Bureau of Ocean Energy Management
Environmental Studies Program

STUDIES DEVELOPMENT PLAN 2019–2021






BOEM
Bureau of Ocean Energy Management

Photos courtesy of David Pereksta

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1.1 Introduction

1.1.1 Bureau of Ocean Energy Management (BOEM) Mission

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

1.1.2 Environmental Studies Program (ESP) Vision & Background

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

Environmental stewardship is at the core of BOEM's mission. Diverse Federal laws task BOEM with protecting the marine, coastal, and human environments. BOEM utilizes the best available science to support sound policy decisions and manage Outer Continental Shelf (OCS) resources. Since 1973, Congress has funded an ESP to produce research needed for decision support. The ESP has provided over $1 billion for research to this end since its inception in 1973. BOEM facilitates top-quality research by talented scientists from a range of disciplines, which is targeted to support policy needs and priorities.

BOEM's ESP was mandated after 1978 by Section 20 of the OCSLA to conduct studies that will provide the information needed to assess and manage impacts on the human, marine, and coastal environments from offshore energy and marine mineral development. Section 20 specifically calls for studies addressing impacts on marine biota which may result from chronic, low-level pollution or from large spills associated with OCS production, including onshore facilities. Section 20 also calls for studies to monitor human, marine, and coastal environments. These studies provide time series and data trend information for identifying significant changes in the quality and productivity of those environments and identify the causes of these changes.

BOEM's research mandate under OCSLA is fundamentally to assess and understand how the Bureau's decision-making impacts the environment, including the human environment, and how those impacts can be avoided or minimized. BOEM accomplishes this by recognizing that its decisions and policies contribute to the definition of the regional socio-ecological systems[1] that it stewards. The ESP, together with environmental assessment and regulation, constitute BOEM's environmental program and ensure that environmental protection is a foremost concern and an indispensable requirement in BOEM's decision making. The environmental program as a whole is a core component of BOEM, whose overall mission is to manage development of OCS energy and mineral resources in an environmentally and economically responsible way, and whose core

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

values are responsible stewardship, decisions informed by science, and a commitment to integrity and ethics in all activities.

1.1.3 Funding

Since its inception, the ESP has provided over $1 billion for research on environmental impacts and monitoring from energy and mineral development. Average annual planned funding for the ESP is currently $35 million, although the expenditure level has varied over the years. The ESP funds are currently dispersed for defined projects through three vehicles: interagency agreements (IAs) with Federal agencies; cooperative agreements with State institutions; and competitive contracts. Irrespective of particular funding vehicles and recipients, BOEM aims to use funds in a way that will deliver the most needed and highest quality research at the best value to the government.

Between 2012 and 2018 (**Figure 1**):

- 44% of funds went to Federal agencies
- 26% to academic institutions
- 26% to private organizations
- 3% to State government agencies
- 1% to other researchers

The subject matter allocation of funds over fiscal years (FYs) 2012–2018 (**Figure 2**):

- 34% to habitat and ecology
- 28% to marine mammals and other protected species
- 12% to fate and effects
- 10% to physical oceanography
- 7% to social sciences and economics
- 6% to information management
- 3% to air quality

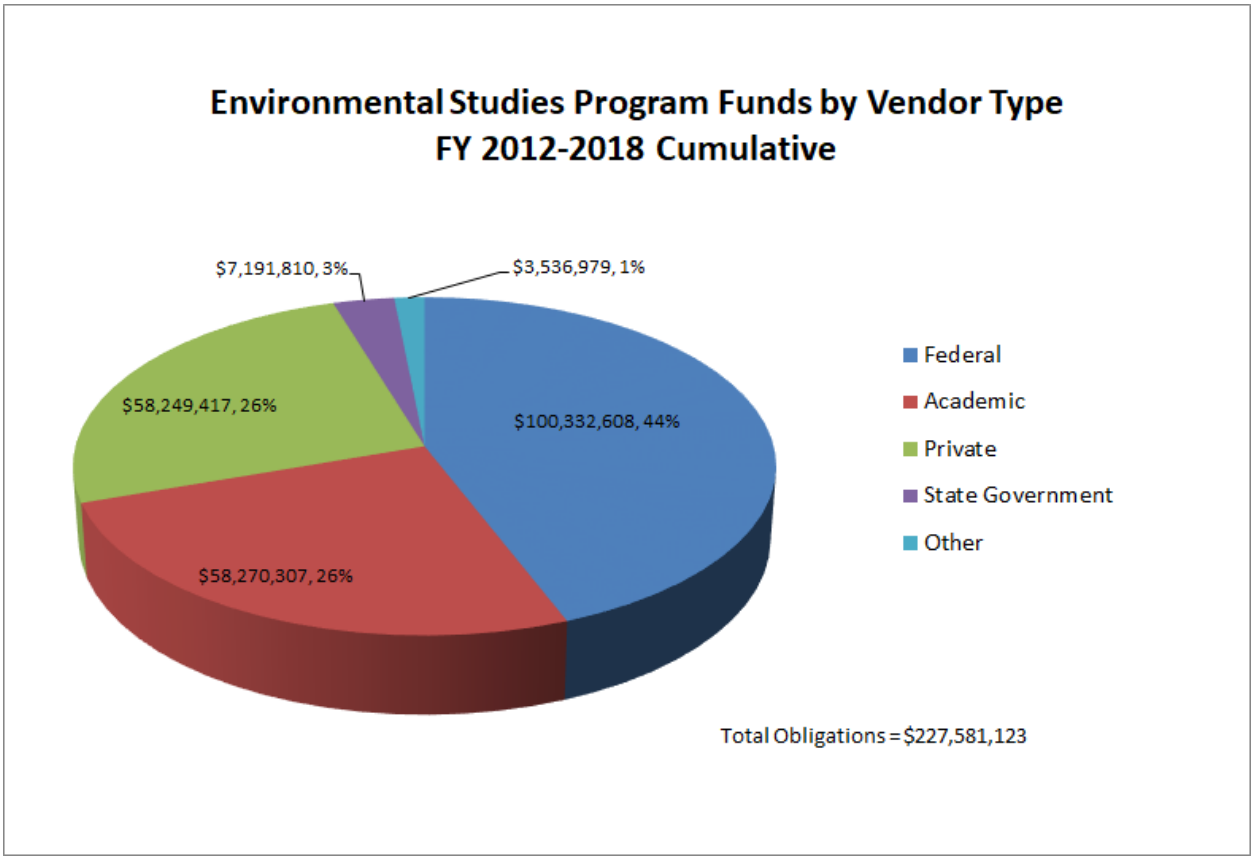


Figure 1. ESP expenditures for FY 2012–2018 by vendor type.

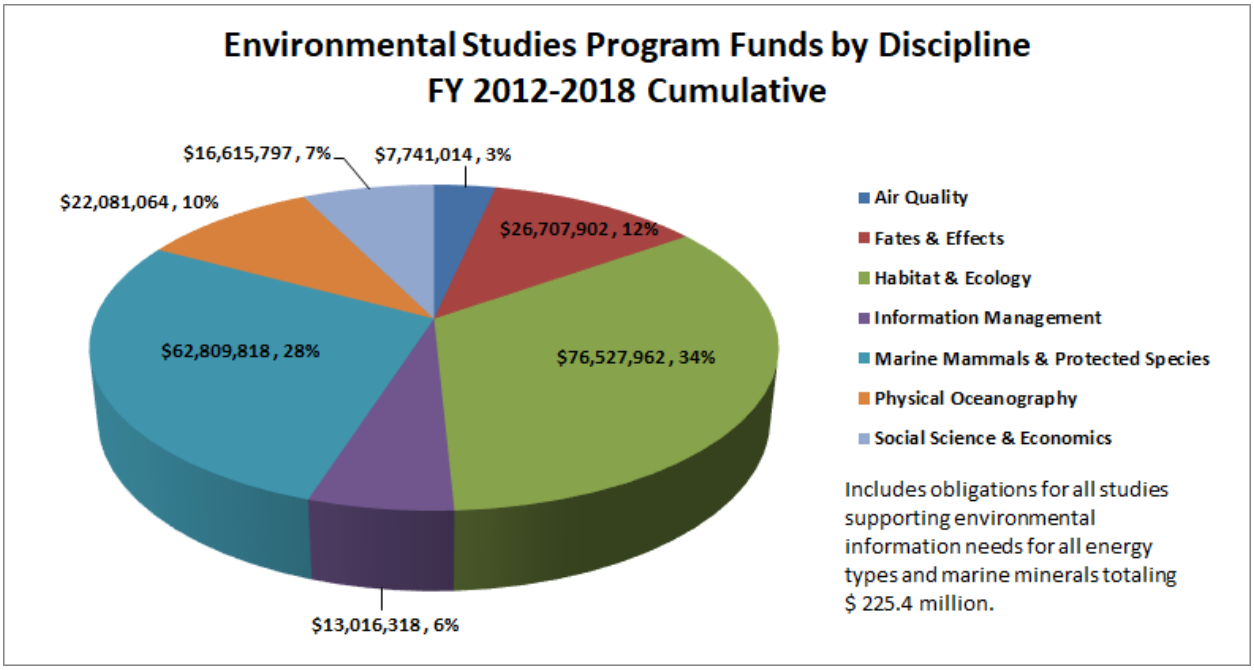


Figure 2. ESP expenditures for FY 2012–2018 by discipline.

1.2 About the Studies Development Plan (SDP)

1.2.1 SDP Overview

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

An overview of BOEM's proposed national and regional research is provided in Chapter 2–Chapter 6. Tables summarizing new studies that are projected to begin in FY 2019 or FY 2020 are included in **Appendix A**, and the study profiles for each region are included in **Appendix B**. All studies proposed in this SDP are subject to the availability of funds. Study needs may be adjusted after the release of this document to respond to shifting priorities, emerging information needs, and the ESP budget. This document is also a critical communication tool for the scientific community and other external stakeholders and partners.

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

1.2.2 What BOEM Needs to Know

1. **Effects of Impacting Activities:** Information on environmental impacts from activities authorized by BOEM, how to prevent or lessen adverse impacts, and how to provide information needed for legal compliance, including:

    - Oil and other chemical releases into the sea or onshore, including both large and low-level, chronic discharges
    - Air pollutant emissions
    - Greenhouse gas emissions
    - Sound in the sea
    - Obstructions to migration or movement of biota
    - Seabed disturbance
    - Coastal lands disturbance
    - Socioeconomic impacts of exploration and development and their interactions

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

    - Distribution and abundance of species, particularly those that are: highly regulated or particularly vulnerable to adverse change in status; important for subsistence, commercial, or recreational use; or invasive
    - Biogeographic areas of particular ecological, cultural, or commercial importance or sensitivity

- Marine environmental quality and productivity
- Air quality
- Diversity and productivity of platform biota
- Presence and nature of cultural resources and cultural landscapes
- Subsistence use and resources relied on by native people for food and culture
- Quality of life indicators for coastal native and other people

3. **Monitoring:** Information from monitoring on the environmental impacts of BOEM's authorizations over the entire time during which those impacts will occur, including potential future decisions

4. **Cumulative Impacts:** Information to address the requirements of the National Environmental Policy Act (NEPA), OCSLA, and other statutes on the cumulative environmental impacts of BOEM's authorizations

5. **Compliance:** Information required to demonstrate that BOEM's decisions comply with all applicable environmental laws

1.2.3 Criteria for Study Development and Approval

The following seven criteria (Criteria) are used in evaluating the priority of study topics during development and for determining whether profiles for the topics should be included in the ESP SDP or NSL.

1. **Need for Information in BOEM Decision Making:** All studies must contribute to BOEM's need to know as described above. This requirement is not meant to favor studies addressing specific impacts (e.g., explosive removal of platforms) as opposed to broader studies whose insights are indirect but important to understanding the impacts of BOEM's activities (e.g., population distribution and abundance, ecosystem dynamics). As noted above, ESP studies include both expenditures to address specific research questions and expenditures for "infrastructure," such as maintenance of museum collections and ocean observing systems which support an array of research projects addressing BOEM information needs. Every study profile must articulate the study's relevance and importance to BOEM decision making, as well as the level of need that must be considered in setting priority. This criterion accounts for the urgency of information and is intended to provide for a reasonable level of support in each region and across BOEM's three programs: oil and gas; renewable energy; and marine minerals.

2. **Contribution to Existing Knowledge:** Studies must be designed to contribute significantly to existing knowledge, and profiles should describe how the proposed work will fill gaps in information or will improve, confirm, or challenge current understanding.

3. **Research Concept, Design & Methodology:** All study profiles must provide sound research concept (including questions asked), design, and methodology. This does not require a high level of detail such as would be provided in specific proposals to carry out the work, but the basic proposal concept, design, and methodology must be sound. Quality and innovation are important considerations evaluated in this criterion. Archiving

data and curation of collected specimens are considered core components of this criterion.

4. **Cost-Effectiveness:** Studies must be cost effective, and the expense of a study is relevant in comparing its value with other study opportunities. This does not mean that costly studies are disfavored if the expense is necessary for important knowledge or leveraged with other funders.

5. **Leveraging Funds:** Study proposals should explore opportunities for shared funding. These may involve transfer of funds from or to BOEM, contributions to a shared account, or coordination of separately funded work toward common objectives.

6. **Partnerships:** Study proposals should support collaboration with native people whenever appropriate and feasible and should explore any opportunities for public outreach and engagement, such as "citizen science" or involvement of aquariums or other non-profits. Partnering is encouraged with other Federal agencies, academic organizations, other non-profits, or commercial enterprises to achieve shared mission needs.

7. **Multi-Regional & Strategic Utility:** Studies gain priority if they support multi-regional or strategic needs. Purely local studies will still be considered, but if everything else is equal, a study serving broader values is of higher priority for funding than one that does not. Collaboration is encouraged for identifying such needs.

1.2.4 Strategic Science Questions

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

Beginning in 2017, in response to internal and external reviews of the ESP, BOEM is providing a series of strategic questions to be addressed at the programmatic level. These questions are meant to provide guidance and drivers to the ESP research portfolio as we move toward more comprehensive understanding of those topics in the 5 to 10 year horizon. These research questions need to be addressed at a national level and have implications across all BOEM regions and programs.

At the highest level, BOEM's ESP should strive to provide information needed to understand the uncertainty and risk of the socio-ecological systems under consideration and communicate those risks and uncertainties to decision makers and the public.

More specifically, BOEM's ESP needs to continue to develop science that addresses the following *key questions*:

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

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

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

1.2.5 SDP Development Process

ESP projects are developed by BOEM through internal and external review. Overall direction and coordination is provided by the Headquarters Office's Division of Environmental Sciences (DES) within the Office of Environmental Programs (OEP). Research projects are built by addressing BOEM's strategic science questions (https://www.boem.gov/Strategic-Framework-2017/) with input from BOEM's regional offices and stakeholders. Project managers identify information needs and develop specific research questions in order to provide BOEM with robust scientific information for its decision-making process on offshore energy planning.

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

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

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

- **Baseline Studies**: Provide information needed for the assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS and potentially affected coastal areas

- **Impact Studies**: Predict impacts on marine biota that may result from OCS activities
- **Monitoring Studies:** Monitor human, marine, and coastal environments to provide time series and data trend information for identifying significant changes in the quality and productivity of these environments, and for designing studies to identify the causes of these changes

1.2.6 Conventional Energy

OCSLA (43 U.S.C. §1344) requires the DOI to prepare a Five-Year Oil and Gas Leasing Program consisting of a proposed lease sale schedule on the size, timing, and location of areas for Federal OCS oil and natural gas leasing. DOI has the role of ensuring that the U.S. Government receives fair market value for acreage made available for leasing and that any oil and gas activities conserve resources, operate safely, and take maximum steps to protect the environment. The program addresses OCS oil and gas exploration, development, and production in the Gulf of Mexico (GOM), Pacific, and Alaska (BOEM 2016a).

1.2.7 Renewable Energy

The Energy Policy Act of 2005 (EPAct; P.L. 109-58) amended OCSLA to add renewable energy to DOI's (and BOEM's) development and environmental protection responsibilities. There is significant potential for renewable energy from wind, wave, and ocean currents offshore along the Atlantic and Pacific coasts. A feasibility study for renewable energy is also currently underway in the GOM. Though these nascent technologies are not producing energy on the U.S. OCS yet, five turbines are now producing electricity in State waters off Rhode Island. Efforts to support current and future renewable energy activities are underway, including 13 active leases along the Atlantic coast from Massachusetts to North Carolina.

1.2.8 Marine Minerals

OCSLA assigns DOI (delegated to BOEM) responsibility for developing non-energy minerals on the OCS, such as sand, and ensuring related environmental protection. Section 8(k) of OCSLA sets forth specific requirements for this activity. To date, all of the leases and agreements issued by the Marine Minerals Program (MMP) have been negotiated noncompetitive agreements for sand. The MMP is also responsible for executing competitive lease agreements of other non-energy minerals such as strategic mineral resources containing copper, lead, zinc, gold, platinum, and rare earth minerals. Developers have periodically expressed interest in obtaining leases to develop these resources; however, there have been no leases issued for these resources, and there are no pending lease requests at this time.

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

Figure 3 depicts, as of May 2017, those areas of the OCS that are (or could potentially be) under the purview of BOEM for development of conventional and renewable energy resources and extraction of marine minerals. Currently, approximately 16 million of these acres are actively leased by BOEM (BOEM 2017) which provide for about 4% of the Nation's natural gas production and about 18% of domestic oil production. BOEM's MMP has executed 54 leases since 1995 and conveyed rights to approximately 146 million cubic yards of sand for coastal

restoration projects along the coast of multiple States in the Atlantic and GOM. These projects have resulted in the restoration of approximately 321 miles of the Nation's coastline, protecting billions of dollars of infrastructure, as well as important ecological habitats.

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

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

1.3 ESP Principles

The ESP is guided by four main principles:

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

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

1.3.1 Use-Inspired Science

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

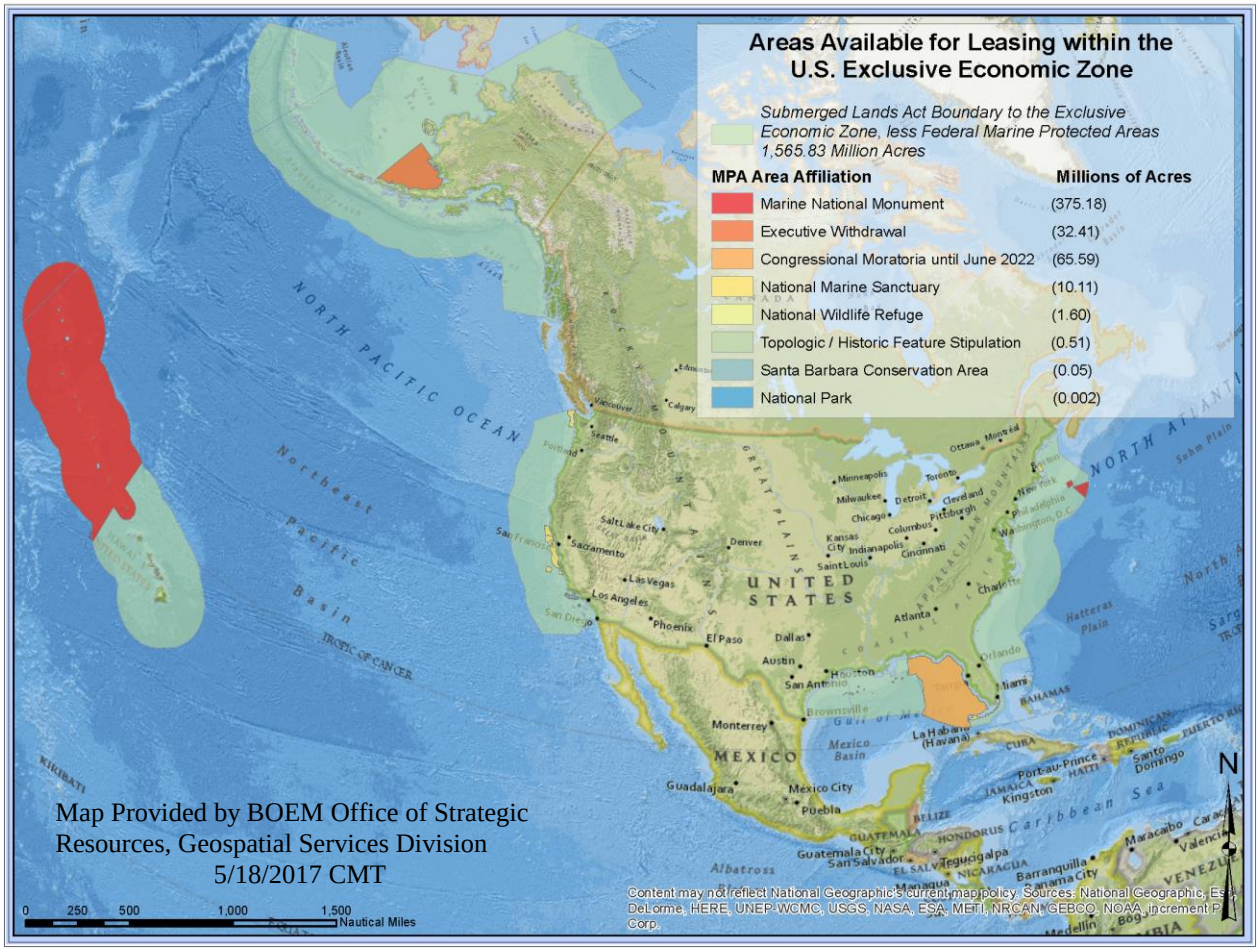


Figure 3. Areas available for leasing within the U.S. EEZ[2].

The Geospatial Services Division of the BOEM Office of Strategic Resources, generated this map. All data used for the map came from authoritative sources (National Oceanic and Atmospheric Administration [NOAA], U.S. Geological Survey [USGS], U.S. Fish and Wildlife Service [USFWS], National Park Service [NPS], and BOEM) and all acreage calculations were performed using ArcGIS® software (ESRI, Inc.).

[2] The 1.57 billion acre figure calculated under the criteria described in §1.3.4 differs from the "1.7 billion OCS acres" figure that is reported in the BOEM Performance Budget "Greenbook" for FY 2018. The 1.7 billion acre figure was calculated to include the full extent of the BOEM Planning Areas.

1.3.2 Scientific Integrity and Credibility

The DOI's Scientific Integrity Policy calls for the use of science and scholarship to inform management and public policy decisions and establishes scientific and scholarly ethical standards. In addition, the policy includes codes of conduct, a process for assessing alleged violations, and clear guidance of how employees can participate as officers or members on the boards of directors of non-Federal organizations and professional societies. This policy applies to all Department employees, including political appointees, when they engage in, supervise, manage, or influence scientific and scholarly activities; communicate information about the Department's scientific and scholarly activities; or utilize scientific and scholarly information in making agency policy, management, or regulatory decisions. Further, it applies to all contractors, cooperators, partners, permittees, and volunteers who assist with developing or applying the results of scientific and scholarly activities. The policy and supporting information can be found at: http://www.doi.gov/scientificintegrity/index.cfm.

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

National attention has been directed toward the ESP's performance measures and accountability. The ESP Performance Assessment Tool (ESP-PAT) ensures the ESP fulfills its mission of providing the best possible scientific information for making decisions concerning our offshore resources. The ESP-PAT is an internal, online system used to monitor the effectiveness of ESP products in fulfilling the Bureau's information needs. This tool also tracks the program's efficiency in delivering products on time.

1.3.3 Peer Review

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

- Internal review of study profiles by BOEM scientists
- External review of study profiles by other Federal and non-governmental scientists
- Review and critical input by Scientific Review Boards or Modeling Review Boards
- Scientific peer review of final reports
- National Academy of Sciences (NAS) peer review panel of study findings and reports
- Publication in peer-reviewed technical and/or scientific journals

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

1.3.4 Partnering and Leveraging

The ESP regularly encourages inter- and intra-agency study collaborations with BOEM's Federal agency partners, and many of BOEM's important and award-winning research efforts were completed through the cooperation with agencies such as the USGS, NOAA, and the United States Navy's Office of Naval Research. BOEM also has established partnerships with the States of Louisiana and Alaska through their respective Coastal Marine Institutes (CMIs), and the Bureau is also a member of several Coastal Ecosystem Studies Unit networks, which enable it to efficiently establish cooperative agreements with State-owned institutions.

BOEM coordinates its efforts with research programs such as the National Oceanographic Partnership Program (NOPP). NOPP is a collaboration of Federal agencies that provides leadership and coordination of national oceanographic research and education initiatives. NOPP adds significant integrative value to the individual oceanographic, ocean science, resource management, and ocean education missions of the Federal agencies and their partners, in common pursuit of the wise use of the oceans and the maintenance of their health. As a charter member of NOPP, BOEM continues to explore options to increase its participation, and its investments have grown dramatically in recent years. The ESP has funded research through NOPP focused on chemosynthetic communities, biological habitats supported by shipwrecks, high frequency (HF) radar mapping of surface circulation in Alaska, improving cetacean electronic data loggers, and a variety of renewable energy projects. Several studies have received the NOPP Excellence in Partnering Award and DOI's Partners in Conservation Award.

1.3.5 Information Management and Dissemination

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

ESPIS presents information about ongoing and completed BOEM ESP studies. This new search tool, launched in 2015, allows text and map-based queries to find relevant study information. Study information includes downloadable electronic documents of study profiles, technical summaries and final reports, and links to associated publications and digital data. ESPIS facilitates information sharing for NEPA assessments, oil and gas and alternative energy leasing, and informing Ocean Planning initiatives. The ESPIS search tool is hosted on a shared platform with MarineCadastre.gov, which is developed in partnership with the NOAA Office for Coastal Management. ESPIS can be accessed at http://www.boem.gov/Environmental-Studies-EnvData/.

The results of BOEM-funded research are presented both domestically and internationally to a variety of audiences, including professional and academic societies, industry forums, and governmental workshops. These events spread scientific information to wide audiences, and many projects have opportunities for educational components.

