39:9–23.

Iafrate JD, Reyier EA, Ahr BJ, Watwood SL, Scheidt DM, Provancha JA, Holloway-Adkins KG, DiMatteo A, Greene J, Krumholz J, Carroll A. 2022. Behavior, seasonality, and habitat preferences of mobile fishes and sea turtles within a large sand shoal complex: habitat connectivity, ocean glider surveys, and passive acoustics. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. 160 p. Report No.: OCS Study BOEM 2022-018.

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Papastamatiou YP, Dean Grubbs R, Imhoff JL, Gulak SJB, Carlson, JK, Burgess GH. 2015. A subtropical embayment serves as essential habitat for sub-adults and adults of the critically endangered Smalltooth Sawfish. Global Ecol Conserv. 3:764–775.

Wiley T, Brame A. 2018. Smalltooth sawfish (*Pristis pectinata*) 5-year review: summary and evaluation of United States distinct population segment of smalltooth sawfish. St. Petersburg (FL): National Marine Fisheries Service. 72 p.

Field	Study Information
Title	The Good, the Bad, the Ugly: A Facilitated Discussion with Dredging Industry to Solicit Recommendations for Low-cost Operational Improvements to Reduce Risk to Protected Species
Administered by	Marine Minerals Program
BOEM Contact(s)	Douglas Piatkowski (douglas.piatkowski@boem.gov), Victoria Brady (victoria.brady@boem.gov), Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2026
Final Report Due	TBD
Date Revised	February 8, 2024
Problem	Limited investment has been made over the last 30 years to engage and solicit perspectives directly from the dredging industry about low-cost operational improvements that could be made within navigation channel and offshore borrow area dredging projects throughout the Atlantic and Gulf Regions to prevent harm to sea turtles.
Intervention	Communicate the project-centric problems and opportunities with dredging industry. Gain insight on current USACE managed dredging contract operational constraints and recommendations for improvement to promote improved dredging efficiencies and reduced impact to protected species.
Comparison	Evaluate project operational constraints relative to current contract language that may lead to increased risk to sea turtles and sturgeon. Recommend contract modifications and related low-cost operational improvements that may mitigate risk.
Outcome	Improved insight from industry regarding real world navigation dredging and borrow area dredging contracts that may lead to reduced efficiencies and higher sea turtle entrainment risk. Industry recommendations for low-cost modifications to existing contract language that could improve operational efficiency and reduce risk of impacts to sea turtles.
Context	Atlantic and Gulf of Mexico Regions

BOEM Information Need(s): The Outer Continental Shelf Lands Act (OCSLA) provides BOEM the authority to manage minerals in the Outer Continental Shelf (OCS) and the requirement to provide environmental oversight. BOEM's MMP authorizes the use of sand, gravel, and/or shell resources from the OCS for shore protection, beach nourishment, and wetlands restoration. Extracting these resources from the seafloor may require large trailing suction hopper dredges and other associated equipment which could impact benthic-oriented protected species, including sea turtles (engendered) and sturgeon. As the lead Federal agency charged with responsibly managing OCS sediment resources, BOEM needs to understand species behavioral parameters relative to the operational components of hopper dredges to identify opportunities to avoid impacts.

Background: Sea turtles and sturgeon near the seabed are at risk of being entrained during dredging operations and injured, often lethally. A significant investment was made in the early 1990s to develop engineered solutions to mitigate risk and observe for incidental captures (e.g., inflow and/or overflow screening and protected species observers). The dredging industry has adopted these measures as standard business practice for over 30 years. BOEM continues to invest in biologging studies to better understand fine scale sea turtle and sturgeon behavior patterns in the vicinity of OCS sand resource areas. Though insightful, these studies are often expensive and require extensive planning and coordination to obtain environmental permits and approvals to handle protected species. Limited investment has been made to engage and solicit feedback to better understand hopper dredging operations and constraints using currently approved designs relative to project-centric conditions and where low-cost operational improvements could be made to further prevent harm to protected species.

Objective(s): Identify "hot spot" navigation channels and offshore borrow area locations in the Atlantic and GOM regions with the greatest impact to sea turtles and sturgeon. Collaborate with the dredging industry to assess what channel and borrow area design factors may contribute to the high risk. Provide recommendations to USACE and BOEM for improved contract plans and specifications for each project that may facilitate operational improvements to reduce take risk, when considering known fine scale behavior patterns from previous studies.

Methods: Summarize data and prioritize "hot spot" locations. Gather priority data components for each location. Conduct a facilitated workshop with Industry representatives (including graphic illustration) to draft recommendations for improved contract design for dredging of navigation channels and borrow areas designs that promote operational efficiency and reduce risk to protected species.

- **Relevant data:**
    - Authorized and/or permitted navigation channel and borrow area boundaries.
    - Recent pre dredge multibeam survey data.
    - Existing project centric contract language for each.
    - Project specific data from the National Dredging Quality Management database.
    - Historic incidental take data from "hot spot" projects.
- **Anticipated products:**
    - Take summary by channel and borrow area and defined "hot spot" locations.
    - Industry statements on existing conditions and contract design components of each location that reduce operational efficiency and increase risk of take.
    - Industry recommendations for design improvements at each location
    - Potential Meeting Locations: 2024 WEDA eastern chapter meeting will be held at the Maritime Conference Center in Baltimore, Maryland, from October 15–17, 2024

Specific Research Question(s):

1. When considering existing species behavior and bottom time calculations, what are the critical aspects of hopper dredge operations that may contribute to higher entrainment risk when dredging within navigation channels and offshore borrow areas?
2. Through facilitated discussion, can industry make specific low-cost recommendations for contract improvements to promote efficiency and avoid risk of entrainment at the sea floor?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References: N/A

Field	Study Information
Title	Updating the Dredging Project Emissions Calculator (DPEC) 2024
Administered by	Marine Minerals Program
BOEM Contact(s)	Jennifer Bucatari (jennifer.bucatari@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2026
Final Report Due	TBD
Date Revised	January 22, 2024
Problem	Appropriate tools are needed to estimate a BOEM MMP proposed activity's emissions n of pollutants over the shallow inner shelf and coastal region. In 2013, MMP developed the Dredging Project Emission Calculator (DPEC) to assess air quality impacts from dredging projects. This calculator is outdated and needs revisions to address new methodology and inclusion of methane and sulfur dioxide emissions (which was previously omitted).
Intervention	The 2013 DPEC will be updated to incorporate new methodology and address changes in the guide that was developed for the pre-existing DPEC.
Comparison	N/A
Outcome	Enable accurate evaluation of the potential effects from dredging projects on local air quality and the potential contribution to climate change.
Context	Atlantic, Pacific, Gulf of Mexico, and Alaska Outer Continental Shelf waters, up to 50m depth for sand dredging.

BOEM Information Need(s): BOEM needs an updated tool to calculate emissions from BOEM-authorized dredging activities. The need to estimate air emissions from beach renourishment projects is necessary for BOEM to evaluate the potential impacts to air quality under BOEM's National Environmental Policy Act (NEPA) mandate. Existing NEPA requirements and guidance require analysis of greenhouse gas (GHG) and climate change effects of proposed actions under NEPA. In addition, the Clean Air Act (CAA) requires that any action authorizing the use of OCS sand resources does not cause or contribute to air quality violations in areas not meeting the National Ambient Air Quality Standards (NAAQS) or does not cause a violation of these standards in areas that meet the NAAQS. Estimating a proposed activity's emissions is critical in evaluating the potential effect of the proposed activities on air quality and determining appropriate mitigation.

Background: BOEM is required to analyze emissions from proposed dredging activities which includes criteria pollutants: carbon monoxide (CO), nitrogen dioxide (NO_2), lead (Pb), sulfur dioxide (SO_2), ozone (O_3) and particulate matter (PM). BOEM is also interested in inventorying emissions of greenhouse gases (CO_2, CH_4, N_2O) and hazardous air pollutants (HAPs) (for onshore equipment). In recognition of the need for greater scrutiny of air quality impacts for all types of projects, BOEM created the Dredging Project Emissions Calculator (DPEC) database program to develop accurate emission estimates in support of Environmental Assessments and Environmental Impact Statements for beach nourishment projects (ENVIRON International Corp. and Woods Hole Group 2013). The DPEC uses the project's design parameters and basic information about the diesel-powered equipment to be used to estimate a project's emissions. These design parameters include estimates for all facets of the project including the time dredging, pumping out material to the shoreface, associated onshore equipment, as well as transit. Emissions associated with beach nourishment and coastal restoration projects result from use of main and auxiliary engines on marine vessels including dredges, tugs, barges and support craft, as well as shore-based equipment including construction equipment (e.g., loaders, dozers), and material handling equipment such as pumps, cranes and forklifts (to move pipes, for example) and other industrial equipment. Consideration of operational outputs that were not previously considered such as the rehandling of dredged material and the potential for truck haul of material. After 10 years of use for MMP environmental analyses, the DPEC needs updates including updates to emissions and loading factors, updates to equipment types and use, and the addition of methane to the estimates.

Objective(s): Update the DPEC in order to estimate air emissions from dredging projects.

Methods:

1. Collect updated data from past (historical) beach nourishment projects to reexamine typical project parameters, engine and equipment characteristics, and their relationship to fuel consumption and emissions. Use this historic data to ensure the preexisting heuristic relationships between project design parameters, engine requirements and fuel consumption, are still valid for calculating air emissions from future projects using time in mode, fuel consumption and other operational data.
2. Complete an updated literature and/or technical report review, including BOEM-funded studies, to compile and refine information about operational characteristics, activity profiles, loading factors, and emission factors. This includes an update on emission factors provided by the EPA for onshore and offshore equipment types as listed in ENVIRON International Corp. and Woods Hole Group (2013) Appendix B. In the case of onshore equipment, the EPA NONROAD model was run to develop gram per horsepower-hour emission factors for each type of equipment.
3. Add additional emissions that were not previously considered (such as methane, nitrous oxide, sulfur dioxide, hazardous air pollutants) to the DPEC using EPA emissions factors.
4. Update the DPEC User's Guide (Shah et al. 2012) as needed. In addition, develop a video tutorial on how to use the DPEC for users internal and external stakeholders.
5. Analyze the 50-year contribution (to match typical lead agency, USACE, 50-year planning horizon) of dredging emissions to climate change by reviewing previous projects in a given region (Atlantic, Gulf of Mexico).

Specific Research Question(s):

1. What are the priority pollutants and GHG emissions associated with all facets of a beach renourishment project?
2. How can we quantify these emissions in relation to our projects to understand the impacts and apply mitigation measures when necessary?
3. What is the cumulative impact of dredging associated emissions?

References:

ENVIRON International Corp., Woods Hole Group. 2013. Improving emission estimates and understanding of pollutant dispersal for impact analysis of beach nourishment and coastal restoration projects. Herndon (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management Headquarters. 69 p. Report No.: OCS Study BOEM 2013-123.

Shah T, Lindhjem C, Stoeckenius T. 2012. User's manual for Dredging Projects Emission Calculator. ENVIRON International Corp.

Field	Study Information
Title	Comprehensive Vulnerability of Marine Birds to Inform Offshore Wind Energy Development Throughout Waters Surrounding Pacific Offshore Continental Shelf of Hawaiʻi
Administered by	Pacific OCS Region
BOEM Contact(s)	David M. Pereksta (david.pereksta@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	United States Geological Survey (USGS) Western Ecological Research Center
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	May 2, 2024
Problem	Approximately 25 species of marine birds breed in the Main Hawaiian Islands (MHI). Offshore wind energy infrastructure (OWEI) may affect Hawaiian marine birds by increasing risk of mortality from collision and by increasing energetic costs associated with disturbance and displacement of individuals from suitable habitats.
Intervention	Data quantifying distribution and abundance of marine birds combined with information about life histories and behaviors of species at sea can benefit evaluations of offshore wind energy development location and scope of potential impacts to species.
Comparison	BOEM and the US Geological Survey (USGS) have conducted extensive at-sea tracking of breeding Hawaiian marine bird species to collect baseline data on movements, habitat associations, and behavior. Furthermore, an updated registry of marine bird nesting locations and population estimates throughout the eight leeward islands will soon to be available.
Outcome	To inform marine spatial planning for OWEI, ranked species vulnerability assessments and fine-scale, spatially continuous maps of seabird density will be developed for the waters surrounding the MHI using the data identified above.
Context	Pacific Offshore Continental Shelf off the MHI

BOEM Information Need(s): OWEI may affect Hawaiian marine birds by increasing risk of mortality from collision and by increasing energetic costs associated with the disturbance and displacement of individuals from suitable habitats (i.e., foraging areas and movement corridors). Although data on the distribution and abundance of seabirds can advise the selection of locations for renewable energy projects, the seasonal abundance, life histories, and behaviors of birds at sea should also be taken into account because these factors also affect vulnerability (collision, displacement, and population) and vulnerability is expected to vary among diverse species assemblages.

Background: U.S. Pacific Outer Continental Shelf (POCS) waters surrounding Hawaiʻi support approximately 25 species that breed in the MHI, including the endangered Hawaiian petrel and band-rumped storm-petrel and threatened Newell's shearwater; additional migratory non-breeding marine birds occupy these waters seasonally. All species are protected under the Migratory Bird Treaty Act and all breeding seabirds in Hawaiʻi are protected by the State. Furthermore, Hawaiian seabirds are culturally important and regarded as ʻaumākua (spiritual guardians).

BOEM and USGS have conducted extensive at-sea tracking of breeding Hawaiian seabird species to collect baseline data on movements, habitat associations, and behavior (Adams et al. 2020, Donahue et al. 2012, Gilmour et al. 2022). Furthermore, an updated registry of seabird nesting locations and population estimates throughout the eight leeward islands will soon to be available (Adams and Kelsey et al. In prep). To inform marine spatial planning for OWEI, these data are necessary inputs for developing ranked species vulnerability assessments that do not yet exist for Hawaiʻi and fine-scale, spatially continuous maps of seabird density (e.g., Ronconi et al. 2022) around the MHI.

Objective(s):

1. Develop collision and displacement vulnerability indices for all seabirds expected to regularly occur throughout the Hawaiʻi POCS waters by ranking the same suite of key vulnerability metrics developed by Adams et al. (2017) and revised by Kelsey et al. (*In prep*) for waters off Oregon, Washington, and California.
2. Generate fine-scale, predictive spatial maps of Hawaiian seabird densities by combining Hawaiian seabird tracking data (Adams et al. 2020) and the new updated MHI colony registry.
3. Integrate seabird-OWEI vulnerability for the main Hawaiian Islands with predicted seabird densities to generate continuous coverage, mapped representations of cumulative marine bird vulnerabilities for the waters off Hawaiʻi.

Methods: Consistent with the west coast POCS, USGS will combine existing new data with quantitative assessment and modeling to create comprehensive, fine-scale maps of density and cumulative vulnerability to OWEI for seabirds in the POCS waters surrounding Hawaiʻi. This will provide cumulative density and vulnerability scores for continuous, fine-scale (~2-km resolution) maps of the Hawaiʻi POCS and could inform offshore renewable energy development by highlighting important at-sea areas for vulnerable seabirds.

Task 1. The USGS will develop collision and displacement vulnerability indices for all seabirds expected to regularly occur throughout the Hawaiʻi POCS waters by ranking the same suite of key vulnerability metrics developed by Adams et al. (2017) and revised by Kelsey et al. (In prep) for waters off Oregon, Washington, and California. This includes a comprehensive review of existing information to generate OWEI vulnerabilities for Hawaiian breeding seabirds and subtropical migratory marine birds. The Species USGS will evaluate in the index will include all seabirds expected to regularly occur throughout the Pacific OCS waters surrounding Hawaiʻi. These will include approximately 21–23 breeding species of seabirds nesting in the main Hawaiian Islands and a number of additional migratory non-breeding marine birds that occupy these waters seasonally. In addition, the Hawaiian marine bird vulnerability may include other species of concern that may be traveling or migrating over water such as certain shorebirds (Pacific golden-plover, bristle-thighed curlew, etc.). The factors incorporated into the vulnerability index include flight maneuverability, flight altitude, percentage of time flying, nocturnal flight activity, and avoidance of OWEI. Each species-specific factor will be scored using a scale from low potential vulnerability to high potential vulnerability following Adams et al. (2017).

The ranking of each factor for all species will be independently evaluated by a selected group of experts. The experts will be chosen by USGS, in collaboration with BOEM, based on their experience with the species in the targeted regions or other areas where the species occur. Because applications for offshore wind or hydro power construction may be decided in many locations before comprehensive, medium- to large-scale, ecological studies on the status of marine wildlife are completed, predicted effects must largely be based on current knowledge. This should include conclusions from studies of wind power facilities on land and offshore (the latter in Europe) and from knowledge of the spatiotemporal patterns of abundance and movements of birds at sea that might be at risk.

Task 2. To build off Winship et al. (2016) and generate predictive spatial maps of MHI seabird densities, additional approaches are necessary. USGS will create fine-scale, predictive spatial maps of Hawaiian seabird densities by combining Hawaiian seabird tracking data (Adams et al. 2020) and the new updated MHI colony registry. Specifically, integrating extensive telemetry data (Adams et al. 2020) and species nesting locations and abundances will provide colony-based species distribution maps for important MHI breeding species.

Task 3. USGS will integrate seabird-OWEI vulnerability for MHI with predicted seabird densities to generate continuous coverage, mapped representations of cumulative marine bird vulnerabilities for the waters off Hawaiʻi. This synthesis will allow better assessments of areas proposed for offshore renewable energy development. The methods are consistent with what we have proposed for Washington, Oregon, and California POCS.

Specific Research Question(s):

1. What are the collision and displacement vulnerability indices for seabirds expected to regularly occur off the MHI?
2. What is the predicted spatial distribution of seabirds off the MHI?
3. What are the continuous mapped representations of cumulative marine bird vulnerabilities for the waters off the MHI?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Adams J, Felis JJ, Czapanskiy MF. 2020. Habitat affinities and at-sea ranging behaviors among main Hawaiian Island seabirds: breeding seabird telemetry, 2013–2016. Camarillo (CA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 111 p. Report No.: OCS Study BOEM 2019-051.

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Gilmour ME, Felis J, Hester M, Young L, Adams J. 2022. Laysan albatross exhibit complex behavioral plasticity in the subtropical and subarctic North Pacific Ocean. Mar Ecol Prog Ser. 697:125–147. https://doi.org/10.3354/meps14148.

Kelsey EC, Felis JJ, Czapanskiy M, Pereksta DM, Adams J. 2018. Collision and displacement vulnerability to offshore wind energy infrastructure among marine birds of the Pacific Outer Continental Shelf. J Environ Manage. 227:229–247.

Ronconi RA, Lieske DJ, McFarlane Tranquilla LA, Abbott S, Allard KA, Allen B, Black AL, Bolduc F, Davoren GK, Diamond AW, et al. 2022. Predicting seabird foraging habitat for conservation planning in Atlantic Canada: integrating telemetry and survey data across thousands of colonies. Frontiers Front Mar Sci. 9:816794. doi:10.3389/fmars.2022.816794.

Winship AJ, Kinlan BP, Balance LT, Joyce T, Leirness JB, Costa BM, Poti M, Miller PI. 2016. Chapter 7: environmental setting. In: Costa BM, Kendall MS, editors. Marine biogeographic assessment of the main Hawaiian Islands. Camarillo (CA) and Silver Spring (MD): Bureau of Ocean Energy Management and National Oceanic and Atmospheric Administration. 359 p. Report No.: OCS Study BOEM 2016-035 and NOAA Technical Memorandum NOS NCCOS 214. p. 283-356.

Field	Study Information
Title	Guidance on Compensatory Mitigation to Achieve Net Positive Impacts of Offshore Wind Energy to Seabirds
Administered by	Pacific OCS Region
BOEM Contact(s)	David M. Pereksta (david.pereksta@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2026
Final Report Due	TBD
Date Revised	May 2, 2024
Problem	Marine wildlife are impacted by offshore wind energy development, and it will not be possible to prevent all impacts. To achieve no net loss or net positive impacts to wildlife, residual impacts must be offset by compensatory mitigation measures, but there is uncertainty about how to implement compensatory mitigation.
Intervention	Develop guidance for an actionable process to assess residual impact of offshore wind energy development to seabirds and outline a process to identify costs to replace losses that may be used to compensate for residual impacts. We will also provide guidance on viable structures to pool compensatory funding across a region and strategically identify conservation actions with the best return on investment to boost populations of the most vulnerable species.
Comparison	Provide guidance for adaptive management of conservation actions used as compensatory mitigation measures to ensure viability.
Outcome	The guidelines provided will aid BOEM in developing compensatory mitigation plans for wildlife in response to offshore wind energy development.
Context	Pacific OCS seabirds will be used as a case study, and guidelines provided may be applied nationally.

BOEM Information Need(s): Seabirds are threatened by a wide array of human impacts, including fisheries bycatch, entanglement, invasive predation at breeding sites, and habitat loss (Croxall et al. 2012). The construction and operation of offshore wind energy development (OWED) will add new risks to these existing threats, with the greatest concerns being collision with infrastructure and displacement from critical habitats (Goodale and Milman 2016). With the demand for renewable energy sources increasing and current policy plans to rapidly accelerate OWED in the US, BOEM needs to ensure that wind energy projects are developed responsibly, with minimal impact on the environment and wildlife. Seabirds are vulnerable to the development of offshore wind energy, so it is imperative to identify the species most at risk of impact and prioritize conservation efforts to achieve net positive outcomes for these species. By leveraging existing modeling and monitoring tools, this project will produce a data driven and comprehensive approach to identify the species most in need of focus for research and restoration efforts, ultimately providing BOEM a framework that will allow them to handle bird impacts in a way that will streamline the development process by reducing uncertainty around mitigation efforts.

Background: To facilitate renewable energy production, it is critical to develop a data-driven framework to assess its impact and a robust approach to avoid, minimize, and offset its negative impacts (Croll et al. 2022). For OWED, avoidance of seabird impacts consists of selecting sites for offshore wind facilities in areas of low seabird use, particularly species with declining or threatened populations. Minimization includes modification of development layout as well as structural or temporal alterations to turbine design and operation (Croll et al. 2022). Avoidance and minimization have the capacity to reduce seabird impacts but will not fully mitigate offshore wind energy impacts due to siting, engineering, and efficacy constraints (Arnett and May 2016; May et al. 2020; Smallwood and Karas 2009). Therefore, offsetting is an important potential solution to mitigate residual impacts and achieve net positive benefits such that development of offshore wind energy infrastructure could lead to the increase of threatened seabird populations (Moilanen and Kotiaho 2021).

In 2021, a team from the University of California, Santa Cruz (UCSC) led a National Center for Ecological Analysis and Synthesis working group funded by BOEM to develop a globally-applicable framework of best practices for assessing and mitigating (OWED impacts to seabirds (Croll et al. 2022). The key takeaways of this effort were the need to utilize modeling approaches as tools to evaluate impact, and to build out capacity to compensate for impacts that cannot be prevented via avoidance and minimization.

Objectives:

1. Outline a clear process for impact assessment and the conversion of residual impact into replacement cost to fund compensatory mitigation measures on a regional scale.
2. Develop guidelines to prioritize data collection and mitigation action for the species most vulnerable to offshore wind energy development.
3. Develop a process to identify the most effective compensatory mitigation actions for vulnerable populations.

Methods: Industry, agencies, and conservation managers need a streamlined approach to mitigate seabird impacts of the rapidly developing OWED industry. The lease areas in the POCS region will be used as case studies to demonstrate how existing datasets and modeling approaches can be used to estimate impacts, identify feasible mitigation options, highlight regional data gaps, and incorporate the analysis into policy.

Task 1: Develop a strategy to offset seabird impacts that cannot be prevented via avoidance and minimization measures. Compensatory mitigation and voluntary offsets have been implemented for seabird impacts of offshore wind energy internationally by individual facilities, but managing residual impacts on a site-by-site basis may be challenging for seabirds given their broad ranges and the need to address cumulative impacts from the potential buildout of OWED on the issued and foreseeable leases on the Pacific OCS. Thus, there is a need to consider management on a regional or global scale. To implement effective compensation in the U.S., a comprehensive and transparent process is required to estimate residual impacts using modeling and identify a monetary value for their replacement via conservation interventions that may be paid into a regional fund to support conservation actions. To do this work, UCSC will collaborate with Aonghais Cook (The Biodiversity Consultancy), Elizabeth Masden (University of the Highlands & Islands), and Kate Searle (UK Centre for Ecology & Hydrology), in the UK, and Evan Adams, Kate Williams, Wing Goodale, Holly Goyert, and Julia Gulka at the Biodiversity Research Institute to build on lessons learned from the United Kingdom and the leasing process thus far in the United States.

Task 2: Develop a process to identify and estimate impacts for species most vulnerable to offshore wind energy development in a given region. To demonstrate the utility of this approach, UCSC will collaborate with Dr. Aonghais Cook (British Trust of Ornithology), and Jeffery Leirness (CSS Inc & NOAA National Center for Coastal Ocean Science) to develop a framework to identify and estimate impact to species most likely to be vulnerable to OWED impacts in the POCS region. The population viability analysis tool developed by their group will be used to identify the population-level consequences for OWED impacts as well as evaluate potential mitigation actions capable of achieving net positive impacts in response to new OWED development in the California region. The results will be published in an open-access journal such as Biological Conservation.

Task 3: With the recognition that there will be limits to funding available to support monitoring and conservation measures for seabirds, it is critical to focus available funds on projects that have the greatest capacity to make real conservation change for the most vulnerable species. The framework and outputs produced during Task 2 will be utilized to produce a comprehensive list of monitoring and mitigation needs for the most vulnerable California current ecosystem seabird species. We will work with Dr. Nick Holmes at The Nature Conservancy and Dr. Brad Keitt at the American Bird Conservancy to identify feasibility and cost for conservation projects and engage international collaborators where species conservation needs would occur outside of the U.S. The results will be published in an open-access journal such as Biological Conservation.

Specific Research Question(s):

1. What are the potential impacts to the most vulnerable avian species from OWED projects?
2. What are the replacement costs for avian species impacted by OWED projects?
3. Are there monitoring and mitigation needs for the most vulnerable avian species that can be supported through mitigation to offset impacts to reach a net conservation benefit?

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Arnett EB, May RF. 2016. Mitigating wind energy impacts on wildlife: approaches for multiple taxa. Hum-Wildl Interact. 10(1):28–41.

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Field	Study Information
Title	Ichthyoplankton Entrainment Assessment for HVDC Cooling Systems
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	Interagency Agreement, Cooperative Agreement, or Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	May 2, 2024
Problem	The State of California established a policy that prohibits and/or phases out once-through-cooling (OTC) systems for coastal power plants due to the potential negative effects that entrainment of fish larvae has on fisheries. It is unknown if this policy will be applicable to offshore wind farms that propose OTC, given the different ichthyoplankton communities found on the Outer Continental Shelf (OCS) and slope where farms will be located and the potential to limit intake of seawater to depths that reduce entrainment of fish larvae.
Intervention	Classic (net-based) and genomic sampling of ichthyoplankton communities.
Comparison	Spatial (cross-shelf, latitudinal), temporal (seasonal, diel), and depth (surface, 30 m, 100 m) distribution and abundance of ichthyoplankton communities vulnerable to entrainment from high voltage direct current (HVDC) cooling systems.
Outcome	The outcome of this study will be project design criteria regarding OTC and wind farms (e.g., uptake and discharge depths), information about potential impacts needed for essential fish habitat (EFH) consultations related to construction and operations plans, and guidance needed by industry to successfully meet Coastal Zone Management Act (CZMA) certification and state permitting requirements.
Context	BOEM Planning Areas within the California Current System: Oregon-Washington; Northern California, Central California, Southern California

BOEM Information Need(s): The production and transport of electricity by offshore wind farms may rely on OTC systems that will require millions of gallons of seawater per day. Previous studies examining the effects of OTC in coastal power plants concluded that OTC removes billions of aquatic organisms, including fishes, fish larvae and eggs, crustaceans, shellfish and many other forms of aquatic life (Schwarzenegger, 2005; Ferry, 2010; Raimondi, 2010). Because of this, the State of California established a policy that prohibits and/or phases out OTC systems for coastal power plants due to the potential negative effects that entrainment of fish larvae has on fisheries and ecosystem health. It is unknown if this policy will be applicable to offshore wind farms that propose OTC given the different ichthyoplankton communities found on the outer continental shelf and slope where farms will be located and the potential to limit intake of seawater to deeper depths that could reduce entrainment of fish larvae. Outcomes of this study will include project design criteria regarding OTC and wind farms (e.g. uptake and discharge depths), information regarding potential impacts required for NEPA documents and EFH consultations related to construction and operations plans, and guidance needed by industry to successfully meet CZMA certification and state permitting requirements.