Information concerning ongoing research supported through the ESP is accessible at: https://www.boem.gov/Ongoing-Environmental-Studies-by-Region/. The ongoing research is arranged by BOEM OCS Region and discipline. Information provided for each study includes a complete description, status report, cost, and expected date of its final report. Affiliated web sites, presentation abstracts, and papers are provided where applicable.

1.3.6 Outreach and Education

BOEM, like many other Federal agencies, must be able to attract well-qualified marine scientists and engineers to meet expanding and changing workforce needs. The ESP undertakes a number of activities to encourage students in their academic training and provide young professionals with opportunities to succeed in their careers. These activities are in support of the ESP's education goals of: (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) an ocean literate marine workforce. To achieve these goals, the ESP undertakes a number of activities aimed at increasing ocean literacy and building a strong marine workforce. Through cooperative agreements with universities, BOEM often supports undergraduate and graduate research. Research teams on ESP-funded projects using undergraduate and graduate students contribute to the training and career development of the next generation of marine scientists.

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

2 HEADQUARTERS STUDIES

2.1 Introduction

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

To meet national assessment needs, OEP considered the areas of information that BOEM needs to know as posed in the BOEM Strategic Framework (BOEM 2016c). Comparison of these areas with the historical knowledge of national scientific needs identified through either the development of the 2017–2022 Programmatic Environmental Impact Statement (BOEM 2016b), the 2019–2024 Programmatic Environmental Impact Statement (under development), or other NEPA analyses and associated consultations led to the development of this year's nine study profiles.

2.2 Alignment with Strategic Science Questions

At the national level, BOEM's ESP has focused on a few of the strategic science questions that support BOEM and ESP operations as a whole over the past few years (**Table 1**). These areas of focus are the use of existing or emerging technology to achieve more effective or efficient scientific results, the acute and chronic effects of sound from BOEM-regulated activities on marine species and their environment, and understanding the air emissions impacts of BOEM-regulated activities to the human, coastal, and marine environment.

To address these issues, BOEM has funded several studies that look to utilize or optimize new technologies such as utilizing satellite and high resolution aerial imagery to identify and count marine and avian species, incorporate eDNA analyses for species monitoring, or use existing satellite resources to better detect and track large marine organisms. The ESP has also funded key interagency programs that are seeking to develop data and metadata standards for oceanographic data required by many Federal agencies to support science informed decisions. BOEM's ESP has also conceptualized and funded studies to better understand the effects and dynamics of natural and anthropogenic sound in the marine environment.

BOEM is committed to the continuous improvement of OSRA estimations. As offshore activity expands into deeper waters and new geographic areas, BOEM oil spill modeling will be applied to pertinent risk assessments and validated with environmental observations. BOEM has also worked to update regional air quality models and their inputs to better understand the potential impacts of OCS energy development on the human and marine environment. Similarly, at a national level, BOEM's ESP has worked to proactively develop and fund updates to key economic analyses that support the National OCS Leasing Program.

Table 1. Alignment of proposed FY2019 Headquarters studies with BOEM programs and strategic science questions.

BOEM ENVIRONMENTAL STUDIES PROGRAM (ESP) STUDIES PROPOSED FOR FY 2019
HEADQUARTERS

Priority Rank	Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on species and ecosystems?	What is the effect of **LANDSCAPE ALTERATION** from BOEM-regulated activities on coastal and marine resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
1	Compendium on Oil Spill Science	✓			✓		✓	✓					✓
2	Creating Environmental Studies Program Information System (ESPIS) Linked Data to Enhance Support of BOEM Business Lines	✓	✓	✓									
3	Understanding the BOEM Footprint on Vulnerability of Communities Using Baseline Data	✓	✓	✓				✓		✓			✓
4	Air Quality Modeling for the Atlantic Oil and Gas Development	✓									✓		
5	Developing an auditory weighting function for low-frequency whales	✓	✓	✓	✓	✓						✓	✓
6	Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery	✓	✓	✓								✓	✓
7	Archaeological Investigations in Support of Development of Energy and Mineral Resources on the US Outer Continental Shelf	✓	✓	✓				✓	✓			✓	
8	Demonstration Project, Integrating DNA Profiles, Genomics and Photo-Identification data in long term monitoring of long lived marine megafauna.	✓	✓	✓	✓			✓	✓				✓
9	Catalog of Seabird Colonies	✓	✓	✓	✓			✓				✓	✓
10	Standards for the Collection and Analytical Processing of Subsurface Core Samples			✓				✓	✓	✓		✓	
11	Mortality risk for Large Bodied/Low Trophic Feeding Elasmobranchs during energy and mineral operations.		✓	✓				✓				✓	
12	Developing a Roadmap to Maximize Efficiency in Developing Environmental Analyses.	✓	✓	✓				✓		✓		✓	
13	Potential effects of seismic airguns on zooplankton in the US OCS	✓			✓	✓		✓					
14	High Resolution Modeling of the Gulf of Mexico		✓	✓	✓			✓				✓	
15	Incorporating the Seascape Paradigm in Monitoring Marine Ecosystems, a Next Step for the Marine Biodiversity Observation Network (MBON)	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
16	Identification and characterization of mini biological hotspots associated with methane seeps in the northern Gulf of Mexico		✓		✓			✓					✓
17	Support for Fifth International Conference on the Effects of Noise on Marine Life	✓	✓	✓									
18	Marine Mammal Bioenergetics Workshop	✓	✓	✓	✓	✓		✓	✓			✓	✓
19	BOEM Graduate Student Award for Applied Scientific Research	✓	✓	✓									

3 ALASKA STUDIES

3.1 Introduction

The Alaska OCS encompasses 15 planning areas in the Arctic, Bering Sea, and Gulf of Alaska sub-regions (**Figure 4**). BOEM's Alaska Office oversees more than one billion acres on the OCS and more than 6,000 miles of coastline, which is more coastline than in the rest of the United States combined. The vastness of the Alaska OCS presents many challenges for working in the region, including: large and remote planning areas; diverse and extreme environmental conditions; still-evolving hydrocarbon extraction technology; and potential environmental hazards associated with offshore activities, such as seasonal sea ice coverage.

Since the ESP began more than 40 years ago BOEM has funded nearly $500 million in environmental studies in Alaska, producing more than 1,000 technical reports and peer-reviewed publications. Completed study reports are posted at http://www.boem.gov/ESPIS/. An alternate location for browsing Alaska Region study reports by year is http://www.boem.gov/AKpubs. Although much relevant information exists for certain Alaska OCS planning areas and trophic levels, data are patchy at a large marine ecosystem scale, while environmental conditions and other anthropogenic stressors keep changing over time.

Environmental change is more evident in the Arctic than in other areas, with summer sea ice extent decreasing to record historical lows. The loss of ice cover is causing changes to the ocean currents, water chemistry, and ecosystem productivity, and has serious implications for marine mammals, as well as bird and fish species that live on, below, or near the ice. Environmental change also entrains many socioeconomic issues. Some immediate concerns include: increased shoreline erosion and permafrost melt that threatens Arctic communities and infrastructure; changes in distribution and availability of hunted subsistence species; and potential changes in commercial and subsistence fisheries as commercial species such as salmon move north. In consideration of such transition, scientists are challenged to project how the changing environment will interact with OCS activities in the Arctic over the next 25–50 years.

In 2016, BOEM released the Proposed Final OCS Oil & Gas Leasing Program 2017–2022 (BOEM 2016), which includes a lease sale in the Cook Inlet Planning Area in 2021. However, as directed in Executive Order 13795 (April 28, 2017) and DOI Secretary's Order 3350 (May 1, 2017), BOEM is in the process of developing a new National OCS Program for 2019–2024 that, if approved, will supersede the 2017–2022 Program. The first of three proposals for 2019–2024, the National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program (BOEM 2018), was released on January 4, 2018. This Program proposes 19 lease sales for Alaska OCS planning areas: three sales in the Beaufort Sea in 2019, 2021, and 2023; three sales in the Chukchi Sea in 2020, 2022, and 2024; two sales in Cook Inlet in 2021 and 2023; and one sale in each of the other Alaska Planning Areas, except the North Aleutian Basin, in 2023.

Currently, the Alaska OCS Region has 35 active leases from previous lease sales, 14 in the Cook Inlet Planning Area and 21 in the Beaufort Sea Planning Area. The Alaska OCS Region has an additional 19 leases in the Beaufort Sea that are subject to a Suspension of Operation (SOO) determination by the Bureau of Safety and Environmental Enforcement (BSEE). The 19 SOO

leases encompass approximately 108,172 acres in the Beaufort Sea and the status of these 19 leases as either active or expired will be determined following BSEE's decision on the SOO.

Figure 4. Alaska OCS Region planning areas.

On July 12, 2017, BOEM approved an Exploration Plan (EP) submitted by Eni US Operating Company, Inc. to conduct drilling into leased OCS areas in the Beaufort Sea from their Spy Island Drillsite, an existing gravel island located in State waters. BOEM also is currently in the process of evaluating and preparing a final Environmental Impact Statement (EIS) for a Development and Production Plan (DPP) submitted by Hilcorp Alaska, LLC proposing construction of a gravel island and production facility for the Liberty Unit, which is estimated to contain up to 150 million barrels of recoverable crude oil. The Liberty Unit is located in the central Beaufort Sea about 5.5 miles offshore in Federal waters and 6 miles east of the existing Endicott Satellite Drilling Island.

Northstar is a joint Federal/State of Alaska production unit located in the Beaufort Sea about 12 miles northwest of Prudhoe Bay. The Northstar Unit includes three OCS leases, which account for nearly 18% of total Northstar production, while the remaining 82% is allocated to State leases. Total production of crude oil through March 2018 is more than 170 million barrels, with the Federal portion comprising approximately 30 million barrels.

3.2 Strategic Science Questions Unique to the Alaska Region

In addition to the programmatic strategic science questions identified in Section 1.2.4, the Alaska Region must consider issues related to sea ice, including the following questions:

- What role will ocean currents and sea ice play in distribution of anthropogenic pollutants near exploration and development prospects?
- How are ocean currents changed under reduced sea ice conditions?
- How do cold temperatures and presence of sea ice alter the fate of spilled oil?

3.3 Alignment with Strategic Science Questions

In recent years, BOEM has placed primary emphasis on studying the Beaufort Sea, Chukchi Sea and Cook Inlet Planning Areas, conducting interim baseline research and monitoring for trends in diverse fields of interest.

Most of the projects exhibit complex, multilateral collaborations, with explicit interdisciplinary linkages between the physical and biological sciences. Many of them also provide a role for active participation by Alaska Native residents and input from sources of traditional knowledge.

A better understanding of trophic and community structure in nearshore habitats in the Beaufort Sea is needed to support evaluation of resiliency of fish and invertebrate populations under changing environmental conditions. The need for information about Arctic cod is particularly acute, including description of essential fish habitat and details about timing and location of spawning. Residents of Beaufort Sea coastal communities have expressed concerns about long-term effects of OCS activities, particularly changes to currents and sedimentation rates and potential effects on social systems, including subsistence whaling activities, in the vicinity of Northstar and Liberty. Additional information also is needed about landfast ice and under ice circulation, and improved tools are needed to help assess the effects on marine mammals of anthropogenic activities, including increased noise and vessel traffic through the Chukchi and Beaufort seas in support of oil and gas exploration and development activities.

The need for updated information about the physical and biological environment in Cook Inlet and Shelikof Strait is also ongoing. Some particular interests for information include, but are not limited to: an improved understanding of distribution and geographic range of the endangered Cook Inlet beluga whale stock; assessment of variability and long-term trends in oceanographic conditions and biological communities, including the presence and distribution of the critically endangered North Pacific right whale; and obtaining further baseline information about potential impacts from oil and gas-related activities to the economy and subsistence use of lower Cook Inlet.

As noted above, oil and gas lease sales are also proposed for 11 of the other 12 Alaska Planning Areas through the Bering Sea and Gulf of Alaska. Collation and synthesis of existing baseline information is needed to support NEPA analyses for these areas that have not been considered for leasing in decades. In addition, the Alaska Region is partnering with the University of Alaska Fairbanks to assess the environmental feasibility of a wave energy project in State of Alaska waters off Yakutat. This project represents a uniquely cost-effective opportunity for BOEM to

help establish methods and procedures that can be employed in future wave energy site resource assessments in both State and Federal waters across the Nation.

The Alaska Region has considered the strategic science questions identified above together with these specific information needs to develop our list of studies proposed for FY 2019. The studies proposed for the Alaska Region inform a broad repertoire of knowledge and address each of the strategic science questions to varying extents. **Table 2** contains a matrix indicating the strongest intersections between each study and the strategic questions. Of particular note is the long-standing cooperative program between BOEM, the University of Alaska, and the State of Alaska known as the Alaska CMI. Through the CMI, BOEM can partner with the University of Alaska to conduct studies to address any of the strategic questions.

Tables of proposed studies for the Alaska Region are included in Section 7. Profiles for these proposed studies are provided in **Appendix B**.

Table 2. Alignment of proposed FY2019 Alaska OCS Region studies with BOEM programs and strategic science questions.

BOEM ENVIRONMENTAL STUDIES PROGRAM (ESP)
STUDIES PROPOSED FOR FY 2019
ALASKA REGION

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS									REGION QUESTIONS		
		Conventional Energy	Renewable Energy	Marine Minerals	How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on coastal and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated activities on ecological processes?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?	What role will **OCEAN CURRENTS AND SEA ICE** play in distribution of anthropogenic pollutants near exploration and development prospects?	How are ocean currents and biota affected by **REDUCED SEA ICE CONDITIONS**?	How do cold temperatures and presence of sea ice **ALTER THE FATE OF SPILLED OIL**?
1	Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea	✓			✓			✓	✓			✓	✓	✓		
2	Landfast Ice in the Beaufort and Chukchi Seas and Under Ice Circulation Processes on the Beaufort Sea Shelf	✓							✓	✓				✓	✓	
3	Alaska Coastal Marine Institute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Synthesis of Current Environmental Literature for OCS Planning Areas in the Northern Gulf of Alaska	✓	✓		✓		✓		✓	✓						
5	Underwater Sound Signatures and Propagation for OCS Activities Permitted by BOEM	✓			✓	✓						✓				
6	Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty DPP	✓			✓		✓			✓		✓	✓			
7	Range-Wide Distribution of Cook Inlet Beluga Whales (*Delphinapterus leucas*) in the Winter	✓						✓					✓			
8	Model-based essential fish habitat descriptions for Arctic cod, saffron cod and snow crab in the Alaskan Arctic	✓			✓		✓	✓	✓				✓		✓	
9	Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbls	✓					✓				✓			✓		✓
10	Oil Spill Occurrence Estimators for Offshore and Onshore Cook Inlet and Onshore Alaska North Slope Spills	✓					✓						✓			
11	Synthesis of Current Environmental Literature for OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Islands	✓			✓		✓		✓	✓				✓		✓
12	Generation of Synthetic Audiograms by Applying Finite Element Modeling to CT Scans for Walrus, Ice seals and Beluga Whales	✓			✓	✓						✓	✓			

4 GULF OF MEXICO STUDIES

4.1 Introduction

Ongoing activities in the GOM consist of conventional oil and gas development as well as non-energy marine mineral leasing of sediment resources to support coastal restoration projects. While there is no current development of OCS renewable energy resources in the GOMR, future interest in wind energy and possibly other offshore technologies may be on the horizon.

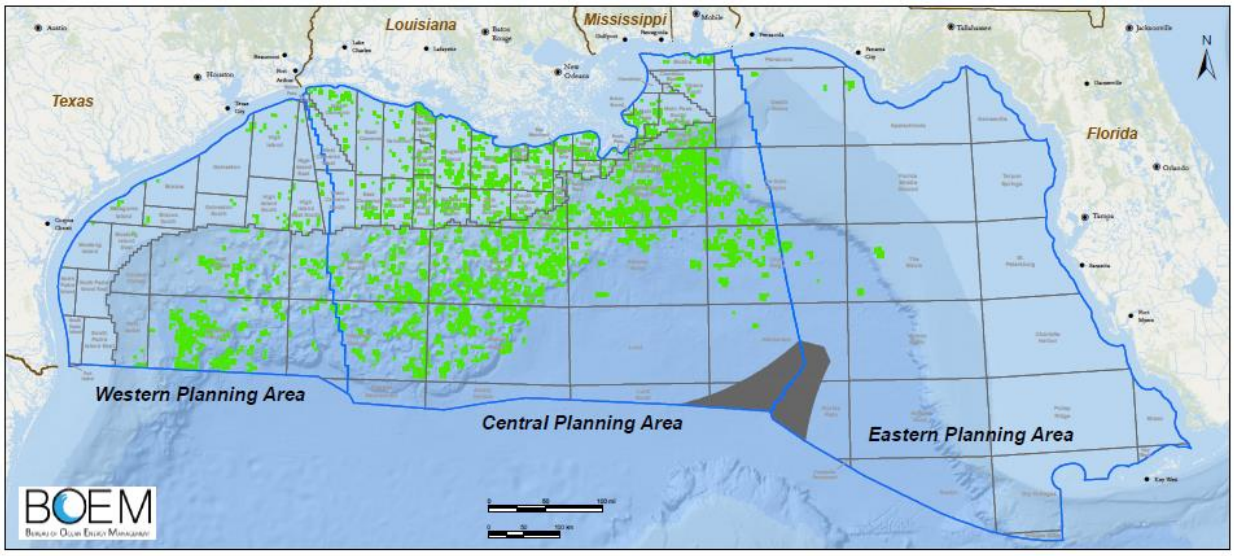
The environmental studies in the GOMR address issues from pre-lease through post-lease operations for conventional energy as well as marine minerals extraction from the OCS. In 1992, the former Minerals Management Service (MMS), now BOEM, entered into a partnership with the Louisiana State University (LSU) to establish the first CMI. This partnership, which continues today between BOEM and LSU, was developed as part of an initiative to cultivate new State-Federal cooperative agreements on environmental and socioeconomic issues of mutual concern. These projects are designed to help answer questions regarding the potential impacts from oil and gas and marine minerals activities.

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

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

4.1.1 Conventional Energy

As of March 1, 2018, there are more than 2,700 active oil and gas leases on the GOM Federal OCS (**Figure 5**). Within active leases, there are nearly 2,000 platforms making significant contributions to the Nation's energy supply. The GOMR currently provides approximately 25% of U.S. domestic oil production and 11% of U.S. domestic gas production. Energy exploration and production activities include leasing, exploration, development, removal of platforms, and installation of pipelines. The recently released Draft Proposed Program for FY 2019–2024 proposes GOMR lease sales in the Central Planning Area, Western Planning Area, and some portions of the Eastern Planning Area. Final decisions on the extent of leasing areas in the GOMR that will be available in future lease sales will be made in 2019. Two lease sales, proposed in the previous final Five-Year Program (FY 2017–2022) are scheduled for 2018; the first was held on March 21 and a second will be held later in 2018. The March 2018 lease sale offered 76.9 million acres for oil and gas exploration and development in the GOM. For more information on the GOMR please visit http://www.boem.gov/Gulf-of-Mexico-Region/.



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	407	2,297,418
Central	12,409	66,446,351	2,272	11,885,103
Eastern	11,537	64,357,859	36	200,670
Sub-Totals	29,186	159,381,023	2,715	14,383,191
CPA / EPA Shared Blocks*	(86)		(2)	
Totals	**29,100**	**159,381,023**	**2,713**	**14,383,191**

Active Lease
Exclusive Economic Zone
Northern Portion of the Eastern Gap
Planning Area Boundary
* CPA and EPA contain 86 shared blocks of which 2 are leased. These blocks are given both a CPA and EPA designation in the data which accounts for a higher block total.

Figure 5. GOM OCS planning areas and active oil and gas leases (March 1, 2018).

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

4.1.2 Marine Minerals Program

The MMP is actively leasing OCS sediment in the GOM, some of which for restoration projects proposed to repair natural resources damaged during the *DWH* oil spill or storm-related events. Projects recently completed in the GOM include Caminada Headland Beach and Dune Restoration Project (**Figure 6**) and Cameron Parish Shoreline Restoration Project. More than 10 million cubic yards of material has been authorized to be dredged from the OCS for these two projects. These projects are part of the overall Federal effort to work with Gulf Coast communities to help rebuild coastal marshes and barrier islands, restore damaged beaches, and

conserve sensitive areas for wildlife while enhancing the natural protection that these landforms provide from storms. The Gulf provides a unique environment of complex competing use challenges resulting from sand resource areas that may also be optimum sites for oil and gas platforms and associated pipelines (**Figure 7**). These circumstances, access, and potential environmental resource conflicts are becoming more complex and deserving of rigorous and integrated environmental study, monitoring, and management.

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

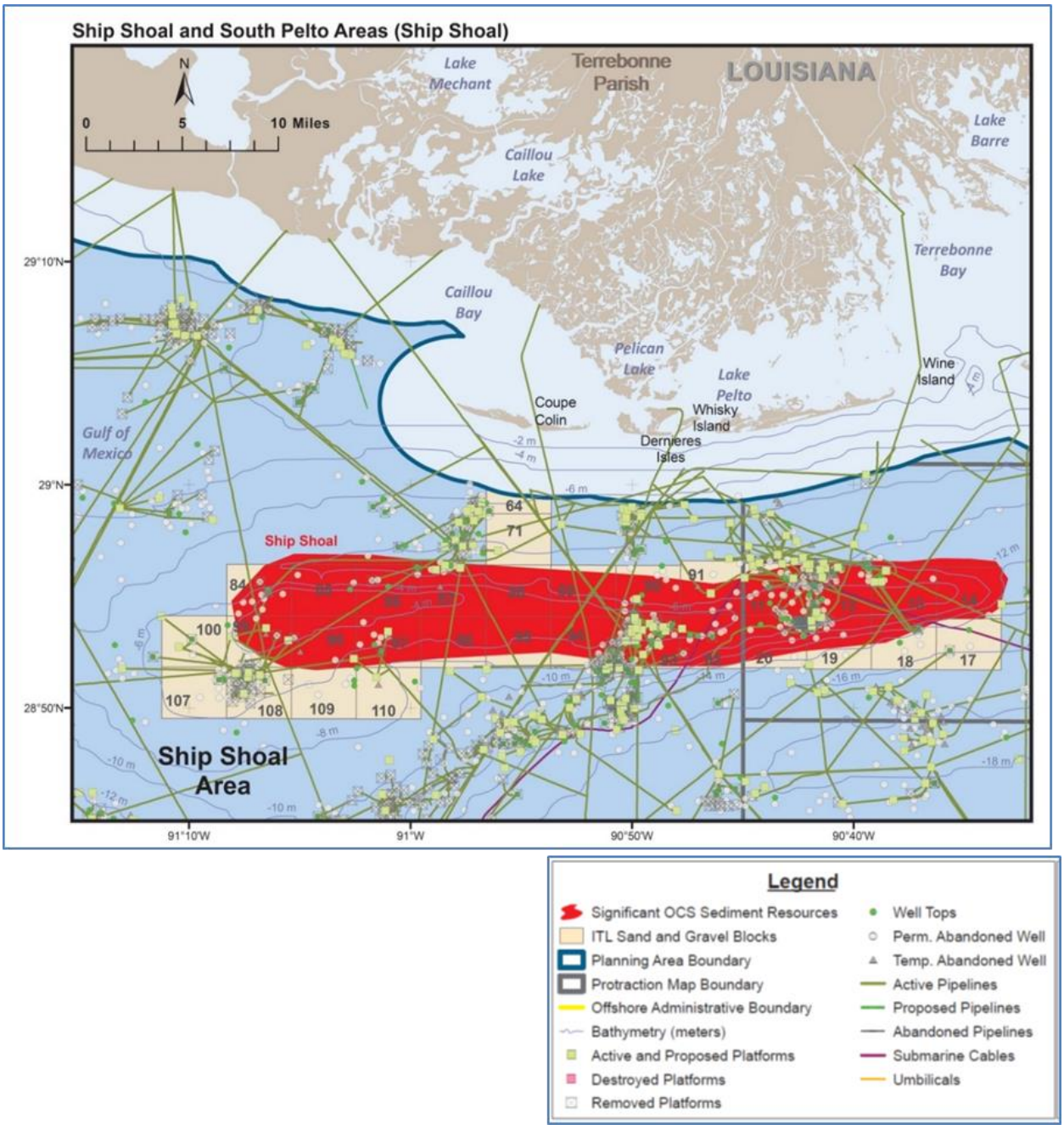


Figure 7. Complex competing use challenges with respect to oil and gas platforms, pipelines, and the Ship Shoal significant OCS sediment resources in the GOM.

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

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

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

4.2 Alignment with Strategic Science Questions

With a robust conventional energy program spanning several decades, the GOMR continues to identify information needs related to actual and potential impacts from oil and gas-related activities that will inform cumulative impacts and other NEPA analyses, environmental consultations, mitigations, and oil spill modeling. Collection of baseline data in areas currently devoid of oil and gas activities will inform future decision making as well as lay the foundation for long-term monitoring. Existing and new monitoring programs often rely on partnerships and will continue to provide valuable environmental information. In addition, studies related to marine minerals extraction will continue to provide important information for BOEM decision making. Understanding the ecosystems in which dredging occurs, both with and without construction activity, improves BOEM's analyses of impacts and management of the resource for long-term use.

Tables of proposed studies for the GOMR are included in **Appendix A**. Profiles for these proposed studies are provided in **Appendix B**.

4.2.1 Conventional Energy

The GOMR is proposing 10 ranked study profiles for the FY 2019 NSL with an additional 9 study profiles submitted for consideration yet unranked at this time. All of the profiles address at least one national strategic science question, while several profiles address two or more questions (**Table 3**). The majority of profiles will inform the conventional energy program. In addition, several profiles will also inform the Marine Minerals and Renewable Energy Programs. Profiles include discipline-specific as well as interdisciplinary studies that address topics in Archaeological Resources Protection, Biology, Fates & Effects, Information Management & Other, Meteorology & Air Quality, or Social & Economic Sciences.