Background: Offshore wind development on the OCS needs to effectively transport the power produced by the turbines to an onshore electrical power grid. It is expected that an HVDC system will be used to minimize power losses than can occur over long transport distances. When alternating current (produced by wind turbines) is converted into HVDC, heat is generated as a byproduct. This conversion system requires cooling to protect equipment from damage and breakdown, and standard OTC technology used by industry to provide this cooling function requires millions of gallons of seawater per day.

Studies required by the California Energy Commission and other State agencies have shown that coastal power plants that use seawater for OTC are contributing to declining fisheries and the degradation of estuaries, bay and coastal waters. These power plants indiscriminately 'fish' the water in these habitats by killing the eggs, larvae, and adults when water drawn from the natural environment flows through the plant (entrainment impacts) and by killing large adult fish and invertebrates that are trapped on intake screens (impingement impacts). These facilities also affect the coastal environment by discharging heated water back into natural environments.

Concerns have been raised by stakeholders to BOEM about how HVDC systems are cooled and the impacts of the cooling systems to the environment. As of 2022, innovations in cooling systems are being studied and developed, but so far, no new systems are tested and available for use on a commercial scale (Middleton and Barnhart, 2022).

Objective(s): The overall goal of this study is to understand how once-through-cooling systems likely to be proposed by the offshore wind industry may impact outer continental shelf and slope ichthyoplankton communities.

Methods: The study will acquire and compare long term data on ichthyoplankton assemblages in nearshore and offshore environments to guide the future field sampling schedule and identify potential gaps in reference libraries needed for genomic sampling. Direct field sampling of ichthyoplankton by classic (net-based) and genomic methods will quantify the distribution and abundance of larvae at various spatial scales (cross-shelf, latitudinal), temporal scales (seasonal, diel), and depths (surface, 30 m, 100 m). Cost-effective genomic sampling methods will supplement classic sampling methods to improve temporal resolution of data.

Specific Research Question(s): Specific research questions of this study include:

1. What is the distribution and abundance of ichthyoplankton in coastal and offshore environments?
2. Are there data gaps in fish reference libraries used for genomic sampling?
3. What are the spatial, temporal, and depth patterns of ichthyoplankton abundance that could be entrained by HVDC cooling systems?

4. Could OTC impacts be reduced by requiring seawater intakes to be positioned in depths deeper than 30 m or by reducing intake flow speeds?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Impacts of Floating Offshore Wind Subsurface Infrastructure to Hydrodynamics, Biogeochemistry, and Primary Productivity in the Pacific OCS
Administered by	Pacific OCS Region
BOEM Contact(s)	Alice Kojima (alice.kojima@boem.gov); Thomas Kilpatrick (thomas.kilpatrick@boem.gov)
Procurement Type(s)	Interagency Agreement or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	May 2, 2024
Problem	Recent and ongoing modeling studies examine the impact of wind wakes (i.e., atmospheric disturbance) from Pacific Outer Continental Shelf (OCS) offshore wind farm development on upwelling and related nutrient availability. However, these studies do not consider fluid-structure interactions between oceanic flow and subsurface wind farm infrastructure (i.e., floating substructures).
Intervention	This study will fill a knowledge gap by modeling interactions between oceanic flow and underwater infrastructure of wind farms to determine how they may influence hydrodynamics (HD), biogeochemistry (BG), and primary productivity (PP).
Comparison	Model simulations that incorporate oceanic flow-floating substructure interactions (ocean wakes) will be compared against a control simulation with no wind farms and available observational data in the region for model validation. There will also be a comparison with a “no-ocean wake” scenario to characterize contribution of ocean wakes to changes in HD, BG, and PP.
Outcome	This study will help provide the full picture of how Pacific OCS offshore wind development may impact HD, BG, and PP via changes in both atmospheric and ocean circulation. Outcomes of this study will be crucial for productive interactions with stakeholders and will inform both the National Environmental Policy Act (NEPA) review process and future construction and operation plans.
Context	The modeling domain will be the Pacific OCS region extending from southern California to Washington, with particular focus on existing lease areas (California) and wind energy areas (Oregon).

BOEM Information Need(s): To support offshore wind (OSW) development in the Pacific OCS region in an environmentally responsible way, BOEM must evaluate the potential impact of OSW infrastructure on the physical upwelling properties of the California Current and associated biogeochemistry (BG). By bringing nutrient-rich waters to the surface, upwelling forms the foundation of the exceptional productivity of the California Current Large Marine Ecosystem (CCLME). Modeling studies to date investigate the potential impact of wind wakes (i.e., reduced wind stress) produced by Pacific OCS wind farm infrastructure on upwelling volume transport and nutrient delivery (Raghukumar et al., 2023) and related BG (NT-23-09). However, these studies do not consider the subsurface interactions between oceanic flow and the floating substructures of the wind farms (i.e., ocean wakes). Environmental impacts of the floating substructure will be considered in the National Environmental Policy Act (NEPA) review process and may inform the designs proposed in construction and operations plans submitted by lessees.

Background: The California Current flows along the Pacific coast of the U.S. and is highly productive due to the upwelling of deep, nutrient-rich waters to the surface. This delivery system of nutrients to the surface allows organisms of all trophic levels to thrive in this region and is thus of primary interest to stakeholders. A recent modeling study funded by the State of California demonstrates a modest impact of OSW infrastructure to patterns of upwelling near the Morro Bay wind energy area (WEA) in central California (Raghukumar et al. 2023). In particular, Raghukumar et al. (2023) observed a slight reduction in upwelling strength on the lee side of the wind farm and a change in the spatial signature. Ever since the results of this study were made public, many stakeholders of the Pacific OCS have expressed concern about the impacts of OSW development on upwelling during the various comment periods of the OSW leasing process (most recently, in response to the Oregon draft WEAs). BOEM has invested in a subsequent modeling study (NT-23-09) to investigate OSW farm impacts more broadly on ocean BG and PP offshore California and Oregon. Both studies represent the presence of floating wind farms as a reduction in wind stress (i.e., wind wake) at the sea surface, but do not include interactions between subsurface infrastructure and oceanic flow (i.e., ocean wakes) as part of their impact.

The dynamics of these ocean wakes produced by floating substructures remain poorly understood in both well-mixed and stratified pelagic waters due to the relatively new expansion of the OSW energy sector into deeper waters (Dorrell et al. 2022). The semi-submersible type of floating substructure is most commonly used in global floating offshore wind farms to date (Musial et al. 2020), and is also the most likely and preferred technology to be used for Pacific floating offshore wind development (Trowbridge et al., 2023). This study will employ the semi-submersible substructure type together with wind wake parameterizations to demonstrate how turbines and substructures together impact HD, BG, and PP.

Objective(s): The objectives of this study are as follows:

- Model interactions between oceanic flow and floating semi-submersible substructures and combine with parameterized wind wake effect to characterize impacts of Pacific OCS wind farms on local HD, BG, and PP.
- Create an engaging communication product (e.g., ArcGIS StoryMap) to share the outcomes of this study with stakeholders and develop related talking points that can be used by BOEM Pacific staff when answering questions about upwelling and public-facing meetings.

Methods: This study will develop a model framework that couples an established general circulation model (e.g., MITgcm) with an ecosystem model (e.g., Darwin package), or use a similar approach. Oceanic flow can be simulated at 10-m resolution (in both *x* and *y*) and as high as 3-m resolution (*z*) using MITgcm (Hughes et al. 2022). The model simulations produced by this framework will be of sufficient resolution to distinguish changes in physical currents beneath and around a semi-submersible floating substructure and the associated HD, BG, and PP impacts. The semi-submersible substructures will have dimensions that support 10- and 15-MW wind turbines.

First, these simulations will be compared against a "no-turbine" control run to determine the full magnitude of impact on HD, BG, and PP. Second, these simulations will be compared against a "no-ocean wake" control to quantify the added influence that the ocean wake has on HD, BG, and PP. The magnitude of change from the "no-ocean wake" control will also be compared against the results of previous modeling studies that incorporated only wind wake effects to demonstrate model differences (e.g., MITgcm vs. ROMS). Relevant observational data (e.g., glider data) will be used to help validate these model simulations. This study will provide a more complete picture of how Pacific OCS offshore wind farm infrastructure will impact HD, BG, and PP of the surrounding area and provide a basis for potential higher trophic level responses.

Specific Research Question(s):

1) How will ocean wake effects from oceanic flow-floating substructure interactions combine with wind wake effects from wind field-turbine interactions of offshore wind farms to impact HD, BG, and PP?
2) How will interactions between oceanic flow and floating substructures influence ocean stratification and thermocline depth in WEAs?
3) How do these changes (ocean stratification and thermocline depth in WEAs, local and regional HD, BG, PP) compare to those that occur due to natural variability (Jacox et al. 2015) and climate change?
4) How do HD and BG changes simulated in MITgcm compare to those simulated in ROMS?
5) How can these modeling results inform a monitoring effort focused on turbine-scale oceanic flow-structure interactions?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Potential Environmental Effects from Impressed Current Cathodic Protection Systems
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder (donna.schroeder@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	May 15, 2024
Problem	Although impressed current cathodic protection (ICCP) systems may generate changes in electromagnetic fields (EMFs) orders of magnitude greater than expected changes from submarine cables, virtually nothing is known about the potential environmental consequences of these systems.
Intervention	Field experiments to test for changes in behavior for select electrosensitive species using EMF produced by ICCP systems likely to be employed to prevent corrosion in marine energy infrastructure (e.g., anode sleds).
Comparison	Compare (1) model output with direct field measurements of EMF changes resulting from ICCP use, and (2) changes in behavior among different electrosensitive species.
Outcome	Study products will fill data gaps critically needed for NEPA reviews and Endangered Species Act and Essential Fish Habitat Consultations, and be useful for government-to-government Tribal consultation and stakeholder outreach.
Context	Renewable and Conventional Energy Programs; All BOEM Planning Areas that may use ICCP to protect marine infrastructure (pipelines and platforms).

BOEM Information Need(s): Though BOEM has funded reviews on understanding potential effects of EMF on marine organisms and has several field investigations regarding potential environmental consequence of submarine cables, to date no field studies have been conducted examining effects of EMF from ICCP on electrosensitive species (e.g., sharks, rays, and sturgeons) even though the environmental changes are orders of magnitude greater (Schroeder, personal observation). Tribes and commercial fishermen have consistently voiced their concern regarding potential effects of EMF emitted from ocean energy infrastructure. Further investigation into this topic would assist BOEM in future NEPA analyses of proposed energy projects in both renewable and conventional energy programs, assist industry in understanding environmental tradeoffs between using galvanic versus ICCP systems, and show a commitment from BOEM to the concerns raised by Tribes and fishermen.

Background: Both renewable and conventional energy programs involve a large amount of metal infrastructure (e.g., platforms and pipelines) in the marine environment which is susceptible to corrosive effects from seawater. Corrosion prevention remains a critical and somewhat costly component of operational success and safety for offshore energy production. Passive or galvanic methods of corrosion protection may rely on sacrificial anodes (e.g., zinc, aluminum, or magnesium) which can contaminate local sediments (Rousseau et al. 2009; Kirchgeorg et al. 2018) and may have reduced efficacy in large structures (National Physical Laboratory 2018). An alternative method is using an impressed current cathodic protection system (ICCP system) (Jessup 2015). The potential environmental consequences of ICCP systems are unknown and remain a critical knowledge gap that could compromise future impact analyses.

Objective(s): The focus of this research is to determine how electromagnetic fields are altered by ICCP systems used to protect offshore energy infrastructure and to determine the responses of representative electro- and magnetosensitive species to these changes.

Methods: This study would use a multi-task approach involving both field and lab-based investigations:

- Using industry-standard algorithms, model expected changes to ambient EMFs from ICCP systems currently in use or foreseeable in the future using a range of power levels and other relevant conditions.
- Using either divers, autonomous underwater vehicles, and/or remotely operated vehicles equipped with EMF measuring instrumentation, map ambient and ICCP-induced changes to EMF in natural environments under a range of relevant conditions and compare with modeling expectations.
- Develop field and laboratory experiments to assess the response of representative electro- and magnetosensitive species. Methods may include: mesocosm experiments using existing energy infrastructure and operating ICCP systems; using underwater cameras to observe behavior in the field near the ICCP systems and reference and/or control sites; mark and recapture of commercially important species to track their movements near operating ICCP systems and reference and/or control sites; and laboratory experiments to quantify the type of response that each target species has to different levels of EMF.

Specific Research Question(s):

1. What is the extent and magnitude of the EMF generated by ICCP systems used to protect offshore infrastructure?
2. What electromagnetic (EM)-sensitive species may encounter the altered EMF?
3. Focusing on fishes, how do key EM-sensitive species behaviorally respond to altered EMFs?
4. What is the significance of behavioral changes, if any, to regional populations?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Probability Analysis of Derelict Fishing Gear Interactions with Floating Offshore Wind Mooring Systems Offshore California
Administered by	Pacific OCS Region
BOEM Contact(s)	Dr. Desray Reeb (desray.reeb@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	NOAA Southwest Fisheries Science Center
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	May 2, 2024
Problem	Offshore floating wind turbine moorings and power cables have been identified as potential vectors of secondary entanglement of protected species due to associated derelict fishing gear. There is currently no way of assessing the probability of this happening offshore California.
Intervention	Develop a drift model for derelict gear, e.g., a particle tracking model based on where fishing is occurring and using the latest oceanographic and/or current models (e.g., UCSC West Coast Operational Forecast System [WCOFS]) to assess the cloud of possible interactions.
Comparison	This would be the first effort of its kind and will provide an important assessment tool that can be tested for validation using limited empirical data.
Outcome	With limited data on fishing gear loss, this model will provide resource managers, regulators, and industry with a tool to inform the probability of derelict gear associating with offshore floating wind mooring systems. This tool would allow for the more accurate assessment of the risk and/or need for mitigation of secondary entanglement of protected species in these systems. This approach could be replicated for the Gulf of Maine.

BOEM Information Need(s): BOEM has issued five leases for floating offshore wind development in California, recently announced Call Areas offshore Oregon, and Call Areas exist offshore Hawaii. There is no centralized, standardized data available on how much fishing gear is lost each year in the Pacific, and where these losses occur. To accurately assess the risk of secondary entanglement to protected species from derelict gear associating with floating wind mooring systems, BOEM needs to understand the probability of this association occurring. Impact assessment information is required under NEPA, ESA, and MMPA.

Background: Numerous stakeholders along the U.S. West Coast have commented on their concerns that offshore floating wind presents entanglement risks to marine wildlife. The most recent qualitative risk assessment done was for floating turbines in 50 m of water offshore Scotland (Benjamins et al. 2014; Harnois et al. 2015); they state that recommendations need to be developed to assess the risk of entanglement of offshore renewable energy mooring configurations at the beginning of their design process. In addition, the entanglement review stated that although risks of entanglement between derelict fishing gear and offshore marine renewable energy (ORE) moorings and structures clearly exist, further studies are required to quantify the level of risk (Benjamins et al. 2014).

BOEM is currently funding the development of a 3-D simulator to assess entanglement risk to whales and leatherback sea turtles in offshore floating wind turbine moorings, cables, and associated derelict fishing gear offshore California (PC-19-x07). This ongoing simulator development work assumes that derelict gear will interact with floating OSW infrastructure and present a potential for entanglement. The simulator will run scenarios to produce statistical assessments of whale entanglement risk from offshore floating structures and derelict fishing gear. However, there is a significant need to understand the probability of the association between derelict fishing gear and offshore wind structures, in order to provide context to these results. The proposed study builds on the simulator work by endeavoring to calculate the probability of floating OSW structures and derelict gear interacting.

Information on lost fishing gear is not systematically collected in the Pacific. Although information on replacement commercial fishing tags suggests loss up to 10% per season, experts from NOAA suggest that this is an overestimate, and that loss is more likely around 5% (https://pacificoceanenergy.org/wp-content/uploads/2020/07/POET-Cetacean-Webinar-Slidedeck.pdf).

Various modeling approaches have been used to understand the fate of objects or substances drifting in the ocean (Córdova and Flores 2022;) or for understanding and monitoring the environmental effects of marine renewable energy (Buenau et al. 2022; Johnson et al. 2021). Since there is currently no centralized, standardized data available on how much fishing gear is lost each year in the Pacific, or where the gear settles, drift models using oceanographic and available fisheries data can be developed to better understand the probability of derelict fishing gear become associated with floating offshore wind infrastructure.

Objectives: To assess the probability of derelict gear interactions with offshore floating wind structures offshore California, that can be used to identify regions of greatest risk.

Methods: Using oceanographic and fisheries data, a drift model will be developed for derelict gear e.g., a particle tracking model based on where fishing is occurring and using the latest current models. These models will allow us to explore multiple release sites and multiple release dates to get a cloud of possible interactions. Because the locations of gear loss are unknown, this approach would present regions with the greatest risk.

Specific Research Question(s): What is the probability of derelict fishing gear associating with planned floating offshore wind mooring systems offshore California?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Testing a Next Generation Tagging Technology for Sea Otters (Enhydra lutris)
Administered by	Pacific OCS Region and Alaska OCS Regional Office
BOEM Contact(s)	Kimberly Klein (kimberly.klein@boem.gov), Christina Bonsell (christina.bonsell@boem.gov), Ingrid Biedron (ingrid.biedron@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	U.S. Geological Survey (USGS) Western Ecological Research Center
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	May 2, 2024
Problem	Studies of sea otters have relied on visual observation or abdominally implanted radio telemetry technology; this has resulted in incomplete information.
Intervention	This project tests and deploys a low cost, solar power flipper tag that provides location data via a long-range (LoRa) real-time transmission network.
Comparison	Location data is used to understand movement, dispersal, diving behavior, social connectivity, and habitat use. This data will allow study of sea otter response to planned or existing coastal energy development, disturbance (e.g., vessel traffic, energy transmission), and catastrophic events such as oil spills.
Outcome	This project will move development of a sea otter flipper tag from prototype to production, field testing (Monterey Bay, California), and deployment (Morro Bay, California).

BOEM Information Need(s): Tracking data is critical for BOEM's analyses of impacts of energy development on animal movement and habitat use and for understanding response to disturbance (e.g., vessel traffic, construction, operations, etc.) and catastrophic events such as oil spills. Existing tag technology is not well suited for sea otters. 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 implants is expensive and invasive, requires heavy personnel attendance, and is limited by weather conditions, geography, and battery life. Technological advances are necessary for monitoring threatened sea otters in energy development areas in Alaska and California, near the Morro Bay Wind Energy Lease Area, and in the future, near Oregon's Coos Bay Call Area, where reintroduction is being considered (USFWS 2022).

Background: BOEM has oil and gas lease areas that overlap with sea otter habitat in AK. Additionally, BOEM has issued five leases for floating offshore wind development in California and recently announced Call Areas offshore Oregon.

There are two distinct sea otter subspecies in the U.S., the northern sea otter and the southern (or California) sea otter. Northern sea otters live in the nearshore waters of Alaska, British Columbia, and Washington State, and southern sea otters live along the central coast of California and at San Nicolas Island in southern California. Historically, sea otters were distributed continuously along the north Pacific Rim, with Oregon serving as a transition zone between the two subspecies.

With the passage of Public Law 116-260 on December 27, 2020, in recognition of the sea otter's critical ecological role as a keystone species that significantly affects the structure and function of its marine environment, the U.S. Fish and Wildlife Service (USFWS) was directed by Congress "to study the feasibility and cost of reintroducing sea otters on the Pacific Coast of the contiguous United States," including Oregon, Washington, and California. The assessment determined that relocation is feasible (USFWS 2022). Although no decision to move forward has been made and there is no active proposal to reintroduce sea otters at this time, there is tribal interest and support for this to occur in Oregon (Elakha Alliance).

This project would leverage extensive research and development by the USGS and the National Aeronautics 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 is transmitted to network gateway receivers via Long Range Wide Area Network (LoRaWAN) and Internet of Things (IoT) technology. Fixed or mobile gateways relay data up to a distance of 15 km to a wireless receiver or a satellite network. No field trials have yet been conducted, but a prototype has been tested on captive sea otters at the Monterey Bay Aquarium where it survived the "chew test" 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 personnel and field supplies, including a new capture and tracking boat. They are currently supporting work by an engineer at the NASA Ames Research Center on fabrication of the second-generation prototypes. The California Department of Fish and Wildlife (CADFW) and the U.S. Fish and Wildlife Service have also made commitments of in-kind field support.

Objectives:

1. Conduct power and range testing to calibrate the tag performance in marine ecosystems.
2. Conduct pilot test by tagging 10 wild sea otters. Deploy implanted VHF transmitters for comparison with GPS/LoRa tags and to aid in tag recovery (if needed).
3. Refine data collection and analysis procedures. Modify existing USGS methods (i.e., migratory bird) for spatial data storage, acquisition, analysis, interpretation, and presentation.
4. Plan for and conduct field deployment of new technology on 30 sea otters at Morro Bay, CA, where wind energy and sea otter occupancy overlap (Larson and Bodkin, 2015).

Methods: Power and range testing will employ captive otters and tag-only tests in ocean environments. Initial 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. Routine remote sensing monitoring data from these sea otters will be provided to BOEM, USFWS, and CADFW. Project deliverables will include a written project synthesis, materials for visual interpretation (poster, story map, etc.), and geospatial data in an Esri ARCGis® compatible format.

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 does solar power regulation and optimization for signal transmission differ between pilot tests and field deployment?
3. How can existing sensor technology such as pressure sensors and/or accelerometers be incorporated into the flipper tag to gather additional data on diving depth and duration? What types of biological and environmental sensors can be incorporated?
4. Can diving behavior be used to predict solar power generation and battery use for other species? What production factors are needed to allow the tag to be adapted to other species?
5. What are the baseline behaviors, habitat use, and movement patterns of sea otters near the Morro Bay wind energy lease area prior to possible effects of development activity.

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Larson SE, and Bodkin JL. 2015. Chapter 1: the conservation of sea otters: a prelude. In: Larson SE, Bodkin JL, Van Blaricom GR, editors. Sea Otter Conservation. Cambridge (MA): Academic Press. 447 p.

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Field	Study Information
Title	Updating Climate Science Integration into BOEM Pacific Decision-making
Administered by	Pacific OCS Region
BOEM Contact(s)	Alice Kojima (alice.kojima@boem.gov), Jeneva Wright (jeneva.wright@boem.gov)
Procurement Type(s)	Interagency Agreement, Cooperative Agreement, or Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025-2026
Final Report Due	TBD
Date Revised	May 2, 2024
Problem	Though climate change is widely cited as a Federal-, DOI-, and BOEM-level priority, it is difficult to translate high-level guidance into regionally applicable best practices and actionable outcomes that can be productively integrated into BOEM Pacific decision-making.
Intervention	This study will identify and synthesize critical climate change-related information (e.g., baseline climate conditions, climate projections, Traditional Ecological Knowledge (TEK), scenarios, resource vulnerability, and socioeconomic factors) that are relevant to the Pacific region. It will then develop a systematic and intentional strategy for integrating this information into BOEM's decision-making processes in a way that aligns with BOEM-, Department-, and Federal-level efforts to better understand and address climate change.
Comparison	The outcomes of this study will be compared against similar strategic plans and climate change-related guidance (e.g., National Park Service 2023, Forest Service 2009, Brandt and Schultz 2016).
Outcome	Compilation of basic Pacific-focused climate change information, potential resource impacts, recommended future climate scenarios, and a strategic plan for integrating this information into BOEM Pacific decision-making, particularly in support of the National Environmental Policy Act (NEPA). Best practices and talking points for BOEM Pacific staff to handle climate change-related questions from stakeholders.
Context	This is a baseline effort for the Pacific Region that will complement NT-24-05 and DOI Climate Science Applications Coordination Team efforts and will ensure that BOEM's public documents include up-to-date information and climate scenarios for informing BOEM Pacific actions.

BOEM Information Need(s): BOEM's 2024–2028 Strategic Framework highlights the need to "…increase BOEM's ability to understand and address the risks and effects of climate change as they relate to BOEM authorized activities" (Operational Priority #4). With NEPA requiring BOEM to consider the environmental impact of its proposed actions, incorporating climate change-related information into the NEPA process would address this priority. Such an effort would also be in alignment with the DOI Climate Action Plan and Secretarial Order 3399, which states that "…identifying important interactions between a changing climate and the environmental impacts of a proposed action in NEPA documents can help decision makers identify opportunities to reduce GHG emissions, improve environmental outcomes, and contribute to protecting communities from the climate crisis." (Sec. Order No. 3399). Further, guidance from the Council of Environmental Quality states that agencies should consider using "…the best available information and science when assessing the potential future state of the affected environment in NEPA analyses…including scenarios and climate modeling information that are most relevant to a proposed action" (CEQ 2023).

Despite extensive guidance and directives, BOEM's Pacific region lacks the tangible direction necessary to incorporate climate change science and information into its decision-making processes (like NEPA) and stakeholder engagement activities in a productive way. Baseline climate data, TEK, and specific future climate scenarios relevant to the Pacific OCS environment are not currently being used to inform NEPA review and other environmental law compliance, and there is a general lack of confidence in addressing climate change-related questions raised by stakeholders.

Background: At the department level, the DOI Coordination Program for Resilience and Environment's (CPRE) Climate Science Applications Working Group (CSACT) is compiling climate change-related resources and developing a technical guidance document: "Best Practices for Incorporating Climate Change Science into DOI Analyses, Consultations, and Decision-making" (expected to be published September 2024). At BOEM's national level, study NT-24-05 ("Synthesis of Climate Change Sensitivity and Information Gaps in Priority Management Areas of the Outer Continental Shelf") is taking a national approach to compiling and evaluating existing information on climate change impacts on OCS environments, particularly for deeper waters and areas with vulnerable species and habitats, identifying knowledge gaps, and creating a "one-stop shop" that can be referenced by BOEM subject matter experts (SMEs). The scope of NT-24-05 does not include developing a strategy for incorporating this information into BOEM decision-making. BOEM's Pacific region needs a clear framework that not only identifies the various climate stressors that impact the region and their projected future changes, but also how they interact with BOEM Pacific activities. This framework should also provide a systematic and intentional strategy for integrating this information into its processes and procedures. Ongoing efforts at the department and bureau levels do not specifically address this need. By developing this framework, this study will facilitate BOEM Pacific's compliance with existing NEPA requirements and align with BOEM-wide (2024-2028 Strategic Framework, Operational Priority #4), Department-wide (DOI Climate Action Plan, S.O. 3399, 523 DM 1, 526 DM 1), and Federal-level (CEQ 2023; E.O. 14008) efforts to better understand and address climate change, and will serve as a model that can be adapted to other BOEM regions and inform HQ planning.

Objective(s): The main objectives of this study are as follows:

- Identify, compile, and synthesize key existing climate change-related information (e.g., baseline climate conditions, TEK, and future scenarios of biotic, abiotic, and socioeconomic factors) relevant to the Pacific OCS region and BOEM Pacific's proposed activities.
- Develop a systematic strategy with NEPA coordinator and SME buy-in for incorporating this information into the NEPA review process and other BOEM Pacific decision-making; this includes generating a process model that demonstrates how to adjust this strategy as needs evolve and additional sources of data become available.

- Develop talking points that can be used by BOEM Pacific staff when answering climate change-related questions at public-facing meetings.
- Complement and integrate with the ongoing National Study NT-24-05 through close communication with the POC, sharing resources, and two-way feedback.