Table 3. Alignment of proposed FY2019 GOM OCS Region studies with BOEM programs and strategic science questions.

BOEM ENVIRONMENTAL STUDIES PROGRAM (ESP)
STUDIES PROPOSED FOR FY 2019
GULF OF MEXICO REGION

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
		Conventional Energy	Renewable Energy	Marine Minerals	How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **SOCIAL SCIENCES** in assessing the impacts of activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
1	Understanding the Recreational Uses of OCS Infrastructure	✓								✓			
2	Wind Tunnel Experiments for Oil Platform Downwash	✓									✓		
3	An Analysis of Seafloor Impacts on the Gulf of Mexico OCS for Adaptive Management Strategies	✓	✓	✓	✓			✓					
4	Preliminary Study: GOMR Coastal Ambient Air Quality Monitoring Program	✓									✓		✓
5	OCS-Related Transportation Infrastructure in Louisiana and Texas	✓								✓			
6	Meeting the Challenge: Developing Baseline Data Collection and Action Plans	✓			✓					✓			
7	Baseline Monitoring of Avian Activity and Offshore Structure Interactions	✓						✓					
8	Strategically Focused Support for Oil and Gas Activities in the Gulf of Mexico OCS Region	✓			✓					✓			

Three profiles address the strategic science question: *How can BOEM best assess cumulative effects within the framework of environmental assessments.* Studies such as "An Analysis of Seafloor Impacts on the Gulf of Mexico OCS for Adaptive Management Strategies" propose to compile and analyze information about actual seafloor impacts due to various OCS energy extraction and development-related activities to inform adaptive impact mitigations. Studies within the Social & Economic Sciences discipline will collect baseline information to inform socioeconomic impact assessments of catastrophic oil spills ("Meeting the Challenge: Developing Baseline Data Collection and Action Plans") and provide "Strategically Focused Support for Oil and Gas Activities in the Gulf of Mexico OCS Region."

Two profiles address the strategic science question: *What is the effect of habitat or landscape alteration from BOEM-regulated activities on ecological and cultural resources?* One study, "An Analysis of Seafloor Impacts on the Gulf of Mexico OCS for Adaptive Management Strategies," will compile and analyze available information on seafloor-disturbing activities. Another study, "Baseline Monitoring of Avian Activity and Offshore Structure Interactions," is proposed to collect information about avian migrations and the net effect of avian interactions with existing offshore structures.

Four profiles address the strategic science question: *How does BOEM ensure the integrated use of its social sciences in assessing the impacts of OCS activities on the human environment?* Three studies will address OCS-related infrastructure. The study "Understanding the Recreational Uses of OCS Infrastructure" will obtain information about the recreational use of OCS infrastructure and Rigs-to-Reefs sites as well as evaluate actual and anticipated behavioral shifts resulting from removal of infrastructure. The study "OCS-Related Transportation Infrastructure in Louisiana and Texas" will provide information about onshore transportation activities and infrastructure related to OCS activities. A third study, "Meeting the Challenge: Developing Baseline Data Collection and Action Plans," will identify the key baseline information that is needed for assessing catastrophic oil spill impacts and will identify best practices for collecting such information. A fourth study, "Strategically Focused Support for Oil and Gas Activities in the Gulf of Mexico OCS Region," is proposed as an indefinite-delivery, indefinite-quantity (IDIQ) contract to compile social science-related information that will be used for scenario development and impact analyses need for NEPA documents.

Two profiles address the strategic science question: *What are the BOEM-regulated industry impacts of air emissions to the human, coastal, and marine environment?* The study "Wind Tunnel Experiments for Oil Platform Downwash" will determine the effects of oil platform structure on air flow and plumes to determine how these characteristics might affect pollutant dispersion. A second study, "Preliminary Study: GOMR Coastal Ambient Air Quality Monitoring Program," will measure and monitor critical air pollutants at selected shoreline sites to compare with air quality modeling predictions and NAAQS standards.

Finally, one profile addresses the strategic science question: *What affected resources, measures, and systems are best used for long-term monitoring?* The profile "Preliminary Study: GOMR Coastal Ambient Air Quality Monitoring Program" as discussed above will focus on monitoring coastal ambient air quality in the GOMR.

4.2.2 Marine Minerals Program

BOEM's MMP consistently strives to understand the uncertainty and environmental risk of individual and cumulative leasing decisions and promotes a "science strategy" that contributes to existing knowledge and aligns future investments with anticipated high-risk data gaps. While all of the proposed MMP studies address more than one of the ESP's key questions, for clarity and brevity, only the most pertinent question is linked to a given study. For FY 2019–2021, the proposed MMP studies for the GOM primarily align with strategic science questions related to (1) the effect of habitat or landscape alteration on ecological resources and (2) use of existing or emerging technologies to achieve more effective or efficient scientific results.

In support of strategic science question (2) (*i.e.*, new technology applications), the MMP is continuing to take advantage of telemetry technology to better understand the behavior patterns of threatened and endangered sea turtles within OCS borrow areas. Sea turtles are at risk of entrainment and mortality associated with offshore hopper dredging activities. Despite the impressive body of research available on sea turtle movements, there is still little known about their fine-scale activities and behavior due to limitations in technology and the ability to conduct laboratory tests. However, new and more cost-effective telemetry technologies have been recently developed to support high resolution tracking of sea turtle behavior within the water column. Deployment of satellite tags capable of logging dive data on turtles captured in relocation trawling projects is currently underway for an existing study in collaboration with USGS (NT-16-07). The current BOEM/USGS project is collecting a robust data set on dive profiles of both immature and mature endangered Kemp's ridleys and threatened loggerheads of both sexes. However, there is an additional need to calculate fine-scale dive profiles and activity budgets within borrow area sites to better inform decisions. The proposed study titled "Fine-Scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico" is proposing to use emerging satellite telemetry technologies (i.e., acceleration data loggers [ADLs]) and data retrieval techniques to provide such fine-scale data. ADLs provide high resolution data that can be translated into specific movements, such as gliding or resting. These results will link three BOEM projects by providing detailed information on dive profiles and behavior of turtles within the water column. Data for this project, collected in the GOM, will support MMP decisions in both the Gulf and Atlantic regions and will be integrated into the ongoing study (NT-15-02) titled "Development of a Decision Support Tool to Reduce Sea Turtle Dredging Entrainment Risk." NT-15-02, which relies on the best available sea turtle behavior data like that collected in the FY 2018 proposed study, will evaluate and document entrainment risk parameters for dredging activities in the OCS and develop a geographically and temporally based decision support tool to assess project-specific dredging entrainment risk and guide mitigation planning decisions.

5 PACIFIC STUDIES

5.1 Introduction

BOEM's Pacific Region includes the OCS areas offshore California, Oregon, Washington, and Hawaii (**Figure 8**). The Region's current responsibilities encompass three BOEM programs: ongoing conventional energy operations, renewable energy development, and potential leasing of marine mineral resources. The ESP started in the Pacific Region in 1973. Over its 45 year history the program has evolved in response to (1) change in the geographic areas of activity and study, (2) change in the emphasis of disciplines highlighted for research, (3) change in the status of the Southern California Planning Area from a frontier to a mature oil and gas producing area (and a corresponding shift from pre-lease to post-lease information needs), (4) change to include frontier areas for renewable energy development offshore California, Oregon, and Hawaii, and (5) recent interest in marine sand resources offshore California.

For this FYs 2019–2021 SDP, BOEM Pacific Region participated in outreach to many stakeholders for input, including public and private academic institutions, Federal and State agencies, the general public, private consultants, and tribal governments. BOEM Pacific Region received and considered 49 study ideas from stakeholders, including universities, consultants, Federal agencies (NOAA, USGS, PNNL, and Army Corps of Engineers), and State agencies (Oregon and Washington). Additionally, nine BOEM Pacific Region staff proposed 30 study ideas. Regional managers and staff considered all relevant and mission-oriented studies; those found to be of direct relevance and timely were prioritized by regional managers and staff, and are proposed in this SDP (see **Appendix A** and **Appendix B**).

5.1.1 Conventional Energy Activities

As directed in Executive Order 13795 (April 28, 2017) and Secretary's Order 3350 (May 1, 2017), BOEM is initiating a process to develop a new National OCS Oil and Gas Leasing Program for 2019–2024 to, upon completion, replace the current 2017–2022 Program. The new Program in development includes consideration of new lease sales in the Washington/Oregon, Northern California, Central California, and Southern California planning areas (**Figure 8**).

The current Five-Year OCS Oil and Gas Leasing Program does not include new oil and gas lease sales for the Pacific Region. Nonetheless, oil and gas production is ongoing in Federal waters in the Southern California Planning Area (**Figure 9**) and will continue for the foreseeable future. As of December 31, 2017, cumulative production was nearly 1.4 billion barrels (bbls) of oil and 1.9 trillion cubic feet (cf) of gas; annual production was 5.7 million bbls of oil and 4.0 billion cf of gas (C. Baver, personal communication). Production has declined from previous levels due to the shut-in of six platforms following the May 2015 break of an onshore pipeline that transported oil from the platforms; once pipeline repairs are completed, production is expected to increase. On platforms unaffected by the pipeline break, production operations continue.

The expectation of future decommissioning of platforms in Federal waters has been discussed for years. It now appears that the decommissioning process for two platforms in the Southern California Planning Area, Platform Gail and Platform Grace, is starting. Industry intends to submit a decommissioning application to BSEE for review and approval. BOEM maintains close

coordination with BSEE and other Federal, State and local permitting agencies throughout the decommissioning process.

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

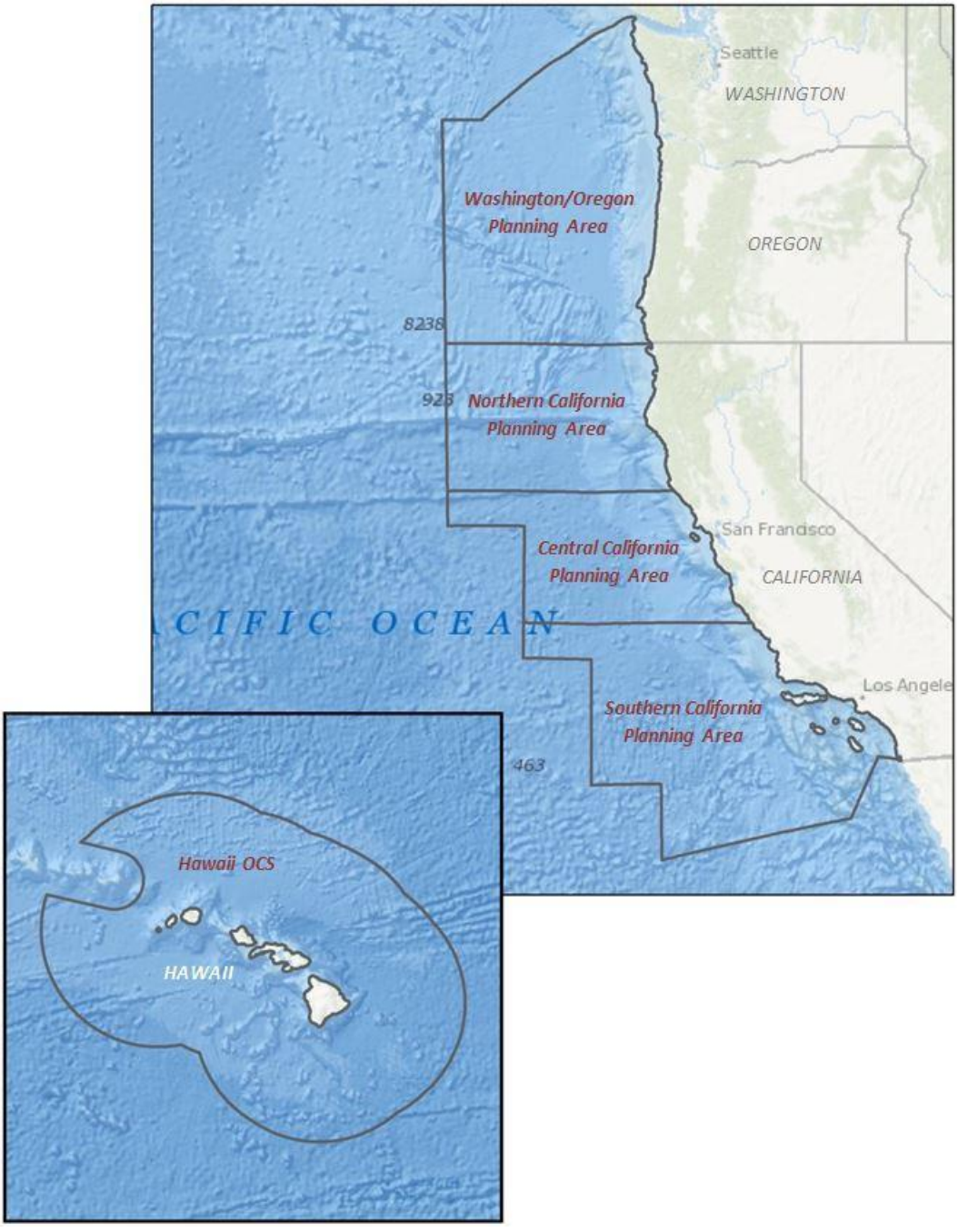


Figure 8. OCS planning areas in the Pacific Region.

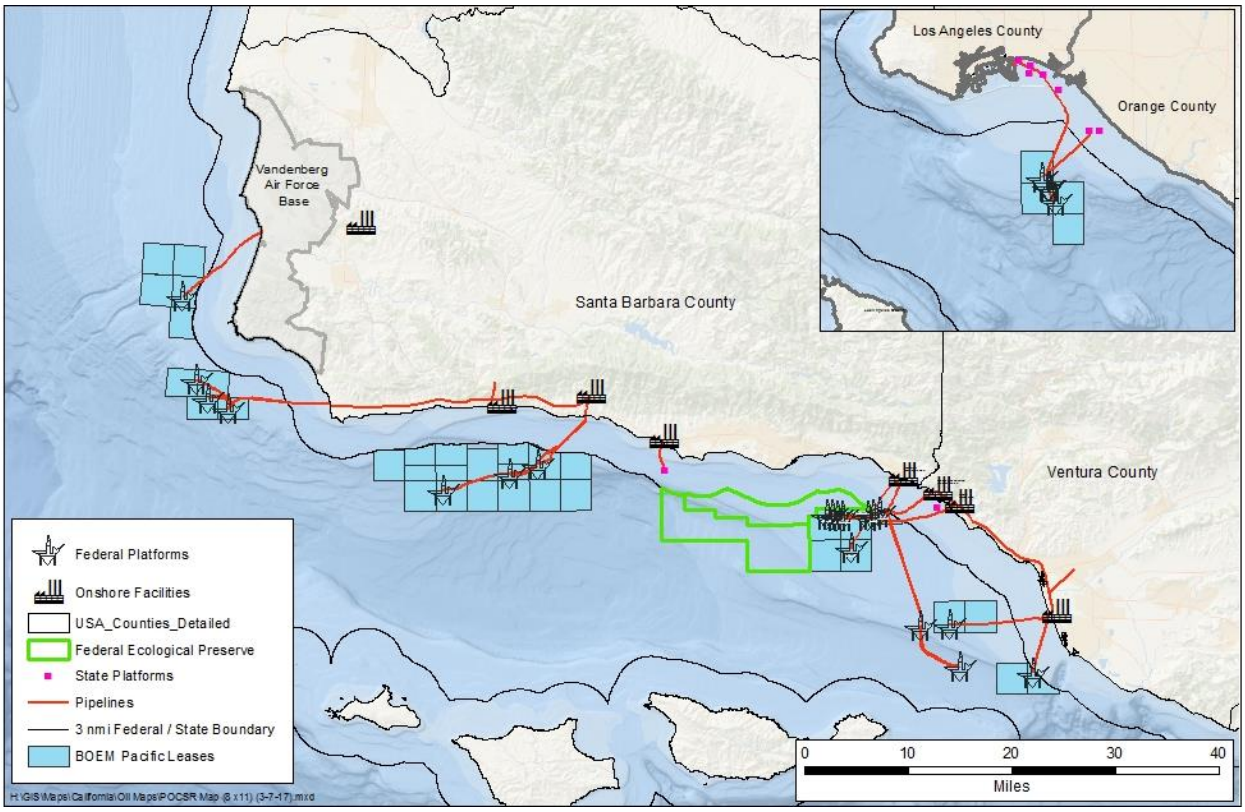


Figure 9. Oil and gas leases and facilities in the Pacific Region.

5.1.2 Renewable Energy Activities

Significant wind and wave potential along the U.S. West Coast and offshore Hawaii (**Figure 10, Figure 11**) has stimulated interest from renewable energy developers. Deepwater floating wind and wave energy projects have been proposed offshore California, Oregon, and Hawaii. Currently, wind energy projects are proposed in the California and Hawaii OCS and a wave energy project is proposed in the Oregon OCS (**Figure 12**). Additionally, seafloor cables on the OCS that transmit renewable energy originating from terrestrial sources is in the planning phase in Hawaii (**Figure 13**). Ongoing and proposed studies will provide important information for offshore planning efforts, NEPA reviews of construction and operation plans, consultations, conditions of approval, development of notices to lessees and operators, assessment of lease stipulation and mitigation measure effectiveness, renewable energy task forces, and stakeholder outreach activities.

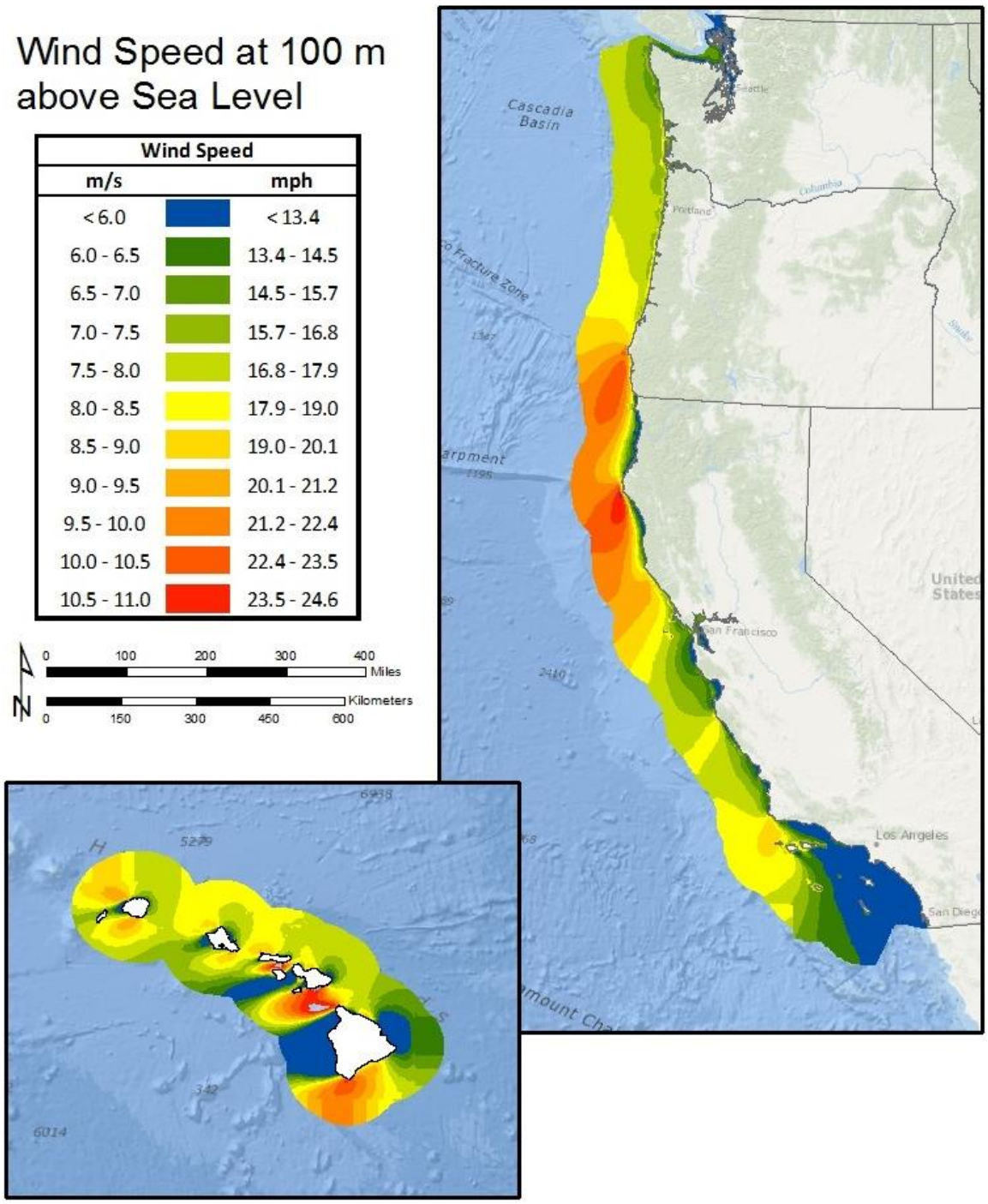


Figure 10. Annual average wind speed offshore the U.S. West Coast and Hawaii.
Maps based on National Renewable Energy Laboratory's assessment of offshore wind energy resources (Musial et al. 2016). Data available at https://maps.nrel.gov/wind-prospector.

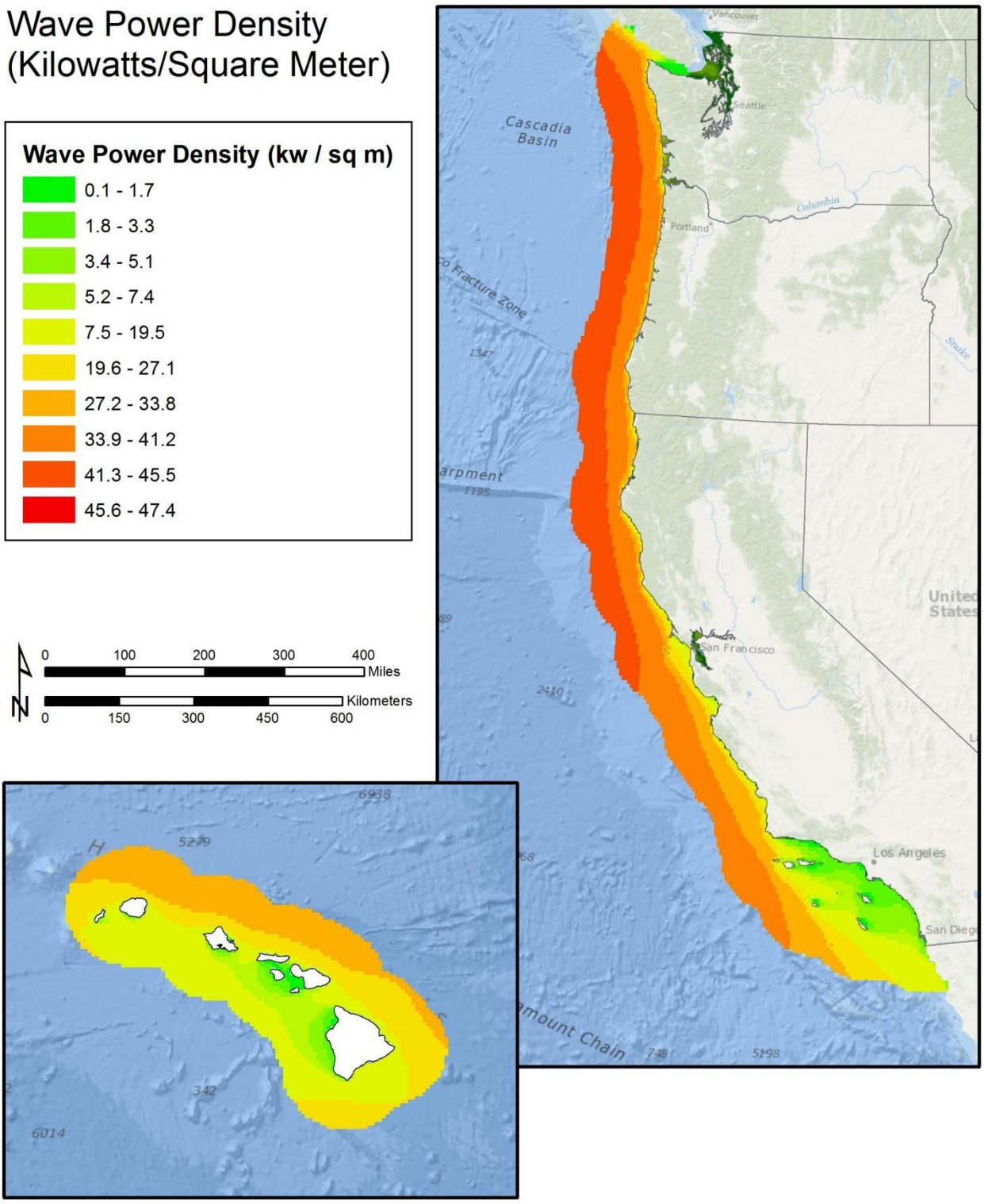


Figure 11. Annual average wave power density offshore the U.S. West Coast and Hawaii.
Maps based on Electric Power Research Institute's assessment of ocean wave energy resources (EPRI 2011). Data available at https://maps.nrel.gov/mhk-atlas.