Methods: First, resources relevant to climate change in the Pacific region will be compiled, including pre-existing baseline climate data, TEK, future climate scenarios, and climate assessment and/or vulnerability reports. This phase of the study may take the form of a workshop, where Federal and State agencies, academics, Tribes, and other stakeholders come together to contribute what they consider valuable climate change-related information that they believe should be incorporated into BOEM's decision-making processes. As part of this effort, other existing Federal climate-focused studies and committees, such as NT-24-05 and CPRE CSACT, will be consulted, and climate change-related mitigation measures that are already in place may also be summarized. Available future climate scenarios will be evaluated based on their likelihood and relevance to the Pacific region (e.g., projections of sea-level rise, sea-surface temperature, upwelling indices, storm intensity, etc.). Then, through coordination and review with Pacific region NEPA coordinators and SMEs, either through an internal workshop or a series of meetings, relevant climate change-related text and figures will be developed for incorporation into BOEM's NEPA documents. Text may include a description of climate projections relevant for the affected environment and additional climate-related mitigation measures. A process model will also be created that clearly expresses the factors to consider at each step of the NEPA process (similar to Brandt and Schultz 2016). This model will also consider how to adjust this approach as needs evolve and new data emerge. Finally, a series of talking points for Pacific climate change-related questions will be developed together with communications personnel, both at the detailed level approved by SMEs for the purpose of Pacific stakeholder meetings, and at high level for upper management to reference at national-scale meetings.

Specific Research Question(s):

1. What climate change-related information pertaining to the Pacific region already exists?
2. What is the best way for this information to be applied to the NEPA review process and other aspects of BOEM Pacific's decision-making?
3. Which future climate scenarios should be used for the Pacific region and why? What are their caveats?
4. How can we continue to integrate climate change information into BOEM processes, even as our needs evolve and new data and/or information emerge?
5. What are the best practices for talking about climate change to stakeholders? How can BOEM Pacific staff be best prepared to handle questions from stakeholders regarding climate change, like "How is offshore wind energy development combating climate change"?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	A Data Inventory and Assessment of Submerged Aircraft Loss Records on the Gulf of Mexico Outer Continental Shelf
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov), James Moore (james.moore@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	January 30, 2024
Problem	BOEM has a deficiency in information about 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 Gulf of Mexico (GOM) OCS. The database 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 records will be documented.
Outcome	A listing of data sources will help BOEM target information collection on potential sunken aircraft sites along the OCS.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): On February 20, 2019, a survey company operating in the GOM snagged a sunken aircraft with the umbilical of a remotely operated vehicle (ROV) while deploying an ocean bottom node (OBN). 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. This is, unfortunately, not the only such occurrence in recent years. In May of 2023, another seismic exploration company snagged on a previously uncharted seafloor obstruction. The visibility was too poor to identify the object, but self-reporting from the operator stated that no damage was visible to the object. BOEM does not currently require that archaeological surveys take place before 3D or 4D seismic surveys are conducted because many of these survey areas cover thousands of OCS blocks. Cost projections of full high-resolution surveys of one such project would be in the hundreds of millions of dollars and take multiple years to execute and process. Many of these surveys include dense placements of OBNs on the seafloor that can lead to site disturbance, as illustrated in the examples above. Submerged aircraft are a type of cultural resource that have been predominantly overlooked in planning considerations for Federal offshore industrial development. BOEM's databases have little consolidated information about the loss of historical aircraft over the OCS. An inventory of general information about these resources will assist BOEM develop a future database and starting to address this data gap for the agency. Unfortunately, the current review process and protection measures do not adequately address submerged aircraft because BOEM is not requiring survey in all circumstances due to exorbitant related costs. Also, submerged aircraft often have a very small signature in geophysical surveys and so are very difficult to detect. The overall lack of loss records and information are impeding BOEM's ability to use and apply avoidance protections.

Background: According to the National Park Service (NPS), "much of America's 20th century history is inextricably linked to aviation. At times, American inventors, scientists, engineers, pilots, and military and civilian leaders headed pioneering efforts to develop aviation technology and uses. In different periods, the United States lagged behind other nations and needed highly dedicated and costly efforts to catch up" (1998). BOEM's information management system is focused primarily on data relating to shipwrecks and prospective paleocultural landscapes and sites on the OCS. A comprehensive overview of submerged aircraft would provide documentation sources, historical context, and loss data locations that could be integrated into new aircraft databases as a follow-on to this data inventory study.

Objective(s): This study's objective is to create a comprehensive listing of the types of 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 also rank data sources based on the rapid availability and potential for incorporated into operational GIS planning tools. Potential database resources include:

- Airforce Legacy Program
- Army Center of Military History
- Aviation Archaeological Investigation and Research
- 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 Park Service
- National Register of Historic Places
- Naval Historical Center
- U.S. Coast Guard Museum
- State Historic Preservation Offices
- National Trust for Historic Preservation

Specific Research Question(s): Who has data on submerged aircraft losses? Are these data usable for BOEM's operational and permitting needs? How feasible would database development be using these data?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Milbrooke AE, Andrus P, Cook J, Whipple DB. 1998. Guidelines for Evaluating and Documenting Historic Aviation Properties. National Register Bulletin 43. Washington (DC): U.S. Department of the Interior, National Park Service, National Register of Historic Places. 56 p. [accessed 2024 Jan 23]; https://www.nps.gov/subjects/nationalregister/upload/NRB43-Complete.pdf

Field	Study Information
Title	Air Quality Modeling in the Gulf of Mexico Region - 2025 Update
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov)
Procurement Type(s)	Interagency Agreement, Cooperative Agreement
Conducting Organization(s)	U.S. Environmental Protection Agency
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	March 28, 2024
Problem	BOEM needs updated photochemical modeling assessing air quality impacts from oil and gas activity scenarios in the Gulf of Mexico (GOM) used in BOEM's environmental impact statements, and to improve air dispersion modeling for oil and gas plans in the GOM.
Intervention	Use BOEM's emission inventories to estimate scenario air emissions, generate necessary meteorological data files, and conduct air quality modeling to report ambient air concentrations under different oil and gas activity scenarios.
Comparison	The modeled ambient air concentrations from an oil and gas single sale scenario would be compared against the ongoing and cumulative scenarios. The modeled meteorological conditions and ambient air concentrations may also be compared to field measurements and/or satellite data, if available.
Outcome	Modeled ambient air pollutant concentrations from oil and gas activity scenarios to address air quality impacts in BOEM's environmental impact statements.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): BOEM needs updated air quality photochemical modeling (including meteorological modeling) to support the air quality analysis in BOEM's environmental impact statements (EISs) for the National Environmental Policy Act (NEPA) and to support the requirements in the Outer Continental Shelf Lands Act (OCSLA). This information would also be used to address air quality impacts specific to Environmental Justice (EJ) areas, as required by Executive Order 12898. Under E.O. 12898, to consider disproportionate environmental effects of agency actions to EJ communities.

Background: In 2019, BOEM completed a study, "Air Quality Modeling in the Gulf of Mexico Region" (OCS Study BOEM 2019-057); now that information is dated. The study performed meteorological modeling using the Weather Research and Forecasting (WRF) model to support the air quality modeling for calendar years 2010-2014 and used single lease sale scenarios from the 2017–2022 GOM Multisale EIS. Also, the 2019 study did not model a range of impacts to address low, mid, and high impacts, and emissions from other air pollutants like hazardous air pollutants and greenhouse gases. Recent BOEM emission inventories include estimates of hazardous air pollutants and greenhouse gases that can be used in future air quality modeling efforts. A tiered-observing strategy using airborne measurements may also be used to address uncertainties in the emission inventories and modeling (McDonald et al., 2023).

Oil- and gas-related activities authorized under OCSLA must comply with the National Ambient Air Quality Standards (NAAQS). Section 5(a)(8) of OCSLA 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. The 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. Hazardous air pollutants and pollutant greenhouse gas types are also considered harmful to the public (USEPA 2024; USEPA 2009).

Objective(s): This study will use emission inventories to model ambient air concentrations from oil and gas activity scenarios for a single proposed oil and gas lease sale in the GOM.

Methods: This project would collaborate with the U.S. Environmental Protection Agency (USEPA) and leverage ongoing work to develop a new photochemical modeling platform representing 2022. That USEPA effort would be augmented with resources from BOEM to add a finer resolution (~4 km) model domain over the GOM to best represent meteorology, offshore emissions, and the complex land-water interface. Model contribution from offshore sources output from that finer resolution modeling would be processed in a way that is consistent with USEPA's Guideline on Air Quality Models (Appendix W to 40 CFR Part 51) and other relevant permit program modeling guidance.

The project would additionally involve funding from BOEM to conduct meteorological modeling with the Weather Research and Forecasting Mesoscale Model (WRF) for two more annual fine-scale (~4 km) simulations in addition to 2022 (specific years will be determined later). These additional WRF simulations will leverage new WRF data generated by USEPA with a 12-km grid. All the WRF output will be evaluated for use over the GOM and used to make inputs for the photochemical grid modeling. Further, all three years of WRF output would be used to develop the mesoscale model interface (MMIF) files for air dispersion modeling. Wilson et al. (2019) generated meteorological data for WRF and MMIF and are provided at https://boem.gcoos.org/. These meteorological files would replace the existing files.

BOEM resources will support photochemical grid modeling for the fine scale (4 km) domain over the GOM for 2022. This photochemical model application will include source apportionment for specific offshore sources and/or defined offshore source regions to estimate contribution to model predicted O_3, secondary $PM_{2.5}$, and primary $PM_{2.5}$ at distances greater than 50 km. A comprehensive air emission inventory would be developed using USEPA's existing data added with BOEM's emission inventories to depict emissions within the study area for a low, mid, and high impact using the base case (ongoing scenario), single lease sale plus base case, and future year scenario (cumulative scenario with and without the single lease sale) to support photochemical grid modeling. Photochemical grid modeling would be conducted to examine the potential air quality impacts of a low, mid, and high single sale scenario representative of a typical oil and gas lease sale for the GOM.

The baseline photochemical model simulation will be processed and compared with routine surface measurement network data to support an operational model evaluation. The modeled ambient air concentrations would be processed and compared to applicable standards such as the NAAQS and AQRVs. Select air toxins (i.e., hazardous air pollutants) would also be modeled and, when possible, compared to any standards. Model predictions will be paired with demographic data to support environmental justice analytical efforts.

Core model products developed with BOEM funding leveraging USEPA modeling efforts: 1) annual 4 km WRF simulations for 2022 and two additional years (likely 2023 and 2024); 2) annual 4 km photochemical grid modeling simulation for 2022 for a) baselines scenario, b) low impact scenario, c) mid-impact scenario, and d) high impact scenario; 3) annual 4 km photochemical grid model simulation for 2022 with source apportionment to track specific sources and/or source regions in the GOM; 4) annual 4 km MMIF output files for dispersion model applications for 2022 and two additional years (likely 2023 and 2024); and 5) WRF and photochemical model baseline model performance (for 2022) technical support document.

Optional tasks would be to address uncertainties in emission inventories and provide more complex diagnostic model evaluation using satellite data and special measurements made as part of relevant field studies like “Airborne Surveys on Oil and Gas Activities in the Gulf of Mexico Region” and the NASA’s SCOAPE II cruise. The optional tasks would include:

1) Examine how well does the modeling system capture meteorological conditions and processes in the GOM related to elevated levels of $PM_{2.5}$ and O_3 using special field measurements made as part of field studies. Examine how well does the model capture $PM_{2.5}$, O_3, and important precursors and intermediate chemical compounds in the GOM using measurements made as part of special field studies (e.g., SCOAPE 2019 and 2024) and if feasible satellite products (e.g., TEMPO).
2) How can emissions inventories (criteria air pollutants and methane) for sources in the GOM be evaluated and improved through airborne measurements and satellite products.

Specific Research Question(s):

1) Which meteorological conditions are realistic and most conducive to higher ambient air concentrations overland and overwater, including expected future trends in emissions and climate change projections? And how do these meteorological conditions align (temporally and spatially) with the forecasted emissions from a representative single sale?
2) What are the differences between the emissions using activity and production levels from the activity scenarios? Which is more appropriate to use for modeling and why?
3) What are the low, mid, and high modeled ambient air concentrations offshore, onshore, and within the modeling grid for all scenarios and their locations?
4) What are the low, mid, and high modeled ambient air concentrations on areas with EJ communities for all scenarios?
5) (Optional) Do EJ communities in the Gulf Coast located within NAAQS nonattainment areas have air quality impacts from OCS oil and gas activities (either cumulatively, from a single sale, or cancellation of a single sale)? If so, is it possible to determine if they are disproportionate compared to impacts experienced by other communities in the NAAQS nonattainment areas?
6) (Optional) How can emission inventories (criteria air pollutants and methane) for sources in the GOM be evaluated and improved through airborne measurements and satellite products?

Current Status: N/A

Publications Completed:

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. 656 p. Report No.: OCS Study BOEM 2019-057.

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Affiliated WWW Sites: N/A

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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. 656 p. Report No.: OCS Study BOEM 2019-057.

Field	Study Information
Title	Airborne Air Emission Surveys of Oil and Gas Activities in the Gulf of Mexico Region
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Cholena Ren (cholena.ren@boem.gov), Nellie Elguindi (nellie.elguindi@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	National Oceanic and Atmospheric Administration
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	April 5, 2024
Problem	BOEM needs basin to facility scale airborne air emission surveys to assess air quality impacts from oil and gas activity activities in the Gulf of Mexico (GOM) and to address potential data gaps in BOEM's emission inventories used for NEPA.
Intervention	Collaborate with NOAA to extend their existing multi-aircraft campaign to take airborne measurement surveys offshore in the GOM.
Comparison	The quantified emissions would be compared to newly launched satellite sensors for monitoring and measuring methane emissions (e.g., MethaneSat, Carbon Mapper) and other air emission data products, when possible. Also, the field measurements may be used to examine how well the modeling system capture meteorological conditions and processes in the GOM.
Outcome	Quantification of basin and/or facility scale emissions on a limited set of air pollutants in the GOM.
Context	Western GOM, Central GOM

BOEM Information Need(s): BOEM has jurisdiction over Outer Continental Shelf (OCS) air emissions in the GOM west of 87.5 degrees West longitude on a limited set of air pollutants. Oil- and gas-related activities authorized under the Outer Continental Shelf Lands Act (OCSLA) must comply with the National Ambient Air Quality Standards (NAAQS). This study supports BOEM's ability to monitor air emissions over the OCS, improve quantification of air emissions, and work towards assessing the impact of regulated air emissions and those not controlled by regulation. BOEM needs to evaluate its emission inventory and quantify the associated uncertainties to fully characterize the impact of its oil and gas activities in the GOM.

Background: The 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. Hazardous air pollutants and pollutant greenhouse gas types are also considered harmful to the public (USEPA 2024; USEPA 2009). Oil and gas operators in the GOM are required to report to BOEM's emission inventory, the Outer Continental Shelf Air Quality System (OCS AQS). OCS AQS estimates air emissions from routine oil and gas activities, but the air emissions are not monitored and measured. It has been demonstrated there are uncertainties in OCS AQS (Gorchov Negron et al. 2023). BOEM can collaborate with the Bureau of Safety and Environmental Enforcement (BSEE) risk-based inspection program as a supplemental approach to effectively use resources to survey near high-risk facilities with an air quality focus (BSEE 2019). Quantification of air emissions can be completed near the high-risk facilities and then $PM_{2.5}$, O_3, and other important precursors and intermediate chemical compounds can be examined in the photochemical modeling by the U.S. Environmental Protection Agency (EPA). Gorchov Negron et al. (2023) was able to take airborne air emission measurements for methane and compare them to OCS AQS at a basin and facility-level. A tiered-observing strategy using airborne measurements can be used for quantification of oil and gas emissions (McDonald et al. 2023).

Furthermore, this project would evaluate a hazardous air pollutant (USEPA 2024), formaldehyde, which is the highest emitted hazardous air pollutant reported in OCS AQS for BOEM's 2021 Emission Inventory. The BOEM's 2021 Emission Inventory indicates the highest offshore oil and gas source of formaldehyde emissions—not controlled by regulation—are from combustion flares (Thé C et al. 2023). The airborne air emission surveys will be able to analyze destruction and removal efficiencies (DRE) for flares. To-date, few field measurements have been taken of formaldehyde emissions from offshore oil and gas operations in the GOM (Duncan 2020).

Note this study overlaps with the study profile NT25, Verification of OCS AQS and Development of a Satellite-based Top-down Emissions Inversion System, and if costs are shared between the offices, each office's contribution would be lower. The study also overlaps with the study profile GM25 Air Quality Modeling in the Gulf of Mexico Region – 2025 Update for the optional task described in the methods.

Objective(s): This study will quantify basin to facility scale emissions (including methane, nitrogen oxides, total reactive nitrogen, formaldehyde, ethane, and CO) from oil and gas activities in the GOM.

Methods: This project would use in-kind contributions from NOAA. NOAA would operate and use their NOAA's P-3 and/or Twin Otter aircraft to collect measurements. The NOAA P-3 would perform about 38-hour sampling times over 14 days and the Twin Otter would perform about 7-hour sampling times per day for 7 days. Airborne surveys and satellite remote sensing data could occur near high-risk facilities using BSEE's risk-based inspection program. The quantified emissions would be compared to OCS AQS at a basin, facility, or source level, when possible. If the data indicates the air emissions reported in OCS AQS is underestimated or overestimated, then BSEE may follow-up with an inspection. Due to limited space on the Twin Otter aircraft, this project would be limited to a set of air pollutants (nitrogen dioxide, methane, carbon dioxide, ozone, and formaldehyde). The NOAA P-3 aircraft is larger and can hold more instruments than the Twin Otter therefore additional air pollutants can be measured like sulfur dioxide, volatile organic compounds, and ammonia.

An optional task would be to address uncertainties in the emission inventories and modeling system through these airborne measurements and/or satellite remote sensing data, when possible. This optional task would require collaboration with EPA through other BOEM studies like the Air Quality Modeling in the GOM region – 2025 Update. EPA would examine the modeling system using measurements made as part of these special field studies. NOAA would help and share knowledge with EPA.

Specific Research Question(s):

1. Based on field measurements, are any air emissions reported in OCS AQS being underestimated or overestimated? Can the facility and/or emissions source be identified?
2. What is the cause of the overestimation or underestimate of the air pollutants?
3. (Optional) How can emission inventories for sources in the Gulf of Mexico be evaluated and improved through airborne measurements and satellite products?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Green Hydrogen (GH2) Production from Offshore Wind Energy: Informing Management Needs Through a Focused Literature Review, Information Synthesis, and Gap Analysis
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Allen Brooks (Robert.Brooks@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2026
Final Report Due	December 2026
Date Revised	October 10, 2023
Problem	BOEM) has regulatory authority to lease and manage offshore wind (OSW) projects on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS). The region's first renewable energy lease sale was held in 2023 and potential operators have expressed interest in using OSW generated electricity to produce green hydrogen (GH2). Information on potential impacts to human, marine, and coastal environmental resources from offshore production of GH2 is needed to inform National Environmental Policy Act (NEPA) and management decisions.
Intervention	Perform a literature review and synthesis on the potential impact producing factors (IPFs) related to the production of hydrogen with offshore wind (GH2-OSW); use this information to document the potential impacts to the human, marine and coastal GOM environments; and identify potential mitigation and knowledge gaps.
Comparison	Build on the earlier BOEM study, Assessment of BOEM's Role in Reviewing Hydrogen Production as a Complement to Offshore Wind, which provides background, technical analysis, and recommendations to update regulatory guidance for OSW development on the OCS, and compile technical and environmental information to support future, potential environmental reviews and consultations related to GH2-OSW.
Outcome	A reference resource for BOEM to use in assessing (e.g., NEPA and consultations) the potential effects of OSW development supporting green hydrogen.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): OSW on the OCS is a significant renewable resource that can support utility-scale green hydrogen (GH2) production. Per 30 CFR 585.101(c), BOEM is required to ensure that renewable energy activities on the OCS are conducted in a safe and environmentally sound manner, in conformance with the requirements of subsection 8(p) of the Outer Continental Shelf Lands Act

(OCSLA), other applicable laws. GH2 production (electrolysis) uses energy derived from OSW and can be performed either (1) via an offshore electrolyser(s) where the derived H_2 is transported onshore through a pipeline[1]; or (2) via an onshore electrolyser(s) powered by an OSW export cable. To meet environmental review requirements, BOEM needs information on GH2 project-related factors (e.g., processes, infrastructure, hazards, by-products) that may affect the environment, and on the pathway(s), nature, and spatial and temporal extent of potential effects (e.g., direct, indirect, and cumulative effects). GH2 onshore and offshore infrastructure designs and component technologies need to be evaluated to assess potential contribution to such project-related impact producing factors (IPFs). The resulting information would be used in review of proposed activities (e.g., NEPA, Construction and Operation Plan reviews, consultations) and inform development of reasonable, effective and enforceable conditions of approval as needed.

The recent BOEM study, Assessment of BOEM's Role in Reviewing Hydrogen Production as a Complement to Offshore Wind, provided background information, technical analysis, and recommendations to inform regulatory guidance and identified gaps in technical review expertise for administering GH2-OSW permitting and safety enforcement (Banks et al., 2022)[2]. Based on that assessment, multiple potential IPFs require identification and evaluation for GH2-OSW projects, including, but not limited to, process and/or cooling water uptake[3], process water discharge (i.e., brine), entrainment and/or impingement, vessel traffic, and offshore construction (e.g., pile driving, pipelines) These IPFs may affect water quality, pelagic resources (e.g., plankton, fisheries), benthic resources (e.g., hard-bottom), protected species, archeological resources, socioeconomic resources, etc. The manner and intensity of these potential effects should be investigated more closely. Production, storage, and transport of H_2, a highly flammable gas, introduce potential environmental and human health hazards (e.g., leaks). Information is needed about the potential impacts to the human, marine, and coastal environments from offshore GH2 production and possible mitigation measures. This study will help fill these knowledge gaps and identify remaining ones.

Background: H_2 gas has the highest energy content by weight of any fuel (EIA, 2023) and can be produced from water by electrolysis. Electrolysis, which splits water molecules into pure H_2 and oxygen[4], is an existing, commercially available technique at the industrial scale. "Green" H_2 refers to when the energy used for electrolysis comes from a renewable source (e.g., wind, solar). Pairing GH2 production with OSW could provide a significant advantage to an OSW project. Electrolyser technology can feasibly ramp up and down matching OWS energy output with limited technical constraints reducing or eliminating curtailment, unlike typical onshore electric grid interactions.

The Administration set a goal of deploying 30 gigawatts (GW) of OSW energy capacity in the U.S. by 2030 (Biden, Executive Order 14008)**.** The first GOM OSW lease sale was held on August 29, 2023. The GOM is primed as a target area for offshore GH2-OSW projects. As of 2020, there were 1,608 miles of active H_2 pipelines in the U.S.; over 90 percent are located along the GOM coast serving refineries and ammonia plants. Potential GOM OSW lessees have expressed interest in a combined GH2-OSW development; the Governor of Louisiana has entered into a multi-state partnership to establish a regional hub for H_2 (Louisiana Office of the Governor, 2022).

[1] Depending on the length of the pipeline, compression might be needed.
[2] Banks et al. (2022) discusses technical elements of GH2 production but does not evaluate environmental impacts.
[3] The volume of water required for the electrolysis process and subsequent discharge is a critical element.
[4] Electrolysis itself does not produce any byproducts or emissions other than hydrogen and oxygen.

Objectives: Conduct a literature review and synthesis of relevant, up-to-date information to identify (1) potential IPFs from GH2-OSW projects; (2) characterize potential impacts of these IPFs to the human, marine, and coastal environments; (3) characterize the possible pathways of the potential impacts; (4) identify possible avenues to minimize environmental effects; and (5) document gaps in the information needed to fully evaluate the potential environmental effects of proposed GH2 projects.

A synthesis report will characterize potential environmental impacts, including direct, indirect, and cumulative effects, specific to the GOM OCS. It will also discuss potential measures to minimize environmental impacts. Finally, the report will document information gaps and recommend topics for future research and/or modeling (e.g., brine discharge plume).

Methods: Review and synthesize current relevant literature, focusing on (1) potential IPFs from GH2-OSW combined activities; (2) potential impacts to the human, marine, and coastal environments; (3) characterizing the possible pathways of the potential impacts; (4) possible mitigation measures that have been identified, if any, to minimize potential impacts; and (5) knowledge gaps and potential areas of study. Resources may include scientific literature, white papers, information from test sites, discussions with offshore wind developers and equipment manufacturers, etc. Available information on the subject is rapidly growing. For example, GH2-OSW projects are currently in development in Europe; the first hydrogen produced by a pilot project was during the summer of 2023 (Hydrogen Insight, 2023). Some countries (e.g., Norway, Scotland) are looking at potential projects to facilitate large-scale transport of GH2 across Europe (Crown Estates Scotland, 2023; Offshore, 2024). Relevant information from onshore electrolysis and H_2 transportation projects that could translate to the offshore may also be included, if identified. The study will also generate an EndNote® reference library for use in future analyses.

This study entails compiling, vetting, and analyzing available information relative to GH2-OSW project impacts, then synthesizing it to create a useful resource to address BOEM's GOM-region needs. Future potential study needs will also be identified to address knowledge gaps. SME input will be included during development of the statement of work and the study to maximize use of the final deliverables.

Specific Research Question(s):

1. What are the potential IPFs associated with GH2-OSW project activities, what information is available on the potential IPFs, and, of the potential IPFs, which are of concern specific to the GOM region and why?
2. What information is currently available on the mechanisms, scope, and scale of potential impacts from GH2-OSW project activities to human, marine, and coastal environmental resources?
3. What are any previously identified mitigation measures, if any, to minimize potential impacts to environmental resources from each phase (e.g., construction, operations) and process (e.g., cooling water uptake, brine discharge) of GH2-OSW project activities?
4. What are the data and/or information gaps in understanding potential effects to environmental resources (resource specific) from GH2-OSW project activities?
5. What knowledge can be translated from overseas projects, recent European pilot projects?
6. What information and data are currently available regarding potential impacts from onshore electrolysis and H_2 transportation projects that can be translated to the offshore environment?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Gulf of Mexico Environmental Justice Fact Book: Coastal Communities Affected by Activities on the Outer Continental Shelf
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Dustin Reuther (dustin.reuther@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	April 3, 2024
Problem	Currently there is no comprehensive resource for the identification and characterization of Gulf of Mexico (GOM) environmental justice (EJ) communities as they relate to BOEM-adjacent activities and resource management, or region-wide analyses of whether these communities may be disproportionately impacted from agency activities.
Intervention	A study that uses mixed methods to identify and characterize GOM EJ communities of particular interest to BOEM, especially as they relate to environmental impact analyses conducted by BOEM.
Comparison	Capture the demographic assemblages and impacts for EJ analyses and outreach efforts related to the oil and gas program, and could subsequently be used for marine mineral, renewable energy, and carbon sequestration programs in the region.
Outcome	Help BOEM address environmental justice considerations raised by recent Executive Orders, cooperating agencies, and litigants within NEPA analyses and in conducting engagement and outreach more effectively to those communities through the creation of an all-in-one regional EJ Fact Book.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): Multiple vulnerable communities exist across the GOM region that are classified as EJ communities based on national legislation and related policies and efforts. Previous BOEM-sponsored EJ-related studies in the GOM have focused mostly 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, 14096). Particularly, BOEM needs a better understanding of which EJ communities are most impacted by BOEM-related actions and what sorts of cumulative stressors exist within those communities. A systematic analysis (rather than piecemeal studies) is needed so that BOEM can identify if EJ communities are *disproportionately* impacted by its programs–something that cannot be done in NEPA analyses for lease sales for the oil and gas (O&G) program because of a variety of constraints (such as onshore locations for activities being largely unknown at the time of a lease sale). Addressing whether agency actions have disproportionate impacts (including indirect and cumulative impacts) is a main component of EJ-related EOs. Further, this data would be an important resource in strengthening BOEM outreach and engagement activities across the region. As part of the Environmental Justice Technical Workshops for the GOM Region (GM-21-x03) this proposed study was recognized by a team of external experts as one of the most pressing data needs for BOEM's GOM EJ analyses and activities, as well as being an appropriate way to capture that data.

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 that touch on EJ concerns (e.g., Austin et al. 2014; Regis and Walton 2022). The GOM 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 O&G development and EJ concerns. For example, one study (which this proposed study would build from) 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 O&G 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 region 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 for those programs.