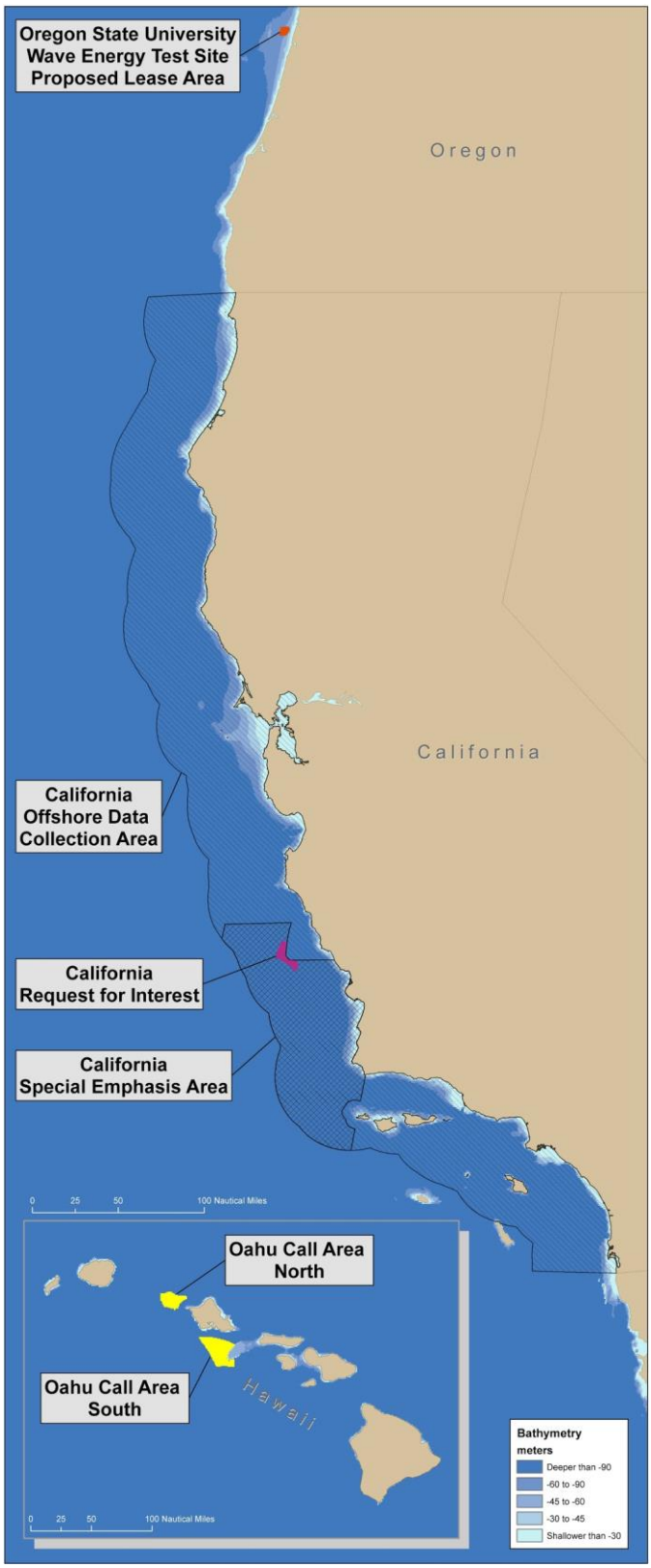


Figure 12. Areas of interest and proposed leasing for renewable energy in the California, Oregon, and Hawaii OCS.

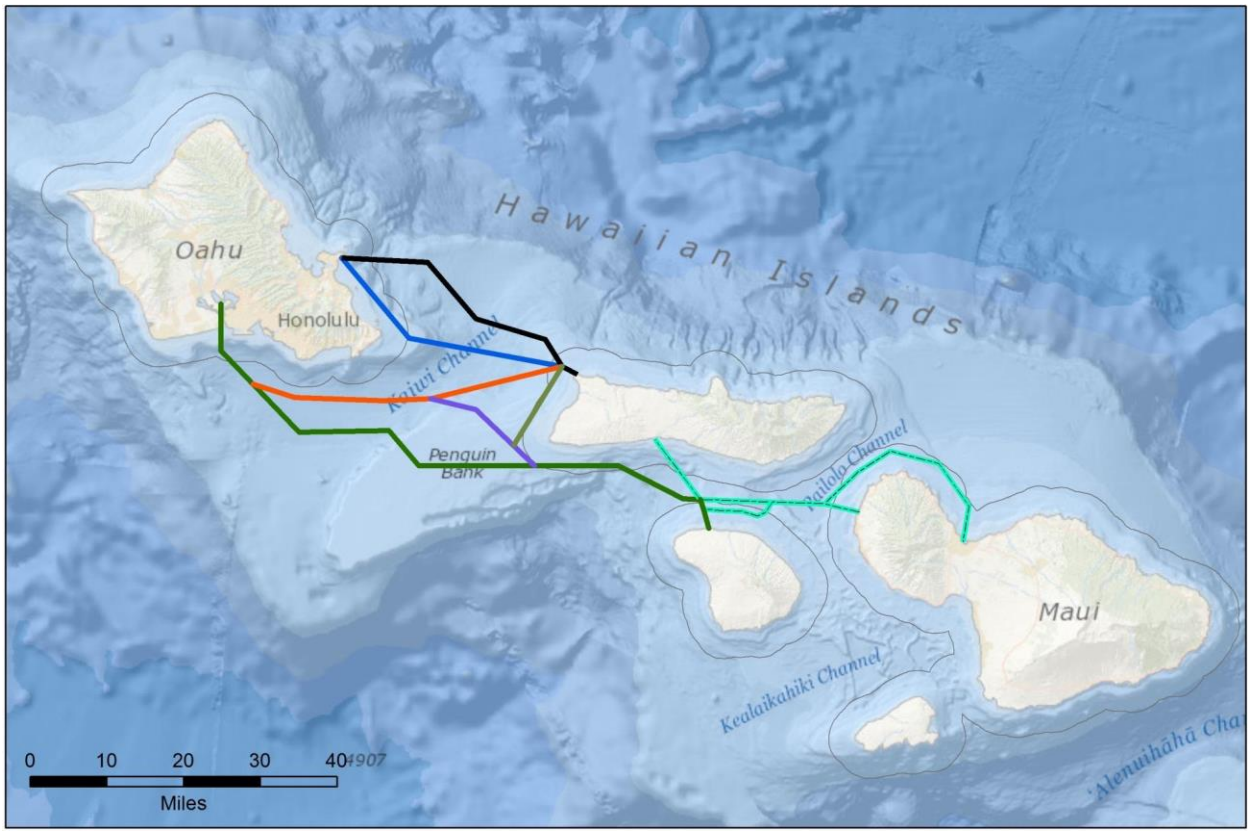


Figure 13. Possible routes for inter-island power transmission cables offshore Hawaii.

5.1.3 Marine Minerals Activities

Marine minerals are not currently being extracted from the Pacific Region, although the State of California has expressed interest in offshore sand resources for remedial nourishment of severely eroded coastal beaches. The management of coastal sand resources is under consideration by the Coastal Sediment Management Workgroup, a collaborative group of Federal, State, and local agencies. BOEM, USGS, and California National Resources Agency are currently sponsoring a USGS evaluation of offshore sand resources near critical erosion hotspots; the four-year study is scheduled to be complete in 2020.

The MMP is in an early stage of development and two studies have been proposed by the Region that will focus on characterizing environmental conditions and biological communities in the offshore environment. The proposed study area is within and adjacent to potential borrow areas offshore California, thus providing incidental data in support of the MMP. This information will help to inform offshore planning efforts and provide baseline information needed for impact assessments associated with NEPA reviews.

5.2 Alignment with Strategic Science Questions

Current and forecasted activities in the Pacific Region (see Section 5.1), and BOEM's decision making related to those activities, are the basis for BOEM's information needs and science strategies. Among the portfolio of Pacific Region studies proposed for FY 2019, 8 will inform

conventional energy, 13 will inform renewable energy, and 2 will inform marine minerals. Of the 13 proposed studies in the portfolio, 8 have potential applicability to more than one program (**Table 5**).

As shown in **Table 5**, each proposed study addresses one or more of BOEM's strategic science questions (themes), including:

- Assessing cumulative impacts (4 studies)
- Determining effects of exposure to hydrocarbons (1 study)
- Determining effects of habitat or landscape alteration (12 studies)
- Determining how future ocean conditions and dynamics may mask effects of OCS activities (3 studies)
- Using social science research in impact assessment (5 studies)
- Using existing or emerging technology to improve research results (5 studies)
- Determining which resources, measures, and systems are best used for long-term monitoring (2 studies)

Notably, several proposed studies address the effect of habitat or landscape alteration from potential renewable energy activities offshore California, and results from some of those studies can also be used to address conventional energy information needs.

Tables of proposed studies for the Pacific Region are included in **Appendix A**. Profiles for these proposed studies are provided in **Appendix B**.

Table 5. Alignment of proposed FY2019 Pacific OCS Region studies with BOEM programs and strategic science questions.

BOEM ENVIRONMENTAL STUDIES PROGRAM (ESP)
STUDIES PROPOSED FOR FY 2019
PACIFIC REGION

Priority Rank	Study Title	BOEM PROGRAMS			ESP STRATEGIC SCIENCE QUESTIONS								
		Conventional Energy	Renewable Energy	Marine Minerals	How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of BOEM-regulated activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM-regulated activities to the human environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
1	BOEM-MARINe (Multi-Agency Rocky Intertidal Network)	✓	✓					✓				✓	
2	Supplemental Data Regarding the Behavioral Response of Rock Crabs to the EMF of Subsea Cables and Potential Impact to Fisheries	✓	✓					✓					
3	Offshore Acoustic Bat Study along Western U.S. Continental and Hawaiian Island Coastlines		✓					✓				✓	
4	The Ecological Status of Artificial Reefs Offshore California	✓	✓		✓			✓		✓			
5	A 3-D Assessment of West Coast Continental Shelf Seabird Density: Species Composition at Different Heights above the Sea Surface		✓					✓					
6	Understanding Biological Connectivity among Offshore Structures and Natural Reefs	✓	✓					✓	✓				
7	California Deepwater Investigations and Groundtruthing (Cal DIG) II	✓	✓					✓		✓		✓	
8	A Marine Biogeographic Assessment of the California Current Ecosystem	✓	✓	✓	✓							✓	✓
9	Evaluating Connectivity among Hawaiian Fisheries and Potential Socio-economic Impacts of Offshore Wind Energy Installations		✓					✓		✓			
10	Biofouling, Non-indigenous Species (NIS), and Ecological Value: Cataloging NIS Communities on Offshore Platforms to Inform Upcoming Decommissioning Decisions and Potential Renewable Energy Siting	✓	✓					✓	✓				
11	Pacific Seabird Monitoring Network	✓	✓	✓	✓		✓	✓	✓			✓	✓
12	Values and Beliefs Baseline for Offshore Wind Development in California		✓		✓			✓		✓			
13	Deep Ocean Trails to Hawaii's Second Pearl Harbor		✓					✓		✓			

5.2.1 Conventional Energy Science Strategy

For new studies proposed for FY 2019, 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 and socioeconomic information to prepare for decommissioning of oil and gas facilities. As such, proposed studies informing conventional energy address these key information needs and applied uses by BOEM:

- *Information needs:*
    - Status and trends of environmental conditions and human uses within the Southern California Planning Area related to understanding cumulative impacts to affected resources and assessing effectiveness of lease stipulations and mitigation measures
    - Environmental and socioeconomic impacts of ongoing oil and gas activities
    - Potential environmental and socioeconomic impacts of decommissioning of oil and gas infrastructure

- *Applied uses:*
    - Environmental review and analysis of changes in ongoing oil and gas activities, as required under NEPA
    - Compliance with other environmental statutes, regulations, and Executive Orders (e.g., ESA, Marine Mammal Protection Act [MMPA], Magnuson-Stevens Fishery Conservation and Management Act [MSFCMA], Migratory Bird Treaty Act [MBTA], National Historic Preservation Act [NHPA], and Environmental Justice)
    - Planning for decommissioning (*e.g.*, acquire information needed to evaluate foreseeable industry applications, including decommissioning, Rigs-to-Reefs, and alternate use proposals; providing information to the Interagency Decommissioning Working Group and to other affected stakeholder groups)
    - Compliance with DOI-level strategic plan regarding mitigation policies and practices and assessment of the effectiveness of past lease stipulations, mitigation measures, and permit requirements to inform other energy programs

5.2.2 Renewable Energy Science Strategy

For new studies proposed for FY 2019, the strategy to support the Pacific Region's renewable energy program is centered on (1) refining information about environmental conditions and biological communities in areas of potential renewable energy development offshore California, and (2) obtaining baseline information about archaeological resources in areas of renewable energy potential offshore Hawaii and socioeconomic impacts of offshore renewable energy in Hawaii. As such, proposed studies informing renewable energy address these key information needs and applied uses by BOEM:

- *Information needs:*
    - Baseline environmental conditions and human uses offshore California, Oregon, and Hawaii
    - Potential environmental and socioeconomic impacts of renewable energy development for floating wind, wave energy, and hybrid technologies

- Effectiveness of lease stipulations, mitigation measures and other actions in similar programs that can inform decisions related to research and commercial projects

- *Applied uses:*
  - Decisions and actions related to issuance of research and commercial leases for renewable energy offshore California, Oregon, and Hawaii (*e.g.*, offshore planning, provide information to renewable energy task forces and to other affected stakeholder groups)
  - Environmental review and analysis of renewable energy development activities, as required under NEPA
  - Compliance with other environmental statutes, regulations, and Executive Orders (e.g., ESA, MMPA, MSFCMA, MBTA, NHPA, and Environmental Justice)
  - Compliance with DOI-level strategic plan regarding mitigation policies and practices

5.2.3 Marine Minerals Science Strategy

For new studies proposed for FY 2019, the strategy to support the Pacific Region's MMP is centered on refining information about environmental conditions and biological communities within and adjacent to potential sand borrow areas offshore California. As such, proposed studies informing marine minerals address these key information needs and applied uses by BOEM:

- *Information needs:*
  - Baseline environmental conditions and human uses within the Southern California and Central California Planning Areas
  - Potential environmental and socioeconomic impacts of marine mining activities on the OCS
  - Effectiveness of lease stipulations, mitigation measures and other actions in similar programs (*e.g.*, State waters) that can inform leasing decisions

- *Applied uses:*
  - Decisions and actions related to issuance of leases for marine minerals offshore California (*e.g.*, offshore planning, develop lease stipulations and mitigation measures, provide information to affected stakeholder groups)
  - Environmental review and analysis of marine mineral development activities, as required under NEPA
  - Compliance with other environmental statutes, regulations, and Executive Orders (*e.g.*, ESA, MMPA, MSFCMA, MBTA, NHPA, and Environmental Justice)

6 ATLANTIC STUDIES

6.1 Introduction

The Atlantic OCS extends from Maine to Florida and is divided into four planning areas (**Figure 14**). The OCS planning areas extend from the State/Federal boundary at 3 nm out to the outer boundary of the EEZ at approximately 200 nm. Although not by design, these planning areas roughly coincide with the large marine ecosystems (LMEs) along the Atlantic as defined by NOAA (https://www.st.nmfs.noaa.gov/ecosystems/lme/). On the Atlantic OCS, the Renewable Energy Program and MMP are actively managing leases, while the conventional energy program is planning nine lease sales as part of the 2019–2024 National Program.

6.1.1 Conventional Energy Program

On May 1, 2017, an Executive Order was signed directing BOEM to develop a new five-year plan for oil and gas exploration in offshore waters, including full consideration given to leasing in the mid- and south Atlantic. The Draft Proposed Program for 2019–2024 National Program was released in January 2018 and considers nearly every leasing area on the Federal OCS for potential oil and gas development including the Atlantic OCS. The final decision as to which areas will be available for oil and gas development will be made in 2019. In the meantime, BOEM anticipates new information needs in the Atlantic OCS Region that will support and inform a possible conventional energy program.

In keeping with the long-term view and mission of the ESP, BOEM will continue to strategically pursue specific studies which add to our knowledge of the North and South Atlantic LME and to provide baseline information to inform decision making across program areas and for future Five-Year Programs. BOEM currently has several studies underway that fill data needs across program areas, including for conventional energy. These studies include:

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

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

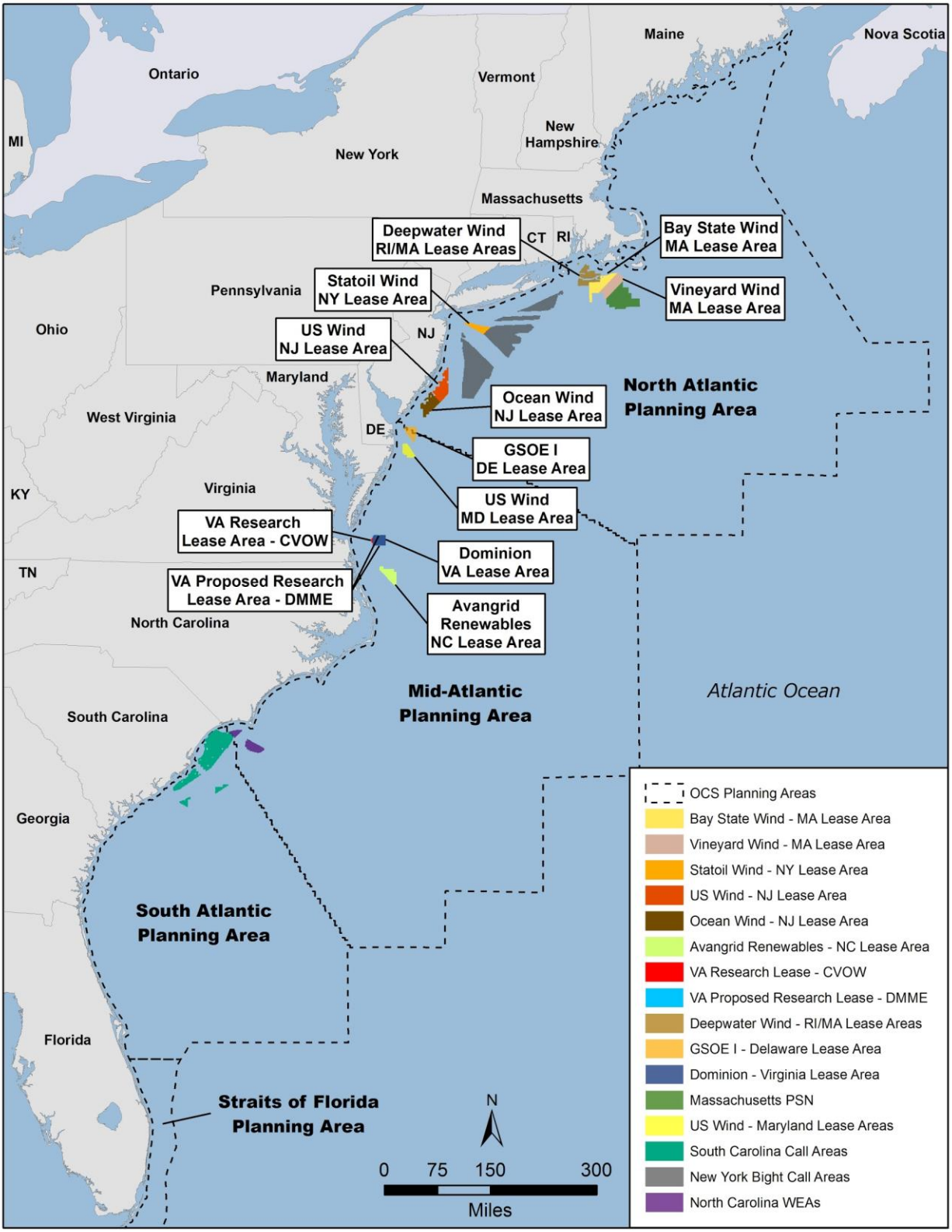


Figure 14. Atlantic OCS planning areas and renewable energy lease locations.

6.1.2 Renewable Energy Program

BOEM's Office of Renewable Energy Programs (OREP) is responsible for implementing and managing the Atlantic's offshore renewable energy development, including leasing, leading intergovernmental task forces, State consultations, and post-lease plan approval in Federal waters off the East Coast (**Figure 14**). The focus of the program is currently for wind projects.

OREP now has 13 active leases along the Atlantic coast with 1.4 million acres leased. Site assessments are underway in many of the areas that include geophysical and biological surveys and wind resource measurements using LiDAR (light detection and ranging) buoys. The next phase of development is the submittal of construction and operation plans (COPs) by industry for these lease areas. BOEM received one COP and anticipates several more during 2019. The focus areas for development are off Rhode Island and Massachusetts. The detailed development plans will undergo environmental review which may include identification of mitigations as well as post-construction monitoring requirements.

6.1.3 Marine Minerals Program

Since the inception of its Marine Minerals Program in the mid-1990s, BOEM has issued 39 agreements for approximately 69,000,000 cubic yards of Federal sand for beach nourishment and coastal restoration projects along the Atlantic coast. BOEM has issued agreements in NJ, MD, VA, NC, SC and FL. There is a developing interest in the use of Federal sand offshore DE, NY, and in New England. OCS sand has been used to protect valuable Federal and State assets and infrastructure such as NASA's Wallops Island Flight Facility in northern VA (**Figure 15**).

Following the extensive damages caused by Hurricane Sandy in 2012 and subsequent hurricanes Matthew in 2016 and Irma in 2017, response efforts along the Atlantic coast have focused on a more proactive regional approach to building coastal resilience rather than responding to sand renourishment needs at the individual project scale or in the aftermath of a natural disaster. Hurricane Sandy damage also triggered a wide range of emergency management response initiatives, such as restoration of multiple federally authorized USACE coastal storm risk management projects damaged or destroyed by the storm. More recent storms emphasize the need for all Atlantic coastal States to evaluate storm readiness and the integrity of their natural coastal infrastructure such as beaches and dunes. As a result, there is a need for BOEM to proactively identify offshore sand resources to support quick recovery. Many of the Federal and non-Federal projects along the Atlantic coast need OCS sediment resources to support their short- and long-term needs, and require MMP authorization before proceeding. MMP's current pursuit of a national sand inventory of OCS sand resources to support future coastal resiliency projects is precedent-setting for future decision making.

In support of regional partnerships in the Atlantic region, the MMP participates in the Northeast Regional Ocean Council, Mid-Atlantic Regional Council on the Ocean, the Governor's South Atlantic Alliance, and other organizations supporting regional initiatives that identify and prioritize sand resource needs. Currently, BOEM is undertaking efforts along the Atlantic coast to identify potential new sand resources through 13 State cooperative agreements and a contract to acquire geophysical and geological data from Maine to Miami, Florida. A sand resource inventory in the Atlantic region will provide a regional perspective and strategy for identifying sand resources available for coastal projects and evaluating proactive opportunities to minimize

and/or avoid environmental impacts. Upon completion of developing this framework of Atlantic OCS sand resources, the MMP will be better positioned to assess the long-term cumulative footprint of dredging activities relative to geomorphologic features and associated habitat types. Coupled with ongoing environmental monitoring initiatives, these efforts will facilitate a regional sediment resource management perspective and support strategic planning and management of OCS sand resources.

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

Figure 15. NASA's Wallops Island Flight Facility, VA before and after restoration using OCS sand.

6.2 Alignment with Strategic Science Questions

Tables of proposed studies for Atlantic Programs are included in **Appendix A**. Profiles for these proposed studies are provided in **Appendix B**.

6.2.1 Conventional Energy Program

Table 6 shows how the Atlantic OCS Region studies focused on conventional energy address the strategic science questions. As a result of the released Draft Proposed Program which considers potential leasing for oil and gas development in the Atlantic OCS, BOEM is proposing four new studies; one will address air quality monitoring and three will focus on socioeconomic information needs. These four study profiles address three strategic science questions.

The first study, "Atlantic Coastal Ambient Air Quality Monitoring Program," addresses two strategic science questions: *What are the BOEM-regulated industry impacts of air emissions to the human, coastal, and marine environment?* and *What affected resources, measures, and systems are best used for long-term monitoring?* This air quality study proposes to establish a

monitoring program to collect data on ambient air quality at the shoreline prior to offshore oil and gas development. This information will inform estimates of impacts from new incremental emissions related to oil and gas activities offshore.

Three profiles address the strategic science question: How does BOEM ensure the integrated use of its social sciences in assessing the impacts of OCS activities on the human environment? The profile "Fact Book Update: Onshore Oil and Gas Infrastructure to Support Development in the Atlantic OCS Region" proposes to expand an existing study to acquire information about existing infrastructure along the Atlantic coast that can support offshore oil and gas exploration, development, and production. This information will be used for scenario development and NEPA environmental impact analyses. The second study, "Estimating the Economic Impacts of Atlantic Oil and Gas Activities," will build upon existing economic modeling tools to produce economic estimates of the impacts of offshore oil and gas activities. The profile "Coastal Maine Land Use" proposes to investigate and document land use in coastal Maine with particular attention paid to Environmental Justice communities.

6.2.2 Renewable Energy Program

Table 7 shows how the Atlantic OCS Region studies focused on renewable energy address the strategic science questions. As offshore wind development along the Atlantic moves from the leasing phase to the development of plans for construction, the information needs of the renewable energy program are also evolving. Early years focused on the collection of baseline information and the addressing of concerns raised by the public. Through the *Real-time Opportunity for Development Environmental Observations (RODEO)* study, observations were made during the construction and early operation of the first offshore wind development in US waters near Block Island, Rhode Island. Now the focus is on specific locations with 12 projects in the pipeline ranging from 2 turbines for research purposes to over 100 for commercial production. The scientific concerns that are at the forefront for fiscal year 2019 involve fish and fishing, protected species including marine mammals and sea turtles, and additional analysis of avian distribution data.

6.2.2.1 Marine Fish

The effects of renewable energy development on fish and shellfish range from physical modification of the seafloor habitat to behavior modification due to noise. Fundamental to protecting fish species is an understanding of the physical habitat and the fish use of these habitats during particular times of the year and during crucial times during the animal's' life history. It is important to understand this information not only at the project-level but also at the regional level. BOEM has invested resources in understanding high priority fish or fisheries (Atlantic sturgeon, lobster, sea bass) , locations (leased areas), and impact producing factors (seafloor disturbance, sound, electromagnetic field [EMF]). To date, these priorities are identified through Intergovernmental Task Forces, public meetings, formal information solicitations via the Federal Register, and recommendations made in BOEM-funded studies. In the Atlantic renewable energy program, BOEM has placed endangered and threatened fish species and commercially important fish species as a high priority. Within that group BOEM then evaluates the vulnerability of the species to BOEM-approved activities. Species that BOEM has invested in to date include Atlantic sturgeon (occurrence and habitat use in offshore overwintering areas), American lobster in southern New England (abundance and EMF impacts),

Jonah crab (abundance), and skates (EMF impacts). High priority areas for study are driven often by the leasing and development timeframe and by studies that are providing baseline data on lease areas to determine if there are any habitats that may be sensitive to potential development impacts. In this plan studies regarding larval transport and localization of vocalizing fish are included.

High priority impact producing factors that have been identified include EMF, physical habitat disturbance, and underwater sound. BOEM has invested in EMF studies in both the Pacific and Atlantic and has worked collaboratively with the DOE on assessing the effects of EMF to electro- and magnetic-sensitive species. Regarding physical habitat disturbance, BOEM has invested in baseline habitat surveys, regional circulation modeling, and has evaluated empirical data from European offshore wind facilities, studies conducted by BOEM's MMP, and data collected by lessees. Regarding noise and its impact to fish and invertebrates, BOEM has conducted a literature synthesis and held a comprehensive workshop with international experts on sound and impacts to fish and invertebrates. Data collected through baseline marine fish studies have allowed BOEM to identify priority species, such as black sea bass and longfin squid, that may be negatively impacted by construction and operational noise from offshore wind energy development.

6.2.2.2 Marine Mammals

Marine mammals on the Atlantic seaboard are generally highly migratory and use a wide amount of the outer shelf. As a result, they may be impacted from all of BOEM's leasing programs. Thus studies of marine mammal abundance and distribution are handled across programs through the *Atlantic Marine Assessment Program for Protected Species*. This program includes surveys to determine distribution and abundance as well as the use of passive acoustic monitoring to understand migration. Additionally, sea turtle ecology in the northeast is an area for future focus as the addition of structures will provide foraging locations for the turtles. With construction of commercial facilities expected within the next five years, planning for post-construction is necessary. First a workshop to assess existing knowledge from surveys will be used to identify post-construction information needs.

6.2.2.3 Avian Species

The potential effects of offshore wind development on avian species and the overall negative impacts on avian populations have been a concern since the first proposal to build an offshore wind facility. Although an individual project may trigger many environmental concerns, effects related to avian resources tend to extend beyond the relatively small footprint of an individual project. For this reason, BOEM's avian research efforts for the Atlantic OCS are focused on identifying areas where Atlantic offshore wind energy development is least likely to negatively impact avian populations at the regional scale. BOEM has already invested significantly in studies that address the distribution and abundance of birds and their interaction with wind development (https://www.boem.gov/Renewable-Energy-Completed-Studies/, Birds and Bats). The next phase is to focus on integrating field survey results with telemetry, to provide a more complete picture of where and how avian species use the OCS. The aggregation of all existing data into a single database also allows for analysis of changes over the past few decades to inform future predicted shifts in species distribution.

6.2.3 Marine Minerals Program

Although all of the proposed MMP studies address more than one of the ESP's key questions (**Table 8**), for clarity and brevity, only the most pertinent questions are linked to a given study. For FY 2018–2020, the proposed MMP studies in the Atlantic region primarily align with the strategic science questions related to (1) cumulative effects assessments, (2) the effect of habitat or landscape alteration on ecological resources, and (3) the affected resources, measures, and systems best for long-term monitoring. The specific studies proposed test hypotheses related to the geological, physical, and biological aspects of both removing sediment from the OCS and placing it within the nearshore system.

With respect to coastal resiliency initiatives, nearshore and offshore sediment sources are integrated components of the complete Regional Sediment Management (RSM) "system" and quantifying the influence of OCS resources to the regional sediment budget is critically important, especially when analyzing cumulative effects, an important issue recognized in the strategic science questions. One of the perceived benefits of using offshore OCS resources is that new sediment is introduced into the coastal sediment budget, as opposed to using limited nearshore sources that are often part of the active coastal system, thereby improving project sustainability and geomorphic function. To better understand this question, the MMP is currently conducting the study, "Economic and Geomorphic Comparison of OCS Sand vs. Nearshore Sand for Coastal Restoration Projects (GM-14-03-06)" which seeks to provide a baseline understanding and quantification of the economic, ecologic, and geomorphic long-term benefits of using OCS sediment versus nearshore sediment for coastal restoration projects. These data will provide information about the overall "value" of OCS sand relative to alternative nearshore sources and support borrow area tradeoff analyses and associated cost justifications.

Under the umbrella of RSM investments, MMP is proposing to complement this ongoing initiative by testing hypotheses related to sediment transport and transport pathways following beach placement. The information gathered from the MMP proposed study, "Sediment Evolution Following Beach Fill Construction: A Literature Review and Technical Workshop," will better facilitate stewardship of finite OCS sand resources and elucidate questions regarding potential environmental impacts to adjacent resources. This a complex question that has been raised by multiple stakeholders to inform future coastal management decisions. However, a collaborative and comprehensive strategy has not yet been identified for how to best address this critical science need. An analysis of sediment transport processes using empirical data collection (i.e., geophysical surveys, geochemical tracers, sediment particle tracers, etc.) and numerical modeling is required to fill critical data gaps and address the questions of where, how, and when sediment is moving following beach fill construction compared to natural conditions (including storm events) and how this movement relates to valued habitat. Robust field initiatives to appropriately test this hypothesis are significant, costly, and require extensive collaboration to leverage data. Therefore, BOEM proposes to lead a multi-agency collaborative effort to develop a concept plan that identifies and prioritizes the key questions, appropriate field sampling methods, numerical modeling, etc. to address this complex problem. This concept plan will be shared with national and regional planning groups (i.e., NOPP, Gulf of Mexico Alliance, etc.) to leverage multi-agency funds for future field work initiatives. This study will build upon and leverage data from ongoing BOEM study investments (e.g., borrow area optimization [NT-15-

03] and sediment sorting [NT-15-05]), and will inform short- and long-term MMP planning decisions.

Valuable information on resident and transient fish communities and their habitat use pre- and post-dredging has been gathered in ongoing studies in the Southeast U.S. and GOM, but is lacking in the Mid-Atlantic. These data needs specifically address the ESP strategic science question regarding habitat alteration effects on ecology. In the New Jersey and New York Regions, collectively the New York Bight (NYB), limited information exists on the ecological function and biological significance of sand waves, ridges, swales, shoals, and other OCS features, especially in response to dredge-related disruptions to economically important fish and related industries. Based on actions identified in the Mid-Atlantic Ocean Action Plan, State initiatives, and recent discussions with recreational and commercial fishermen in New Jersey, the MMP identified an opportunity to leverage knowledge from ongoing investments to pursue another comprehensive study in the NYB titled "Fish, Fisheries, and Sand Features: Improving Knowledge of Demersal and Benthic Organisms' Habitat Use, Impacts of Dredging at Offshore Sand Sources, and Time Series of Recovery in the New York Bight." This is a comprehensive multi-year study proposed to monitor conditions before, during, and after dredging, in order to understand mesoscale and microscale habitat use, species assemblages, biodiversity, and habitat associations. A plan to gather local stakeholder knowledge (e.g., fisheries industry, sport fishing, diving) through appropriate and methodical outreach activities (e.g., meetings, online forums, and fishing activity surveys) would be developed and implemented to highlight issues, strengthen partnerships, and further inform study methodology. These data and continued engagement with stakeholder communities in the NYB will help the MMP better plan for OCS demands within the region and support BOEM actions identified in the Mid-Atlantic Ocean Action Plan to engage fishing communities in project planning. This individual study will also support the other two ongoing research initiatives in the Southeast U.S. and GOM and will complement the ongoing National sand resource inventory initiative for a multi-regional approach to understanding the effects of BOEM actions.

Table 6. Alignment of proposed FY2019 Atlantic OCS Region conventional energy studies with BOEM programs and strategic science questions.

BOEM ENVIRONMENTAL STUDIES PROGRAM (ESP)
STUDIES PROPOSED FOR FY 2019
ATLANTIC REGION CONVENTIONAL ENERGY PROFILES

Priority Rank	Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM-regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
1	Atlantic Coastal Ambient Air Quality Monitoring Program	✓									✓		✓
2	Fact Book Update: Offshore Oil and Gas Infrastructure to Support Development in the Atlantic OCS Region	✓								✓			
3	Estimating the Economic Impacts of Atlantic Oil and Gas Activities	✓								✓			
4	Coastal Maine Land Use	✓								✓			

Table 7. Alignment of proposed FY2019 OREP studies with BOEM programs and strategic science questions.

BOEM ENVIRONMENTAL STUDIES PROGRAM (ESP)
STUDIES PROPOSED FOR FY 2019
OFFICE OF RENEWABLE ENERGY PROGRAMS

Priority Rank	Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
1	Understanding Potential Economic Impacts to Commercial Fishing from Offshore Wind Energy Development		✓		✓					✓			
2	Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance		✓		✓								✓
3	Understanding of Atlantic Sturgeon Migratory Patterns – Integrating Telemetry and Genetics		✓	✓	✓			✓				✓	✓
4	Movement Patterns of Fish in Southern New England		✓		✓			✓					✓
5	Atlantic Marine Assessment Program for Protected Species III	✓	✓	✓	✓			✓				✓	✓
6	Hydrodynamic Modeling and Particle Tracking in the U.S. Mid-Atlantic Bight		✓						✓				✓
7	Integrated Analysis of Marine Wildlife At-Sea Survey and Tracking Data to Inform Planning for Energy Development on the OCS		✓		✓			✓					✓
8	Workshop to Identify a Scientific Monitoring Framework for Protected Species in Atlantic Wind Energy Areas		✓		✓	✓						✓	✓
9	Fish Auditory Thresholds – Part 2 Field Component	✓	✓	✓		✓		✓				✓	
10	Southern New England Ichthyoplankton and Juvenile Fish Survey		✓		✓			✓				✓	✓
11	Monitoring the Behavioral Ecology of Sea Turtles in Ecologically Dynamic North Atlantic Foraging Grounds		✓	✓	✓			✓					✓
12	Predicting Future Seabird Distributions on the Atlantic Outer Continental Shelf (OCS)	✓	✓	✓	✓			✓				✓	✓
13	A Database and Acoustic Reference Catalog of Marine Fish Sounds - Atlantic Pilot	✓	✓	✓		✓						✓	

Table 8. Alignment of proposed FY2019 MMP studies with BOEM programs and strategic science questions.

BOEM ENVIRONMENTAL STUDIES PROGRAM (ESP)
STUDIES PROPOSED FOR FY 2019
MARINE MINERALS PROGRAM

Priority Rank	Study Title	BOEM PROGRAMS: Conventional Energy	BOEM PROGRAMS: Renewable Energy	BOEM PROGRAMS: Marine Minerals	ESP STRATEGIC SCIENCE QUESTIONS: How can BOEM best assess **CUMULATIVE EFFECTS** within the framework of environmental assessments?	What are the acute and chronic effects of **SOUND** from BOEM-regulated activities on marine species and their environment?	What are the acute and chronic effects of **EXPOSURE TO HYDROCARBONS OR OTHER CHEMICALS** on coastal and marine species and ecosystems?	What is the effect of **HABITAT OR LANDSCAPE ALTERATION** from BOEM-regulated activities on ecological and cultural resources?	How will **FUTURE OCEAN CONDITIONS AND DYNAMICS** amplify or mask effects of BOEM-regulated OCS activities?	How does BOEM ensure the **INTEGRATED USE OF ITS SOCIAL SCIENCES** in assessing the impacts of OCS activities on the human environment?	What are the **AIR EMISSIONS** impacts of BOEM-regulated activities to the human, coastal, and marine environment?	How can BOEM better use **EXISTING OR EMERGING TECHNOLOGY** to achieve more effective or efficient scientific results?	What are the best resources, measures, and systems for **LONG-TERM MONITORING**?
1	NY Bight Fish, Fisheries, and Sand Features: Improving Knowledge of Demersal and Benthic Organisms' Habitat Use, Impacts of Dredging, and Time Series of Recovery of Regional Offshore Sand Sources		✓	✓	✓			✓					✓
2	Fine-Scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico	✓		✓	✓		✓	✓				✓	
3	Sediment Evolution Following Beach Fill Construction: A Literature Review and Technical Workshop			✓	✓			✓				✓	

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APPENDIX A: PROPOSED STUDIES FOR FY 2019 AND FY 2020

Table 9. National studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Study Title
67	FE	Compendium on Oil Spill Science
69	IMO	Creating Environmental Studies Program Information System (ESPIS) Linked Data to Enhance Support of BOEM Business Lines
72	SSE	Understanding the BOEM Footprint on Vulnerability of Communities Using Baseline Data
75	MAQ	Air Quality Modeling for the Atlantic Oil and Gas Development
77	PS	Developing an Auditory Weighting Function for Low-Frequency Whales
81	BIO	Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery
83	AR	Archaeological Investigations in Support of Development of Energy and Mineral Resources on the US Outer Continental Shelf
86	BIO	Demonstration Project, Integrating DNA Profiles, Genomics and Photo-Identification Data in Long Term Monitoring of Long Lived Marine Megafauna
89	BIO	Catalog of Seabird Colonies
92	AR	Standards for the Collection and Analytical Processing of Subsurface Core Samples
95	BIO	Mortality Risk for Large Bodied/Low Trophic Feeding Elasmobranchs During Energy and Mineral Operations
99	BIO	Developing a Roadmap to Maximize Efficiency in Developing Environmental Analyses
102	BIO	Potential Effects of Seismic Airguns on Zooplankton in the US OCS
106	PO	High Resolution Modeling of the Gulf of Mexico
109	IMO	BOEM Graduate Student Award for Applied Scientific Research
111	BIO	Marine Mammal Bioenergetics Workshop
117	IMO	Support for Fifth International Conference on the Effects of Noise on Marine Life
119	BIO	Identification and Characterization of Mini Biological Hotspots Associated with Methane Seeps in the Northern Gulf of Mexico

Profile Page #	Discipline	Study Title
121	BIO	Incorporating the Seascape Paradigm in Monitoring Marine Ecosystems, a Next Step for the Marine Biodiversity Observation Network (MBON)

Discipline Codes

AR = Archaeological Resource Protection

BIO = Biology

IMO = Information Management & Other

FE = Fates & Effects

MAQ = Meteorology & Air Quality

PS = Marine Mammals & Protected Species

SSE = Social Science & Economics

Table 10. Renewable energy studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Study Title
124	SSE	Understanding Potential Economic Impacts to Commercial Fishing from Offshore Wind Energy Development
128	FE	Evaluation of Potential Electromagnetic Field (EMF) Effects on Fish Species of Commercial or Recreational Fishing Importance
130	PS	Understanding of Atlantic Sturgeon Migratory Patterns – Integrating Telemetry and Genetics
132	BIO	Movement Patterns of Fish in Southern New England
134	PS	Atlantic Marine Assessment Program for Protected Species III
136	PO	Hydrodynamic Modeling and Particle Tracking in the U.S. Mid-Atlantic Bight
139	BIO	Integrated Analysis of Marine Wildlife At-Sea Survey and Tracking Data to Inform Planning for Energy Development on the OCS
142	PS	Workshop to Identify a Scientific Monitoring Framework for Protected Species in Atlantic Wind Energy Areas
145	BIO	Fish Auditory Thresholds – Part 2 Field Component
147	BIO	Southern New England Ichthyoplankton and Juvenile Fish Survey
149	PS	Monitoring the Behavioral Ecology of Sea Turtles in Ecologically Dynamic North Atlantic Foraging Grounds
152	BIO	Predicting Future Seabird Distributions on the Atlantic Outer Continental Shelf (OCS)
154	BIO	A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot
Discipline Codes		
BIO = Biology		IMO = Information Management & Other
PS = Marine Mammals & Protected Species		SSE = Social Science & Economics

Table 11. Marine minerals studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Study Title
157	FE	NY Bight Fish, Fisheries, and Sand Features: Improving Knowledge of Demersal and Benthic Organisms' Habitat Use, Impacts of Dredging, and Time Series of Recovery of Regional Offshore Sand Sources
160	PS	Fine-Scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico
162	FE	Sediment Evolution Following Beach Fill Construction: A Literature Review and Technical Workshop
Discipline Codes		
FE = Fates & Effects		PS = Marine Mammals & Protected Species

Table 12. Alaska OCS Region studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Study Title
165	BIO	Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea
168	PO	Landfast Ice in the Beaufort and Chukchi Seas and Under Ice Circulation Processes on the Beaufort Sea Shelf
171	IMO	Coastal Marine Institute
173	IMO	Synthesis of Current Environmental Literature for OCS Planning Areas in the Northern Gulf of Alaska
175	IMO	Underwater Sound Signatures and Propagation for OCS Activities Permitted by BOEM
177	SSE	Monitoring the Cross Island Subsistence Whale Hunt for Effects from Liberty Development and Production, Central Beaufort Sea, Alaska
180	PS	Range-Wide Distribution of Cook Inlet Beluga Whales (*Delphinapterus leucas*) in the Winter
183	BIO	Model-Based Essential Fish Habitat Descriptions for Arctic Cod, Saffron Cod and Snow Crab in the Alaskan Arctic
186	IMO	Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbls
188	IMO	Oil Spill Occurrence Estimators for Offshore and Onshore Cook Inlet and Onshore Alaska North Slope Spills
191	IMO	Synthesis of Current Environmental Literature for OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Islands
193	PS	Generation of Synthetic Audiograms by Applying Finite Element Modeling to Computerized Tomography (CT) Scans for Baleen Whales, Belugas, and Pinnipeds, Phase 1
Discipline Codes		
BIO = Biology IMO = Information Management & Other PS = Marine Mammals & Protected Species		PO = Physical Oceanography SSE = Social Science & Economics

Table 13. Alaska OCS Region studies proposed for the FY 2020 NSL.

Profile Page #	Discipline	Study Title
196	BIO	Red-throated Loons and Their Fish Prey in the Beaufort Sea as a Biomonitor for Ecosystem Health
199	BIO	Arctic Cod Winter Spawning Survey
201	PS	Acoustic Detection of Critically Endangered North Pacific Right Whales off Kodiak, Alaska
203	BIO	Arctic Marine Biodiversity Observing Network (AMBON) on Alaska's Arctic Outer Continental Shelf (OCS)
206	SSE	Subsistence Mapping and Traditional Knowledge Studies for Six Cook Inlet Communities: Nanwalek, Port Graham, Seldovia, Nikiski, Alexander Creek, and Tyonek
208	SSE	Kenai Peninsula Borough Economy, 2007 to Current Year
Discipline Codes		
BIO = Biology SSE = Social Science & Economics		PS = Marine Mammals & Protected Species

Table 14. Atlantic OCS Region conventional energy studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Study Title
211	MAQ	Atlantic Coastal Ambient Air Quality Monitoring Program
214	SSE	Fact Book Update: Onshore Oil and Gas Infrastructure to Support Development in the Atlantic OCS Region
217	SSE	Estimating the economic impacts of Atlantic oil and gas activities
219	SSE	Coastal Maine Land Use
Discipline Codes		
SSE = Social Science & Economics		MAQ = Meteorology & Air Quality

Table 15. GOM OCS Region studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Study Title
222	SSE	Understanding the Recreational Uses of OCS Infrastructure
225	MAQ	Wind Tunnel Experiments for Oil Platform Downwash
228	AR	An Analysis of Seafloor Impacts on the Gulf of Mexico Outer Continental Shelf (OCS) for Adaptive Management Strategies
230	MAQ	Preliminary Study: GOMR Coastal Ambient Air Quality Monitoring Program
232	SSE	OCS-Related Transportation Infrastructure in Louisiana and Texas
234	SSE	Meeting the Challenge: Developing Baseline Data Collection and Action Plans
237	BIO	Baseline Monitoring of Avian Activity and Offshore Structure Interactions
239	SSE	Strategically Focused Support for Oil and Gas Activities in the Gulf of Mexico OCS Region
Discipline Codes		
AR = Archaeological Resource Protection IMO = Information Management & Other SSE = Social Science & Economics		BIO = Biology MAQ = Meteorology & Air Quality PS = Marine Mammals & Protected Species

Table 16. Pacific OCS Region studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Study Title
242	BIO	BOEM-MARINe (Multi-Agency Rocky Intertidal Network)
246	BIO	Supplemental Data Regarding the Behavioral Response of Rock Crabs to the EMF of Subsea Cables and Potential Impact to Fisheries
248	PS	Offshore Acoustic Bat Study along Western U.S. Continental and Hawaiian Island Coastlines
250	BIO	The Ecological Status of Artificial Reefs Offshore California
253	PS	A 3-D Assessment of West Coast Continental Shelf Seabird Density: Species Composition at Different Heights above the Sea Surface
256	FE	Understanding Biological Connectivity Among Offshore Structures and Natural Reefs
259	BIO	California Deepwater Investigations and Groundtruthing (Cal DIG) II
263	BIO	A Marine Biogeographic Assessment of the California Current Ecosystem
266	SSE	Evaluating Connectivity among Hawaiian Fisheries and Potential Socio-economic Impacts of Offshore Wind Energy Installations
269	FE	Biofouling, Non-indigenous Species (NIS), and Ecological Value: Cataloging NIS Communities on Offshore Platforms to Inform Upcoming Decommissioning Decisions and Potential Renewable Energy Siting
271	PS	Pacific Seabird Monitoring Network
274	SSEs	Values and Beliefs Baseline for Offshore Wind Development in California
277	AR	Deep Ocean Trails to Hawaii's Second Pearl Harbor
Discipline Codes		
AR = Archaeological Resource Protection FE = Fates & Effects SSE = Social Science & Economics		BIO = Biology PS = Marine Mammals & Protected Species

APPENDIX B: FY 2019–FY 2020 STUDY PROFILES ORGANIZED BY REGION

Title	Compendium on Oil Spill Science
Administered by	Headquarters
BOEM Contact(s)	Jennifer Bucatari, Jennifer.Bucatari@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$300 (in thousands)
Performance Period	FY 2019–2020
Date Revised	December 7, 2017
PICOC Summary	
Problem	Lack of a recently completed (since *Deepwater Horizon*) synthesis available that reviews and summarizes known impacts from oil spills. Such a synthesis is crucial as a reference for our NEPA analyses.
Intervention	Compile and synthesize current scientific understanding of chemical, biological, physical, and socio/cultural impacts related to residual and acute impacts associated with OCS and State water spills and remediation efforts.
Comparison	The results of this synthesis would compare an environment impacted by an oil spill to the non-spill baseline.
Outcome	This synthesis will be used in NEPA documents, as well as to identify information needs for guiding future study questions. The understanding of a post-spill environment, short-term and long-term impacts is crucial for quantifying the potential spill impacts for a defensible NEPA analysis that supports agency decision making.
Context	US State marine and OCS waters

BOEM Information Need(s): BOEM needs to synthesize the results from interrelated and complex spill impact studies in order to:

- Continue compliance with environmental regulations, specifically to analyze potential impacts for our proposed actions in Programmatic EIS analyses and to discuss impacts from reasonably foreseeable spills as required by the Council on Environmental Quality (CEQ)
- Support its responsibility to manage public resources in an environmentally sound manner
- Refine our knowledge of long-term, cumulative impacts that are important for making current and future management decisions and for relaying these impacts accurately and succinctly in our NEPA documents

Background: From 1964–2015, approximately 5.2 million barrels (MMbbl) of oil have been spilled from Outer Continental Shelf (OCS) operations. In addition, production and transportation of oil in State waters has resulted in spills with applicable effects along the OCS. Following most spills, a rush of scientific research occurs which investigates the impacts of the oil and the spill response on the oceanic ecosystems in

order to improve our understanding of the dynamics of such events and their environmental and public health implications.

To date a wide range of research topics have been explored over a variety of potential impact areas and response methodologies. There is a great deal of historical, along with new DWH related, research. In addition, other spills have resulted in similar research efforts. BOEM considers all relevant research during the process for leasing and development of oil and natural gas on the OCS. Considering the wide range of research topics to be reviewed following a spill, including impacts from spill response, there are considerable challenges associated with reviewing, analyzing, and applying these data in our NEPA analyses. Existing syntheses are either too vague with respect to resource impacts (Oil in the Sea III) or are regionally or spill focused (Gulf of Mexico Research Initiative; National Academies of Sciences, Engineering, and Medicine efforts). This effort will synthesize all available oil spill research (1964–2017) and enable BOEM to better meet our responsibilities of managing offshore energy while considering the potential impacts in an efficient and holistic manner.

Objectives:

- Compile and synthesize current scientific understanding of chemical, biological, physical, and socio/cultural impacts related to residual and acute impacts (from existing literature, databases, etc.) associated with OCS and State marine water spills and remediation efforts.
- Following this compilation, identify information needs in science regarding spill and response impacts.
- Share the synthesized information with BOEM subject matter experts (SMEs) to encourage discussion on results and information needs.

Methods: The contractor will conduct a survey of all published literature and data related to chemical, biological, physical, and socio/cultural impacts related to OCS and State water spills and associated response activities. The contractor will summarize findings from studies by region and then by resource area. A synthesis of all relevant information is expected, with provided boundaries for clarity, and with quantitative techniques to synthesize findings, if possible. The contractor will synthesize these data into a compendium with regional sections and, within them, highlight the different resource areas that BOEM considers in our NEPA analyses. Each section will summarize the research and any information needs as best known at the time of the publication.

This project will include the submission of an Endnote database with all cited works for use by the BOEM SMEs. In addition, this database will hold copies of all published works cited in the compendium (when available), serving as a local copy for BOEM analysts to discover and access any relevant literature. The contractor will organize webinars (per resource area) to provide BOEM SMEs the opportunity to discuss the compendium results, identify information needs, and develop future study needs.

Specific Research Question(s):

1. What are the known impacts from oil spills in a range of sizes and ecosystems?
2. What information is unknown about oil spill and oil spill response impacts?