EJ communities often have compounding stressors impacting them, such as air quality, environmental degradation, weather events, economic stress, etc. For example, weather-related oil and gas spills, such as the onshore Murphy Oil refinery spill following Hurricane Katrina, have negatively impacted EJ communities and this is compounded by increasingly worsening hurricanes. Further compounding 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, it can be seen how some GOM EJ communities are impacted by the compounding effects of global climate, local environmental deterioration, O&Gs procurement and refining, and local and national policies.

Objective(s): BOEM requires a better understanding of how to systematically and programmatically 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-14-03-09). Also, BOEM seeks a strategy to identify organizational capacity and existing leadership within those communities so that BOEM can more effectively execute outreach and/or engagement efforts.

Methods: This study will use a mix of methods due to its multiple goals and issues about data availability. 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 concluding "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 for this purpose.

Desktop analyses will use existing datasets, such as the Census Bureau's American Community Survey (ACS) 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 connected to OCS development captured in the existing and upcoming GOM Infrastructure Fact Books (e.g., GM-14-03-09). The specifics of these desktop analyses will be informed by efforts from past GOM EJ study efforts, the concluding Environmental Justice Technical Workshops for the GOM Region (GM-21-x03), and BOEM's national EJ Best Practices work, the Characterization of EJ Communities pilot study (NT-23-05), and the Health Impacts to EJ Populations literature review (NT-23-08). 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 for cumulative burdens (such as captured in EJScreen).

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. These on-the-ground assessments are also productive for communities where existing data (such as the ACS) 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 synthesized within the overarching project?
2. Are there potentially disproportionately impacted EJ communities when the region is analyzed as a whole? In what ways can we prioritize focus to specific communities to efficiently use 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?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Offshore Wind Energy Facilities Impact on Hydrodynamics and Primary Production in the Gulf of Mexico
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Mary Kate Rogener-DeWitt (mary.rogener-dewitt@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	February 1, 2024
Problem	The Louisiana-Texas shelf is a highly productive, broad continental shelf with complex hydrodynamics. 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 (GOM). BOEM) needs information to assess the potential impacts to the northern GOM for mitigation efforts and future environmental analyses.
Intervention	A coupled hydrodynamic-nutrient phytoplankton zooplankton detritus (NPZD) biogeochemical model will be used to estimate the potential impacts of offshore wind energy facilities and various wind turbine configurations on the hydrodynamics, water quality, and primary productivity in the GOM region, specifically within planned Wind Energy Areas (WEAs).
Comparison	This study will use model simulations to investigate hydrodynamics, water quality, and primary productivity prior to offshore wind construction, post installation of a single facility, post full build-out of a realistic configuration of multiple facilities across the wind energy areas, as well as various turbine configuration scenarios in the GOM region.
Outcome	This study will estimate the potential impacts of offshore wind energy facilities, at different stages of development and various turbine configurations, on GOM Outer Continental Shelf (OCS) hydrodynamics, water quality, and primary productivity. This information is necessary for mitigation efforts and future environmental analyses.
Context	Western GOM, Central GOM

BOEM Information Need(s): Per 30CFR585.101(c), BOEM needs to ensure that renewable energy activities on the OCS are conducted in a safe and environmentally sound manner. To satisfy this obligation and support the sustainable development of offshore wind in the GOM, BOEM needs to understand and estimate the potential impact of offshore wind development on local and regional hydrodynamics, and resulting impacts on water quality and primary productivity.

This study would help BOEM estimate potential impacts of offshore wind energy facilities–during the various stages of construction and/or operation and configuration scenarios–on the hydrodynamics, water quality, and primary productivity of the GOM; provide information to stakeholders through impact assessments and consultations; and guide potential mitigation measures. These results would be included as part of impact assessments pursuant to the National Environmental Policy Act (NEPA), Endangered Species Act, and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: The GOM is a highly productive, broad continental shelf system with complex hydrodynamics due to multiple river plumes with varying spatial distributions, Loop Current, Loop Current eddies, and seasonally driven shelf circulation resulting in stratification along the shelf (Hetland and DiMarco 2012). These complex oceanographic regimes make the GOM prone to low oxygen conditions. Research in the North Sea, a similar low oxygen prone system, shows that wind energy facilities further decrease dissolved oxygen concentrations (Daewel et al. 2022). Studies from other regions have shown that offshore wind energy facilities alter regional and local hydrodynamics, surface wind fields, biogeochemistry, and primary productivity (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; 2023). However, the relevance of the impacts found in other regions (North Sea, California Current, and the Mid-Atlantic Bight) to the GOM is unknown. Due to the productive and dynamic nature of the GOM, it is important to understand how offshore wind energy development in the GOM may impact hydrodynamics, water quality, and primary 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 water quality (e.g., sediment and nutrient transport and resuspension) and primary productivity. To date, BOEM has funded studies to analyze the impacts of offshore wind energy facilities on physical and oceanographic processes in the California Current, Nantucket Shoal, and Mid-Atlantic Bight (Chen et al. 2016; Johnson et al. 2021; BOEM Study AT-22-01A&B; BOEM Study NT-23-09; NASEM 2023). Conditions in those regions differ from the physical and biological dynamics of the GOM.

Recently, BOEM issued one lease for offshore wind development on the OCS of Louisiana and has finalized four more WEAs for future development[1]. Stakeholders have expressed concern regarding the impacts of large and multiple wind projects on circulation patterns in response to recently published findings on the impacts of wind energy facilities on hydrodynamics, primary production, and local oxygen concentrations. To address the knowledge gaps in the GOM 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 GOM was in the summer 2023; this study would provide vital information during the development and environmental review of future lessees' Construction and Operation Plans.

Little is known about the hydrodynamic impacts of various wind turbine configurations (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

[1] https://www.boem.gov/renewable-energy/state-activities/gulf-mexico-activities

WEAs in the Mid-Atlantic determined that wind speed, turbulence, friction velocity, and sensible heat fluxes at the surface of the water are 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 configuration to ensure the least amount of local hydrodynamic impact on the environment as practicable.

Objective(s): Use model simulations to estimate the potential impacts of offshore wind energy facilities in the GOM on hydrodynamics, water quality, and primary production. Investigate various development scenarios and turbine configurations and evaluate how the scenarios and configurations affect the hydrodynamics, water quality, and primary production. Synthesize available empirical data and use data to inform, verify, and validate model results. 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 and 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 GOM regional modeling approach will be used, and the spatial domain of the model will include the WEAs on the Louisiana-Texas OCS. 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-nutrient, phytoplankton, zooplankton, detritus (NPZD) biogeochemical model that offers the best approach and resolution to complete the objectives and specific research questions. Possible models include but are not limited to HYCOM, FVCOM, ROMS, Delft3D. The hydrodynamics of different scenarios will be simulated. Example scenarios include conditions before offshore wind farm construction, after installation of a single facility, and a realistic configuration of multiple facilities across the WEAs. Additional scenarios may include configurations of varying turbine sizes, spacing, and future forecasts of climate change scenarios over 30 to 50 years.

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 water quality (e.g., sediment and nutrient transport and resuspension), and subsequent primary production throughout the area?
3. How might alternative siting or turbine configurations act as mitigation efforts and limit impacts on hydrodynamics?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Oil and Gas Vessel Strike Risk Analysis: Cetaceans in the Northern Gulf of Mexico with a Focus on the Endangered Rice's and Sperm Whale
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Allen Brooks (robert.brooks@boem.gov), Hayley Karrigan (hayley.karrigan@boem.gov), Tre Glenn (tre.glenn@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	September 2027
Date Revised	February 1, 2024
Problem	BOEM is required to analyze effects to Endangered Species Act (ESA)-listed and proposed species, ESA-listed species critical habitat (designated and proposed), and Marine Mammal Protection Act (MMPA) protected species resulting from ongoing and future actions associated with BOEM-regulated activities. Based on recent information concerning the possible distribution of Rice's whale (*Balaenoptera ricei*) within the northwestern Gulf of Mexico (GOM) and proposed designation of critical habitat for the Rice's whale, there is a need to evaluate vessel strike risk to this species, and other protected cetaceans (i.e., ESA-listed sperm whales [*Physeter macrocephalus*]), relative to BOEM-regulated vessel activities.
Intervention	Evaluate vessel strike risk for the ESA-listed Rice's and sperm whales in the GOM; using recommendations provided in the BOEM study, Vessel Strike Risk to Rice's Whale in the Gulf of Mexico: Review of Previous Methodologies, Information Gaps, and Recommendations for Future Efforts to Predict Strike Risks, to perform a rigorous, statistically-meaningful vessel strike analysis.
Comparison	The risks from oil and gas vessel collisions in the northern GOM will be put into context of the possible distribution of Rice's whale and other cetacean species within the northwestern GOM.
Outcome	Assessment of vessel strike risk to Rice's and sperm whales in the GOM from BOEM-regulated vessel activities, identification of assumptions and knowledge gaps, and informing of future analyses.
Context	Northern GOM

BOEM Information Need(s): To fulfill requirements under the ESA and MMPA relative to the endangered Rice's and sperm whales, BOEM's Gulf of Mexico Regional Office (GOM) must inform its future efforts to predict reasonable and defensible vessel strike risk for these species**.** Specifically, BOEM needs to use recommendations from previous assessments, including the BOEM study, Vessel Strike Risk to Rice's Whale in the Gulf of Mexico: Review of Previous Methodologies, Information Gaps, and

Recommendations for Future Efforts to Predict Strike Risks, to conduct a rigorous, statistically-meaningful vessel strike analysis; identify the assumptions (e.g., limitations) that are part of the assessment; and identify additional information that is needed to inform future vessel strike analyses. The study will result in more accurate predictions of risk from oil and gas activities.

Background: BOEM is required to analyze effects to ESA-listed species or species proposed for ESA-listing, and designated or proposed critical habitat, and species protected under the MMPA, resulting from ongoing and future actions associated with BOEM-regulated activities. One risk to protected marine mammal species is strikes (i.e., collisions) from vessels conducting BOEM-regulated activities (i.e., oil and gas [O&G]). Collisions between whales and large vessels could injure or kill a whale.

Most reports of vessel collisions with marine mammals involve large whales, though collisions with smaller species also occur (van Waerebeek et al. 2007). Laist et al. (2001) compiled data and found that most severe and lethal whale injuries involve large ships (> 80 meters) at higher speeds (>14 knots). The risk of encounter and possible strikes also depend on species-specific characteristics (e.g., time at surface, migration patterns), and factors such as the location of ports, transit areas, vessel numbers, geographic region, and time of year. To date no strikes to Rice's whale have been observed attributed to Federal O&G-related activities. The only known and documented strike of a sperm whale by an OCS O&G-related vessel was in December 2020. To avoid and minimize the potential for vessel strikes for permits, plans, and other authorizations, the following protocols were and are applied: *Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting* and *Condition of Approval for Vessel Transit within Rice's Whale Core Distribution Area.*

Evaluating the risk of collision is reliant upon the methodology used (both quantitative and qualitative), baseline data incorporated (e.g., suitability, inclusiveness, spatial/temporal extent), and key assumptions made. BOEM recently initiated the *Vessel Strike Risk to Rice's Whale in the Gulf of Mexico: Review of Previous Methodologies, Information Gaps, and Recommendations for Future Efforts to Predict Strike Risks* study to inform the design of future assessments of vessel strike risks in the GOM.

BOEM has also completed a study of vessel strike risk for whales along the U.S. East coast: *Encounter Rates Between Large Whales and Vessel Traffic from Offshore Wind Energy Study* (Offshore Wind Strike Risk Study). The calculator derived from that study provides a risk assessment based on predicted animal-vessel encounters aggregated either along a vessel route or within a wind farm over a user-defined period of time. The user-created scenarios of vessel activities provide the ability to explore different "what-if" scenarios to address planning issues and assess potential cumulative risk to animals from development of offshore wind across the OCS. Phase II of the Offshore Wind Strike Risk Study (*Risk Assessment to Model Encounter Rates Between Large Whales and Vessel Traffic from Offshore Wind Energy, PHASE II Study, AT-23-03*) is currently being initiated; one objective is to expand applicability of the calculator to include other areas, including the GOM. This proposed GOM Strike Risk Study will differ from the Offshore Wind Strike Risk Study in that:

- Most important, this study will incorporate recommendations for methodology and data input that are derived from the *Vessel Strike Risk to Rice's Whale in the Gulf of Mexico: Review of Previous Methodologies, Information Gaps, and Recommendations for Future Efforts to Predict Strike Risks* study. These recommendations may inform Phase II of the Offshore Wind Strike Risk Study if applicable and feasible to incorporate, but they will be the focus of the GOM study.
- This study is interested in predicting how future GOM OCS development may affect risk and also in assessing strike risk based on the current programmatic-level of O&G activities (i.e.,

assessment of actual recent vessel activity). Risk is to be assessed OCS-wide, not at a user-defined individual project (or cumulative project) level.

- The Offshore Wind Strike Risk Study focuses on the vessel type, number, function, and dimensions expected to operate during wind farm site investigation surveys, construction, operations, and maintenance, creating seven categories of vessels. But this study will focus on the O&G vessel categories known to occur in the GOM, at least initially. The similarity of O&G vessel categories to that of offshore wind is yet to be fully determined.
- The Offshore Wind Strike Risk Study has two components: a port-to-wind farm route (transit) component and an on-site (within the wind farm) component. The concern for the Rice's whale in this GOM study will focus on transits through the 100-m to 400-m depth contour. The best methodology to assess risk from transits through this area will need to be determined and should be available from the *Vessel Strike Risk to Rice's Whale in the Gulf of Mexico: Review of Previous Methodologies, Information Gaps, and Recommendations for Future Efforts to Predict Strike Risks* study.
- This study will include an evaluation of how best to include the current Conditions of Approval (COA) that are assigned for Rice's whale protection into the strike risk model.

Objective(s): Predict vessel strike risks to protected cetaceans in the northwestern GOM, focusing on the Rice's and sperm whale, from BOEM-regulated O&G activities when using the current Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting Protocols. This study will generate a written synthesis that provides a critical analysis of strike risk, a summary of assumptions that were built into the analysis, and recommendations for going forward with future analyses. This study will also provide a tool that BOEM staff can use to predict risk across the northwestern GOM given inputs of differing vessel activity levels and patterns. The tool can also be expanded in the future to other cetacean species.

Methods: Use the recommendations provided in the *Vessel Strike Risk to Rice's Whale in the Gulf of Mexico: Review of Previous Methodologies, Information Gaps, and Recommendations for Future Efforts to Predict Strike Risks* study to a conduct a rigorous, statistically-meaningful vessel strike analysis for protected cetacean species in the GOM with a focus on Rice's and sperm whales. Generate a tool that BOEM staff can use to incorporate location and vessel information into to make strike risk predictions.

Specific Research Question(s):

1. How can the probability of encounter risk be translated into a scale of relative risk, with a focus on transits through the 100-m to 400-m depth contour and risk to the Rice's whale?
2. What is the vessel strike risk in the GOM from BOEM-regulated O&G activities to Rice's and sperm whales?
3. What additional information is needed to inform future vessel strike analyses?
4. What tool can BOEM staff use to make strike risk predictions from specific ports in the northern GOM?
5. How do the results relate to the Rice's whale output of specific transit corridors using the tool derived from Phase II of the Offshore Wind Strike Risk Study?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	The Value of View: Visual Impact Analysis from Green Energy Development on Cultural Resources Along the Gulf of Mexico
Administered by	Gulf of Mexico Region
BOEM Contact(s)	Scott Sorset (scott.sorset@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	January 30, 2024
Problem	New offshore technologies are being introduced to the Gulf of Mexico (GOM) region that BOEM must analyze for their visual impacts to cultural resources to be in compliance with national regulations and best practices. BOEM lacks the basic inventory datasets to determine where resources of concern are located because previous oil and gas development activities did not have significant onshore visible effects.
Intervention	Each State maintains a cultural resources inventory of known sites and this information can be complied into a geographical information system (GIS) database for analysis.
Comparison	Identified sites and cultural properties will be compared against GIS projections of possible viewshed impacts from offshore wind, green-hydrogen, and carbon sequestration.
Outcome	BOEM will be prepared with the necessary information for imminent NEPA analysis, consultations, and public meetings related to green energy development in the GOM.
Context	Western GOM, Central GOM, Eastern GOM

BOEM Information Need(s): BOEM lacks a comprehensive inventory of cultural resources along the GOM coastline and in state waters. BOEM needs to collect this information from State Historic Preservation Offices (SHPO), National Park Service, local municipalities, other government agencies, and State and Federally recognized Tribes to assist in compliance with various elements of Sections 106 and 110 of the National Historic Preservation Act, Coastal Zone Management Act, and the National Environmental Policy Act requirements.

Background: Novel green-energy technologies are emerging in the GOM. BOEM needs a basic baseline inventory of locations of all cultural resources known within state waters and the onshore coastal margins of coastal Texas, Louisiana, Mississippi, Alabama, and, potentially, a small swath of Florida to assess visual impacts to known cultural resources from operations like those from offshore wind energy development. GIS can project the locations of those resources relative to projected maximum viewshed impacts along the GOM thereby defining, for planning purposes, areas of concern. This, in turn, enables more targeted and meaningful outreach and specific engagement with those stakeholders most directly affected by development. These data will accelerate the often-lengthy process of adverse effect determinations with appropriate Tribes, SHPO, and the Advisory Council on Historic Preservation (ACHP).

"Cultural resources" has a broad definition and include buildings, districts, sites, structures, and objects that have been recognized by Federal or State government as historically and culturally important and worthy of preservation. Tribes and local communities may also have information on traditional cultural properties which are places that are prominent in a particular group's cultural practices, beliefs, or values. This study will also seek to incorporate traditional knowledge, community knowledge, and environmental justice considerations into its marine spatial planning related to special places similarly to how we consider effects to archaeological sites. Section 110 of NHPA requires Federal agencies to assume responsibility for the preservation of historic properties within their jurisdiction, which includes being aware of the location of such resources. Section 106 of the National Historic Places Act requires Federal agencies to consider the impacts, including visual impacts, of their undertakings on the ability of certain historic properties to convey their historic significance (Andrus 1997). Collecting this information in advance of individual development proposals will go a long way toward demonstrating BOEM's proactive and broad regional approach during consultations and will aid agency planning efforts to minimize space-use conflicts. Each state maintains unique databases and records systems that further complicates region-wide analyses for BOEM. There is insufficient staff and support in the region nor adequate lead-time to pursue this as an internal development project. BOEM environmental staff need additional lead time to address potential adverse effect determinations in Tribal consultations, SHPO consultations, and relevant environmental justice communities. The Gulf Wind 1 lease auction has been completed, Gulf Wind 2 is imminent, and more are in the early planning stages. A similar study along the Atlantic proved beneficial and was completed in 2012 as BOEM report number 2012-006. This project documented and mapped 9,600 known cultural resources for agency consultations and in total, 9,175 were considered to have a historically significant maritime setting, and 1,108 were considered to have a historically significant view toward the open sea. We were subsequently commended by SHPOs and the ACHP for our due diligence in completing this significant analysis (Klein et al. 2012).

Objective(s):

- Identify cultural resources within an appropriate corridor along the coastal GOM.
- Map the locations of known resources within GIS.
- Project maximum viewsheds based on associated visual impact estimations.
- Use concentration mapping to identify areas with high adverse effects or dense concentrations of resources to aid agency space-use conflict planning.

Methods: Selected contractor or university will use known repositories to develop a database of known cultural properties along the GOM. They then will use professional archaeologists, historians, and/or other preservation professionals to filter out resources to which viewshed is unimportant to their significance. GIS tools will then be used to project the remaining resources against estimations of potential viewshed impacts. The resulting maps will provide BOEM both an inventory and planning tool to enhance consultations, space-use conflict analysis, preservation planning, and mitigation development.

Specific Research Question(s):

1. What cultural resources are located within visual range of potential offshore wind, green-hydrogen, and carbon sequestration developments in the Gulf of Mexico?
2. Which of the known cultural resources draw their significance from an unobstructed view of the Gulf?
3. What are the estimated maximum viewsheds for each proposed activity type?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Assessment and Minimization of Avian Collision and Displacement Risk Associated with Renewable Energy Infrastructure in the Cook Inlet Planning Area, Alaska
Administered by	Alaska Regional Office
BOEM Contact(s)	Shane Gray (shane.gray@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	10 February 2024
Problem	Avian collisions with infrastructure are a primary obstruction for migratory bird movements. Unlike many other stressors (e.g., disease, invasive species), collision and displacement risk can be mitigated when movement patterns and responses to artificial attractants, such as lighting is better understood (FCC 2021, Longcore et al. 2012). A recent report by the National Renewable Energy Lab (Meadows et al. 2023), showed that Cook Inlet, Alaska has the potential to generate 95 gigawatt (GW) of energy from wind (1 GW can power 300,000 to 750,000 homes representing 2–5 times the number of homes in all of Southcentral Alaska). Lower Cook Inlet including Shelikof Strait, northern Kodiak Archipelago, and the Kenai Peninsula support ≈325 seabird colonies totaling >500,000 breeding birds.
Intervention	This study will identify locations and seasonal use of avian migratory corridors in the Cook Inlet Planning Area using technologies including radar, telemetry, and publicly available datasets that when completed will result in a temporal and spatial assessment of collision and displacement risk.
Comparison	This study will first complete a review of available publications, reports, and data from federal and state agencies including the U. S. Geological Survey Alaska Science Center and U.S. Fish and Wildlife Service Migratory Bird and Refuge Programs; Alaska Department of Fish and Game; academic and research institutions; industry; conservation groups (e.g., Cook Inlet Keepers, Prince William Sound Science Center, Alaska Sea Life Center), and citizen science organizations including the University of Washington Coastal Observation and Seabird Survey Team (https://coasst.org/). This review will: (i) inform seabird and sea duck habitat use in Lower Cook Inlet to produce maps of currently known high use areas and (ii) provide insights and ultimately inform the design of field methods and data collection.

Outcome	Results from this study will assist BOEM with: (i) marine spatial planning of potential renewable energy wind facilities in Cook Inlet, (ii) fulfill obligations related to National Environmental Policy Act (NEPA), Endangered Species Act (ESA) and Migratory Bird Treaty Act (MBTA), and (iii) ultimately serve to reduce impacts to marine birds associated with permitted infrastructure in coastal Alaska. Deliverables will include an outreach component to ensure best management practices are shared broadly with pertinent government, nongovernment organizations, and private industry stakeholders, improving their conservation value.
Context	Lower Cook Inlet

BOEM Information Need(s): To assess the potential impacts of renewable energy facilities to migratory birds in Cook Inlet, BOEM needs (i) information on the number, location, and seasonal use of migratory bird corridors; (ii) estimates of number, seasonal use, and types (e.g., seabird, sea duck, shorebird) of migratory birds using corridors across Cook Inlet, (iii) altitudes used by migratory birds to fly across Cook Inlet, (iv) how weather impacts migratory behaviors, (v) risk and consequences of collisions with renewable energy infrastructure; and (iv) recommendations to avoid or mitigate impacts. BOEM needs this information to address regulatory requirements under the ESA, MBTA, and NEPA.

Background: Avian collisions and displacement from infrastructure are a primary concern for migratory bird movements. The increase in offshore industrialization via offshore wind turbines increases risks and consequences of migratory bird collisions and disruptions of migratory movements. Given increased risks of collision and the substantial declines in many species of migratory birds (Hüppop et al. 2016), regulatory agencies should increase efforts to design and implement relevant and feasible mitigation to reduce impacts. Over 40 million or ≈75% of North America's seabirds breed in Alaska (Sowls et al. 1978; Stephensen and Irons 2003). Lower Cook Inlet including Shelikof Strait, northern Kodiak Archipelago, and Kenai Peninsula support ≈325 seabird colonies totaling >500,000 breeding birds. Between 1950 and 2010, the global seabird population declined by 69.7% (Paleczny et al. 2015). In addition to seabirds, Cook Inlet provides winter habitat for Steller's eiders (*Polysticta stelleri*; Larned 2006, Martin et al. 2015) of which the Alaska-breeding population is a threatened species and protected under the Endangered Species Act. Avian collision with offshore infrastructure, including wind turbines presents an additional stress to migratory birds, particularly seabirds and sea ducks. However, unlike many other stressors (e.g., disease, invasive species), collision or displacement risk can be mitigated when movement patterns and responses to artificial attractants, such as lighting are better understood (FCC 2021, Longcore et al. 2012). The National Renewable Energy Lab (Meadows et al. 2023) showed that Cook Inlet, Alaska has the potential to generate 64.5 gigawatt (GW) of renewable wind energy, enough electricity to support all of Southcentral Alaska. In 2023, the State of Alaska revised the Energy Security Task Force to assess not only oil and gas but to increase efforts to develop all forms of energy including wind, solar, hydro, tidal, geothermal, micronuclear, and hydrogen.

Objectives:

1. Determine location and relative importance of avian migratory corridors and seasonal movements in the Cook Inlet Planning Area.
2. Describe the number and proximity of migratory corridors and seasonal movements of migratory birds for two sites identified in Cook Inlet as having the greatest potential for wind facilities.

3. Develop a spatial and temporal model of migratory bird movements in Cook Inlet to determine risk and severity (frequency, magnitude, conservation status) of collisions with offshore wind facilities.
4. Develop conservation measures to avoid, minimize and mitigate impacts to avian migratory corridors from renewable energy infrastructure in Cook Inlet.

Methods: A brief description of proposed methods and estimated costs include:

- Review available scientific peer-reviewed publications, reports including agency gray literature, and data sets from federal and state agencies; universities, colleges, and research institutions; industry, conservation organizations, and citizen-science programs to describe location and seasonal use of avian migratory corridors in the Cook Inlet Planning Area, that would produce maps of currently known high use areas. $40K
- Determine seasonal migratory bird movements from the currently available NEXRAD radar sites that have coverage in Lower Cook Inlet, including PAHG (Kenai) WSR-88D radar operated by the NOAA National Weather Service in Anchorage, Alaska and PAKC (King Salmon) WSR-88D radar operated by the NOAA National Weather Service in Anchorage, Alaska. $130K
- Install localized radar equipment to identify bird movements near Barren Islands or Augustine Island. $200K.
- Assess daily movements and seasonal migrations of seabirds including but not limited to murres, kittiwakes, puffins, and storm-petrels to compare with results described in literature and existing data sets, weather station radar, and localized experimental radar. GPS telemetry of a sample of seabirds in Lower Cook Inlet $300K.

Specific Research Question(s):

1. What are the locations of avian migration corridors in Cook Inlet?
2. What is relative importance of avian migratory corridors across Cook Inlet as measured by seasonal use, frequency of use, and types and numbers of migratory birds?
3. What is the proximity and relative importance of avian migratory corridors to potential sites of renewable wind facilities?
4. How do diurnal movements and seasonal migrations of seabirds compare to corridors identified by weather and localized radar data?
5. Given findings of this study, what marine spatial planning and conservation measures may be designed and implemented to avoid or decrease risks of migratory bird collisions with offshore renewable energy infrastructure?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Distribution and Abundance of Threatened Steller's Eiders in the Cook Inlet Planning Area: Use of Photographic Monitoring and Satellite Telemetry
Administered by	Alaska Regional Office
BOEM Contact(s)	Shane Gray (shane.gray@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	U.S. Fish and Wildlife Service
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	February 5, 2024
Problem	In 1997, the Alaska-breeding population of Steller's eiders was listed as a threatened species under the Endangered Species Act. Steller's eiders winter range extends east to Lower Cook Inlet and Kodiak Island, but distribution and population data have not been collected in this area since 2005. Information on movements and distribution within Cook Inlet at night, and potential risks of collision with wind and hydrokinetic facilities are unknown.
Intervention	Assess the distribution and population of Steller's eider during winter in Cook Inlet using emerging technologies including aerial photographic and machine learning (daytime distribution and abundance) and satellite telemetry (nighttime distribution). Development of these methods for Steller's eiders within the Cook Inlet Planning Area will provide updated data to assess energy development risks to an Endangered Species Act (ESA) listed species and advance new marine bird survey technologies with applications throughout all areas under BOEM jurisdiction.
Comparison	Determine if Steller's eider distribution and abundance in Cook Inlet has changed over the past 20 years. Determine if diurnal movements and roosting areas are near priority wind and hydrokinetic sites.
Outcome	A current and defensible understanding of the distribution and abundance of Steller's eider in Cook Inlet during day (foraging, resting) and distribution at night (roosting).
Context	Cook Inlet OCS

BOEM Information Need(s): In 1997, the U.S. Fish and Wildlife Service classified the Alaska breeding population of Steller's eider as Threatened under the ESA. Steller's eiders wintering in Cook Inlet and near Kodiak Island occur within BOEM's planning areas or in potential range of Gulf of Alaska oil spills. To assess the potential effects of offshore energy activities on Steller's eiders wintering in Cook Inlet, particularly in sites with the highest potential for wind and tidal energy, BOEM needs to understand distribution and population status.

Background: Steller's Eeders (*Polysticta stelleri*) that breed in Alaska are listed as threatened under the U.S. ESA. From the mid-1990s to mid-2000s, aerial and boat-based surveys (Agler et al. 1995, Larned 2006), and satellite telemetry (Rosenberg et al. 2014, Martin et al. 2015) described Steller eider molting and wintering sites in coastal waters proximate to the Cook Inlet Planning Area. Because Steller's eider distribution and abundance data from the Cook Inlet Planning Area are now over 20 years old, more current information is needed for BOEM to comply with ESA Section 7 consultation obligations and environmental assessment responsibilities under the National Environmental Policy Act (NEPA). Steller's eider distribution and abundance data are needed to assess potential impacts and identify feasible and effective conservation measures to avoid or minimize adverse effects associated with future conventional and renewable energy activities. Previous survey data is out of date, and also failed to address biases resulting from species identification, flock size estimation, and incomplete detection.

In "Distribution and movements of Alaska-breeding Steller's Eiders in the nonbreeding period" Martin et al. (2015) showed that Steller's eiders occur in deeper (>10m) water during winter. Specifically, they stated "[u]se of deep water (>10 m) was widespread among individuals and tended to occur after November [and] occupancy of deep water after November was significantly influenced by time of day ... with 36% ... of nighttime and 5% ... of daytime locations predicted to be in waters >10 m deep." This study showed that based on telemetry, Steller's eiders behaved as expected during the day (occurring in shallow waters less than 10m deep), but at night they flocked up and fed in deeper waters, although the maximum depth was not described in their paper. Steller's eiders were found to frequently use up to 30-m deep water almost exclusively at night during winter and that nighttime occupancy of deeper water habitats may be for resting and/or for consumption of zooplankton species, such as euphausiids, that are abundant and well known for their nocturnal vertical migrations in the water column (Martin et al. 2015). In summary, the authors state that "[r]egardless of the behavioral basis for the observed nighttime use of deep-water habitats, the presumption that Steller's Eiders almost exclusively occupy waters <10 m deep (e.g., Federal Register 2001) should be reevaluated. Recognizing that Steller's eiders use deeper-water offshore habitats during December through April could possibly improve the efficacy of environmental impact analyses, as well as the accuracy of population estimates obtained from aerial surveys."

Objectives:

- Assess distribution and describe habitats used by wintering Steller's eiders in Cook Inlet.
- Estimate the abundance of Steller's eiders in Cook Inlet during the winter.
- Evaluate the distribution and number of Steller's eiders relative to sites identified for potential wind and tidal energy development.

Methods: Modern marine bird monitoring techniques are transitioning from low level ocular aerial surveys to higher altitude aerial photographic surveys coupled with automated counting algorithms that account for bias, estimate precision, reduce disturbance to birds, and increase safety of survey crews (Weiser et al. 2022).

This study proposes using a Cessna 206 aircraft for eastern Cook Inlet and a Partnavia twin engine aircraft for western Cook Inlet. Each aircraft would be equipped with two Canon 5DS-R cameras and Canon 200mm f/2.8L II USM autofocus lenses mounted in the belly ports. Cameras will be angled away from each other at 5–6 degrees to avoid lateral photo overlap. The technology used will consist of AeroScientific's Aviatrix software, an aerial mapping and flight management system with airborne camera control to collect photographs at 1,000 ft at a 2 second trigger rate. Transects will be spaced 0.5

km apart and will be placed from shoreline to the 10 m bathymetry line. Three replicate surveys, each requiring 40 flight-hours, with one each in late fall, midwinter, and early spring would be performed to determine distribution and abundance.

Steller's Eider overhead imagery collected by the U.S. Fish and Wildlife Service Alaska Region Migratory Bird Program in Nelson Lagoon Alaska in 2018-2019 will be used as a learning dataset with program YOLO to develop an automated identification and counting algorithm. The trained algorithm would then be used for Cook Inlet photographs to identify and enumerate Steller's eiders. Steller's eider density would then be calculated based numbers of birds in photographs and the sample fraction. A human verification step would follow using a random sample of photographs from which false positive and false negatives would be determined and applied to the density estimate as a correction factor. The final step would be estimation of population size and development of mapping products. Approximate cost of conducting three replicate surveys, each requiring 40 flight-hours, with one each in late fall, midwinter, and early spring is $275,000 (detailed budget available upon request).

To assess distribution of Steller's eiders in Cook Inlet at night, birds will be captured in select locations within the Cook Inlet Planning Area. Satellite transmitters will be implanted following a technique modified from Korschgen et al. (1996) and described by Mulcahy and Esler (1999). Transmitters are expected to weigh 38–40 g and be less than 5% of a bird's body mass at the time of capture. All transmitters will be programmed to transmit with a 60 sec pulse rate and a duty cycle to sample all hours of a day with the expected battery life of > 6 months. The transmitters will be equipped with sensors that monitor internal body temperature and battery voltage. GPS receivers will yield precise location data to allow a better understanding and synopsis about habitat use, daily movements, and the breeding derivation of the Steller's eiders that winter in Cook Inlet. A realistic budget including personnel costs, boat charters, transmitter purchases (n=30), equipment costs, veterinarian support, data management, oversight, and analysis totals approximately $310,000 (detailed budget available upon request).

Quarterly progress reports and a final report would be produced describing methods, results, management implications, and recommendations. GIS layers describing the distribution of Steller's eiders will be created and saved as a geodatabase. A peer reviewed publication would follow after completion of the project.

Specific Research Question(s):

1. What is the change in Steller’s eider distribution and abundance in the last 20 years?
2. What habitats are Steller’s eider using during the winter in Cook Inlet?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Geographic Coverage, Duration and Type of Sea Ice in Cook Inlet, Alaska: Informing Site Selection for Renewable and Conventional Energy
Administered by	Alaska Regional Office
BOEM Contact(s)	Caryn Smith (caryn.smith@boem.gov)
Procurement Type(s)	Contract, Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	April 4, 2024
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	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. Evaluate remotely sensed imagery, field observations, and contributions of physical forcing mechanisms for new insights into changes in sea ice.
Comparison	Results will document geographic coverage, field observations, and changes in sea ice cover for almost a quarter of a century.
Outcome	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, structure, 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 tidal and coupled ice-ocean circulation models used to support renewable energy characterization and OSRA.

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, structure, 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 and complicates oil spill response. 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 (e.g., type, area, thickness, velocity, 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 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. Researchers will develop algorithms 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 compile and synthesize available literature, historical observations, and information on sea ice type in Cook Inlet. Researchers will document and conduct observations of the sea ice (e.g., type, structure, growth, melt, velocity or other physical properties) 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 coupled ice-ocean 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?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Occurrence, Seasonal Distribution, and Density of Mysticete Cetaceans in Lower Cook Inlet, Alaska
Administered by	Alaska Regional Office
BOEM Contact(s)	Christina Bonsell christina.bonsell@boem.gov, Chris Crews christopher.crews@boem.gov
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	NOAA
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	3 April 2024
Problem	Information is needed on the seasonal occurrence, distribution, and density of cetaceans in Lower Cook Inlet (here, defined as OCS waters south of Anchor Point to the Barren Islands). Contemporary data on the presence and/or absence, seasonal occurrence, distribution, and abundance of cetaceans in this area are needed to: (i) determine movement into, and seasonal use of Lower Cook Inlet; and (ii) identify and evaluate potential effects from Outer Continental Shelf (OCS) renewable energy activities. Relevant, timely, and defensible data are required to ensure cetaceans are protected from potential impacts of federally regulated activities.
Intervention	Replicating aerial surveys during May, June, July, and August for two years will provide estimates of cetacean distribution, abundance, and density. Year-round passive acoustic monitoring will provide information on the seasonal movements of cetaceans into Cook Inlet and their occurrence in specific areas known to have the highest potential for wind and hydrokinetic renewable energy potential.
Comparison	The results of this study will inform the design and implementation of appropriate mitigation measures and be used for Endangered Species Act (ESA) Section 7 consultation, National Environmental Policy Act (NEPA) analysis, and Marine Mammal Protection Act (MMPA) incidental harassment authorization requests.
Outcome	Density, distribution, and seasonal occurrence of cetaceans in Lower Cook Inlet, including information required to assess potential impacts at sites with the highest potential for wind and hydrokinetic renewable energy.
Context	Lower Cook Inlet

BOEM Information Need(s): Data on the occurrence, distribution, and density (for take estimates needed in MMPA authorizations and ESA consults) of cetaceans in lower Cook Inlet are required to assess potential effects of renewable energy development. Results will address regulatory requirements under the ESA, MMPA, and NEPA.

Background: All cetaceans are protected by the Marine Mammal Protection Act. Mysticete (baleen whale) species occurring in, or near Cook Inlet, that are listed under the Endangered Species Act include two stocks of humpback, North Pacific right whale (NPRW), sei, blue, fin, and gray whales. The eastern stock of NPRW that inhabit the waters of Alaska are estimated to number 31 individuals in the population. The most frequently observed large cetaceans in Lower Cook Inlet during summer are fin (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*) and minke (*Balaenoptera acutorostrata*) whales. At least three humpback whale stocks potentially occur in Lower Cook Inlet. North Pacific right (NPRW; *Eubalaena japonica*), blue (*Balaenoptera musculu*), sei (*Balaenoptera borealis*), and gray (*Eschrichtius robustus*) whales may also use Lower Cook Inlet where it joins the Gulf of Alaska; however, seasonal occurrence, distribution, and abundance estimates for these species in this area are dated or unknown. Cook Inlet has recently been surveyed and determined to be capable of annually producing 18 gigawatts of energy from tidal power, in addition to 95 gigawatts of potential power from wind (Meadows et al. 2023). Information about baleen whale presence and numbers in and around Cook Inlet is needed if BOEM is to comply with NEPA, the MMPA, and ESA and pursue renewable energy efforts in and near LCI (Young et al. 2023).

NOAA Fisheries (NOAA) conducts aerial surveys for Cook Inlet belugas (CIB; *Delphinapterus leucas*) every two years during June to estimate their distribution and abundance from Upper Cook Inlet south to Cape Elizabeth. Since 2018, NOAA, partnering with BOEM, has also conducted spring and fall aerial surveys for CIB distribution in Upper and Lower Cook Inlet. Although other marine mammal observations are also recorded, survey design, timing, and spatial coverage prohibit estimates of occurrence, distribution, and abundance of other marine mammal species.

NOAA has successfully used passive acoustic monitoring equipment to record the occurrence and foraging behavior of CIB in Cook Inlet (Castellote et al. 2023; Kumar et al. 2024) and presence of NPRW in the Gulf of Alaska (NOAA, unpublished data). The focus has been on these species due to their very low population numbers (331 for belugas; 31 for NPRW). Contemporary information on the occurrence, distribution, and abundance of NPRW, sei, sperm, blue, fin, and gray whales is lacking or dated for Lower Cook Inlet. Use of passive acoustic monitoring will allow BOEM to (i) assess movements of humpback, NPRW, sei, blue, fin, and gray whales into and near Cook Inlet and (ii) evaluate their occurrence near sites with the highest potential for wind and hydrokinetic energy development. A BOEM-funded study (Meadows, et al. 2023) identified two wind energy locations and one hydrokinetic energy location in the Lower Cook Inlet OCS that have the highest potential in providing ocean-based renewable power. This study would include these three areas and gather information for use in future BOEM planning, environmental analyses, and consultation documents.

Objectives:

1. Determine occurrence and distribution of humpback, fin, minke, NPRW, sei, sperm, blue, fin, and gray whales in Lower Cook Inlet (OCS waters from Anchor Point to the Barren Islands) and their occurrence near the areas with the greatest potential for wind and hydrokinetic energy development.
2. Identify areas of seasonal and year-round use by mysticete whale species in Cook Inlet, Kennedy Entrance, and the Barren Islands, Alaska.

Methods: A line transect aerial survey will be conducted in Lower Cook Inlet from Anchor Point to the Barren Islands twice a month, May through August, in 2025 and 2026 to estimate distribution and abundance of all cetaceans. From this, density estimates for each species will be calculated where the data allows.

Five passive acoustic monitoring devices will be deployed at specific locations in Lower Cook Inlet to detect (i) humpback, fin, minke, NPRW, sei, blue, fin, and gray whale movements into Cook Inlet; and (ii) occurrence of these species at sites with the highest potential for wind and hydrokinetic renewable energy. Devices will record the seasonal occurrence of more common species (i.e., gray, humpback, minke) but also less common species unlikely to be observed on the aerial survey due to their scarcity including NPRW, sei, blue, and fin whales. Passive acoustic monitoring receivers will be selected, calibrated, and strategically placed upon further consultation between BOEM and NOAA.

Specific Research Question(s):

1. What is the distribution and abundance of mysticete whales in Lower Cook Inlet between Anchor Point, St. Augustine Island and the Barren Islands?
2. What are the seasonal movements of humpback, fin, minke, NPRW, sei, blue, fin, and gray whales into Cook Inlet and do these species occur near sites with the greatest potential for wind and hydrokinetic energy development?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	University of Alaska Coastal Marine Institute
Administered by	Alaska Regional Office
BOEM Contact(s)	Sean Burril (sean.burril@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	University of Alaska Coastal Marine Institute
Total BOEM Cost	TBD
Performance Period	FY 2025–2026
Final Report Due	TBD
Date Revised	February 9, 2024
Problem	The BOEM Environmental Studies Program needs applied scientific research to manage conventional and renewable energy and marine mineral activities on the Alaska Outer Continental Shelf (OCS).
Intervention	Scientific data are required to ensure potential impacts associated with leasing, exploration, and development decisions are avoided or mitigated to the extent practicable.
Comparison	The Coastal Marine Institute (CMI) facilitates collaborative research between BOEM, University of Alaska (UA) faculty and the State of Alaska.
Outcome	The CMI provides BOEM direct access to faculty and research scientists to assist in identifying, designing, and implementing relevant and critical research to allow responsible energy and marine mineral exploration, development and production on the Alaska OCS.
Context	Alaska OCS Planning Areas

BOEM Information Need(s): The BOEM-University of Alaska CMI research partnership enables the assessment and management of potential effects from OCS energy and marine mineral leasing, development, and production activities to ensure compliance with National Environmental Policy Act and other federal laws and statutes. BOEM requires current research that addresses physical, chemical, and biological oceanography; fisheries and wildlife ecology; and sociocultural and economic resources. Specifically, BOEM seeks to have an improved understanding of properties, movement, degradation and effects of potential oil spills into water and ice environments; distribution, abundance, foraging ecology, and behavior of marine mammals and migratory birds; effects of a warming climate on nearshore and offshore ecosystems; properties and changes in nearshore, landfast, and offshore ice; and perspectives of Alaska Native peoples on cultural, traditional and nutritional resources dependent on the Alaska OCS.

Background: The University of Alaska (UA) CMI was established by a Memorandum of Agreement between BOEM and UA. BOEM oversees the exploration and development of the nation's offshore energy resources and supports scientific studies to inform responsible resource management on the U.S. OCS. The partnership strengthens BOEM-State relationships in addressing common information needs.

Principal Investigators for CMI-funded projects are faculty and other research scientists within the University of Alaska system.

Objective(s):

- Collect and disseminate environmental information needed for OCS conventional and renewable energy, and marine minerals decisions.
- Address local and regional OCS-related environmental and resource issues of mutual interest.
- Strengthen the partnership between BOEM and the State of Alaska by addressing OCS oil and gas and marine minerals information needs.
- Fund projects that inform across disciplines, including fisheries, biomonitoring, chemical and physical oceanography, and oil biodegradation.

Framework Issues:

- Scientific studies for a better understanding of marine, coastal, or human environments potentially affected by the exploration and development of OCS energy and marine mineral resources.
- Modeling studies of environmental, social, economic, or cultural processes related to OCS oil and gas or renewable energy activities to improve scientific predictive capabilities.
- Experimental studies for better understanding of environmental processes or the effects of OCS activities.
- Projects that improve collection or sharing of data or scientific information about marine or coastal resources or human activities, to support prudent management of energy and marine mineral resources.
- Synthesis studies of scientific environmental or socio-economic information relevant to the OCS oil and gas, renewable energy, and marine mineral programs, including workshops and literature syntheses.

Methods: UA, in concert with BOEM, develops and disseminates an annual Call for Letters of Intent (LOI) to identify studies designed to collect information necessary to evaluate how BOEM's decision-making impacts the environment. LOI are evaluated for relevance, timeliness, and scientific merit. They will be reviewed by the CMI Technical Steering Committee, which includes representatives from UA, BOEM, the Alaska Department of Fish and Game, and the Alaska Department of Natural Resources. CMI is supported for up to $250,000 through a subsequent Notice of Funding Opportunity. CMI project awards require 1:1 non-federal cost-share and LOI must identify non-federal sources of cost-share and in-kind contributions. CMI awards are limited to a minimum of $10,000 and a maximum of $100,000 (not including required 1:1 cost-share) and must start by the end of September of the award year. LOI involving graduate students may be submitted with the Graduate Advisor acting as the Principal Investigator. Topic areas of interest include:

- Carbonate chemistry conditions and the response of marine organisms, to assess the potential for coastal and ocean acidification and impacts on biological resources.
- Fate and weathering of oil spills from renewable and conventional energy projects in open water and ice conditions, including refinements to modeling algorithms.

- Characterization and structural properties (e.g., extent, thickness, velocity, seasonality, frequency of occurrence) of sea ice, including frazil and submerged ice.
- Effects of climate change on marine ecosystem functions.
- Immigration and emigration pathways for adult and juvenile salmon.
- Seasonal presence and spatial distribution of baleen whales in lower Cook Inlet and Shelikof Strait.
- Impacts of vessel traffic in Cook Inlet on Cook Inlet belugas, ESA listed stocks of humpback whales, Northeast population of fin whales, North Pacific right whale, and the Southwest sea otter population, including collision risk and potential to disturb foraging, breeding, and calving and/or pupping activity.

Specific Research Question(s): N/A

Current Status: N/A

Publications Completed: N/A

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

References: None

Field	Study Information
Title	All Impacts Are Not Equal: Artificial Intelligence Approaches for Understanding Impacts of BOEM Permitted Activities on Sperm Whale Vocal Clans
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jake Levenson (jacob.levenson@boem.gov), Morgan Martin (morgan.martin@boem.gov)
Procurement Type(s)	TBD
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	January 11, 2024
Problem	Sperm whales seasonally use the shallow waters of the offshore continental shelf. This brings them into proximity to wind energy area construction activities that may cause localized disruption to this species.
Intervention	Evaluate the seasonal presence, demographics and site fidelity of vocal clans.
Comparison	How are sperm whale vocal clans distributed across both regions and seasons?
Outcome	This study will provide essential data on clan composition and distribution for future examination of effects of WEA activities and increased ocean noise.
Context	All BOEM Western North Atlantic planning areas.

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

Background: Sperm whales, *Physeter macrocephalus*, are classed as endangered. In the western North Atlantic Ocean, they are primarily thought to forage and reside in deep offshore waters even though they are occasionally sighted on the OCS. A recent passive acoustic monitoring (PAM) study has shown that sperm whales were heard in the shallow waters of the Southern New England (SNE) wind energy area (WEA) near year-round, with seasonal peaks in the summer and fall (Westell et al. in press). Preliminary investigation of PAM data from other regions of the OCS also show that they are present in shallow shelf waters (e.g., NYDEC report 2022). Their use of these waters brings them into proximity to WEA development activities that may cause localized disruption to this ESA listed species.

Sperm whales have advanced cognitive abilities, communication systems, and social structure (e.g., Rendell & Whitehead 2003). Besides their well-known foraging clicks, sperm whales also use codas, which are socially learned, stereotyped sequences of clicks. Sperm whales in social units are often related, have long-term membership, and will have a vocal dialect, which can include more than 20 different coda types. A vocal clan is composed of all social units, which overlap in distribution and share the same vocal dialect. Vocal clans have been identified in the Pacific and Atlantic oceans, and show different social behavior, dive behavior, and diet. Vocal clans are formed as a result of oceanic cultural transmission between sperm whale groups based on the acoustic temporarily patterned signals used within their own clan (Rendell & Whitehead 2003). Clan culture is thought to be a more important determinant of sperm whale population structure than genes or geography; this has major implications for our understanding of the species' behavioral and population biology. It also influences how different clans may respond to environmental changes or anthropogenic disturbance. Though sperm whale codas have been extensively studied, and coda libraries established in the Caribbean, Azores, Gulf of Mexico, Mediterranean, and the Eastern Tropical Pacific (ETP), codas have not been cataloged or studied in the western North Atlantic since the 1970s (Watkins & Schevill 1977).

Currently it is unknown how many vocal clans use the shallow waters of the OCS or the nearby deeper waters. The home range, seasonal distribution, and demographic composition of sperm whales clans across WEAs is unknown except for in SNE, where a recent study revealed that most of the sperm whales detected in this region are likely part of social units, composed of mature females and related juveniles and calves (Westell et al. in press). Vocal clans may exhibit different behaviors, foraging strategies, and levels of site fidelity that in turn can affect their level of susceptibility to anthropogenic disturbance. Therefore, improving the understanding of sperm whale demographics and vocal clan home ranges across the OCS will allow BOEM to improve regulatory measures and monitoring requirements to mitigate harm from wind energy development.

Objective(s):

- Develop a coda library for the western North Atlantic, updating it from Watkins and Schevill (1977) and compare it to other existing coda libraries for other regions (e.g., Gulf of Mexico and the Caribbean).
- Apply machine-learning techniques to automate and speed up the detection and categorization of codas and vocal clan coda dialects across available OCS PAM data sets.
- Understand the distribution of vocal clans and their demographic composition across OCS waters to determine distribution of impacts within a population.
- Assess potential changes in vocal clan presence and/or distribution during periods of wind energy development and construction.

Methods: This study will use extensive existing PAM data from both towed arrays (2016 and 2021 NMFS cetacean abundance surveys) and from stationary bottom mounted recorders deployed since 2020 off the SNE, Gulf of Maine and the Mid Atlantic. The first step to this project will be to create a library of all distinct codas detected using subsets of existing PAM data from the Gulf of Maine, SNE and mid-Atlantic regions. Recordings will be analyzed using Pamguard (Macaulay & Gillespie 2022) to determine the inter-click intervals (ICIs) of the recorded codas and thus, their temporal structure. Clicks belonging to the same coda will be marked and grouped, so that each coda can be represented by the set of ICIs. The repertoire between the groups will then be compared using the absolute inter-click intervals (ICI) to represent the temporal structure (rhythm and tempo, defined as the production pattern of clicks within a coda) of each coda to produce a baseline library (e.g., Gero et al. 2016).

Based on the method established by Bermant et al. (2019), machine learning (ML) techniques will be applied to develop an efficient method for detecting and categorizing codas, given the quantity of acoustic data that exists and will be generated in the future. The first step would involve training a neural network to identify and categorize sperm whale coda types. The neural network would then be used to automate the categorization of codas in large acoustic datasets. In addition, vocal clan classification could be used to identify the clans detected. This will allow for large volumes of PAM data to be more readily analyzed and a comprehensive catalog to be built. Once a northwestern Atlantic coda library has been created, it can be compared across coda libraries from different regions where sperm whale clans have been studied (e.g., Mediterranean, Caribbean) to see if those clans inhabit our study region. This library can also be compared to Watkins and Schevill's 1970s recordings to evaluate any change in clan composition 50+ years later.

The seasonal presence of sperm whales will be evaluated using an automated multi-step detection algorithm built in MATLAB to identify sperm whale echolocation clicks from the audio data (e.g., Solsona-Berga et al. 2022). Standard echolocation clicks are long trains of regularly spaced clicks, lasting for several minutes and transmitted during deep dives. Detections will be grouped into encounters and manually validated in DetEdit by an experienced analyst. Demographic composition will follow the method described in Westell et al. (in press) and developed by Solsona-Berga et al. (2022), where a MATLAB based interface (referred to as an ICIgram) is used to visualize patterns in ICI over time and manually annotate encounters (5-minute intervals) if a demographic class was confirmed by the analyst. The variability in seasonal presence, demographic composition and sperm whale vocal clans will be explored across the OCS WEAs. Finally, comparative analyses of changes in the distribution, site fidelity and movement of clans throughout this region, and where possible their potential response to both anthropogenic disturbance and climatic changes in food sources (e.g., Ilex squid) will be explored.

Specific Research Question(s):

1. How many distinct coda types can be identified in existing PAM data across the OCS? How do these compare to codas described by Watkins and Schevill (1977)? How do they compare to codas identified in other regions of the western North Atlantic (e.g., Caribbean and Gulf of Mexico)?
2. How do machine-learning techniques perform for automating detection and categorization of codas? Can machine-learning techniques effectively be used to identify one or more vocal clans based on the usage of codas?
3. How does seasonal presence and demographic composition vary across OCS regions? Can variability be understood based on oceanographic, prey availability (Ilex squid) or anthropogenic activities?
4. Can the distribution and/or movement of a vocal clan be tracked based on detection of codas? Does the presence of a vocal clan vary before, during, or after WEA construction (using SNE data)?
5. What is the importance of these areas of overlap between a vocal clan and WEA development to endangered sperm whales?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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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
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	December 6, 2023
Problem	Sounds produced by BOEM-authorized projects may impact sea turtles; a current lack of knowledge about the behavioral and physiological impacts of sound may lead to inaccurate assessment of impact on sea turtles.
Intervention	Gather behavioral and physiological data on the impacts of sound exposure 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): 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, since BOEM is required to estimate potential acoustic impacts on sea turtles from industry sound sources. 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 sea turtles. When it comes to potential impacts of underwater sound, sea turtles remain the most poorly investigated taxa and the most impacted by a changing climate.

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. When considering impacts to hearing, current regulatory practice uses auditory thresholds derived from fishes, despite very different hearing anatomy. When considering behavioral responses, thresholds are derived from the responses of two individual turtles when exposed to airguns in open-water pens (Department of Navy 2017, McCauley et al. 2000). Finally, no data are available to assess the potential impacts of sound on physiological (stress) responses. In the Biological Opinion on G&G permitting in the Gulf of Mexico, NMFS identified a critical data gap regarding our knowledge of the impacts of sound: "Although all sea turtle species studied exhibit the ability to detect low-frequency sound, the potential effects of exposure to loud sounds on sea turtle biology remain largely unknown (Nelms et al. 2016)."

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 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 at 140 kg/cm^2 in a canal, however behaviors were not consistent, with some turtles approaching the airguns and some avoiding them. The studies conducted thus far have largely focused

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

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, but 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.

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 *2022*). 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.

Objectives: Use the most-up-to date information about sea turtle hearing and response to sound to perform a behavioral and physiological response study of sea turtles to anthropogenic sounds. New data gathered from hearing sensitivity tests and behavioral studies will be used 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 significant behavioral responses in sea turtles?
2. What are the received levels of low-frequency anthropogenic sound that elicit physiological responses in sea turtles?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Building an Integrated, Sustained, Marine-life-observing Capability for U.S. Territorial Waters
Administered by	Office of Environmental Programs
BOEM Contact(s)	James Price (james.price@boem.gov)
Procurement Type(s)	Interagency agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	May 17, 2024
Problem	Increasingly greater climate-scale variability in the atmosphere and oceans necessitates long-term (e.g., climate scale) observations of population impacts for more comprehensive impact analyses. Also, cumulative effects on populations can be significant and not readily observed with short-duration (e.g., a few years or less) studies of the type more commonly done by BOEM and collaborators. Finally, there is a need to observe variability within whole ecosystems to more realistically assess impact from offshore energy development.
Intervention	This study seeks to integrate existing observational programs like the Animal Telemetry Network, Marine Biodiversity Observation Network, and the several Regional Associations of the Integrated Ocean Observation System for longer-term, ecosystem-focused monitoring.
Comparison	Most past and current BOEM-funded (co-funded) studies have been greatly informative but of short duration and limited geographic extent and focused on a few species or populations. This study will specify ambitious goals and offer commensurate funding.
Outcome	This study will enhance the capability to observe longer-term variability (e.g., climate-scale change) and over greater geographic extent (ecosystem-wide) for a more complete assessment of possible adverse environmental impact and an improved capability to differentiate natural variability over anthropogenic impacts.
Context	All U.S. territorial waters; all species (microbes to whales); ecosystem focused.