Title	Creating Environmental Studies Program Information System (ESPIS) Linked Data to Enhance Support of BOEM Business Lines
Administered by	Headquarters
BOEM Contact(s)	Jonathan Blythe, jonathan.blythe@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$300 (in thousands)
Performance Period	FY 2019–2022
Date Revised	February 21, 2018
PICOC Summary	
Problem	Scientific information is needed across the board for evidence-based decision making, but information is managed very differently across the Bureau.
Intervention	Information in ESPIS will be migrated to a new schema based on the World Wide Web Consortium (W3C) PROV model, while also ensuring continuity for geoESPIS search tool requirements.
Comparison	ESPIS currently operates like accounting system to keep track of information products delivered from environmental studies. ESPIS could be a lot more useful if it also tracked how ESPIS information products related to each other, their use in other BOEM information products (like NEPA documents), and how they are used and cited by the broader scientific community.
Outcome	Creates ESPIS linked data including a record of provenance of how ESPIS information supports business lines outside ESP. For example, a study may produce data, but another BOEM program uses said study data to create a map visualization that is used in another BOEM product or decision process.
Context	Study Development Plan, study profile, study products, ESPIS, Information Technology (IT)

BOEM Information Need(s): ESPIS is a public outreach tool that demonstrates accountability for ESP expenditures by cataloging studies with nested listings of study products. Enhancements to this simple receipt tracking functionality are needed that address the scientific workflow for ESP information. For example, study profiles are critical for defining the requirements for deliverables. Further, there may be specific tasks that define scientific research activities that, if captured in ESPIS, could enhance accountability for study products. Finally, once we can determine that a study has delivered it's full complement of information products, it may be possible to take accountability further to show the utility of the acquired information. For example, ESPIS could track and display how study information is used in National Environmental Policy Act (NEPA) documents (i.e. Environmental Impact Statements, Environmental Assessments), and could provide innovative solutions to provide deep background for NEPA documents. Citations in the scientific literature could be collected to calculate the citation index for each study and an impact factor for environmental science in ESPIS.

Background: In 2015, ESPIS was modernized from a circa 1995 bibliographic catalog and report retrieval system, to a contemporary geographically enabled search and discovery tool for studies reports, data, and related publications (see https://marinecadastre.gov/espis/#/) (Office of Coastal Management, 2018). The new ESPIS, known as geoESPIS, emulates contemporary web-based search tools, like Google Search. This enhancement was developed through a partnership with the National Oceanic & Atmospheric Administration (NOAA) Office of Coastal Management, drawing upon BOEM's and NOAA's shared investments in the MarineCadastre.gov platform. BOEM continues to steward geoESPIS in partnership with NOAA.

The ESPIS enhancements created a logical method of listing study products on study landing pages, and added references to other types of study products such as data products, and related publications that were not supported in the preceding ESPIS report catalog and retrieval system. These enhancements required cataloging of studies using a class of information called business metadata, which, according to the Department of the Interior's Metadata Implementation Guide, is an important construct for enabling discovery of relevant information in catalog systems (Obuch et al. 2018). However, where ESPIS focuses only on the dissemination of study results, more work is needed to show the applicability of ESP information in a variety of settings.

With ESPIS enhancements, BOEM has opened a dialog with stakeholders and the public, by speaking in the language of the modern Internet era. However, to speak the language of the Internet intelligently, ESPIS has to move beyond a catalog's discovery functionality and be able to also demonstrate how study information has or can be used. For example, the oceanographic community is beginning to support data catalogs of linked data (Ledbetter et al. 2013), which builds upon the W3C Internet standards, such as the PROV model (Missier et al. 2013). These Internet tools can depict sophisticated relationships between information objects, like how PROV supports information presented in the National Climate Assessment with references to scientific papers and datasets (Tilmes et al. 2013).

Objectives: The objectives of this study are to:

- Design quality control criteria for listing of data products on landing pages.
- Represent ESP research activities and their relationship to study products.
- Redesign of ESPIS landing pages to summarize study information use.

Methods: Draw upon best practices for data representation and widely adopted Internet standards, such as W3C PROV model, for capturing the relationships between study planning (profiles) and product materials (final reports, data). Provide a logical construct to be able to link to study information that can be coordinated with the timely production of NEPA activities. Produce landing pages that are the targets of links that allow interested parties to "drill down" and evaluate supporting ESPIS materials. Relationships concepts should be designed generically enough to be able to support any product from across the BOEM business lines. Provide queries for provenance information for systematic program analysis and generate metrics of ESP performance. Design and implement an ESPIS relational database optimized for linked data, but that is backwards compatible with geoESPIS, using relational operators such as join.

Specific Research Question(s):

1. What are the relationships between study products listed in ESPIS?
2. Which study products need to be maintained by BOEM?
3. Which study products serve as documentation and have no further use?
4. How do study products relate to task and sub-task plans for a study?
5. How are study products used in other BOEM business lines, like NEPA?

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Title	Understanding the BOEM Footprint on Vulnerability of Communities Using Baseline Data
Administered by	Headquarters
BOEM Contact(s)	Keely Hite
Procurement Type(s)	Contract/Cooperative Agreement
Approx. Cost	$750 (in thousands) over three years
Performance Period	FY 2019–2022
Date Revised	May 9, 2018
PICOC Summary	
Problem	BOEM requires environmental justice data for coastal areas along the South Atlantic Program Area. This data needs to be finer resolution data than the census block level on the relationships between various sub-populations closest to OCS support infrastructure and activities. BOEM currently has no studies that address vulnerability on the Atlantic coast. How race, income, and social status affect different socioeconomic groups can make sub-populations more/less resilient to the effects of potential impact producing factors from OCS oil and gas activities.
Intervention	Examination of the relationships between sub-populations focusing on how they interact and are situated in relation to shared resources (e.g. community services, parks, utilities, etc.) and potential hazards (e.g. “fence line communities” in close proximity to: industrial plants, waste treatment and remediation facilities, etc.).
Comparison	This baseline study is the first of its kind for BOEM and focuses solely on the subject of environmental justice in the south Atlantic. BOEM has only three related studies, which have all been finalized in the GOM (Environmental Justice: A Comparative Perspective in Louisiana, and Environmental Justice Considerations in Lafourche Parish, LA); the most recent being completed in 2014.
Outcome	Provides a framework to measure and understand impacts that could occur on vulnerable groups from OCS activities; highlighting those communities we need to ensure are adequately coordinated with and addressed in our analyses.
Context	This is a pilot study; in the South Atlantic Program Area where BOEM needs a baseline to support upcoming assessments.

BOEM Information Need(s): BOEM’s environmental analyses need to be informed by the latest scientific data for the human environment. Results from this and related studies are essential to BOEM decision making in order to:

- Identify baseline conditions of specific geographic areas and determine how policy decisions for Federal waters adjacent to affected coastal communities Impact various sub-populations

- Analyze and monitor changes in these communities near potential OCS activity, as set forth in the Department of the Interior's Environmental Justice Implementation Policy (Part 525 DM 1)

- Comply with the OCS Lands Act, the National Environmental Policy Act (NEPA), and Executive Orders (EOs): 12898-*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* and 13175-*Consultation and Coordination with Indian Tribal Governments*

The information collected from this study will provide the best available science to support upcoming environmental analyses, future BOEM decision documents, and community outreach efforts. This baseline study addresses the current baseline and cumulative effects of OCS activities on the human environment, as well as support for long-term monitoring.

Background: BOEM's environmental justice analyses focus on discrete sub-populations (e.g. historically marginalized racial and ethnic groups, low-income) within a community, with little information on the relationship between sub-populations in the community. This study addresses the crux of environmental justice issues, by identifying potential impacts to the most vulnerable sub-populations; and examining the relationships to shared public resources and potential hazards between different socioeconomic groups in close proximity.

Objectives: Gather baseline data on the vulnerabilities affecting environmental justice communities adjacent to the OCS South Atlantic Program Area.

- Gain an understanding of the proximity between high, median, and low sub-populations to industrial zones for offshore support activities and infrastructure; and any cumulative impacts that may result from this relationship.

- Gain an understanding of how these variables (relationship to location, history, and existing resources) affect the vulnerability of each community; allowing BOEM and others to plan and develop proactively, and mitigate potential impacts.

Methods: A literature review and secondary data analysis will be used to identify vulnerable communities in the South Atlantic Program Area, based on criteria laid forth in EOs 12898 and 13175, and data from the U.S. Census at the county and tract level. Ethnographic data collection at the census block level will identify areas of analysis at the neighborhood level. A geospatial analysis of these data will be used to identify the demographic trends that characterize these groups over time.

Based on demographics and community planning data, locate high concentration communities of low-income neighborhoods and/or communities of color in coastal counties adjacent to BOEM program areas.

- **Literature Review & Secondary Data Collection:** Identify locations of low-income neighborhoods and/or communities of color in coastal counties affected

by BOEM program areas; as well as their spatial relation to median and high income populations.

- Define and identify vulnerabilities within the study areas.
- **Geospatial Analysis:** Map proximity to industrial zones for oil and gas offshore support activities and infrastructure, public resources, and potential hazards.
- Map how these populations have moved, changed, or remained the same and shared resources during the past 20 years.
- Analyze how findings (relationship to location, history, and existing resources) might affect the ability of each neighborhood to recover from environmental impacts and disasters.

Specific Research Question(s): For each geographic area, determine:

1. Where are the exact locations of environmental justice communities relative to onshore oil and gas support industries?
2. How close are low, middle, and high income neighborhoods to one another in these areas?
3. What makes these communities vulnerable? And how equipped are these communities to recover from disaster?

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Patterson, M. (2013). Vulnerability: A Short Review. ICR Working Paper #3. Available at: http://www.viu.ca/icr/resources/publications/

"Supporting Information." Mapping Social Vulnerability. NOAA Fisheries, National Marine Fisheries Service, n.d. Web. 10 Feb. 2017.

Title	Air Quality Modeling for the Atlantic Oil and Gas Development
Administered by	Headquarters
BOEM Contact(s)	Holli Ensz, Holli.Ensz@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$1,500 (in thousands)
Performance Period	FY 2019–2020
Date Revised	March 13, 2018
PICOC Summary	
Problem	No air quality impact assessments have been conducted on potential oil and gas activities for the Atlantic Region.
Intervention	Utilize existing meteorological datasets, onshore emission estimates, and BOEM's Draft Proposed Program (DPP) scenario to examine potential oil and gas exploration, development, and production emissions impacts as required under the National Environmental Policy Act (NEPA) and the Outer Continental Shelf Lands Act (OCSLA).
Comparison	Photochemical modeling would compare baseline (no action) versus future (with action).
Outcome	Determine possible air quality impacts caused by potential oil and gas activities in the Atlantic Region as required under NEPA and OCSLA.
Context	Atlantic Region

BOEM Information Need(s): BOEM needs information on the air quality impacts from potential Outer Continental Shelf (OCS) oil and gas exploration, development, and production in the Atlantic Region. The 1990 Clean Air Act Amendments (CAAA) requires the U.S. Environmental Protection Agency (USEPA) to set the National Ambient Air Quality Standards (NAAQS) for widespread pollutants from numerous and diverse sources considered harmful to public health and the environment. The OCSLA states that OCS oil and gas exploration, development, and production activities cannot significantly impact the NAAQS of any state. Photochemical modeling needs to be conducted to ensure that Atlantic Region potential OCS oil and gas sources proposed in the recent DPP do not significantly impact the NAAQS. This information will be used by BOEM in the NEPA documents and could be used for mitigation purposes, if needed.

Background: The recent DPP includes opening up a large portion of the Atlantic Federal waters for oil and gas exploration, development, and production. Therefore, BOEM will need data on the air quality impacts from these potential OCS oil and gas sources to consider in NEPA documents. In order to conduct air quality impact assessments, photochemical modeling should be conducted using USEPA Appendix W and other modeling guidelines. BOEM can use the USEPA's national Weather Research and Forecasting model (WRF) dataset that includes the Federal waters of the Atlantic Region, existing Atlantic States emissions datasets from the USEPA's National

Emissions Inventory (NEI), and onshore monitoring programs. This study would use the existing datasets to develop all necessary Atlantic Region OCS modeling inputs and conduct photochemical modeling assessing air quality impacts.

Objectives: to assess air quality impacts from potential OCS oil and gas activities in the Atlantic Region under the DPP.

Methods: Using USEPA's existing national WRF and NEI datasets, the contractor should calculate potential OCS oil and gas emissions based on the DPP, perform photochemical modeling, and post processing of the modeling results. Photochemical modeling using the Community Multi-scale Air Quality model (CMAQ) and/or the Comprehensive Air quality Model with extensions (CAMx) is needed to estimate potential impacts of OCS air emissions to the air quality of any State. For photochemical modeling, the DPP scenario emissions must be developed, all onshore and offshore emissions must be preprocessed, WRF meteorological datasets should be compiled, resolution grids over the Atlantic Region with finer, nested grids over non-attainment areas and the Class I areas should be established, and any other dataset needed should be compiled to run the photochemical model. The modeling results would assist in defining the DPP scenario impacts, if any, of all oil and gas sources induced by OCS activity, including the formation of secondary fine particulate matter (PM2.5) and ozone, plus visibility impacts analysis for Class I areas. Dispersion modeling (AERMOD-COARE and/or CALPUFF) will be conducted, if needed, for any PSD Increment Analysis and Conformity Determinations.

Specific Research Question(s):

1. Will the potential OCS oil and gas activities under the DPP scenario in the Atlantic Region impact the air quality of any State?

Title	Developing an Auditory Weighting Function for Low-Frequency Whales
Administered by	Headquarters
BOEM Contact(s)	Erica Staaterman, Erica.staaterman@boem.gov
Procurement Type(s)	Interagency
Approx. Cost	$600 total (in thousands); 200k/year over three years
Performance Period	FY 2019–2022
Date Revised	April 9, 2018
PICOC Summary	
Problem	It is not possible to conduct a hearing test on a large baleen whale, yet we are required to know this information for analyses under the Marine Mammal Protection Act (MMPA) and Endangered Species Act.(ESA) . Therefore, the hearing abilities of low-frequency (LF) whales remains one of the major "unknowns" as the regulatory community has tried to deal with effects of noise on marine mammals. The result is potential over-estimation of takes and/or effects and improper application of mitigation.
Intervention	There are multiple scientific approaches to answer the question (see below). Although this question has existed for some time, this is the right place and right time to pursue this project, mainly due to partnership interest and advances in research methodologies. The Subcommittee on Ocean Science and Technology (SOST) interagency task force for ocean noise and marine life (comprised of approximately eight agencies) recently identified this question as the #1 information need on marine sound issues for broad-scale interagency support. Agency members of this task force have committed to contributing funds to partner on this project.
Comparison	There is no way to obtain a behavioral audiogram or electrophysiological audiogram from a free-swimming baleen whale. Instead, we can examine the physiology of the auditory system from whale carcasses and, using finite element modeling, generate a digital model. Then that digital model can be subjected to sound waves to determine how the auditory system would respond (i.e., how the whale would "hear" if it was alive). This is the currently the best conceivable method for addressing this question. The other approach is to obtain auditory evoked potential (AEP) measurements from stranded animals. In this case, neurological responses to played-back sounds would be measured. If this project is not implemented, the best estimates for baleen whale hearing will continue to come from proxy species (e.g., odontocetes), but the accuracy of these proxies is also unknown.
Outcome	Results from either of these methods would be compared to the existing low-frequency hearing function used in the 2016 National Marine Fisheries Service (NMFS) acoustic criteria and would serve to improve the criteria. This criteria, in turn, forms the foundation of all analyses under the MMPA and ESA. For all other hearing groups *except* LF whales, these criteria are based off of real data. The lack of meaningful, validated data for LF whales has made it extremely challenging for NMFS and others to derive meaningful regulatory "not-to-be-exceeded thresholds" for noise sources, as required

	under the MMPA and ESA. The results of this study will be used to inform future versions of the NMFS acoustic criteria and be more immediately used in BOEM marine sound analyses. Further, this project contains the validation of hearing models—models which were previously rejected by NMFS due to lack of validation. It also will advance the technology for obtaining new data from stranded whales. Accurate hearing data will allow for more accurate "take" estimates under the MMPA and ESA or BOEM-authorized activities such as geological and geophysical (G&G) surveys and pile-driving. At the moment the models are likely to be overly conservative due to the lack of data and potentially result in overestimates of effects and over-application of mitigation.
Context	Depends on the method chosen. The data need is national. Information on hearing abilities from just one species of baleen whale will significantly advance the current understanding (which is almost nonexistent), so the results from one species would be extrapolated to other species.

BOEM Information Need(s): Understanding the auditory capabilities of LF whales is the biggest remaining knowledge gap in the field of marine bioacoustics as well as regulatory analyses under the MMPA and ESA. Specifically, BOEM needs to know the shape of the audiogram, as well as the lowest-amplitude sound that LF whales can detect, in order to build auditory weighting functions. These weighting functions are built into the "acoustic criteria" that NMFS requires for estimating "takes" from acoustic exposure. Therefore, this information is imperative for BOEM to assess the potential effects of its noise-producing actions (from both oil and gas and renewable energy) on these species, many of which are highly threatened, are afforded additional legal protection and are the focus of stakeholder concerns. Faced with the lack of information that we have now, regulators are forced to use information from proxy species (captive odontocetes) as stand-ins, but given the differences in life histories, hunting strategies, and communication signals between baleen and toothed whales, these proxies are likely inadequate.

Background: Due to a lack of knowledge about their hearing capabilities, the NMFS 2016 Acoustic Criteria used conservative assumptions in establishing the auditory weighting function for low-frequency whales, especially for the lowest frequencies (< 1 kHz). This resulted in relatively low numerical thresholds for several source types, such as low-frequency impulsive sources (i.e. airguns). Low thresholds result in increased take estimates, a larger number of animals that would experience temporary or permanent threshold shift. This in turn leads to overly conservation analyses of effects and additional requirements for mitigation, the effectiveness of which is also poorly understood.

It is worth noting that BOEM has funded field work which looked at the behavioral response of certain cetacean species to man-made sounds. At-sea Controlled Exposure Experiments are inevitably high-cost, but due to high individual variability and the difficulty of obtaining large sample sizes for such highly migratory species, these studies have yielded mixed results. The return on investment for these field studies has been relatively low. The methods proposed here are not field-based behavioral work, but instead rely on physiological or modeling methods (which need to be validated). As

such, their potential return on investment (especially when comparing costs between methodologies), is much higher.

The time is right for this project because:

- This has been a need for the last several decades, but there is more focused attention on this issue since the publication of the NMFS acoustic criteria in summer 2016.

- BOEM has surveyed Federal agencies via the SOST Ocean Noise and Marine Life task force to rank over 100 remaining "knowledge gaps" related to ocean noise. This topic emerged as the #1 knowledge gap across agencies. It also ranked at the top within a group of 13 BOEM SMEs that were also surveyed.

- The SOST group plans to put forth this topic in the next Navy's Living Marine Resources (LMR) Program Broad Agency Agreement (summer 2018) in order to solicit proposals.

- Within the Navy, Office of Naval Research (ONR) and LMR are ready to commit about $250,000/year over three years, with MMC, NSF, and NOAA able to contribute smaller amounts (in the 10s of thousands).

- One of our Federal colleagues already has a permit in-hand for accessing stranded animals for hearing tests. This was previously a big logistical hurdle and would be very helpful in the later stages of this project.

- It is also worth mentioning that the US Navy and others have previously funded projects that used finite element modeling (FEM) of the head and inner ear of some LF species. Because this work has not been fully validated (although it could be, pending implementation of this study), NMFS did not incorporate this data into the 2016 acoustic criteria. Additionally, there has been recent progress in electrophysiological (AEP) techniques that measure the neural response of stranded whales, but these tools require further development.

Objectives: To build an audiogram for low-frequency cetacean(s).

Methods: The SOST group has decided to put forth a Broad Agency Announcement (BAA) that would include three research areas:

1. Validation of finite element model outputs of whale skulls, may include:
    a. Validation of the bone conduction pathway
    b. Scanning an additional baleen whale species—e.g., a bowhead that is obtained from subsistence harvest, or a stranded animal that can be mobilized quickly before decomposing.
2. Improve equipment and methodology for AEP methods
    a. Development of appropriate transducer (a portable speaker that can reproduce sounds < 1kHz). This remains a major technological hurdle.

b. Testing of appropriate size and placement of subcutaneous needles, which can be started with sounds above 1 kHz, before the appropriate transducer has been developed.
c. Note: later stages of AEP work would include testing on real, stranded animals, but the steps above are necessary first.

3. Open-ended call for proposals that aim to build an auditory weighting function for LF whales using new ideas, methods, or technology

Specific Research Question(s):

1. What is the shape of the audiogram for LF whales?

References:

Cranford, T. W. and P. Krysl (2015). "Fin whale sound reception mechanisms: skull vibration enables low-frequency hearing." PLoS One 10(1): e0116222.

Cranford, T. W., P. Krysl and M. Amundin (2010). "A new acoustic portal into the odontocete ear and vibrational analysis of the tympanoperiotic complex." PLoS One 5(8): e11927.

National Marine Fisheries Service. 2016. Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (NOAA technical memorandum NMFS-OPR-55)

Johnson, A. C. (April 2018). Scientists use rocket scanner to learn how whales hear: first whole-body CT scan of a minke whale yields insights on whale communication. This is a recent article about forthcoming work from Cranford and colleagues (not published yet, but will be presented at an upcoming conference).

Title	Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery
Administered by	Headquarters
BOEM Contact(s)	Timothy White timothy.white@boem.gov
Procurement Type(s)	Contract, Interagency agreement, Cooperative Agreement
Approx. Cost	$500 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 11, 2018
PICOC Summary	
Problem	A major challenge to integration of remote sensing methods for population surveys is the tremendous volume of data that is collected during image-based surveys and the lack of suitable tools for automated detection, classification, and counting of wildlife targets collected on at-sea transects. Current methodology requires experts to manually identify all species on an image-by-image basis, a strategy that will soon be untenable due to the magnitude of datasets required to process by a limited number of expert teams.
Intervention	Artificial Intelligence (AI) in the form of computer vision and machine learning has potential to relieve the manual workload of experts by automating the identification and count process.
Comparison	This method will use images of marine wildlife collected on BOEM-funded studies to train the algorithm and compare classification efficiency across species and dynamic survey conditions.
Outcome	A transferrable computer vision algorithm that can be used to identify and count marine wildlife collected on aerial survey operations.
Context	This proof of concept will be applied to digital imagery collected the Atlantic shelf and shelf break systems.

BOEM Information Need(s): High resolution camera systems are now deployed on nearly all aerial surveys to capture transect-level imagery of seabirds, sea turtles, and marine mammals. This method will develop and/or evaluate methods for efficiently automating counts of wildlife in aerial photographs, and may reduce costs of long-term monitoring programs through rapid data processing. This approach may also improve species identification, particularly of species difficult to identify by observers on aerial surveys.

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

observations. A major challenge to integration of remote sensing methods for population surveys is the tremendous volume of data that is collected during image-based surveys and the lack of suitable tools for automated detection, classification, and counting of at-sea wildlife targets. In some cases, individual low-level surveys collect data on dozens of marine species, are regional or continental in scope, and involve the simultaneous operations of up to a dozen aircrews for a month-long time period. Automation of marine animal detections and classification is critical if remote sensing solutions are to be cost-efficient (Groom et al. 2013, Chabot et al. 2016).

Objectives: The goal of this project is to initiate development of automated detection and classification algorithms for marine wildlife (e.g., cetaceans, seabirds, and sea turtles) in digital aerial imagery.

- Develop and annotate a digital aerial imagery archive to be used to train computer vision and machine learning algorithms
- Develop computer vision and machine learning algorithms for detection, taxonomic classification, and counting of the target species in open water environments
- Provide recommendations and guidance on image and environmental characteristics that maximize detection and classification accuracy.

Methods:

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

Specific Research Question(s):

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

References:

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

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

Title	Archaeological Investigations in Support of Development of Energy and Mineral Resources on the US Outer Continental Shelf
Administered by	Headquarters
BOEM Contact(s)	Brandi Carrier. brandi.carrier@boem.gov
Procurement Type(s)	IDIQ Multi-Year Contract
Approx. Cost	$1,500 (in thousands) over five years (i.e., $300,000 per year)
Performance Period	FY 2019–2023
Date Revised	December 8, 2017
PICOC Summary	
Problem	Potential development and minerals usage is constrained because it is uncertain whether a geophysical survey target is, in actuality, a significant archaeological site.
Intervention	By performing targeted groundtruthing investigations, BOEM can confirm which potential sites warrant protection and which do not. The information will also assist BOEM by improving its target selection for avoidance or additional investigation.
Comparison	Prior pilot exercises in Virginia and Maryland suggest that 50% of targets identified for avoidance prove, through ground truthing, to *not* be historic properties eligible for protection under the National Historic Preservation Act (NHPA); these may be cleared for development. The remaining 50% are resources eligible for protection and avoidances are warranted.
Outcome	With confirmation, additional areas will be available for development and minerals usage, resulting in more flexibility for industry, greater development of a lease area, and full compliance with the NHPA. After incorporating the findings of this study in BOEM's analyses, the successful identification of targets selected for avoidance that actually are historic properties may be expected to improve.
Context	This study is intended to be utilized in all BOEM regions and by all operational program areas, in rotation, year-to-year.

BOEM Information Need(s): BOEM needs to gather additional information on previously identified geophysical targets to determine if they potentially represent archaeological sites, and if so, if they are eligible for listing on the National Register of Historic Places (NRHP). This information also will improve BOEM's analysis of industry-provided remote sensing data supporting plans, and future selection of targets for avoidance and/or further investigation.

Background: At present, BOEM requires oil and gas and wind energy developers to either avoid or investigate all geophysical targets (sidescan sonar contacts and magnetic anomalies representing historic shipwrecks and downed aircraft, or sub-bottom profiler contacts representing potential paleolandforms) that may potentially represent an archaeological resource. BOEM also avoids all potential targets identified as part of sand

resource assessments. In actuality, previously identified geophysical targets may prove to be significant archaeological resources that should be avoided, or they may prove not to be significant archaeological resources and therefore they should not prevent development or require additional investigation.