BOEM Information Need(s): Whereas BOEM has done an excellent job making use of the best available science to inform managerial decisions and to comply with NEPA, ESA, MMPA, etc. requirements, spatial and temporal coverage of most (but not all) of BOEM's studies have been somewhat limited to fully resolve the variability in the natural environment. And the focus of these studies has been on one or a few species or populations. This has been necessary in some cases. But the cumulative effects from long-term or broad-scale exposures to stressors and the downstream consequences to ecosystems are being missed. A more comprehensive assessment of possible adverse impacts requires an expanded, multi-agency observational capability.

Background: Over the past dozen years, BOEM has invested considerably in establishing collaborative partnerships for ocean monitoring, in particular the Animal Telemetry Network (ATN) and the Marine Biodiversity Observational Network (MBON). They in turn have established working relationships with the regional associations of the Integrated Ocean Observing System (IOOS) and their university affiliates, GEOBON, the International Association for Biological Oceanography (IABO), the international Ocean Biodiversity Information System (OBIS), and its U.S. node, the Canadian-initiated, international Ocean Tracking Network, and the Smithsonian Institution's Tennenbaum Marine Observatories Network (Duffy 2016).

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

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

Objective(s): The objective of this study is to initiate a NOPP call for proposals addressing climate-scale variability in entire ecosystems. Together with NOAA and NASA partners, BOEM will fund or co-fund one or a few of the most highly rated proposals submitted in response on scientific merit and that, additionally, address a BOEM's informational need or needs.

Methods: BOEM personnel and personnel from the other sponsoring agencies will conduct a formal peer review of the proposals submitted in response to a joint NOPP call for proposals. The sponsors' review panel will rank the proposals based upon scientific merit. Then, Studies Chiefs from BOEM's regional offices, the Office of Renewable Energy, and the Division of Marine Minerals will review the proposals based upon their value towards contributing to BOEM's informational needs. If there are any worthy of funding, the studies chiefs can recommend their adoption on the National Studies List (NSL).

Specific Research Question(s): To be determined by the research groups submitting proposals.

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites:

Animal Telemetry Network: https://ioos.noaa.gov/project/atn/

ATN data archive for animal tagging observations: https://portal.atn.ioos.us/#

Marine Biodiversity Observational Network: https://marinebon.org/

Integrated Ocean Observing System: https://ioos.noaa.gov/about/ioos-by-the-numbers/

GEOBON: https://geobon.org/

International Association for Biological Oceanography: http://www.iabo.org

International Ocean Biodiversity Information System (OBIS): https://obis.org/

OBIS U.S. node: https://www.usgs.gov/ocean-biodiversity-information-system-usa

Ocean Tracking Network: https://oceantrackingnetwork.org/ https://oceantrackingnetwork.org/

BIOTRACK: https://marinebon.org/pages/biotrack/

NOAA CoastWatch: https://coastwatch.noaa.gov/cwn/index.html

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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
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	May 17, 2024
Problem	All regions and programs within BOEM, as well as other DOI agencies such as U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM) and the National Park Service (NPS), depend on animal telemetry for managing the nation's land and waters. However, no coordinated investment across DOI 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	Develop a 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, and 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.; and 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 monitoring of marine life, enabling BOEM studies to focus on specific issues and species, and not the infrastructure needed.
Context	All OCS planning areas

BOEM Information Need(s): BOEM requires robust information on fishes and protected species (e.g., marine mammals and sea turtles) movement in and around areas identified for energy development and mineral extraction.

Animal telemetry can provide vital information to inform environmental analysis (e.g., per the National Environmental Policy Act) and consultations (e.g., per the Endangered Species Act and Magnuson-Stevens Act) across program areas such as OSW placement locations, oil and/or gas leasing, sand mining and even be used in monitoring impacts of climate change (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 entity, 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 infer changes related to activities in the OCS, such as turbine installation construction, operation, and demolition. (Block et al. 2016; Roquet et al. 2017).

Background: This study proposes development of national infrastructure for animal telemetry across Federal, State, and non-government organizations and international partnerships for transboundary movements.

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 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, FWS, USGS, Navy, NOAA, and NSF and results in institutions and granting agencies absorbing the frequent expense of installing new receivers. Such studies 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 permitted 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. 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 will also open partnership opportunities with offshore wind, fishers, and other ocean stakeholders. It presents 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 would develop vital infrastructure for the responsible development of offshore energy resources.

Objective(s):

- Deploy a national infrastructure for large scale monitoring of wildlife movements.
- Develop minimum data standards and requirements for delivery for key metrics (residency, presence/absence of species) and other minimum standard metrics.
- 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.
- Develop recommendations around standards for the timing of the public dissemination of information collected as a part of infrastructure projects.

Methods:

- Deploy remote monitored acoustic receiver gateways at strategic locations.
- Convene stakeholders to develop minimum data standards and submissions for long term discoverability.

Specific Research Question(s):

1. What are the needs for long term animal movement monitoring on the OCS?
2. What are the distributions, movements, and behaviors of fishes, marine mammals, and sea turtles regionally across OCS priority areas in the long-term?
3. What long-term changes from OCS activities can be inferred from expanded animal telemetry?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Combining Machine Learning and Novel Tagging Techniques to Improve the Accuracy of Data Used to Model Leatherback Density, Distribution, and Reproductive Productivity
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov), Douglas Piatkowski (douglas.piatkowski@boem.gov)
Procurement Type(s)	TBD
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	May 17, 2024
Problem	There is not sufficient data on endangered leatherback sea turtles to be able to accurately estimate seasonal habitat use, high-density areas, surfacing behavior, or foraging patterns especially with reference to climate change and marine development. Foraging behavior has been inferred from satellite tags, which has very limited resolution for diving, acceleration, and position. Leatherback sea turtles present a particular challenge; the need to capture an animal for satellite tagging leads to high costs, which can be reduced using more innovative methods.
Intervention	This study will conduct tagging of leatherback sea turtles in offshore waters of the Atlantic and/or Pacific OCS where they will exhibit behaviors similar to BOEM areas of interest using suction cup tags and a new kind of implantable satellite tag that does not involve capturing the animal.
Comparison	This study will compare information with historic data. Where appropriate, historic data will be reprocessed to quantify and improve data efficiencies where foraging metrics were previously lacking and revise distribution/density data.
Outcome	This study will confirm foraging behavior of leatherback sea turtles in the vicinity of wind energy areas. Accurate behavioral information will be used to refine density models which currently have a high level of uncertainty. New methods for understanding leatherback distribution will be made available to scientists worldwide so that climate change impacts can be assessed now and into the future.
Context	All OCS planning areas

BOEM Information Need(s): Regulatory drivers such as the Endangered Species Act (ESA) require BOEM to consider the impacts of regulated activities on protected species. BOEM is required to design and implement mitigation measures to reduce or eliminate impacts from regulated activities on protected species, such as ESA-listed endangered leatherback sea turtles (*Dermochelys coriacea*). However, very little information exists related to the behavioral context of these sightings in offshore waters. The lack of information about their diving behavior and foraging ecology creates a high degree of variability in their detection probabilities from visual observation. BOEM requires robust, current data to (1) fully analyze and disclose the potential for significant impact from Outer Continental Shelf (OCS) activities at the programmatic and site-specific level pursuant to the National Environmental Policy Act (NEPA); (2) to ensure that a species is not jeopardized by an activity or that critical habitat is not adversely modified by that activity pursuant to the ESA; and (3) to fulfill assessment and consultation requirements with other federal agencies. This study will ensure visual surveys are based on the best available science and maximize return on the considerable investment BOEM has made in line transect surveys.

Background: Detection probability, the likelihood of a species being detected in a given survey method, is a pervasive challenge to the application of field collected survey data. Visual surveys are heavily relied upon by BOEM and partners to estimate species abundances for impact analysis, however, these abundance estimates carry significant levels of uncertainty without the behavioral context under which these sightings were collected. Atlantic Marine Assessment Program for Protected Species (AMAPPS) has funded satellite tagging in order to estimate how often turtles are at the surface and available to be seen by survey observers. A preliminary estimate of leatherback surface behavior (Rider et al. 2022) is currently being used, and an update is underway, but a large amount of unexplained variability in surface behavior is still expected. Because estimates of surface availability can have an order of magnitude effect on abundance estimates (NEFSC 2010), deploying short term tags in targeted regions within the survey areas can help us better understand and predict surface behavior in these key habitats.

BOEM planning areas overlap with important sea turtle foraging areas, potentially having more numerous impacts on these taxa, already stressed due to climate change, than any other protected species. Among the sea turtles, Leatherbacks are likely to be the species most negatively affected by Wind Energy Area (WEA) development because they are highly specialized feeders, foraging exclusively on gelatinous zooplankton. This is especially important as climate change and wind development are expected to change prey distributions of zooplankton (National Academies of Sciences, Engineering, and Medicine 2023).

BOEM has made considerable investments in line-transect surveys (AMAPPS, etc.); however currently there is not sufficient data on endangered leatherback sea turtles to be able to accurately estimate seasonal habitat use and high-density areas with reference to climate change and specific marine developments areas. Even where density predictions are robust, the data can only tell us about the location of turtles at various points in time. Investigation of the ecological drivers is better assessed through continuous collection of high-resolution data via animal borne tags. Foraging is critical as it drives reproductive potential, so we want to be certain of foraging behavior. No information exists on the foraging behavior of leatherbacks in offshore waters.

Leatherback status reviews have found that all distinct population segments met the definition of being at high risk of extinction (Wang 2023; Dudley 2014; NMFS 2020). Climate change is expected to impact leatherbacks nesting and at sea. Ocean warming in the Atlantic is also likely to affect leatherback foraging, but in different ways. The northwest Atlantic Ocean is expected to warm at almost three times the global average (Saba et al. 2016), and the environmental drivers associated with climate change may shift prey distribution and ocean currents which would be expected to have implications for leatherback foraging.

Foraging is critical as it drives reproductive potential, so we want to be more certain. No information exists on the foraging behavior of leatherbacks in offshore waters. If foraging is not monitored with respect to wind energy development, simple tracking of animal density and distribution as we do now would fail to detect changes in productivity that could drive further declines in an already decreasing US populations. Continual delay of these important information will lead to perpetuation in potentially inaccurate density data used for assessing impacts.

Abundance surveys can miss leatherback sea turtles that do not surface during the survey period, leading to availability bias in the data. Variations in detectability result in significant data gaps in the distribution/abundance of these species, which impairs BOEM's abilities to assess the potential impacts of disturbance from BOEM-regulated activities (McCallum 2005). This study will improve our understanding and application of the detection probabilities of these deep diving animals.

Prior collected information can be used to estimate sea turtle activity; however, without a behavioral context, this information is highly uncertain. High resolution data on these animals can reveal what is happening within areas of interest that cannot be illuminated by satellite tags alone.

The information collected in prior studies can be used to estimate what sea turtles are doing; however, behavioral tagging is vitally important to ensure accuracy. High resolution data on these animals can give us an understanding of what is happening within areas of interest that cannot be revealed using satellite tags alone.

This study will support reprocessing of AMMAPPS and Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) data as well as past satellite tagging studies, and future surveys. In doing so this study will provide vital information for planning and compliance with environmental regulations.

Objective(s): Observe Leatherback sea turtle behavior in offshore areas by collecting and analyzing high-resolution data and to conduct reanalysis of existing leatherback sea turtle survey images using machine learning algorithms to reduce uncertainty in estimates of abundance.

Methods: Video and 3-D accelerometer behavioral recording tags will be deployed to collect behavioral information to provide a better understanding of foraging, habitat use, and behavior in relation to offshore waters.

Machine learning powered algorithms can analyze vast amounts of data collected from biologging tags to identify patterns and trends in animal behavior, allowing for the rapid and efficient processing of large volumes of previously collected data. This study will improve upon existing capabilities to use machine learning to classify images from animal-borne cameras (Rogers et al. 2024) to increase our efficiency in processing videos of available prey and foraging events.

Specific Research Question(s):

1. What is the surface availability for leatherback sea turtles in high population density areas?
2. What are the foraging behaviors of Leatherback sea turtles in offshore waters?
3. How do the above relate to temperature and water column stratification?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Developing a Reliable Biosurveillance Monitoring System for Offshore Energy Activities Using Environmental DNA (eDNA)
Administered by	Office of Environmental Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement
Conducting Organization(s)	United States Geological Survey (USGS), contractor TDB
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	February 15, 2024
Problem	At-sea biosurveillance systems are needed to collect direct wildlife observations for monitoring offshore wind energy areas and leases.
Intervention	Establish species-specific and community-level analytical pipelines for advancing eDNA as one of the primary biosurveillance monitoring technologies for before-and-after wind industry development.
Comparison	Integrate eDNA samples collected at-sea, near and within wind energy areas and leases, with benchmark samples from long-term monitoring programs (e.g., Atlantic Marine Assessment for Protected Species Program [AMAPPS] observations, EcoMon zooplankton net hauls), and with models of oceanic currents to determine the likelihood of species occurrence, eDNA transport and fate.
Outcome	1) Advance toward developing near-real time species detection systems and scalable at-sea collections. 2) Identification of taxa easily resolved by eDNA and those that are not. 3) Buildout of genetic database and recommendations for improvement. 4) Biostatistical development to inform eDNA monitoring design and decision support.
Context	Applicable to all regions

BOEM Information Need(s): The environmental monitoring efforts of BOEM aim to support informed and effective decision-making. The National Academies of Science Engineering and Medicine encouraged BOEM to explore innovative approaches, technologies, and ideas to continuously improve its environmental studies (National Academies of Sciences, Engineering, and Medicine, 2022). Collecting comprehensive and high-quality ecological data over large spatial and temporal scales presents significant challenges, often within tight time frames. eDNA sampling stands out as a promising tool for ecological sampling and monitoring, as it offers a contemporaneous snapshot of species occurrence within the study area. BOEM intends to evaluate the effectiveness of eDNA sampling in capturing the diversity of known local marine communities and networks, determining its reliability in detecting federally managed species. Additionally, BOEM aims to advance eDNA innovation by assessing the strengths and limitations of genetic libraries and integrating historical data, such as visual observations and trawl data, with eDNA samples to enhance confidence in detection probabilities. The work conducted in lease and wind energy areas will provide case studies and new information that BOEM can use in its assessments.

Background: eDNA sampling is a non-invasive monitoring technique used to detect the presence of organisms in an environment by analyzing their genetic material from environmental samples. It involves collecting water, soil, or sediment samples and analyzing them for traces of DNA left behind by organisms. eDNA sampling is valuable for ecological monitoring, species detection, and biodiversity assessment in ecosystems.

eDNA is released into the environment through sources, such as skin cells, feces, urine, and other bodily fluids. When organisms shed or excrete these materials, their DNA becomes available in the surrounding environment. eDNA can persist from hours to a few days, depending on environmental conditions (Ficetola et al. 2008; Lafferty et al. 2018). This persistence makes it possible to detect the presence of organisms even if they are not directly observed during surveys.

eDNA sampling offers several advantages over traditional monitoring methods such as visual surveys or trawls. It is non-invasive, does not require handling or disturbing organisms, and can detect rare or elusive species. eDNA sampling can also provide information on the relative abundance of species and track changes in species composition and biodiversity over time.

Objective(s): The aim of this project is to test, benchmark, and scale eDNA protocols for measuring marine and continental shelf biodiversity by focused water sampling in areas associated with wind energy development. The seasonal and spatial sampling will coincide with other research programs such as NSF, NOAA, etc., where the expected regional fauna is well understood.

BOEM and the USGS team will use hypothesis-driven science and state-of-the-art miniaturized technology to assess the eDNA "net" for accuracy in resolving community structure in space and through time. This will be done by comparing taxa identified in water samples with benchmarked data associated with quantified hotspots derived from fisheries and observer-based sampling programs, such as AMAPPS. eDNA metabarcoding technology has been used extensively to classify fish community structure; however, this study will widen the eDNA lens to detect many more organisms represented in marine food webs and relevant to BOEM activities, such as clams, zooplankton, cetaceans and seabirds.

The outcomes of this project will produce 1) pipelines for targeted species identification and resolving wildlife community occurrence and 2) ecological relationships through statistical frameworks that consider the transport and fate of eDNA in relation to hydrography and modeled ocean currents. eDNA fate and transport must be considered to alert to false-positive inferences, when eDNA of a species is detected in a water sample even though the target species is not present at a site. This phenomenon can occur when eDNA is carried away from its source by vectors like moving water (e.g., currents) or wildlife (e.g., guano dropped by birds flying overhead). Accounting for eDNA false-positive inferences is critical for effective and efficient decision-making. The project will also reliably resolve the community composition of federally managed taxa to support NEPA evaluations, permitting processes, and population estimates.

Methods: The use of eDNA technology for monitoring different taxa is constantly evolving with the development of new methods. Nonetheless, current applications of eDNA metabarcoding demonstrate its ability to identify more species compared to other standard sampling methods (Pitz et al. 2017, Cordier et al. 2019). This includes identifying cryptic or rare species not previously known to exist in a particular study area (Foote et al., 2012). By conducting a potential study, we can better understand the extent to which eDNA technology can accurately identify managed species and community structure. The study will also guide BOEM and USGS in improving the technology's robustness and unified goals of developing a near real-time biosurveillance system. Additionally, it will help enhance the genetic reference libraries, which are essential for accurate species classification from eDNA samples (Watts and Miksis-Olds, 2018; Liu et al. 2019). Overall, eDNA technology has been shown to be effective and can be deployed at sea for various research and operational interests to improve accuracy in directly detecting marine species (Hansen et al. 2018; Stoeckle et al., 2018).

Temporal and Spatial coverage:

- Temporal: two seasons, one in each year over three years (either spring/fall, spring/spring, or fall/fall comparisons)
- Diel: Sub-daily, high frequency sampling across day and night periods
- Spatial: at foci on the Atlantic, Gulf of Mexico and Pacific EEZ
- Vertical: Replicates at multiple vertical stations (surface, Chlmax, thermocline, bottom, etc.)

eDNA:

- Multi-marker approach to sample vertebrates and invertebrates
- DNA extraction and preliminary QA/QC
- Community metabarcoding approach using next generation sequencing
- Bioinformatics and related quantitative analyses and reporting
- Reference collections that are actively being improved in collaboration with the Smithsonian Institution.
- Build reference collections in publicly accessible databases such as GenBank, consistent with the goals of a multi-genomic-marker approach

Specific Research Question(s):

1. Can eDNA reliably detect managed taxa and community structure (e.g., from clams to seabirds) to support NEPA evaluations and BOEM's permitting processes?
2. How can we use eDNA results and long-term fisheries and observer-based data to evaluate the likelihood of contemporaneous species occurrence in an area of interest?
3. Can we scale up eDNA collections rapidly, advance best practices, and curate reference libraries to support near-realtime observations in the future?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites:

https://www.fisheries.noaa.gov/feature-story/tracking-marine-life-invisible-clues-edna-enhances-ecosystem-monitoring https://www.usgs.gov/centers/norock/science/readi-net-providing-tools-early-detection-and-management-aquatic-invasive

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Field	Study Information
Title	Development of an Instrumented Fish Aggregating Device (iFAD) for Ecological Monitoring of Floating Offshore Wind
Administered by	Office of Environmental Programs
BOEM Contact(s)	Michael Rasser (michael.rasser@boem.gov), Brandon Jensen (brandon.jensen@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	Southeast Fisheries Science Center, NOAA
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	May 16, 2024
Problem	Collecting ecological information concerning pelagic organisms and their environments to support floating offshore wind development is challenging and costly.
Intervention	Develop a standardized instrumentation package to collect data on the impact of floating offshore wind development on the pelagic environment and associated organisms and test implementation on a fish aggregating device.
Comparison	Without intervention, BOEM will not have a standardized tool for collecting important data on pelagic environments and biota impacted by offshore wind. Data collection will be more costly and less comparable among areas of wind energy development.
Outcome	A new tool that can be used to collect a standard suite of data in offshore pelagic environments.
Context	All OCS regions renewable energy structures are being proposed, especially floating wind turbines (Caribbean, Atlantic, Pacific), Gulf of Mexico.

BOEM Information Need(s): BOEM needs information on the ecological impacts of floating offshore wind on pelagic deep-water ecosystems. This study will develop a valuable cost-effective tool to collect information to inform BOEM's offshore wind renewable energy program.

Background: Approximately two-thirds of the U.S. offshore wind resources are in waters that will require the use of floating wind turbines (U.S. Department of Energy 2024). This includes Federal waters in the Atlantic and Pacific Oceans and the Caribbean Sea. The anchoring structure for floating wind turbines will be significantly different from wind turbines that are fixed to the ocean floor. Floating turbines are also being considered for areas in much deeper water than the current and planned offshore wind facilities. We know less about the ecological impacts of floating wind turbines especially when it comes to pelagic species in offshore marine waters because they are more difficult to observe and sample.

Fish aggregating devices (FADs)–human-made floating and submerged structure deployed to concentrate fish–have long been used by commercial and recreational fishers to aggregate fish to increase catch rate in offshore waters. They are especially effective for attracting large pelagic fish, such as sharks, tunas and billfishes. Because FADs aggregate species they are not necessarily an effective way to sample populations. However, they could serve as a valuable proxy for the effects of a floating wind turbine similar to that of a wind farm including:

- Changes in spatial and temporal distribution of species that occupy the FAD.
- Population connectivity among FADs and other existing offshore infrastructure and natural habitats.
- Possible effects on fishing.
- Potential interaction between floating structure and protected species (i.e., marine mammals and sea turtles).

The possibilities for sampling pelagic species using FADs are numerous. The FAD itself can be outfitted with instrumentation (iFAD). Possible instruments that could be used include acoustic receivers to detect tagged fish, video cameras, active acoustic sensor, and eDNA samplers. Sampling can also be conducted in more traditional ways around the FAD. Such methods might include the use of baited cameras and mark recapture studies. Advanced uncrewed systems (UxS), such as remotely operated vehicles (ROVs), autonomous surface vehicles (ASVs) and autonomous underwater vehicles can also be used. The use of FADs has many of advantages over conventional surveys such as trawls or longline surveys to gather data relevant to floating offshore wind. These advantages include:

- FADs serve as a reasonable proxy for floating wind turbines and resultant species aggregation, providing opportunities to manipulate and control the placement of offshore infrastructure, to inform impact assessments for floating offshore wind projects.
- Instrumented FADs (or UxS) can collect standardized data on pelagic species in a replicable manner that is not possible with many traditional sampling techniques. For example, pelagic longline and trawl gear can likely not be used safely and effectively within the expanse of turbines in a wind farm area, as turbine pilings and other subsurface infrastructure will snag/entangle such gear.
- Multiple instruments can be deployed on/around a single FAD, allowing detection, quantification, and correlation among numerous pelagic species and environmental metrics at a reduced cost.
- Technological solutions developed during this study could serve as a foundation for developing and applying instrument packages as a standard monitoring tool to evaluate effects of floating wind turbines.
- A cost-effective scalable solution for ecological monitoring of offshore wind turbines may serve as a valuable solution for industry to meet monitoring requirements. There is a possibility of garnering industry support, perhaps through a joint industry program.
- FADs are moveable. This allows replication in time and space as well as placement in the most important areas that need to be sampled, such as future wind energy areas or project construction areas.
- UxS or remotely operated systems, can be used to provide long-term resident sampling or allow sampling of multiple locations within a larger area with reduced operational costs.

The design of such a system requires careful consideration of the most relevant research questions, the data needed to answer those questions, and the best technological approach.

Objectives: To develop and test and refine iFAD for monitoring pelagic fishes and protected species (e.g., marine mammals, sea turtles) in deep water where floating wind turbines are likely to be placed.

Methods: NOAA Southeast Fisheries Science center has been working on this concept for some time and would partner with BOEM on this study through an interagency agreement. The general approach is outlined below:

1. *Design and Construction of a Prototype* – A prototype sampling package will be developed that will contain a complete suite of instruments. This may include 1) eDNA sampler; 2) video camera for visual sampling; 3) hydrophone for measuring soundscape; 4) environmental sensors such as a CTD, dissolved oxygen, current profiler and LIDAR to measure wind; 5) acoustic telemetry receivers; 6) bird survey instrumentation (e.g., Motus); and 6) active acoustics (echosounders or acoustic cameras).
2. *Testing of Protype* – The prototype will be tested off the coast of Florida through an external partner who has access to an existing FAD network location in the DeSoto Canyon (Williams 2023). If successful, the plan is to submit a future ESP study profile for consideration that would include:
3. *Sampling in the U.S. Caribbean* – In coordination with scientists the pilot prototype will be deployed and tested in Federal waters of the U.S. Caribbean.
4. *Monitoring Project in the U.S. Caribbean* – At least three iFADs will be deployed in an area of interest for offshore wind for ecological monitoring designed to test specific hypotheses relevant to BOEM's information needs.

Specific Research Question(s):

1. What combination and configuration of sensors and technology will allow for the best and most cost-effective data collection to assess the effects of the introduction of floating structures on the pelagic environment and associated biota? Determination of the optimal sampling package, as part of this study, will allow for subsequent assessment of the following, through a second-phase project.
2. What species aggregate at floating offshore structures and in what sequence?
3. Over what area around the structure are species of interest aggregating?
4. What is the degree of population connectivity among structures?
5. How might these floating structures influence the ability of fishers to catch fish?
6. What potential interactions exist between floating structures, and protected species and fishers?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	High performance Computing and Technical Support for BOEM's Aerial Imagery Monitoring Surveys
Administered by	Office of Environmental Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	U.S. Geological Survey, Upper Midwest Environmental Science Center (USGS UMESC)
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	May 20, 2024
Problem	In FY25, BOEM intends to expand this partnership to surveys in the Gulf of Mexico and the Caribbean. BOEM's aerial imagery monitoring surveys require continued support from USGS to archive, process, and serve aerial imagery to ongoing BOEM Wind Energy Area (WEA) site characterization studies in the Atlantic, Caribbean, and Gulf of Mexico.
Intervention	We continue to partner with the USGS UMESC. UMESC successfully developed and continues to update imagery annotation software for BOEM's aerial imagery libraries, serves imagery to project partners, and executes artificial intelligence/machine learning (AI/ML) detection and classification algorithms on USGS high-performance computing clusters for BOEM projects NT-19-04 and NT-22-04.
Comparison	This method will use marine wildlife images collected on BOEM-funded studies to train the algorithm and compare classification efficiency across species and dynamic survey conditions.
Outcome	This project will support transferrable computer vision algorithms for identifying and counting marine wildlife in imagery collected on aerial survey operations and for rapid dissemination of site characterization products concerning the distribution and abundance of marine wildlife near WEA and lease areas.
Context	All OCS planning areas

BOEM Information Need(s): Our continued collaboration with USGS UMESC is needed to continue BOEM's work to develop and evaluate strategies for efficiently automating wildlife counts in aerial photographs for site characterization WEAs, lease areas, and the U.S. Territories. Rapid data processing will reduce the costs of long-term monitoring programs, especially in new collection areas, such as the Caribbean and Gulf of Mexico. Expanding the detection and classification modeling framework will also improve species identification, particularly species challenging to identify by observers on conventional aerial surveys.

Background: Airborne surveys are a key tool for measuring avian population abundance and distribution and are a critical component to planning for offshore energy development and monitoring its effects. To increase pilot safety, data reproducibility and survey accuracy, traditional low-level observer-based surveys are increasingly being supplanted by aerial image-based surveys. When combined with machine learning systems, image-based surveys can rapidly and accurately predict bird locations and taxonomy at broad spatial scales. BOEM's Environmental Studies Program, the U.S. Fish and Wildlife Service's Division of Migratory Bird Management, and USGS UMESC are advancing the science of remote sensing and machine learning integration for aerial wildlife population surveys and a priority of this collaboration is to better coordinate diverse efforts to more rapidly advance toward better data, systems, and models.

In phase one of this project, we developed automated convolutional neural networks to filter out empty water imagery from large volumes of data and to accurately detect wildlife objects within the filtered results (Ke et al. 2021). In phase II, developed classification models for seabird, marine mammals, sea turtle, fish and artificial object classification (Miao et al. 2023). This project will continue to partner with USGS UMESC for AI/ML support using USGS high-performance computing resources. As BOEM's aerial imagery surveys expand to new regions our priority is that high model prediction accuracy in detecting and classifying wildlife from aerial imagery transfers well to new geographic, temporal, or taxonomic domains. Active collaboration between model development and human review is critical for all parts of the workflow. Well-performing models are important but it's equally critical that they are readily transferable or generalizable without ongoing large investments in data collection and human annotation.

Objective(s): The goal of this project is to continue support of automated detection and classification algorithms for marine wildlife (e.g., cetaceans, seabirds, and sea turtles) in digital aerial imagery. USFWS-BOEM have developed an initial machine learning workflow that based on a CVAT annotation tool. A critical need is to advance and coordinate multiple ongoing agency efforts to establish public datasets of images and annotations in order to support in-house model development that can be used to improve detection and classification accuracy. To advance these efforts, this study will:

1. Continue development and annotation of BOEM's digital aerial imagery archive to be used to train computer vision and machine learning algorithms.
2. Develop computer vision and machine learning algorithms for detection, taxonomic classification, and counting of the target species in open water environments.
3. Provide recommendations and guidance on image and environmental characteristics that maximize detection and classification accuracy.

Methods:

- Leverage USGS high computing resources and expertise to support existing workflows developed on BOEM studies NT-19-04 and NT-22-04.
- Continue development and training of detection and classification algorithms in new survey areas.
- Apply computer vision and machine learning algorithms to classify target wildlife species across a range of conditions affecting difficulty in classification.

Specific Research Question(s): N/A

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites:

[Deep Learning for Automated Detection and Classification of Waterfowl, Seabirds, and other Wildlife from Digital Aerial Imagery | U.S. Geological Survey (usgs.gov)]

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Field	Study Information
Title	Inventory and Assessment of Coastal and Submerged Archaeological and Historical Sites along the U.S. Caribbean Territories
Administered by	Office of Environmental Programs
BOEM Contact(s)	James Moore (james.moore@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	January 12, 2024
Problem	BOEM is mandated to preserve any cultural heritage (i.e., archaeological sites) and historic properties that may be impacted by approved actions within its jurisdiction. However, currently BOEM has no baseline information about cultural or historic properties located along the U.S. Caribbean Territories, which include the Commonwealth of Puerto Rico and the U.S. Virgin Islands.
Intervention	Draft a comprehensive historical context and provide baseline geospatial data for known or reported coastal and submerged archaeological sites and historic properties for the U.S. Caribbean Territories. Shipwrecks, remains of coastal maritime infrastructure, and visual impacts from coastal properties will be included. Best practices will also be developed for BOEM consultations with local stakeholders and appropriate territorial government offices and agencies.
Comparison	This study will be similar to previous baseline studies completed for the Atlantic, Gulf of Mexico, Pacific, and the Main Hawaiian Islands.
Outcome	A thorough understanding of the maritime historical context of the U.S. Caribbean Territories and an inventory of known or reported coastal and submerged archaeological sites and historic properties. Identified best practices for National Historic Preservation Act (NHPA) and National Environmental Policy Act (NEPA) consultations will be applied toward engaging local stakeholders and appropriate government territorial offices and agencies.
Context	Information will be applied toward renewable energy development off the Commonwealth of Puerto Rico and the U.S. Virgin Islands (St. Thomas, St. John, and St. Croix).

BOEM Information Need(s): BOEM is required under several mandates, including the Outer Continental Shelf Lands Act (OCSLA), the National Environmental Policy Act (NEPA), and the National Historic Preservation Act (NHPA), to consider the impacts of its approved activities on cultural resource sites (i.e., archaeological sites) and historic properties. The NHPA specifically requires BOEM to preserve those cultural and historic sites that are listed or may be potentially eligible for listing on the National Register of Historic Sites (NRHP) and to identify appropriate consulting parties. Under the Inflation Reduction Act (IRA) of 2022, BOEM's jurisdiction now includes submerged lands within the exclusive economic zone (EEZ) adjacent the U.S. Caribbean Territories. Offshore wind development may occur at some point in the future off the U.S. Caribbean Territories; BOEM needs baseline information on the types and locations of cultural resources and historic properties that could be impacted by Bureau-approved activities. This information will also directly support future NEPA and NHPA assessments and consultations. Additionally, BOEM has no experience working with any appropriate local stakeholders or territorial government representatives, and identifying protocols for engagement and consultation with these individuals will be crucial.

Background: The IRA of 2022 delegated authority to BOEM to conduct wind energy lease sales within the EEZs of the self-governing U.S. Caribbean Territories, which include the Commonwealth of Puerto Rico, and the U.S. Virgin Islands (St. Thomas, St. John, and St. Croix). However, BOEM has no previous experience of operating or conducting environmental research in this area and has no baseline information of the types of coastal and submerged cultural resources and historic properties located there. Such baseline literature research and geospatial data syntheses have been conducted previously for BOEM’s other programmatic areas, including the Atlantic, the Gulf of Mexico, and the Pacific, including the Hawaiian Islands. Information and determinations from these previous studies have served invaluable for historic preservation efforts and NHPA Section 106 and NEPA consultations across all of BOEM’s programmatic areas.

The U.S. Caribbean Territories have a robust maritime history. Since initial European contact in the late fifteenth century the region has been a prominent center for exploration, colonization, trade, and naval engagements. Therefore, hundreds of coastal and submerged archaeological and historic sites, including shipwrecks, from a number of cultures may be located around the Commonwealth of Puerto Rico and the U.S. Virgin Islands. Considering BOEM has not previously worked in this area, protocols are also needed so that effective and respectful consultations can be made with local stakeholders and the respective territorial governments.

Objective(s): The objectives of this study are to (1) acquire and synthesize archival information on the coastal and submerged cultural resources and historic properties along the U.S. Caribbean Territories that could be affected by offshore wind energy leasing; and (2) determine the appropriate local stakeholders and territorial government representatives to engage for NHPA Section 106 and NEPA consultations.

Methods:

1. Research and compile information from primary and secondary sources for known, reported, and potential coastal and submerged archaeological and historic sites within the EEZ of the Commonwealth of Puerto Rico and the U.S. Virgin Islands (St. Thomas, St. John, and St. Croix) that could be impacted by BOEM-approved offshore wind energy leasing, including visual impacts.
2. Synthesize site location information into geospatial data. All geospatial data will be transferred to BOEM’s Office of Renewable Energy Programs (OREP) for inclusion in a historic preservation database.
3. Compile and synthesize information pertaining to appropriate local stakeholder and territorial government contacts for BOEM to engage for required NHPA Section 106 and NEPA consultations and develop best practice protocols for scheduling and holding these consultations.

4. Create visual impact simulations of offshore wind turbines at variable distances from the U.S. Caribbean Territory islands.
5. Prepare a final report of findings that details all study-related efforts and provides a historic context of all aforementioned site types that are or may be located in the project areas.

Specific Research Question(s):

1. What are the types of coastal and submerged cultural resources and historic properties within the EEZ of the U.S. Caribbean Territories of the Commonwealth of Puerto Rico and the U.S. Virgin Islands, and where are they located? If their exact locations are unknown, where are their reported or potential locations?
2. Which cultural resources or historic properties could be impacted by BOEM-approved offshore wind energy activities, including visual impacts?
3. Who are the appropriate local stakeholders and territorial government representatives to contact for NHPA Section 106 and NEPA consultations, and what are the best practices for engaging with them to establish and build trust and to ensure consultations are effective?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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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. 140 p. Report No.: OCS Study BOEM 2017-022. https://espis.boem.gov/final%20reports/5619.pdf.

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
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	January 10, 2024
Problem	Information on marine mammal hearing threshold shift (TS) is limited to effects from purely impulsive and non-impulsive sound exposure. Also, information is lacking about 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 captive marine mammal species 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. Information from this study can be used to establish guidance to quantify cumulative sound exposure that considering 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. But in real-world situations, animals are often exposed to noise fields that include both impulsive and non-impulsive components. 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 about 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. This issue is also raised by the Marine Mammal Commission in its letter to BOEM regarding suggestions for consideration in the development of SDP for FY 2023–2024.

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 barging operating dynamic positioning (DP) systems (non-impulsive source). The duty cycle of impact hammers striking the pile may allow exposed marine mammal to recover from auditory fatigue between noise pulses or between multiple pulsive exposures.

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 (Guan and Brookens, 2021). Studies applying human and terrestrial mammal NITS modeling approach for marine mammals showed that adjust 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).

Very few studies had 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 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.

Objective(s):

- Obtain NITS on selected marine mammal species that are exposed to complex noise at different impulsiveness setting.
- Acquire knowledge on potential auditory recovery on selected marine mammal species that are exposed to intermittent noise as compared to continuous noise.
- Establish appropriate standards for classifying noise types based on metrics of impulsiveness and intermittence from different noise sources under general operating conditions.
- Recommend updating or revising current marine mammal noise exposure criteria based as needed based on study results.

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

Specific Research Question(s):

1. Do marine mammals exhibit different NITS thresholds when exposed to complex noise vs. pure impulsive or non-impulsive noises that have the same exposure energy?
2. Do marine mammals show lower NITS when exposed intermittent noise vs. continuous noise that have the same exposure energy?
3. 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?
4. How do we predict threshold shift in time varying acoustic exposures?
5. 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?
6. 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?
7. Do current NITS thresholds based on pure impulsive and non-impulsive noise exposure need to be updated or revised for BOEM's environmental assessment?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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Field	Study Information
Title	Modeling Carbon Dioxide Leakage and Potential Environmental Impacts from Carbon Sequestration Projects on the Outer Continental Shelf (OCS)
Administered by	Office of Environmental Programs
BOEM Contact(s)	Melissa Batum (melissa.batum@boem.gov), Zhen Li (zhen.li@boem.gov))
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	April 23, 2024
Problem	Potential CO_2 leakage from carbon sequestration (CS) project activities could occur via a number of pathways. Few studies model and/or measure CO_2 leakage, transport, dispersion, attenuation, and environmental impacts in the offshore environment, and those that do exist are preliminary.
Intervention	BOEM needs more information about the dynamics, fate, transport, and potential environmental impacts of CO_2 leakage under various scenarios, including worst-case, on the OCS to inform the new nationwide CS Program and to protect the environment from CO_2 leakage.
Comparison	The study will model CO_2 leakage under various scenarios, including worst-case scenarios, using the GOM OCS Region as a case-study and can be applied to all OCS regions.
Outcome	The leakage and worst-case scenario modeling will aid BOEM's ongoing rulemaking efforts, program development and implementation, and future operational needs including NEPA analyses, lease planning, lease stipulations, consultations, plan and permit approvals, mitigation measures, risk assessment and monitoring requirements, etc. Study results will also provide direction for future studies to include field and/or laboratory analyses.
Context	This study will be applicable to all OCS Regions, with a case-study focused on the Gulf of Mexico (GOM).

BOEM Information Need(s): BOEM needs to understand of the impacts of CO_2 leakage on the coastal, marine, and human environment to evaluate potential impacts from CS activities on the Outer Continental Shelf (OCS). BOEM needs background and modeling information about the dynamics, fate, transport, and potential environmental impacts of CO_2 leakage under various scenarios. The information will inform leasing scenarios and decisions, NEPA analyses, mitigation measures, and risk assessment and monitoring requirements for CS projects and protect the environment from CO_2 leakage.

Background: Atmospheric levels of GHGs are reaching a point where a global reduction of GHG emissions is not enough to curtail the worse effects of climate change; a rapid reduction of GHG emissions to net-zero human emissions is now necessary to prevent the more catastrophic impacts of climate change from striking communities and countries around the world. CS is an necessary part of current climate mitigation models (IPCC 2023, IPCC 2005, NAS 2019, NAS 2021, IEA 2021, US State Dept 2021) and the United States' goal to reach net-zero carbon emissions by 2050, and international goals to limit global surface warming to +2˚C or lower by 2100.

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 U.S. 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)). BOEM and BSEE are currently developing regulations to implement a nationwide OCS CS Program, with the anticipation of a CS lease sale in the GOM after final regulations are published.

Protecting the environment is central to every aspect and phase of the implementation of CS projects on the OCS, especially protection from potential CO_2 leakage. Understanding the impacts of CO_2 leakage is paramount to informing regulatory, policy, and environmental decisions and facilitating effective environmental protection during project implementation. Preliminary studies modeling several CO_2 leakage scenarios in the GOM (e.g., Oldenburg and Pan 2020, RISCS Consortium 2014) could inform the development of a CO_2 leakage model for the OCS. The modeling results from this study will inform CO_2 leakage and worst-case scenarios for NEPA analyses, consultations, mitigations measures, conditions of approval, and other environmental issues and decisions. The study results will also inform ongoing rulemaking efforts, CS program development and implementation, and future operational lease planning, plan and permit approvals, risk assessment and monitoring requirements.

Objective(s): The objectives of this research include:

- Collect and evaluate existing data and information on "background" levels of CO_2 in the marine environment for the GOM OCS region. Information should include seasonal and other types of and mechanisms for variability in naturally occurring CO_2 levels.
- Evaluate existing CO_2 leakage models and pilot tests (small-scale field tests) that analyze the dispersion, fate, and transport of CO_2 in the ocean from various potential leakage pathways (e.g., Oldenburg and Pan 2020, RISCS Consortium 2014) and determine how they can be applied the GOM OCS region.
- Model CO_2 leakage, dispersion, fate, and transport under various scenarios, including worst-case scenarios from multiple projects for the GOM OCS Region. Scenarios, at a minimum, should include varying volumes and pressures from pipeline ruptures, injection well blowouts, and leakages via legacy wells and geologic pathways such as reactivated faults.
- Model potential chemical oceanography and environmental impacts from the various leakage scenarios.
- Recommend methods and protocols for most effectively incorporating modeling scenarios into risk assessment and monitoring requirements for CS projects.

Methods: The study will compile, review, and synthesize existing information and models for modeling CO_2 leakage scenarios from CS project activities via a number of pathways (e.g., pipeline rupture, well blowouts, and leakages via legacy wells and geologic pathways such as reactivated faults) that may be applicable for each OCS region (e.g., Oldenburg and Pan 2020, RISCS Consortium 2014). The study will identify the types of models currently being used in the offshore environment to inform the development of a national OCS CO_2 leakage model.

The study will also collect and evaluate existing data and information on "background" levels of CO_2 in the marine environment for the GOM region of the OCS. Information should include seasonal and other types of and mechanisms for variability in naturally occurring CO_2 levels. Most of the world's ocean CO_2 measurement technologies and methods are conducted by NOAA, which is responsible for measurements of surface ocean CO_2 and ocean carbon chemistry including dissolved inorganic carbon (DIC), pH, and calculated surface ocean pCO_2. EPA also contributes by publishing trends in pH and related properties of ocean water, based on a combination of direct observations, calculations, and modeling. In addition, the US Department of Energy's National Renewable Energy Laboratory and Pacific Northwest National Laboratory also study ocean CO_2 measurement and processes. NASA's ICESAT-2 mission also offers opportunities to monitor ocean carbon fluxes including as air-sea fluxes of CO_2, ocean primary production, lateral fluxes, and the inventories within these fluxes such as, ocean phytoplankton biomass, ocean alkalinity, and open ocean dissolved organic carbon.

The study will model CO_2 leakage under various scenarios, including worst-case scenarios, from multiple projects to determine CO_2 dispersion, fate, and transport for the GOM OCS region. Region specific geologic scenarios will be evaluated. The study will also model impacts to chemical oceanography and potential environmental impacts using the CO_2 background data/information and various CO_2 leakage and worst-case modeling scenarios. The study will deliver modeling methods and modeling analyses for the CO_2 leakage, dispersion, fate, transport, and potential impacts. It will deliver methods and protocols for most effectively incorporating modeling scenarios and results into leasing planning and scenarios, NEPA analyses, consultations, leakage modeling, mitigation measures, lease stipulations, conditions of approval, risk assessment and monitoring requirements, and other environmental needs and decisions (above) for CS projects. The study will also assess the gaps in understanding CO_2 background levels, CO_2 leakage modeling, and leakage impacts, and recommend direction for future studies to include field and/or laboratory analyses.

Specific Research Question(s):

1. What are the existing models and pilot tests that analyze the dispersion, fate, and transport of CO_2 in the ocean from various potential leakage pathways (e.g., Oldenburg and Pan 2020, RISCS Consortium 2014)?
2. What are appropriate CO_2 leakage modeling scenarios for the GOM OCS Region that can be developed into a national OCS CO_2 fate and transport model? What are appropriate worst-case CO_2 leakage scenarios for the GOM OCS region?
3. What are considered "background" CO_2 levels in the GOM OCS region?
4. What are the dispersion patterns, fate, transport, and potential environmental impacts from the various CO_2 leakage scenarios? What are the most important factors affecting CO_2 leakage dispersion, fate, and transport (e.g., water depth)?
5. What are the most effective methods and protocols to incorporate the study results into risk assessment and monitoring requirements for CS project? What are the gaps in understanding background CO_2 levels, CO_2 leakage modeling, and modeling potential environmental impacts from CO_2 leakage?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Offshore Wind Farm Impacts on the Hydrodynamics and Biogeochemistry in Puerto Rico and the U.S. Virginia Islands
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jeff Ji (jeff.ji@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2026
Final Report Due	TBD
Date Revised	May 20, 2024
Problem	Offshore wind (OSW) has the potential to alter local and regional hydrodynamic and biogeochemical processes in Puerto Rico and the U.S. Virgin Islands (PRVI).
Intervention	A coupled hydrodynamic-biogeochemical modeling study is proposed to evaluate the impact of future OSW on hydrodynamics and biogeochemistry (including primary productivity and larval transport) in the PRVI.
Comparison	The model will be used to demonstrate oceanographic conditions prior to OSW construction, post-installation of a single facility, and post full build-out of OSW, in the context of the strong interannual and decadal variability.
Outcome	The study will provide BOEM with quantitative estimates of the impacts of future OSW on hydrodynamics and biogeochemistry in the PRVI, which is necessary for future NEPA analyses and for guiding future PRVI coastal monitoring efforts.
Context	Modeling efforts will cover the coastal region of PRVI.

BOEM Information Need(s): To support the sustainable development of OSW over the Outer Continental Shelf, BOEM must estimate the environmental impacts of OSW. BOEM needs to comprehend potential changes in physical oceanographic processes, both local and regional, that may affect nutrients, phytoplankton, and larval transport patterns. This modeling study aims to help BOEM estimate OSW impacts on primary productivity (which supports fisheries, seabirds, and marine mammals), assure stakeholders, and guide discussions on potential mitigations.

Background: BOEM is a resource management agency and conducts scientific research for managing OCS energy and mineral resources. The Inflation Reduction Act expanded BOEM's geographic scope to include the territories of Puerto Rico, U.S. Virgin Islands, Guam, Northern Mariana, and American Samoa. The federal government has set ambitious goals for renewable energy development. BOEM needs to assess the environmental impacts of OSW for energy planning and to make leasing and management decisions (NASEM 2023).

OSW draws energy from the surface winds, thereby creating a “wake” of reduced wind speed (Raghukumar et al. 2022). OSW structures alter oceanic turbulence and vertical mixing of currents flowing past the turbine structures (Dorrell et al. 2022). Both of these effects may alter local and regional ocean circulation enough to impact the marine ecosystem. As OSW development is still in early stages in the U.S., BOEM has relied on computer modeling experiments to assess OSW impacts on ocean circulation and larval dispersal (Chen et al. 2016; Johnson et al. 2021).

The coastal region of PRVI is characterized by diverse and dynamic oceanographic features. It is influenced by several major hydrodynamic features, causing complex and dynamic water movement patterns. PRVI experiences mixed semi-diurnal tides, with both diurnal and semi-diurnal tidal components. Several major currents influence the region, including the North Equatorial Current, the Antilles Current, and the Caribbean Current. These currents transport heat, nutrients, and larvae, playing a crucial role in the region's ecology. Winds blowing across the Caribbean Sea can drive upwelling events, bringing nutrient-rich water to the surface. This upwelling is important for supporting phytoplankton blooms and primary productivity. Locally, wind-driven currents and wave-driven currents are also important, particularly in shallower coastal areas. Local upwelling and downwelling events occur along the coasts, mainly driven by winds and variations in bottom topography. These events impact water temperature, nutrient availability, and overall water quality in coastal areas (e.g., Richardson 2005; Solano et al., 2018, Rueda-Roa and Muller-Karger 2013).

Potential concerns arise regarding to the alteration of oceanographic transport patterns in the coastal PRVI region as a result of OSW projects. To address these concerns, BOEM needs to accurately assess potential changes in hydrodynamic flows resulting from the build-out of one or multiple offshore wind energy facilities. Evidence shows that offshore structures change local current velocities and flows, as well as wind velocities and their effect on the water surface and vertical motions. Less understood are the cumulative impacts of large and multiple projects on regional circulation patterns. This is especially important concerning how changes in flow may impact the transport of juvenile fish and larvae to and from habitats used at different life stages and the transport of nutrients and phytoplankton throughout the region. This study will address an important knowledge gap for BOEM, namely OSW impacts on hydrodynamics and biogeochemistry in PRVI. Results will help inform potential mitigations (if necessary).

Objectives: The primary objective of this study is to determine, via computer modeling experiments, the impacts of OSW on hydrodynamics and biogeochemistry in the PRVI region, including nutrient availability and primary productivity, and therefore the vulnerability of marine species. The results from this study will be used to evaluate the need for and the formation of mitigation measures.

Methods: A regional computational modeling approach will be used. The spatial domain will cover the coastal region of PRVI. Experiments with simulated wind impacts from OSW will be compared to a control scenario without OSW. The model will simulate hydrodynamical and biogeochemical aspects of the PRVI region response to OSW. An established ocean model in this region should be a good candidate for this effort. One goal of this study is to support open source modeling tools. Open source means that the model codes are publicly available. BOEM would be able to rerun the model simulations internally in the future or provide the code base and model configuration to future vendors/contractors to build upon. Open source modeling therefore provides greater value to the taxpayer, while aligning with the concept of Open Science, which aims to make the fruits of scientific investment available to the wider public (The White House 2022).

This study will include a review of previous publications. This study will also incorporate seasonal conditions, improve upon the particle release and tracking methods, and examine new scenarios involving realistic layouts of multiple facilities. Three model segments will be necessary to address the objective: wind wake, ocean circulation, and biogeochemical processes. The wind wake model will be used to estimate the change in surface wind velocities for input into a high resolution, three-dimensional ocean circulation model capable of resolving small-scale physical processes throughout the water column. The small-scale processes include, but are not limited to, interactions between the structure of individual turbine and currents, the reduction of wind forcing due to turbine structure, and wind wave-turbine interactions. The biogeochemical model describes the evolution of nutrients (N), phytoplankton (P), zooplankton (Z) and detritus (D), which will also be used to release and track particles representing larvae (e.g., Cerco and Cole 1994; Powell et al. 2006).

Example scenarios include an initial condition absent any OSW facilities, a realistic layout of a single project, and a realistic layout of multiple projects. Additional scenarios may include layouts of varying turbine sizes with appropriate number and spacing, and varying particle characteristics. This study will assess the scale of change of offshore wind development on particles traveling through and near to the facilities. The model will also assess the impacts on biogeochemistry in the region as a result of OSW construction and operation. Models should utilize measured data in the region, such as acoustic Doppler current profiles, wind measurements, and geophysical data, which should be available from existing partners/projects.

Specific Research Question(s): This study focuses on different levels of questioning. The first focus is on understanding the hydrodynamic effects—how to estimate the effects of OSW on local hydrodynamics and the key parameters to be included in a model. The second main question is, given estimated changes to the hydrodynamics, what the potential local and regional effects on the ecosystem will be. More specifically:

1. Recent modeling experiments (e.g., Raghukumar et al., 2023) indicate offshore wind farms could result in a modest reduction in upwelling in the vicinity of OSW. How will these changes in upwelling impact biogeochemistry, including nutrient availability and primary productivity?
2. What are the magnitude, spatial footprint, and seasonal expression of OSW-induced changes in biogeochemistry?
3. How does the magnitude of the simulated OSW-induced changes to biogeochemistry compare to the large interannual variability in this region? (Option: How does it compare to projected climate change scenarios?) Would OSW-induced changes to biogeochemistry be detectable given the large interannual variability in the region?
4. How can the hydrodynamic and biogeochemical monitoring efforts around OSW be optimized to detect potential changes to the hydrodynamics and biogeochemistry in this region?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Relationships with Land and Resources: A Cross Regional, Comparative Study of Subsistence Activities
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), Dustin Reuther (dustin.reuther@boem.gov)
Procurement Type(s)	Contract or Cooperative Agreement
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2029
Final Report Due	TBD
Date Revised	April 9, 2024
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 Bureau's responsibilities for coastal communities, environmental justice (EJ), 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. Identifying EJ, Tribal people, and other populations that rely on marine and coastal resources for food security and cultural survival. Inform decision-making on the Outer Continental Shelf (OCS), coastal areas, and vet methods for future research in the Pacific region and elsewhere.
Context	One or more communities in Southcentral Alaska, the Gulf of Maine, and the Gulf of Mexico, including Indigenous, non-Indigenous, low income, and EJ communities.

BOEM Information Need(s): For much of the contiguous U.S., up-to-date formal documentation of subsistence is sparse. All of the regions are showing signs of climate change impacts with extreme weather patterns, oceanographic changes, subsidence, erosion, and sea level rise, leading to habitat changes and concomitant changes in species populations, migrations, and ranges. Initial reports indicate deleterious impacts to subsistence practices of local communities as their access to resources diminishes. To support coastal communities and continued opportunities for subsistence and other cultural land uses, the Bureau must account for these changes in its decisions for offshore energy development.

The Federal government has issued numerous policies and mandates which foreground subsistence activities and traditional land uses (E.O.s 12898 1994; 14096 2023; S.O. 3403, 2021; US DOI 525 DM 1, 2017; US DOI, 2022; US DOI 512 DM 4, 2023). Bureaus must apply information on subsistence activities and harvest patterns to guide decisions on federal stewardship of public lands and waters. Wise management of subsistence resources supports the Nation's Trust responsibilities to Tribal Nations and our commitment to EJ. 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 numerous mandates (e.g., EJ, Tribes, Magnusson-Stevens, NEPA). This research would provide this information and insights about what methodologies are useful for studying subsistence harvest patterns and cultural land uses for all regions of the U.S.

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 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 Atlantic office has significant documentation on commercial and recreational fisheries from routine stock assessments, community fishing profiles, oral histories, and vulnerability assessments. There have been expansive sociocultural studies, space-use studies, and knowledge studies (Acheson 1998 and 2005; St. Martin and Hall-Arber 2008; Ames 2007). However, subsistence fisheries in the region are not as well documented. Research in the Gulf of Mexico (Louisiana) revealed a diverse range of subsistence harvesters and activities (e.g., gardening, hunting, shrimping, fishing, gathering) practiced in coastal Louisiana 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 (e.g., sharing, passing of identity and heritage, and skills to provide for self and family).

We expect differences in patterns of subsistence harvest across regions of the United States (i.e., Gulf of Mexico region; Gulf of Maine; Southcentral Alaska). There may also be important similarities. Social scientists have used comparative methods for over a century (Morgan, Spencer, Durkheim, Boas, Mead, and Kroeber).[1] This approach uses a naturalistic research design to understand sociocultural and cultural characteristics that are group specific or more universal (Scupin and Decorse 2001; Barnard and Spencer 1998; Ember and Ember 1998). The approach is used to understand group identity, cultural heritage, and social resilience related to subsistence practices, which may ultimately inform policy. Three ethnographic case studies are proposed to make comparisons and better understand patterns of subsistence within and across these regions.

Objectives: To enhance BOEM's understanding of subsistence harvest patterns and traditional land uses in three U.S. regions. There are four objectives:

[1] These individuals represent part of the pantheon of early social scientist and have set much of the agenda for sociology, anthropology, social psychology and human geography.