Since the vast majority of targets identified through industry surveys and sand resource assessment surveys are avoided, BOEM never learns their actual identities or whether the avoidance was warranted. In addition to potentially clearing areas for development, this study will also provide information to improve BOEM's analysis of remote sensing data and confidence in which targets are being selected for avoidance or additional investigation. Moreover, Marine Minerals Program activities are a collaboration between BOEM, states, and other agencies, and with shrinking availability of sand resources, and no for-profit developer involved, clearing areas ensures the availability of the most sand resource for development. Finally, archaeological groundtruthing of potential targets and determinations of significance and eligibility for listing on the National Register of Historic Places (NRHP) is necessary for informed, responsible decision making, and for compliance with the NHPA (36 CFR 800).

Objectives: The objective is to conduct additional investigations of previously identified geophysical targets that may potentially represent archaeological resources. The study will assist BOEM with staying informed about the continual evolution of remote sensing technologies and will test the accuracy of data collected from previous site studies.

Methods: Using previously collected geophysical survey data, field operations will involve additional high resolution geophysical survey retrospectively, to relocate each target and ascertain its suitability for diving or Remotely Operated Vehicle (ROV) investigations, and executing diver or ROV investigations with photography and videography to accurately document the resource. Specifically, methods will include: (1) conducting high resolution sidescan sonar, high density magnetometer, and/or high resolution sub-bottom profiler surveys of each identified priority target; (2) determining whether or not the priority target warrants further investigation; (3) completing a rapid assessment exterior survey, via divers or ROV, of those targets warranting further investigation; (4) completing detailed video and photographic surveys of those targets warranting further investigation; (5) as conditions allow, producing a cursory site map (or photomosaic) of each confirmed archaeological site for interpretation; (6) assessing the historical significance and archaeological integrity of each confirmed archaeological site; (7) determining eligibility of each confirmed archaeological site for nomination to the NRHP; and (8) identifying to what degree site preservation is influenced by environmental and anthropogenic formation processes.

In order to fulfill these objectives, BOEM archaeologists must be provided with access to services and equipment necessary to perform these activities. Services and equipment may include vessels, vessel support services, and specialized instrumentation necessary to perform archaeological and complementary scientific investigations. It is proposed that HQ would establish an IDIQ commercial contract against which project-specific task orders (TOs) may be issued for the provision of these services and equipment. TOs would be issued annually, subject to the availability of funds, and would be based on

research designs prepared by BOEM's cultural and archaeological resources team (CART), in conjunction with new and established partnerships in the appropriate region(s). As far as possible, BOEM will seek to partner with affected States and other Federal agencies, including BSEE, to create efficiencies and reduce expenditures; agreements will be drafted between BOEM and State or Federal agencies as appropriate. Annual research designs would be prepared collaboratively and would focus on geographic areas which BOEM anticipates represent the bureau's highest priorities for both energy and marine minerals development activities and for archaeological resource protection needs. It is anticipated that scientific activities supporting other disciplines (e.g., biological, water quality) that are complementary to the field operations may also be conducted in concert with the archaeological investigations. Only previously-recorded targets will be investigated and the study will not involve areas that have never been surveyed.

Specific Research Question(s): For each geophysical survey target with the potential to represent a historic property, determine:

1. Does the geophysical survey target constitute an archaeological site retaining integrity?

2. If so, does the site constitute a historic property (i.e., a site potentially eligible for the National Register of Historic Places)? If the geophysical survey target represents a historic property, then avoidance or mitigation are warranted. If the target does not represent a historic property, then development may proceed without further avoidance restrictions.

3. What have we learned about analyzing geophysical survey targets that can be incorporated into our future analyses of industry-provided and resource-analysis surveys?

Title	Demonstration Project, Integrating DNA Profiles, Genomics and Photo-Identification Data in Long Term Monitoring of Long Lived Marine Megafauna
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson, jacob.levenson@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$350 (in thousands)
Performance Period	FY 2019–2021
Date Revised	December 31, 2017
PICOC Summary	
Problem	A growing number of large-scale, long-term studies of marine mammals and other marine megafauna (e.g., sharks, and turtles) are collecting spatially explicit records linked through individual identification to genetic samples, photo-identification and telemetry. Individual-based studies of long-lived species, require standardization of protocols and distributed access to integrated databases of relevant metadata from multiple studies, including DNA profiles, genomic profiles, photo-identification records and satellite telemetry tracks. For BOEM, the lack of agreed community standards or a collaborative framework for these datasets reduces the potential for long-term monitoring of the health and life history parameters of populations exposed to chronic or acute anthropogenic impacts of BOEM-permitted activities
Intervention	Developing a collaborative framework for data archiving and long-term monitoring of the health and life history of individual samples would establish a common protocol to connect divergent databases and ensure genomic information and long-term individual records are archived to an open-access standard.
Comparison	Identification of population segments and estimates of abundance among largely isolated populations continues to occur in disconnected individual databases limiting our ability for accurate take estimates.
Outcome	Improved identification of population segments and estimates of abundance, especially among largely isolated populations.
Context	Nationwide coastal and offshore waters, however a pilot project could take place among any region, for example, Gulf of Mexico Sperm Whales.

BOEM Information Need(s): Information needs met by this study include standardization and archiving of DNA profiles from past and ongoing studies, e.g., mtDNA haplotypes for maternal lineages, sex identification and microsatellite genotypes for individual identification.

Background: Numerous types of studies have been conducted on cetaceans in the U.S. Outer Continental Shelf (OCS), leading to challenges in the analysis and synthesis of diverse datasets, particularly those from long-term studies of populations exposed to anthropogenic impacts. The Marine Mammal Protection Act, National Environmental Policy Act and the Endangered Species Act require BOEM to consider the impacts of

energy and mineral extraction activities on cetaceans. Together with other agencies, BOEM invested considerably in studies where a number of groups have collected biopsy samples for genetic analyses and photographs for individual identification. In addition, many cases of OCS research across program areas and regions included satellite telemetry for studies of habitat use. For example, over the last two decades, several projects have collected biopsy samples and photo-identification records from sperm whales during tagging deployment (e.g., the Sperm Whale Seismic Study or SWSS in 2002) and similar projects are ongoing. DNA profiles and photo-identification records are increasingly used for defining units of management and for estimating abundance and trends in populations using capture-recapture models. To date, however, there is no single catalog or accessible archive that integrates DNA profiles and photo-identification for individual identity of most of these populations. A web-based, distributed-access data archive compatible with the OBIS-SEAMAP format could consolidate and integrate these data greatly enhancing the potential for long-term monitoring. This type of effort will enable and guide new analyses to inform future management questions regarding cetacean populations, including abundance, range, distribution, and stock identity. A similar information need has been recognized by the Office of Naval Research in funding development of the *geneGIS* tools for the SPLASH program on humpback whales in the North Pacific. However, no one is currently uniting the different groups working on including genetics in population assessments such as, for example, GOM Sperm Whales.

A growing number of large-scale studies of marine mammals and other marine megafauna (e.g., sharks, and turtles) are collecting spatially explicit records linked through individual identification to genetic samples, photo-identification and telemetry. These spatiotemporal records have been used to track the migration and life history parameters of individuals, to estimate the abundance and trends of populations and, in the case of genetic markers, to infer close kinship (e.g., parent/offspring relationships) and define management units, or Distinct Population Segments. The skin and blubber biopsy samples collected for genetic analyses are also used for assaying a growing number of ecological markers (e.g., stable isotopes, fatty acids) and environmental contaminants (e.g., Persistent Organic Pollutants, heavy metals). To date, however, there has been a conspicuous absence of integration and spatial exploration of individual genetic and photo-identification records; in particular, there is a need for linking photo-identification to genetic information (e.g., DNA profiles).

An integrated database of photo-identification and DNA profiles can be used to manage OCS resources by, a) aiding in long-term monitoring of population health, b) enabling easy, open access to data for conducting analysis to support environmental impact statements and c) accounting for more accurate geographic analysis of DNA biopsy samples. This is essential for monitoring habitat use, assessing environmental threats, and defining appropriate listing levels for species exposed to exploration and development. This benefits BOEM by providing the potential for improved estimates of abundance and mortality/survival based on capture/recapture analyses using existing photo-identification and DNA profiles. This, along with improved genetic information on stock identity, can be used to estimate population losses. Additionally, this will develop a data archiving model that can be adopted nationally. The software architecture of the online archive could also provide tools for primary analyses and

visualization of spatial-temporal records, linked through individual identity and genetic markers, as well as export functions for more specialized programs. populations.

Web-based databases are the solution for extending the range of analyses in space and time, standardizing data formats to ensure long-term archive utility, offering a cost-effective data management solution for individual researchers that robustly provides the analysis functions they require, and encourages collaboration among diverse groups of investigators, thus helping establish community standards for these ongoing studies of long-lived species.

This proposed project ties-in closely with existing efforts to monitor cetacean ecology in the GOM, Alaska and Atlantic regions, by creating a database framework that affords a directory to biological sample analysis across varying studies using a common web framework. Information obtained will ensure that BOEM complies fully with environmental regulation and considers the impacts of its programs, on these endangered species while building capacity for further study by other BOEM regions using the same infrastructure.

Objectives: The objective of this study is to improve the current computation capabilities for integrating DNA profiles with photo-identification records for assessment and long-term monitoring of marine mammal populations. To provide standardized database architecture for online access, with associated tools for primary analyses and visualization of spatial-temporal records.

Methods: A web-based, user-friendly computational framework for accessing integrated DNA profiles and photo-identification records, compatible with the OBIS-SEAMAP, will be developed. Associated computational tools for data exploration and export to specialized programs will also be developed. The proposed work will include organizing a workshop of Federal partners, academic researchers and other potential contributors to the databases, to encourage participation in the data archive and promote collaborative research. Data format commonalities and/or conversion needs will also be determined.

Specific Research Question(s): This profile address several subject areas identified in BOEM's ESP Strategic Framework. This includes Affected Resources Information on the status, trends, and resilience of potentially impacted natural and cultural resources…particularly 'highly regulated and vulnerable to adverse change in status'. Specifically, this profile addresses; How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results? What are the best resources, measures, and systems for long-term monitoring?

References:

Dick DM, Walbridge S, Wright DJ, Calambokidis J, Falcone EA, Steel D, Follett T, Holmberg J, Baker CS (2014) geneGIS: Geoanalytical Tools and Arc Marine Customization for Individual-Based Genetic Records. Transactions in GIS 18: 324-350

Title	Catalog of Seabird Colonies
Administered by	Headquarters
BOEM Contact(s)	Timothy White, timothy.white@boem.gov
Procurement Type(s)	Intra-agency Agreement with USGS, FWS or contract
Approx. Cost	$400 (in thousands)
Performance Period	FY 2019–2021
Date Revised	September 27, 2017
PICOC Summary	
Problem	Other than the North Pacific Seabird Colony Database, there are no readily accessible databases of coastal seabird colonies to query in relation to potential impacts by energy and mineral development, and from which regional numbers or trends can be compiled for risk modeling and guidance.
Intervention	An update of the Colonial Waterbirds Database (CWB) is held by USGS at Patuxent, and is currently incomplete and unavailable. Tracking datasets of birds instrumented at colonies is an important missing feature that will strengthen CWB for identification of critical foraging areas during the breeding season.
Comparison	Population numbers and trends within and between States (e.g., How many seabird colonies on Cape Cod support breeding Roseate Terns compared to colonies on Long Island, NY?). Species-specific and community-level foraging areas (e.g., foraging area locations of Roseate Terns breeding on Cape Cod relative to Roseate Terns breeding on Long Island, NY).
Outcome	Open and full access of the Seabird Colony Catalog to assess coastal breeding populations, and offshore foraging locations of seabirds to inform National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Migratory Bird Treaty Act (MBTA) consultations related to BOEM activities. Render the geodatabase publically available via the USGS ScienceBase-Catalog (https://www.sciencebase.gov/catalog/).
Context	National (Atlantic, Gulf of Mexico, Pacific, Alaska).

BOEM Information Need(s): A readily accessible geodatabase that will identify the location, scale and scope of specific seabird colonies. Activities spawned by onshore and offshore facilities (e.g., construction of temporary and permanent roads, pipelines, and cables) impose a high risk of disrupting breeding seabirds when the activity occurs in close proximity to colony. Furthermore, the seabird catalog will grant more power to responders of oil spills, and managers to identify a colony's location, size, and species composition to mobilize a rapid response to a potential threat.

Background: Despite acknowledgment of the importance of monitoring there are no readily accessible colonial seabird databases from which to create a simple map of colony locations, and to compile regional seabird numbers and trends (Nisbet et al., 2013). Aerial and ship-based surveys are rarely timed to monitor specific breeding populations, and survey transects are oftentimes too far offshore to properly capture a colony's spatial footprint on the ocean. Estimates of a colony's abundance, production, and location are uncertain based on at-sea survey platforms, unless designed to specifically monitor breeding populations from sea.

In addition to colony-based abundance estimates and geographic scope, the CWB would benefit by incorporating existing tracking datasets of breeding seabirds instrumented at colonies. This connection will strengthen our understanding of spatial use by breeding seabirds through identification of colony-specific foraging areas and commuting zones. The link between land and sea seabirds life histories via tracking, combined with existing distribution and abundance models based on at-sea surveys, will offer a multi-platform analytical perspective of the spatial ecology of breeding seabirds on the OCS.

Objectives:

- Map breeding colony locations (geographically by phases)
- Calculate population trends
- Map critical foraging areas by linking tracking datasets to the CWB. Tracking data will help identify persistent foraging areas and commuting routes used by seabirds at specific colonies.

Methods: The U.S. Geological Survey (USGS) currently holds an unedited version of the Colonial Waterbirds Database (CWB) that contains population-level records dating back to the early 1900's Regional leads will collect existing datasets (i.e., abundance, tracking, and diet, if available) from Federal, State, academic, and non-governmental organizations. Non-digitized datasets will be transcribed and compiled from reports and publications, most of which have been identified (Nisbet et al., 2013). Phase I will focus on the Gulf of Mexico and Atlantic regions. Lessons learned from Phase I will be applied to the Pacific region in Phase II. The Catalog of Seabird Colonies will be modeled after the North Pacific Seabird Colony Database to provide standardization across regions. The USGS will serve the final version of the database via their ScienceBase-Catalog (https://www.sciencebase.gov/catalog/).

Specific Research Question(s):

Relative to existing and potential energy and mineral development:

1. Where are seabird colonies located on the coastal U.S.?
2. Which colonies support listed and endangered seabirds species?

3. What are species-specific population trends at local, regional, and national scales?
4. Can existing tracking datasets help to link seabird colony locations to colony-specific foraging and commuting areas during the breeding season?

References:

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Nisbet, I.C., Veit, R.R., Auer, S.A. and White, T.P., 2013. Marine birds of the eastern United States and the Bay of Fundy: distribution, numbers, trends, threats, and management.

Title	Standards for the Collection and Analytical Processing of Subsurface Core Samples
Administered by	Headquarters
BOEM Contact(s)	Brandi Carrier, brandi.carrier@boem.gov
Procurement Type(s)	Interagency Agreement (USGS)
Approx. Cost	$750 (in thousands)
Performance Period	FY 2019–2020
Date Revised	December 8, 2017
PICOC Summary	
Problem	Industry and stakeholders alike have noted a lack of clarity in how BOEM collects information about and reconstructs paleolandforms and subsequently uses this information to identify areas which are selected for avoidance.
Intervention	By defining clear standards for industry responsibilities around this subject, and testing them, BOEM can address the problem directly.
Comparison	By defining clear standards, BOEM can establish the methodology for collection and treatment of cores most suitable for identifying archaeological sites located within relict paleolandforms on the Atlantic Outer Continental Shelf.
Outcome	The outcome will provide clarity in terms of areas that ought to be protected while also freeing up areas for development by using a scientifically-defensible standard treatment and approach.
Context	The findings will be applicable throughout the Atlantic region and thus may impact all three of BOEM's major programs: Marine Minerals, Renewables, and, if included in the new National Program, Oil and Gas.

BOEM Information Need(s): BOEM needs to develop standards for adequate and appropriate spacing, density, collection, and post-collection (i.e. laboratory analytical) treatment of vibracores, including final disposition of core samples and data, as methods for aiding in the identification of archaeological sites located within relict paleolandforms.

Background: Although vibracore collection (and similarly-executed boring) is one of multiple subsurface sediment sampling techniques, it is unique with respect to its utility as a direct-sampling method that may be used in the identification of submerged archaeological sites located within relict paleolandforms. As one of the few subsurface sediment sampling techniques that are minimally invasive to these resources, vibracoring results in the collection of an intact, generally 4-inch diameter by (up to) 40-foot cylindrical sample of sediments from the seabed, which may then be subjected to further onshore analysis.

But questions remain to be answered with respect to applying this technology to the identification of archaeological sites as historic properties for the purposes of Section

106 of the National Historic Preservation Act (NHPA). First, consideration must be given to what constitute appropriate and adequate sampling strategies beyond what may be necessary to "ground-truth" high resolution geophysical data. Second, given adequate direct sampling is conducted, appropriate and consistent treatment of the collected cores must include subjection to certain laboratory and other analyses which may point to non-artifact indicators of human habitation (including, for example, macro-sedimentary analyses of bone and shell concentrations and burned materials, grain size analysis, and geochemical analysis of percentages of total organic carbon of zinc and manganese). Standards must be developed for differentiating terrestrial stratigraphic sequences that are not archaeologically sensitive from those that are. Standard operating procedures for the handling and archiving of cores and coring materials (e.g., subsamples) also should be established and observed, including submission of data resulting from geological borings. Finally, standards for reporting of results must be shared with developers to ensure the highest quality data are submitted with plans and applications and thus utilized in BOEM's decision-making process. The outcome will provide clarity in terms of areas that ought to be protected while also freeing up areas for development by using a scientifically-defensible standard treatment and approach.

Participants at BOEM's 2012 Wind Energy Workshop/Archaeology tract discussed these questions and issues, but many of Europe's submerged prehistoric archaeologists, speaking with the benefit of wind energy experience, concluded that no consistency exists on the European side of the Atlantic with respect to analyses utilized. They also commented that, where lacking, standard operating procedures are desirable and would be beneficial. Moreover, many of the paleolandscape reconstructions conducted to date in the literature were performed for individual academic research purposes; little has been done to present concise methodologies that may be used repeatedly in a development context.

The lack of consistent application of standards in the European Atlantic and the question of applicability of Stright's 1986 study (Criteria distinguishing archaeological deposits from natural sedimentary deposits in the Gulf of Mexico coastal region) to the Atlantic region justifies the continued consideration of this topic within the geographic confines of the Atlantic OCS. Moreover, recent studies deliverables, such as Developing Protocols for Reconstructing Submerged Paleocultural Landscapes and Identifying Ancient Native American Archaeological Sites in Submerged Environments: Best Practices provide recommendations for BOEM to consider incorporating, yet which must be operationally tested prior to implementation. Consideration also should be given to what variability may exist, identifying where different study regimes on different portions of the OCS are warranted.

It is anticipated that the methods established by this study will become consistent treatment for Atlantic region core collection and borings conducted in support of plans and applications for both the Renewable Energy and Marine Minerals Programs. Future testing of any methods developed in the Atlantic for use in the Gulf of Mexico and Pacific Regions also may be appropriate.

Objectives: The objective of the study is to develop and test standards for adequate and appropriate spacing, density, collection, and post-collection (i.e. laboratory

analytical) treatment of vibracores, including final disposition, as methods for aiding in the identification of archaeological sites located within relict paleolandforms on the Atlantic OCS.

Methods: (1) This study will involve preparing a methodology for identifying archaeological sites located within relict paleolandforms on the Atlantic OCS using the methods presented in University of Rhode Island 2017 and Stright 1986. The methodology will guide the development of draft standards for using subsurface seabed sediment samples as a means of identifying archaeological sites, including a standard suite of primary-level laboratory analyses and a possible suite of secondary-level analyses dependent upon the results of the first.

(2) The study will then test the methodology prepared in two separate locations of the Atlantic OCS, likely offshore New York and North Carolina, using previously collected, high resolution geophysical data from the Atlantic Sand Assessment Project (ASAP). Because sand resource identification cores previously collected may not be sufficiently deep to access paleolandforms, if warranted, this study may include collecting an additional *up to* 30 cores (15 in each study area) to provide usable data for testing the methodology. The proposed methodology will be applied, to include the processing of the previously collected data and analysis of the previously- or newly-collected cores, in order to test its applicability and suitability within a developer- or contractor-conducted framework. While it is possible that collected core samples will not contain paleocultural artifacts, though the contained sediments would be from the appropriate time period, this chance will be minimized by focusing on areas of the landscape with the highest potential to contain sites, based on terrestrial factors. Additionally, sampling strategies could be altered during this experimental phase of the study to reduce the likelihood of a null result.

(3) Results of the testing will be incorporated into final standards that, if appropriate, BOEM may then consider incorporating into its guidelines for developers and for the use of partner agencies and their contractors.

Specific Research Question(s): What is the appropriate methodology for collection, analysis, and curation of cores most suitable for identifying archaeological sites located within relict paleolandforms on the Atlantic Outer Continental Shelf?

References:

Stright, M.J. 1986. Human Occupation of the Continental Shelf During the Late Pleistocene/Early Holocene: Methods for Site Location. In Geoarchaeology: Vol 1, No. 4, 347-264.

The University of Rhode Island. 2017. Developing Protocols for Reconstructing Submerged Paleocultural Landscapes and Identifying Ancient Native American Archaeological Sites in Submerged Environments: Best Practices. U. S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2017-XXX. (in press).

Title	Mortality Risk for Large Bodied/Low Trophic Feeding Elasmobranchs During Energy and Mineral Operations.
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson, jacob.levenson@boem.gov
Procurement Type(s)	Interagency agreement and/or Cooperative Agreement
Approx. Cost	$520 (in thousands) (Does not include approx $180 in co-funding)
Performance Period	FY 2019–2020
Date Revised	November 28, 2017
PICOC Summary	
Problem	Mortalities of large elasmobranchs, protected under various statutes, such as the Endangered Species Act, and depended upon by the tourism sector, may occur through vessel strikes as well as entanglement in geological/geophysical survey equipment or marine mineral activities.
Intervention	Understanding spatial and behavioral overlap between low trophic feeding/large body size elasmobranchs and vessel operations can decrease mortality risk through effective mitigation and improve our impacts analyses. Change can be measured by mortality reporting and available data on non-lethal vessel injuries as well as vessel behavior change through automatic identification system (AIS) data.
Comparison	This can be accomplished by comparing areas with known mitigation or minimization of strike risk to similar oceanographic locations where there is no attempt at minimization
Outcome	Improved impact analyses leading to ensuring the best environmental practices are used for effective mitigation measures
Context	Atlantic and Gulf of Mexico regions

BOEM Information Need(s): BOEM Information Need(s) to be Addressed: Information on water column use, fine-scale behavior, seasonality and movement as well as modeling risk of vessel interaction, from this study will better quantify the risk of entanglement and ship strikes associated with energy and mineral development. Results from this study could be applied to other lower trophic-level-feeding, large-bodied fishes and will be used in preparation of BOEM environmental impact analyses.

Background: Similar to marine mammals, lower trophic-level feeding, large-bodied elasmobranchs spend a significant amount of time at, or just below, the ocean's surface. This behavior could lead to a higher risk of mortality due to spatial and temporal overlap with energy industry and mineral extraction operations (i.e. geophysical surveys), increased vessel traffic, and/or increased noise exposure levels. The risk of ship strikes or entanglement in geophysical gear may be considerable in waters where BOEM-permitted activities occur. Unlike large whales, which float post-mortem, large sharks such as whale sharks (*Rhincodon typus)* and basking sharks *(Cetorhinus maximus) and* Giant Manta *(M. birostris)* are negatively buoyant and sink out of view; this likely leads

to under-reporting of mortalities from vessel interactions. These species are of concern internationally and are protected by international treaties of which the U.S. is a signatory to the Convention on Migratory Species (CMS) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) as well as, in the case of *M. birostris*, the Endangered Species Act. Multiple geophysical surveys, offshore energy construction, mineral extraction operations, and associated vessel traffic intersect with known aggregations of these species. Lower trophic-level feeding, large-bodied sharks are found globally. Whale sharks typically aggregate at the surface in large numbers in the Atlantic, Pacific, and northern Gulf of Mexico. Additionally, basking sharks are found throughout the U.S. Atlantic and Pacific waters. This surface aggregating behavioral trait exposes both species to energy and mineral operations in multiple countries during their respective migrations. The fourth International Whale Shark Conference in 2016 brought together whale shark experts from around the world to discuss research, conservation, behavior, and population status of the world's largest fish. A common theme emerged that activities associated with oil and gas development likely impact this species globally. At least one confirmed mortality due to entanglement in geophysical survey gear was reported to the BSEE in November of 2014. However, with the exception of nodal surveys, reporting whale shark mortalities has not been required by BSEE. Anecdotal reports of mortalities of whale sharks associated with geophysical operations and vessel traffic have occurred in Mozambique, Mexico, and Belize. Scarification studies demonstrate susceptibility to small vessel strikes (Ramírez-Macías et al. 2012), however risk to large vessel collisions and streamer entanglement risk has not been quantified. Seasonal aggregation sites in the northern and southern Gulf of Mexico represent two of the largest whale shark feeding aggregations known worldwide (de la Parra-Venegas et al. 2013, Hoffmayer et al. 2013; McKinney et al. in press), suggesting that whale sharks may be more susceptible to ship strikes in this region. Additionally, during the *Deepwater Horizon* explosion, oil spill, and response, whale sharks were documented by NOAA airborne surveys swimming in the surface oil slick.

A 2016 update by the International Union for the Conservation of Nature (IUCN) Shark Specialist Group listed the population status of the whale shark as endangered globally (Pierce and Norman 2016). Recent data from mark-recapture and telemetry studies indicate that the Atlantic population has declined about 30% and the Pacific population declined approximately 50% since the last assessment conducted in 2010. Whale sharks support a multi-million dollar tourism industry upon which coastal communities depend. This tourism industry includes scuba diving and whale shark watching excursions and extends from the southern U.S. coastal States throughout Central America.