- Gain a more robust understanding of subsistence across several regions and improve BOEM's environmental assessments by establishing an initial 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.
- Identify and document the similarities and differences in subsistence activities between communities and between regions.
- Provide recommendations and lessons learned for how to conduct research on subsistence practices and traditional land uses.

Methods: This study will collect primary and secondary data. We propose a comparative case study approach to build on previous research sponsored by BOEM (e.g., Kofinas et al. 2016; Regis and Walton 2022; SRB&A 2013). Initially, researchers will conduct a literature review and archival research on subsistence activities and other traditional land uses in three regions, resulting in a literature synthesis. The synthesis will support the identification of relevant communities and their traditional use areas (e.g., Indigenous peoples, environmental justice populations, and other relevant groups).

The research team and the BOEM project team will vet and select three communities for the case studies based on the literature synthesis and the teams' expertise. The researchers will work with knowledgeable individuals (i.e., key informants) to plan and implement the study, assist with community engagement, and refine the case study approach. Researchers will use ethnographic techniques, including open-ended conversations, small group discussions, mapping exercises, and participant observation, and draw on the secondary data. Community selection and identification will be guided by federal planning and assessment needs in each region.

The analysis of the information gathered using ethnographic methods will begin with a comprehensive within-case approach. Once each case is thoroughly examined against the research objectives and questions, the analysts would recognize if similarities across cases have emerged. If they find substantial similarities across cases, they will examine these patterns in a second across-case analysis (Patterson and Williams 2002). If no similarities emerge, the analysis will stop at the within-case stage. Substantial differences across cases would warrant a synthesis describing the key differences and what those mean for the research questions and BOEM's information needs.

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 resources and places are of primary importance for food security?
3. What is the sociocultural role played by subsistence and other traditional land uses?
4. How does subsistence vary between communities (e.g., Tribes, underserved populations, and environmental justice populations)?
5. How are subsistence resources and practices impacted by environmental change (e.g., climate change, land use changes)?
6. Does risk management play a role in subsistence – e.g., possibility of poor harvests?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Sound Source Characterization of Dynamic Positioning Systems: Field Verification
Administered by	Office of Environmental Programs
BOEM Contact(s)	Molly Reeve (molly.reeve@boem.gov)
Procurement Type(s)	Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2026
Final Report Due	TBD
Date Revised	April 4, 2024
Problem	Dynamic positioning (DP) systems are used during offshore construction across many of BOEM's programs. These systems generate underwater noise which may have the potential to negatively impact marine life and ecosystems.
Intervention	The proposed study would provide insight into the scope of the potential impacts to marine fauna from DP systems by providing calibrated measurements of the sound field of a variety of vessel types and multiple DP systems in various operational states and water depths.
Comparison	There are few dedicated studies that have thoroughly characterized DP systems as sources of underwater noise. A selection of vessels representing a range of systems and operational states will be tested to broaden the applicability of the results of this work.
Outcome	This study will facilitate the assessment of potential acute and chronic acoustic impacts of DP sources to marine fauna. The knowledge gained from this study will be used by several BOEM programs and regional offices in assessing impacts of BOEM activities.
Context	Nation-wide relevance for activities involving marine construction.

BOEM Information Need(s): Improved understanding of the acoustic characteristics of DP systems is crucial to predict potential impacts on marine species, and to determine appropriate mitigation, as required under the National Environmental Policy Act (NEPA), Marine Mammal Protection Act (MMPA), and Endangered Species Act (ESA). Currently, there are limited data on the underwater source levels of these systems, and nearly all data collected thus far have been focused on oil and gas activities and related system applications. Further, representative sound field measurements from the use of DP are difficult to obtain because the sound transmitted is often highly directional and context specific. The direction of sound propagation may change as different DP configurations are applied. Of the available data, most reports do not identify the direction in which noise was measured, nor do they provide multiple measurements based on bearing.

The information acquired from this proposed study will be used by BOEM to make more informed assessments of the impacts of its permitted activities, which will include species of ecological and commercial importance. The results will directly inform BOEM's Center for Marine Acoustic's acoustic impact model, as well as technical content made available to other offices within BOEM to better inform environmental impact assessments, biological assessments, and decisions related to the NEPA and ESA processes. Finally, the information will be used by the Center for Marine Acoustics to make recommendations to regulators responsible for updating acoustic impact thresholds with the best available science.

Background: DP systems are used to control a vessel's position with propellers and thrusters for station-keeping (e.g., holding station over a specific seafloor location), docking, and other precise maneuvering during operations. DP uses input from gyrocompasses, motion sensors, GPS, active acoustic positioning systems, and wind sensors to determine relative movement and environmental forces at work. DP systems typically do not have a high peak sound pressure and rapid rise time compared to impulsive sounds but can still produce significant acoustic energy most of which is below 1000 Hz, with tones related to engine and propeller size and type (ANSI 1995; NIOSH 1998). The sound can vary directionally, and this directionality is more pronounced at higher frequencies. Because this is a dynamic operation, the sound levels produced will vary based on the specific operation, DP system used (e.g., jet or propeller rotation, versus a rudder or steering mechanism), and factors such as the blade rate, blade pitch and cavitation, and material condition of the system.

Most of the noise generated by DP systems (low frequency and high amplitude) comes from the vessel thrusters. As with propulsion, source levels during the use of DP vary greatly based on size and type of vessel, type of thruster, and operational conditions including both weather and oceanographic conditions. Generally, a wider variety of thruster types are used in DP than in standard propulsion. Some drive types include transverse tunnel thrusters, Z-drives, L-drives, azipull thrusters, and retractable thrusters (Warner and McCrodan 2011). Transverse tunnel thrusters can be located on the ship's bow or stern, or in both locations. Because the impeller is usually closer to one side or the other, the thrusters produce sound that is both directionally variable and differing depending on which direction they are pushing. The design also makes them more prone to cavitation at relatively low operational speeds, leading to much higher source levels relative to their thrust (Fischer 2000). It is difficult to provide a realistic range of source levels from the data thus far because most reports do not identify the direction from which sound was measured relative to the vessel.

The use of DP is rapidly increasing in shallow water environments for prolonged periods of time due, in part, to the Jones Act, and expeditious offshore wind development. To date, limited field measurements exist regarding source levels, spectrum and directivity from wind turbine installation vessels and other associated construction and service vessels using DP. These sources produce noise at an intensity and frequency which may impact marine mammals and adversely affect their behavior. The focus for this study is directed toward DP systems currently employed in renewable energy construction and operations to inform potential acoustic impacts on marine life. The results of this study may also help to inform and define the aggregate acoustic impact from multiple vessels simultaneously operating DP systems in close proximity. Information garnered from this project will benefit many BOEM program areas (oil/gas, renewable energy, marine minerals) and all BOEM planning areas.

Objective(s): The collection of acoustic measurements of DP systems in field environments, along with basic environmental characterizations, fills a critical knowledge gap about acoustic impacts. The specific objectives of this study are to:

1. Identify a range of vessel types and DP systems to be measured.
2. Develop adequate measurement techniques to successfully characterize source level, spectrum, and directivity of these systems.
3. Perform intentional measurements on a variety of vessel types and DP systems in various operational states and conditions.
4. Provide reliable underwater acoustic measurements of DP systems to multiple stakeholders resulting from comprehensive data analysis which incorporates various operational states and conditions.

Methods: Due to the acoustic nature and availability of actual operating systems, the proponent will need to design and complete the necessary preliminary preparation and field work to:

1. Identify the appropriate study area(s), capitalizing or coordinating with ongoing project development. This will include where and how DP systems are being used, how the optimization of measurements specific for DP will be achieved, and any restrictions or issues in obtaining accurate measurements. The study design and proposed measurement system will be contingent on this information.
2. Characterize the signal and/or sound field, accommodating the nature of the signal to be captured and the study area (e.g., bathymetry, geologic environment, oceanographic properties, and processes at the field site), using the best available science.

Recognizing the challenge of obtaining representative field measurements from DP systems, the objectives may be achieved through one or a combination of dedicated measurements or target of opportunity to reduce cost, and optimize the assets needed. Ideal measurements will include several different systems, for multiple azimuths of the sound field produced from the source, under varying operational conditions. If this cannot be achieved, the study design will need to address contingencies and redundancies to succeed in the measurement and data analysis. The proponent will be expected to consider a variety of approaches, and cost estimates to obtain adequate measurements, potentially including but not limited to sonobuoys, fixed receivers, ship-based receivers, unmanned surface vehicles (USVs), and autonomous underwater vehicles (AUVs).

Specific Research Question(s):

1. What are the signal characteristics, including source level, estimated directionality pattern, and received levels at various ranges and radials, of DP systems from multiple vessel types (e.g., wind turbine installation vessels (WTIVs), crew transfer vessels (CTVs), construction service operation vessels (CSOVs), installation support vessels (ISVs), service operations vessels (SOVs), feeder support vessel (FSVs), field development vessels (FDVs), and Liftboats) in various operational states?
2. How do DP sound characteristics respond to the in situ changes of weather and oceanographic conditions?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Verification of OCS AQS and Development of a Satellite-based Top-down Emissions Inversion System
Administered by	Office of Environmental Programs
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Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	NOAA Chemical Science Laboratory and National Environmental Satellite, Data, and Information Service (NESDIS)
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	March 20, 2024
Problem	BOEM needs to evaluate its inventory, quantify the uncertainties, and develop a modern framework for monitoring and quantifying air emissions that incorporates atmospheric-based measurements and recent technological advances.
Intervention	Conduct a comprehensive aircraft campaign to measure air pollutant and greenhouse gas (GHG) concentrations and estimate basin-wide emissions fluxes. Develop a satellite-based inverse modeling system for long-term monitoring and tracking of emissions in the Gulf of Mexico (GOM) to complement OCS air quality standards(AQS).
Comparison	OCS AQS and satellite-based emissions estimates are compared to the atmospheric-based top-down emissions basin-wide fluxes.
Outcome	An evaluation of the OCS AQS inventory and a quantification of the associated uncertainties. An inversion modeling system to estimate regional emissions fluxes from available satellite data in the GOM to complement OCS AQS, which improve impact assessments required by NEPA and OCSLA.
Context	Gulf of Mexico

BOEM Information Need(s): BOEM has jurisdiction over Outer Continental Shelf (OCS) air emissions in the GOM west of 87.5 degrees West longitude on a limited set of air pollutants. Oil- and gas-related activities authorized under the Outer Continental Shelf Lands Act (OCSLA) must comply with the National Ambient Air Quality Standards (NAAQS). This study supports BOEM’s ability to monitor air emissions over the OCS, improve quantification approaches, and work towards assessing the impact of regulated and unregulated air emissions. BOEM needs to evaluate its emission inventory and quantify the associated uncertainties to fully characterize the impact of its oil and gas activities in the GOM.

Background: An accurate emissions inventory is critical to properly assess the impact of BOEM authorized oil and gas activities on air quality and climate. Inaccuracies and gaps in the emissions inventory can lead to significant errors in air quality modeling efforts aimed at quantifying the impact of oil and gas air pollutant and greenhouse gas emissions on the States' air quality or in quantifying their contribution to climate change (i.e., social cost of carbon, etc.).

Previous studies have highlighted significant discrepancies in BOEM's OCS AQS inventory. Based on airborne surveys, results from the F3UEL project indicate that methane emissions reported in OCS AQS are underestimated by a factor of two (Gorchov-Negron and others, 2020). This trend has been observed in other studies as well (Ayasse et al., 2022). Gorchov-Negron et al. (2023) report that their atmospheric-based estimation of carbon intensity, a measure of the climate impact per unit of energy of produced oil and gas, was nearly three times as much as the government inventory-based estimate in the GOM.

Methane is not the only pollutant that has been identified as exhibiting large discrepancies in government bottom-up inventories of oil and gas emissions. NO_x, a pre-cursor to O_3 which is associated with adverse health effects, has been reportedly over-estimated in government oil and gas inventories. Gorchov-Negron and others (2018) found that the EPA's inventory overestimated NO_x in 75% of the basins. NOx was also measured during the F3UEL campaign and while the discrepancy was not as large, the atmospheric-based inventory total (322 kg NO_x/h [283 to 360, 95% confidence interval]) was significantly less than BOEM's activity-based bottom-up estimate (418 kg NO_x/h). A NO_x discrepancy of this magnitude can have a large impact on the modeling of atmospheric photochemical processes (e.g., formation of ozone) and lead to significant biases in the estimations of air pollutant concentrations.

Bottom-up inventory verification is even challenging offshore since no offshore air quality monitors exist due to the harsh marine environment. Comprehensive airborne surveys, measuring multiple pollutants, are the only practical means of evaluating BOEM's OCS AQS inventory on a basin-wide scale and quantifying the associated uncertainties. This type of information would be highly informative for NEPA analyses, as well as in improving and interpreting results from BOEM's air quality modeling efforts that assess single sale and cumulative impacts of both current and projected oil and gas activities in the GOM on the States' air quality and the climate.

While an airborne survey would provide BOEM with a snapshot of Gulf-wide air emissions from oil and gas operations, in terms of long-term solutions, these campaigns are too costly to be repeated on a regular basis. On the other hand, high-resolution satellite technologies have made significant advances in recent years and can offer a more practical and feasible means of continuous long-term monitoring of air pollutants and GHG concentrations which can then be used to derive regional emission fluxes through techniques such as inverse modeling. Moreover, the scientific community and the National Strategy to Advance an Integrated U.S. GHG Measurement, Monitoring and Information System are working towards developing a modern framework for monitoring and tracking emissions that incorporates atmospheric-based observations, to the extent possible, in a so-called multi-tiered observing system that can complement and enhance activity-based bottom-up inventories (MacDonald and others, 2023; White House, 2023). This includes nascent technologies such as high-resolution, multispectral/hyperspectral satellite imagery which need rigorous verification. BOEM has already invested in such studies (e.g., SCOAPE I and II cruise, NASA's CSDA GHGSat evaluation program).

NOAA is planning to lead a series of airborne campaigns in 2024–2026 to provide comprehensive and quantitative top-down emissions data for methane, other GHGs, and major air pollutants from major U.S. oil and gas basins. Currently, the NOAA's AirMAPS campaign is only focused on the five largest onshore oil and gas regions, but with additional funding the campaign can be extended to other regions such as the GOM.

This study will capitalize on information gained from previous flight and ship campaigns performed in the GOM (i.e., SCOAPE cruises I and II, F3UEL air campaigns). Note this study overlaps and complements the study profile *GM25AQ Airborne Air Emission Survey* submitted to the GOM regional office.

Objective(s):

1. Conduct a comprehensive aircraft campaign to measure multiple air pollutant and greenhouse gas concentrations over the GOM in 2026 to estimate basin-wide (top-down) emissions fluxes from oil and gas activities.
2. Compare BOEM's OCS AQS activity-based bottom-up emissions inventory to the top-down atmospheric measurement-based estimates of basin- or sub-basin-wide emissions fluxes to assess its accuracy.
3. Develop an inverse modeling system to derive basin-wide emissions flux estimates of selected air pollutants and greenhouse gases from satellite data in the GOM. Independently verify these satellite-based estimates with the aircraft-derived emissions fluxes described in (1) to assess the uncertainty and potential of using satellite data for long-term, continuous monitoring of trends and regional emissions fluxes in the GOM to complement the triennial bottom-up inventory.

Methods:

1. NOAA will conduct an airborne campaign in 2026 in Texas, deploying a comprehensive and detailed chemical payload on the NOAA WP-3 aircraft to measure GHGs and co-emitted pollutants in the GOM to provide comprehensive and quantitative top-down emissions data for methane, other GHGs, and major air pollutants from oil and gas activities at basin scale. A mass balance approach will be used to estimate emissions using the difference between upwind and downwind mixing ratios. BOEM's OCS AQS inventory will be compared to the atmospheric-based emissions estimates derived from the aircraft campaign described in (1) to determine which air pollutants or GHGs may be under- or over-estimated in OCS AQS for the month(s) of aircraft measurements. Repeat flights will be performed to improve the robustness of the comparison and spatial coverage for a basin-level evaluation.
2. NOAA will collaborate with BOEM to assess satellite-based emission inversions by the Greenhouse and Air Pollutant Emissions System (GRAAPES) for the GOM. GRAAPES will ingest satellite retrievals of trace gases over the GOM using weather-chemistry models and chemical data assimilation to estimate basin-level emissions. The aircraft mass balance emissions estimates and Doppler lidar will be used to evaluate the performance of the meteorological model and fluxes estimated by GRAAPES.

Specific Research Question(s):

1. What are the quantified errors of the OCS AQS emissions estimates for selected GHGs and air pollutants?
2. Are satellite-based top-down emissions (derived from a modeling inversion system) of oil and gas operations in the Gulf of Mexico reliable enough to be used to supplement the OCS AQS inventory? If yes, for which species and in what capacity?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Very Low-frequency Hearing in Bearded Seals
Administered by	Office of Environmental Programs
BOEM Contact(s)	James Price (james.price@boem.gov)
Procurement Type(s)	Cooperative Agreement or Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2025–2028
Final Report Due	TBD
Date Revised	January 15, 2024
Problem	Too little is known about the hearing in pinnipeds in the band below 100 Hz and the possible adverse effects on the behavior, decision making, and task performance of marine mammals exposed to anthropogenic sound at these frequencies.
Intervention	Derive low-frequency audiograms from behavioral response testing in tanks under controlled conditions with trained pinnipeds. Observe the effects on in-tank behavior of exposed animals as a possible indication of behavior in the natural environment.
Comparison	Hearing thresholds inferred from extrapolations of hearing capabilities of other marine mammals are available for comparison. However, no direct measurements of hearing sensitivities at frequencies below 100 Hz have been made for any marine mammals.
Outcome	Because controlled behavioral response studies looking at higher-frequency hearing in marine mammals (sea otters and seals) (with a few measurements at the very low frequencies) have been successful, it is anticipated that properly designed tank testing at the very low frequencies will be similarly successful in determining low-frequency hearing thresholds and, possibly, also in observing effects on behavior, decision making, and task performance of exposed animals.
Context	This study is widely applicable. Wherever anthropogenic noise is adding low-frequency sound in the ocean, such sound may have adverse impact to marine mammals sensitive to such sounds, e.g., seals.

BOEM Information Need(s): BOEM needs to be able to assess the possible adverse impacts from noise generated by offshore energy development, including construction and operation of wind turbines. The sound generated from these activities includes significant energy at the very low frequencies, those below 100 Hz. At least some marine mammals have significant hearing capability at the very low frequencies. Consequently, BOEM’s impact assessments and possible mitigation strategies require consideration of how anthropogenic sound at theses very low frequencies could adversely affect exposed animals.

Background: Offshore energy development presents possible adverse environmental impacts, including acoustic impacts, to marine mammals from loud or chronic sound exposure. Possible hearing damage, interfering with communications, confusing sensing the physical surroundings, and inhibiting prey detection are known effects. A large amount of research (too much to cite in this profile) has been done to understand how marine mammals perceive and use sound and how anthropogenic noise would factor in. However, very little has been done on the biological sensitivity of different species to noise at frequencies below 100 Hz, wherein there is significant sound pressure and particle motion from both natural and anthropogenic sources.

With the recent accelerated interest in offshore wind turbines and concurrent increase in vessel traffic, noise from their construction, operation, and maintenance is of concern. All that had been learned from studying noise impacts from offshore oil and gas development can be applied to concerns about the wind turbines, except in the very low frequencies, where to little has been studied (National Research Council reports, 1994, 2000, 2003, and 2005).

This study seeks to fill the information gap concerning the very low frequencies. An ongoing BOEM-funded study, NT-21-x14 has made some hearing sensitivity measurements at a few very low frequencies, otherwise little is known in this frequency band. Because true seals (phocid seals) have the most acute low-frequency hearing ability of any marine mammal species studied so far, it is proposed to begin with these as test cases.

Objective(s): The first objective will be to determine the hearing sensitivity (hearing audiogram) of the test animals (captive bearded seals). Then, the study will try to determine how exposure to high-intensity, low-frequency sound affects their in-tank behavior, decision making, and the ability to solve problems in the experimental setting. Inferences will be drawn about natural behavior under exposure with the recognition of the difficulties and uncertainties with extrapolating from in-tank experiments to the natural oceanic environment.

Methods: Hearing sensitivity will be determined by the behavioral response method to derive audiograms in the very low frequency range as was done earlier with sea otters (BOEM-funded study Reichmuth and Ghoul, 2012) at higher frequencies. Through observation and controlled exposures to very low frequency sound, tests will be done to see possible interference with in-tank behaviors, decision making, and problem solving. This work will be an elaboration of an ongoing BOEM-funded study (NT-21-x14). Also, the investigators performing this study can make use of many techniques that have been developed by animal trainers and in other animal behavioral studies.

Funding this work will be conditional on the investigators demonstrating that they have implemented ways to overcome the problems of very-low-frequency sound waves in tanks smaller than or comparable to the wavelengths of the sound waves generated. This can be through mechanical means on the tanks and/or some experimental methods to overcome the problems.

Specific Research Question(s): How well can the test animals hear in the very low frequency range; what are their thresholds as a function of frequency? How do loud and/or chronic exposures to low frequency noise affect the test animals' behavior, ability to make decisions, and ability to solve problems in the test tank. Inferring behavior, etc. in the natural environment from what can be observed in the test tank will be speculative but possibly useful scientifically and practically in impact assessments.

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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Field	Study Information
Title	Vibroacoustic Sensitivity and Subacute Biological Effects of Economically Important Fishes and Shellfishes from Marine Renewable Energy Development
Administered by	Office of Environmental Programs
BOEM Contact(s)	Shane Guan (shane.guan@boem.gov)
Procurement Type(s)	Interagency Agreement
Conducting Organization(s)	Pacific Northwest National Laboratory
Total BOEM Cost	TBD
Performance Period	FY 2025–2027
Final Report Due	TBD
Date Revised	May 29, 2024
Problem	Behavioral and physiological effects on economically important fishes and invertebrates (e.g., crabs, scallops) from particle motion and substrate-borne vibration in relation to marine renewable energy development have not been well studied. Knowledge in these areas is critically needed for BOEM's environmental impact assessments.
Intervention	Conduct controlled exposure studies in field experimental settings to investigate various behavioral and physiological effects of selected fish and invertebrate species. The sources used would be those that are representative of particle motion and substrate vibration from marine renewable energy development.
Comparison	Results would be compared among treatments vs. control in various sound and substrate-borne vibration exposure experiments. Comparisons would also be made from studies conducted in laboratory tank environments vs. in field mesocosm settings.
Outcome	Results would be directly used by BOEM for environmental impact assessments on the effects of offshore renewable energy development. Results can also be used to interpret biological effects of fishes and aquatic invertebrates from other anthropogenic sources from BOEM regulated activities (e.g., seismic surveys, marine mineral extraction). Results can be used to support the fish acoustics exposure criteria BOEM is working on.
Context	Nation-wide relevance for activities involving marine energy construction, operations, and decommissioning including species found in all BOEM Outer Continental Shelf (OCS) regions that could be exposed to marine energy construction and operations.

BOEM Information Need(s): Sensitivity and subacute effects, such as those leading to behavioral and/or physiological responses on fishes and aquatic invertebrates from sound and substrate-borne vibration sound and substrate-borne vibration waves in relation to marine renewable energy development have not been well studied. Most of our understanding on anthropogenic noise effects on aquatic species has been done on marine mammals that are exposed to acoustic pressure. Far fewer studies have been conducted on noise exposure to fishes and even fewer on aquatic invertebrates. Good understanding and knowledge in this area is critically needed for BOEM's environmental impact assessments.

Background: Although much attention has been focused on addressing anthropogenic underwater noise on marine life in recent decades, most of the studies to-date have been conducted on marine mammals and their responses to acoustic pressure (e.g., Southall et al. 2019; 2021). In comparison, very limited funding has been devoted to address noise effects on fishes and aquatic invertebrates (Williams et al. 2015), which has resulted in considerable gaps in our understanding of the biological effects of these species vs. marine mammals in noise impact assessments (Hawkins et al. 2015; Normandeau 2013).

Over the past decade, BOEM has supported a series of efforts to investigate the effects of anthropogenic sounds on fishes and marine invertebrates (e.g., M08PC20010, M11PC00031, M20AC10009, M17PG00029). These studies have gained valuable knowledge in our understanding on physical injury (e.g., Halvorsen et al. 2012; Casper et al. 2013; Popper et al. 2013) and behavioral responses (e.g., Jézéquel et al. 2022; 2023a; 2023b; Jones et al. 2023) on fishes and aquatic invertebrates from noise exposure associated with BOEM-regulated activities. Currently, BOEM is supporting two additional studies through FY 2024 via an interagency agreement with the Pacific Northwest National Laboratory (PNNL; M23PG00011), and a cooperative agreement with the Woods Hole Oceanographic Institution (WHOI; M23AS00363) to further our understanding of the effects of sound and substrate-borne vibration disturbances from offshore renewable energy development on these species.

Unlike marine mammals whose auditory organ primarily responds to acoustic pressure, fishes and aquatic invertebrates sense acoustic energy in the form of particle motion and/or substrate-borne vibration (Mooney et al. 2010; Nedelec et al. 2016; Popper and Hawkins 2018; Hawkins et al. 2021). As such, careful considerations must be given regarding experimental designs that involve boundary conditions, sediment types and thickness, and measurements of animals' audiometric and physiological response. To address these issues, BOEM convened a workshop, Research Methodologies to Study Biological Effects from Particle Motion and Substrate-borne Vibration (140M0123D0001).

However, despite these investments, the overall research funding in this field remains low nationwide when compared to resources available for marine mammal studies. Given that the diversities of fish and aquatic invertebrate species are far greater than that of marine mammals (34,000 extant fish species, 17,500 decapod crustacean species, and 43,600 marine mollusk species vs. 140 marine mammal species), many of which are economically important and, if their stocks become depleted, could affect the livelihood of fishing communities. Expanded research efforts are needed to better understand the acoustic effects on these species. Furthermore, the rapid growth of offshore renewable energy development in the U.S. OCS makes it imperative that we must continue funding such studies (Popper et al., 2022, 2023).

Objective(s): The main objective of this study is to continue collaborating with DOE/PNNL to investigate the effects of sound and substrate-borne vibration disturbance from offshore renewable energy development on fishes and aquatic species, with a renewed approach based on recommendations from BOEM's recent workshop, Research Methodologies to Study Biological Effects from Particle Motion and Substrate-borne Vibration, and a focus on economically important marine species. An additional objective of this study is to gain empirical knowledge that can be used to improve the current fish acoustic exposure criteria, which are critically need for BOEM's environmental impact assessments.

Methods: The proposed study is for a behavioral/physiological assessment of fishes and invertebrates exposed to particle motion and substrate-borne vibration from sound and substrate-borne vibration stimuli in field-based mesocosm settings. The experiments will include controls to assess baseline behavior and physiology status without sound and substrate-borne vibration disturbances. The study will design and construct sound source(s) that can generate substrate-borne vibration and water-borne particle motion similar to those from construction and operations of offshore energy devices (e.g., offshore wind turbine, wave energy converter, tidal energy converter). Measurements will be made of the sound and substrate-borne vibration field (must include well controlled wave disturbances such as compressional, sheer, and Scholte waves), using appropriate tools for each type of sound and substrate-borne vibration waves. The study output will provide appropriate context for assessing the cause of any observed changes in behavior and physiology by including measurements and/or documentation of other relevant disturbances and environmental factors.

Specific Research Question(s):

1. Does the activity elicit any short-term behavioral responses in the species (e.g., flee, startle, freeze)?
2. Does the activity interfere with food finding behaviors (e.g., foraging, filtering, scavenging)?
3. Does the activity elicit changes in the stress hormone levels of the animals (e.g., cortisol)?
4. What is the threshold for behavioral response, is it behavior-specific?
5. What is the threshold for physiological response?
6. Do individuals adapt, acclimate, or become sensitized to exposure and what are the characteristics that define those processes (e.g., onset, duration, etc.)?
7. Do any changes in behavior correlate with changes in the sound and substrate-borne vibration field?
8. Do any changes in physiology correlate with changes in the vibroacoustic sound field?
9. If behavioral responses are detected, are they likely to have population level impacts?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

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