The nation of Qatar limits geophysical survey activity and ship speed in the Al-Shaheen oil fields during seasonal aggregations of whale sharks due to their affinity to oil platforms. U.S. Federal Regulations specify that geophysical operations must not ‘Cause harm or damage to life (including fish and other aquatic life), property, or to the marine, coastal, or human environment’ as a result of geophysical surveys (30 CFR §551.6 (a)(2)). However, BOEM currently does not employ mitigation measures to protect fishes. Information from this study will be used to understand the risk of mortality in

relation to energy and mineral operations, and potentially aid in the development of mitigation measures to protect these species.

Objectives: Objectives of this study include the following: a) Describe the risk to large pelagic sharks, such as whale and basking, posed by OCS activity related ship strikes and entanglement to best inform potential management alternatives to reduce potential impacts, including mortality; b) Compare behavior and strike risk within three area types where whale sharks exhibit similar behavioral states; those with no activity as a control, those with geophysical survey activity only, and those with energy development and production and/or mineral extraction activities only; and c) Determine need for mitigation measures and effectiveness (feasibility, benefits, and trade-offs) for seasonal activity restrictions during peak shark aggregation activity.

Methods: This study will be implemented through a strategic partnership with the National Oceanic and Atmospheric Administration (NOAA) as well as with public aquaria for educational program development. Together, we will employ similar scientific methods as those which have successfully been employed to describe and reduce strike risk to large whales around the world. This will include: 1) Use of data logging inertial measurement tags to describe the fine-scale behavior of whale sharks; 2) Gathering spatial information on movement in relation to energy and mineral operations using satellite-linked telemetry; 3) Use of available land and satellite based AIS receivers to characterize vessel traffic, specifically energy and mineral operations and support vessels, in the vicinity of whale shark aggregation areas to assess spatial and temporal overlap; 4) Combining the information gathered in the above methods to produce a risk assessment model that can be extrapolated to other lower trophic-level feeding, large-bodied sharks which exhibit similar behavior; 5) An education component, in partnership with the Association of Zoos and Aquariums, including video content distributed to NOAA's Ocean Today Kiosk Network and telemetry shared via Science on a Sphere to deliver educational content to an estimated 60 million visitors to partner institutions globally.

Specific Research Question(s): What is the risk to large bodied, low trophic feeding elasmobranchs exposed to vessels engaged in energy and mineral extraction activities?

References:

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Title	Developing a Roadmap to Maximize Efficiency in Developing Environmental Analyses.
Administered by	Headquarters
BOEM Contact(s)	Jacob Levenson, jacob.levenson@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$495 (in thousands)
Performance Period	FY 2019–2020
Date Revised	May 14, 2018
PICOC Summary	
Problem	BOEM currently lacks a holistic view of how the Bureau's decisions impact the physical, biological and human environments. Providing a concise spatial depiction of the trade-offs and impacts of alternatives to decision makers would provide much needed context to meet the challenges associated with resource management across diverse disciplines, resources and uncertainty of impacts. No uniting policy for ecosystem-based management exists at BOEM.
Intervention	Convene a panel of interdisciplinary experts on marine ecosystem-based management and tradeoff analysis to develop a method whereby in producing environmental analyses can be accomplished accounting for dynamic ecosystem service flows and visualization of decision scenarios.
Comparison	This study could support a future pilot Programmatic analysis/EIS to depict how impacts of various alternatives resulting from oil and gas activities can affect stakeholders. This study would be integral to BOEM's streamlining of environmental analyses, allowing us to comply with both Executive and Secretarial directives.
Outcome	An improved environmental analysis that addresses impacts and benefits to the entire ecosystem, accounting for all regulatory requirements.
Context	This study could be applied to the entire OCS, but would initially need to have spatial limitations as a result of the study parameters.

BOEM Information Need(s): BOEM Information Need(s) to be Addressed:
This study is designed to build on the work of the Bureau of Ocean Energy Management (BOEM) Ecosystem Services Task Team (BESTT) to improve the Division of Environmental Assessment's mission aimed to conduct programmatic environmental analyses. The BESTT was chartered in response to the White House Memorandum M-16-01, *Incorporating Ecosystem Services into Federal Decision Making*, which directs Federal agencies to "…promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts." This study will also help facilitate landscape-level planning as directed in Secretarial Order 3330 by furthering BOEM's efforts to approach impact analysis in a structured whole-system, view. This study would directly inform BOEM's implementation of the National

Environmental Policy Act (NEPA), provide better information on the types and scale of potential impacts to species protected under the Endangered Species Act and Marine Mammal Protection Act, and provide improved visualization of information to decision makers as they implement BOEM's responsibilities under the Outer Continental Shelf (OCS) Lands Act. An ecosystem-based management approach would improve BOEM stakeholder engagements by better demonstrating impacts to the natural resources and services of value. By effectively using regularly synthesized spatial data when developing alternatives in programmatic environmental analyses, BOEM can potentially reduce conflict related to multiple uses of the OCS.

Background: NEPA of 1969 requires Federal agencies to assess the environmental effects of their proposed actions prior to making decisions. NEPA directs agencies to ensure that "unquantified environmental amenities and values…be given appropriate consideration in decision-making" (§ 4332[2][B]). Additionally, in cases of potentially significant impacts, NEPA directs preparation of an Environmental Impact Statement (EIS) that, among other things, addresses the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Due to Federal guidelines for ocean management being broadly distributed across a portfolio of narrowly-purposed pieces of legislation, the NEPA process provides a mechanism to take this broad suite of ocean services into consideration. Furthermore, the NEPA process ensures the comprehensive assessment of potential impacts by providing the overarching regulations that govern ocean management. Through the NEPA process, BOEM can more clearly describe how the resources that stakeholders value couldDark ops 940HD four pack be affected. An ecosystem-based management approach to the analysis may better articulate the costs and benefits (trade-offs) to each stakeholder group that could result from the implementation of a proposed action.

This study will further explore the challenges and information needs identified by the Division of Environmental Assessment (DEA) members of BESTT and determine how implementing an ecosystem-based approach could benefit BOEM analyses needed to support decision making.

Objectives: The objectives of this study are:

1. Conduct an analysis of existing BOEM data sources and derived products could be used to implement ecosystem-based management analysis;
2. Develop guidance to maximize efficiency in environmental analyses by leveraging dynamic ecosystem models for streamlining alternatives development, as appropriate, in the Bureau's environmental analyses; and
3. Develop products in support of communicating ecosystem service analysis to non-experts to facilitate meaningful interactions with stakeholders.

Methods: For each objective above (1–3), the following methods would be used:

1. An analysis should include an inventory of data products used in BOEM's environmental analyses (this would be facilitated by BOEM's ongoing data

management program) and identify opportunities for streamlining alternative development,
2. Conduct facilitated meetings with BOEM staff and an expert working group to develop implementation guidance, as well as,
3. Recommend approaches for compatibility analysis (*e.g.*, among alternative uses).

Specific Research Question(s):
This study supports BOEM's mission by addressing how best BOEM can streamline numerous data sources to design alternatives that ensure protected areas, listed species, existing ocean uses and cumulative effects are addressed within environmental analysis frameworks without having to start anew with each National OCS Program.

Title	Potential Effects of Seismic Airguns on Zooplankton in the US OCS
Administered by	Headquarters
BOEM Contact(s)	Erica Staaterman, Erica.staaterman@boem.gov
Procurement Type(s)	Full and open competition
Approx. Cost	$250,000
Performance Period	FY 2019–2020
Date Revised	February 2, 2018
PICOC Summary	
Problem	Zooplankton may be adversely affected by seismic airguns.
Intervention	A single study demonstrating adverse effects is not sufficient for BOEM to evaluate impacts. The solution is to replicate the previous work, in the US OCS, in areas where BOEM authorizes seismic surveys.
Comparison	Within this study, we will compare results from experimental vs. control treatments. Our results will be compared to previous work to assess the relative impact to zooplankton species.
Outcome	This work will broaden our understanding of the effects of seismic airguns on lower trophic-level species, which will aid in our assessment of impacts to higher trophic level (protected) species.
Context	This study needs to be conducted while real seismic surveys are operating, so it would take place in the GOM or off the Atlantic coast, if operations begin there.

BOEM Information Need(s): In order to adequately assess the potential impacts of BOEM activities on protected marine species under NEPA, we should consider impacts to the entire ecosystem. Although low trophic level animals are generally not protected under Federal law, they serve as important prey for larger species that are under protection. Public comments from recent BOEM EISs have raised the issue of potential effects of seismic airguns on planktonic communities, both as direct impacts to plankton species, and as indirect impacts to their predators. In order to adequately address the comments and make accurate significance determinations in our NEPA, we need to improve scientific understanding around this topic.

Background: Very little research has been conducted on the impacts of noise to eggs, zooplankton, and larvae. It is possible that high-intensity noises can irreversibly damage internal anatomy and physiology of planktonic organisms if they are close enough to the source (de Soto et al. 2013, Govoni et al. 2008, Govoni et al. 2003), or could cause them to swim out of harm's way (Dalen and Knutsen 1987). However, most of the research in this topic focused on relatively small spatial scales and showed minimal effects (Kostyuchenko 1973, Bolle et al. 2012, Booman et al. 1996, Saetre and Ona 1996, Holliday and Institute 1987, Pearson et al. 1994,). Therefore, due to the relatively innocuous nature of impacts in these early studies, BOEM NEPA documents have

generally concluded that impacts of seismic surveys on planktonic organisms would be non-significant.

Things changed in 2017, however, when investigators from Australia published a study that contradicted the findings of much of the previous work (McCauley et al 2017). The team conducted an *in situ* experiment in the shallow waters near Tasmania, in which they deployed a single airgun over specific track lines. They conducted plankton tows at different distances from the track, both while the airgun was operational, as well as when it was in the water but not operational. They also used a sonar system to observe the movement of plankton throughout the water column.

Results showed a reduction in zooplankton abundance and an increase in mortality after air gun exposure. Fifty-eight percent of the zooplankton taxa counted in the plankton nets had a >50% reduction in abundance between control and exposure, and the median reduction in abundance was 64%. There was a significant increase (2–3 fold) in zooplankton mortality up to 1.2 km distance from the airgun's passage, with the most pronounced effects occurring closest to the airgun. In addition, on the first day, they observed the development of a "hole" in the sonar backscatter 15 minutes after the passage of the airgun, but this effect was not seen on the second day.

The results from this study contrast findings from previous work, which showed impacts on the order of 10s of meters. As a result, it has been taken very seriously by scientists, regulators, and industry; the International Association of Geophysical Contractors (IAGC) and API even sought independent reviews from a team of scientists, which pointed out several flaws. BOEM's review stated that the direct applicability of the findings to BOEM activities on the US OCS is limited, since this work was conducted in very shallow water, which affects the propagation of sound from the airgun. Clearly there is a need for a follow-up study that addresses the experimental flaws and takes place in realistic water depths.

Objectives: To examine potential effects of seismic airguns on zooplankton in water depths that are typical for the US OCS.

Methods: Exact methods are open for discussion, so here I just provide a general framework. A Before-After-Control-Impact design utilizing a real seismic survey vessel would be ideal for this type of project. A team of plankton ecologists would work off of a small boat (or two) to conduct net tows (for plankton) and water grabs (for water chemistry) before and after the passage of the vessel, while tracking the movement of the relevant water mass with drogues and Acoustic Doppler Current Profilers (ADCPs). This process would need to be replicated over at least five days, with sampling occurring at a range of distances from the source (up to 1500m). The drogues would be left in the water for repeated sampling at 2, 4, 6, and 8 hours post-exposure to see if there is a lingering effect (i.e., delayed mortality) of airguns. A similar process would be done for the control, with the seismic vessel running and airguns in the water, but not firing. The purpose is to compare bodies of water with similar water chemistry and similar zooplankton concentrations in order to isolate the effect of firing airguns from natural variability of the water and plankton. It is also important to measure the received sound level at the locations where the plankton are sampled, which could be achieved through

drifting hydrophones or spot measurements near the plankton tows. To determine whether there are any lingering effects, a similar sampling protocol could take place in the same area after a few weeks. This work could also be replicated across seasons to examine any interaction between natural temporal variability in plankton density and the effects of seismic airguns.

Upon retrieval of the net tows, plankton would be stained and examined under the microscope using the same method as in McCauley et al. Plankton that are dead on arrival appear cloudy or opaque, while those that are alive appear more transparent. Since the plankton can be preserved after staining, the microscope work could be done by an independent group, perhaps engaging the help of a high school or undergraduate class. First it would be important to have a plankton expert examine the samples, and compare their results to those of the citizen scientists to ensure accuracy. Furthermore, photos of the microscope images could be made public, so the experiment remains completely transparent and open.

Specific Research Question(s):

1. Does the operation of seismic airguns increase mortality in zooplankton?
    a. Do the effects differ across species?
    b. Does the effect change with distance from the airguns?
    c. Is there a delayed effect observed several hours after the passage of the airguns?
2. Does the operation of seismic airguns change the distribution of zooplankton in the water column?
3. Does the effect of airguns change with water depth, vessel speed, or density of the plankton patch?

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Title	High Resolution Modeling of the Gulf of Mexico
Administered by	Headquarters
BOEM Contact(s)	Jeff Ji, jeff.ji@boem.gov
Procurement Type(s)	Contract, Interagency agreement, Cooperative Agreement
Approx. Cost	$490 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 4, 2018
PICOC Summary	
Problem	High resolution currents in the Gulf of Mexico (GOM) are needed to conduct oil spill risk analysis (OSRA). The accuracy of the current information, in terms of spatial and time resolution, is critical for the accuracy of the OSRA model results. Understanding the importance of ocean model resolution is also pertinent to analyzing the hydrodynamic and environmental processes in the GOM.
Intervention	This study will be conducted using the existing Hybrid Coordinate Ocean Model (HYCOM). The latest information on bathymetry, river inflows, satellite data, and meteorological fields will be incorporated into the HYCOM. The model grid will have a 1/100°-resolution in the GOM.
Comparison	Perform a 20-year data-assimilative hindcast using a 1/100°-resolution HYCOM configuration of the GOM with accurate bathymetry and enhanced vertical resolution compared to the presently available 1/25°-resolution HYCOM hindcast.
Outcome	The output of this study will be directly used in the BOEM OSRA applications. The improved currents will enhance the accuracy of OSRA model results and help us understand the impact of spatial resolution on the performance of OSRA model.
Context	Gulf of Mexico and Caribbean Sea

BOEM Information Need(s): BOEM needs better and more accurate information on currents and eddy activities in the GOM (BOEM, 2014). Results from this study will expand BOEM's ability to assess oil spill risks in the GOM and improve its ability to estimate oil spill trajectories.

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

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

Objectives:

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

2. Examine interactions of the vertical circulation with the subsurface hydrography and horizontal circulation fields with the goal of providing information to inform OSRA regarding the potential lateral displacement and/or subsurface pooling of oil released at depth.

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

4. Deliver the 20-year HYCOM model results to BOEM for OSRA applications in the GOM.
    a. Hourly surface currents and 3-hourly (or less) subsurface currents.
    b. Domain estimated to cover GOM and eastward through the Caribbean.

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

Specific Research Question(s):

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

2. How can the subsurface information from this high resolution modeling be used in BOEM's Oil Spill Risk Analysis?

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

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Title	BOEM Graduate Student Award for Applied Scientific Research
Administered by	Headquarters
BOEM Contact(s)	James Moore, james.moore@boem.gov Rodney Cluck, rodney.cluck@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$25 (in thousands)
Performance Period	FY 2019
Date Revised	February 26, 2018
PICOC Summary	
Problem	BOEM relies on data from its scientific research to inform its policies and permitting actions. There are many types of data and information that would assist BOEM, but scientific research is often constrained by available personnel and resources.
Intervention	A graduate student working toward their Master's or Doctoral degree will be chosen to receive research and tuition funding by BOEM, and the student's thesis or dissertation will be used by the Bureau to make informed management decisions.
Comparison	Data collected from this study will be used to fill one of BOEM's current information needs. The specific research topic will be chosen by BOEM's management and will be based on the immediacy of an information need among the Bureau's research disciplines.
Outcome	The research conducted by the chosen graduate student funding recipient will address one of BOEM's current information needs. In turn, the student will learn how their hypothesis-driven research will be applied toward BOEM's decision making.
Context	The graduate student chosen to receive funding from BOEM will be from an academic institution that is a member of one of the same Cooperative Ecosystem Study Units (CESUs) as BOEM.

BOEM Information Need(s): BOEM needs to enhance its current knowledge of the various natural, socioeconomic, and cultural resources and systems that it stewards. The BOEM Graduate Student Award for Applied Scientific Research will financially support a graduate student who is performing innovative marine science research, allow the use of the student's data to fill a Bureau information need, and demonstrate how scientific results may be applied to inform Federal management decisions.

Background: BOEM relies on the best available data to inform its decisions. These data inform the development of impact assessment documents and also ensure that BOEM adheres to its diverse Federal mandates to protect marine, coastal, and human environments and to preserve natural and cultural resources that may be adversely impacted by its decisions. BOEM supports a variety of scientific research disciplines and continuously seeks innovative methodologies to receive the best available data to

support its policies. The agency also supports the career development of the next generation of marine science researchers. The financial support of a graduate student during their academic career will have the reciprocal value of providing BOEM with needed data to fill a current information need in one of its supported research disciplines and allow the student to learn how their results may be utilized in the agency's decisions for managing energy and mineral resources along the Outer Continental Shelf (OCS). BOEM, however, does not have the authority to issue grants to academic institutions. The BOEM Graduate Student Award for Applied Scientific Research, therefore, will be created as cooperative agreement between the Bureau and an appropriate institution in an affected State in which both entities are members of the same CESU.

Objectives: 1) To receive necessary data to fill current information needs for one of BOEM's research disciplines. 2) To support innovative research methodologies by engaging the next generation of marine scientists.

Methods: BOEM will choose a study topic based on an important information need from one of its supported research disciplines. The Chairs of appropriate departments at academic institutions in which that institution and BOEM are both members of the same CESU will then nominate one graduate student (Master's or Doctoral degree track) to submit a research proposal to BOEM for the academic institution. The proposal must correspond to the research topic indicated by BOEM, and research will be conducted in an area that may be impacted by BOEM's decisions. All received proposals will be evaluated in regards to the student's understanding of how BOEM will apply their data, the scientific integrity of the research methodology, and the cost-effectiveness and innovativeness of the student's overall research design. BOEM will then choose a single student as the recipient of the BOEM Graduate Student Award for Applied Scientific Research in the amount of $25,000.

The total awarded amount is to be transferred solely to the recipient graduate student and is to be used for their respective tuition- and research-related costs. The student, who will be serving as a representative for their respective academic institution, will be required to submit a report to BOEM detailing their research. The report will be submitted within a mutually-agreed timeframe and may be later adapted to serve as a chapter or the complete basis of the student's thesis or dissertation

Specific Research Question(s):

1. To be determined by BOEM based on the information need.

Title	Marine Mammal Bioenergetics Workshop
Administered by	Headquarters
BOEM Contact(s)	James Price, james.price@boem.gov, Kyle Baker, Kyle.Baker@boem.gov
Procurement Type(s)	Interagency agreement
Approx. Cost	$95 (in thousands)
Performance Period	FY 2019–FY 2020
Date Revised	April 30, 2018
PICOC Summary	
Problem	The problem addressed herein is how to practically and consistently assess the possible adverse physiological impacts to marine mammals from disturbances including lost foraging opportunities, energy-consuming avoidance behavior, increased foraging effort, or increases in allostatic loads.
Intervention	This study will convene a workshop of about 40 prominent researchers in bioenergetics to: review the state of information on marine mammal bioenergetics; identify the data gaps and approaches that can be used to fill them; and compare the different approaches to develop robust bioenergetic models. Improved models will facilitate improved impact assessments.
Comparison	There have often been different approaches to assess the net effects of adverse impacts on marine mammals as predicted by bioenergetics models. Filling gaps in the knowledge of model-sensitive parameters and improving the modeling of the relevant physiology, should promote consistency and provide greater rigor in models that better agree with observable effects (to the extent that they can be observed).
Outcome	The workshop will address the state of knowledge of bioenergetics modeling and marine mammal physiology and recommend approaches to make the models more robust. The workshop will also seek consensus among the experts on the basic parameters and assumptions that are employed in the models.
Context	Improved marine mammal bioenergetics modeling is applicable everywhere marine mammals exist (i.e. in all areas of BOEM's responsibility).

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

assessments of possible adverse impacts to marine mammals from BOEM-related activities.

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

Background: The development of the PCAD/PCoD (population consequences of acoustical disturbances / population consequences of disturbances) framework to assess the possible impacts of anthropogenic disturbance on marine mammals has primarily relied on the use of bioenergetic models to estimate the impacts of lost foraging opportunities or the additional energy costs associated with avoidance (Christiansen et al. 2013, New et al. 2013a, New et al. 2013b, Christiansen et al. 2014a, Christiansen et al. 2014b, New et al. 2014, Christiansen and Lusseau 2015, King et al. 2015, Costa et al. 2016a, Costa et al. 2016b, Schwarz et al. 2016, McHuron et al. 2017, Villegas-Amtmann et al. 2017, Farmer et al. 2018). The conceptual framework for a bioenergetics model is based on the concept that a disturbance reduces prey energy intake by a reduction in the time spent foraging, or by increasing the costs associated with foraging or some other activity such as migration, or by an increase in the allostatic load (McEwen and Wingfield 2010). Regardless of how the energy budget is modified, either via a reduction in energy intake or by increased expenditure, the end result is a reduction in energy available for reproduction and/or, in the worst case, survival of the adult (Costa 2012, Costa and Maresh 2017). While the conceptual linkages are well understood, the quality of the data for the various components and/or parameters that go into developing bioenergetics models vary greatly across marine mammals. Not surprisingly, the best data are available from research on pinnipeds with direct measurements made of the cost of reproduction, assimilation efficiency, basal metabolism, thermoregulatory costs and free ranging metabolic rates (Costa and Maresh 2017). However, there are only a few direct measurements of the metabolic components that are required to build a bioenergetics model for small cetaceans, and, for most large cetaceans, the only direct measurements are associated with measurements of body composition of harvested whales (Lockyer 2007). For gray and minke whales, however, metabolic rates were extrapolated from measurements of lung mechanics (Folkow and Blix 1992, Sumich 1994, Sumich and May 2009).

Given the limited availability of direct measurements of the many parameters needed to develop a bioenergetics model, some parameters are estimated from the few data that are available or derived from expert elicitation (King et al. 2015). Furthermore, the experience and background of individuals who are developing bioenergetics models varies considerably, with some individuals having a deep background in metabolic physiology (Costa et al. 2016c, Bejarano et al. 2017, Costa and Maresh 2017), while others are relatively new to the field (New et al. 2013b, Farmer et al. 2018). This results in an uneven implementation of the parameters necessary to populate a bioenergetics model developed on the PCoD framework, which can result in models of quite different quality and predictive capability (Braithwaite et al. 2015, Villegas-Amtmann et al. 2017). Further, there are many assumptions and parameters that go into developing a bioenergetics model. However, not everyone uses the same approaches and, in many cases, are making their best educated guesses based on the available information.

One example of great relevance to BOEM, is the Farmer et al. (2018) study, which developed a stage-specific bioenergetic model for the Gulf of Mexico sperm whales exposed to seismic surveying sound. Their approach, while similar to models developed by others, uses a fundamentally different set of assumptions and approaches. For example, while Villegas et al (2015, 2017) and Pirotta et al. (2018) attempted to estimate field metabolic rates using observations of ventilation rates, the Farmer et al (2018) study used a value of five times the rate predicted for terrestrial mammals of equal size as defined by Kleiber (1975). This value was taken from Lockyer (1981), but that was just a guess. Some support for this number could have been derived from Bejarano et al (2017) who compared three bioenergetic models of prey intake for bottlenose dolphins using three different methods of inferring field metabolic rates. While the Farmer et al. (2018) study developed a model that implemented a much more robust partitioning of the bioenergetic components into fat, carbohydrate, and protein, the other bioenergetic models did not partition. This is exemplary of the current wide range of modeling strategies and model inputs directed at studying the same phenomena.

Trying to tame the situation, a highly successful workshop on bioenergetics modeling was held in 1985 at the sixth biennial conference of the Society for Marine Mammalogy in Vancouver, British Columbia, Canada. The workshop produced a detailed synthesis of the state of the art of marine mammal energetics modeling and the many problems (and successes) therein (Huntley et al. 1987). Much has been learned and accomplished since 1987. However, it is time now to revisit this topic, particularly since there is increased interest in the theory and practical applications of marine mammal bioenergetics and the development of bioenergetics models.

Objectives: The objectives of this study are: (1.) to comprehensively assess the deficiencies in modeling the bioenergetics of marine mammals; (2.) to develop best practices guidelines for improving the models; and (3.) to identify the deficiencies in existing observations needed as model inputs and suggest observational studies to overcome the deficiencies.

Methods: This study will conduct a bioenergetics workshop in FY 2019 to: review the state of information on marine mammal bioenergetics; identify the data gaps and approaches that can be used to fill them; and recommend ways to develop more robust bioenergetic models. The workshop will comprise individuals who are well grounded in marine mammal metabolic physiology along with individuals who have developed, or are developing, bioenergetic models based upon the PCoD framework. A comprehensive review or synthesis article for publication in a peer-reviewed journal and, possibly, a dedicated volume on marine mammal energetics will be produced.

Specific Research Question(s):

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

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

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

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Title	Support for Fifth International Conference on the Effects of Noise on Marine Life
Administered by	Headquarters
BOEM Contact(s)	Stanley Labak, stanley.labak@boem.gov
Procurement Type(s)	Contract, Interagency agreement, Cooperative Agreement
Approx. Cost	$25 (in thousands) *Current policy is a $10,000 sponsorship limit. Previous sponsorship for this conference was $30,000. Asking for $25,000 this time in case ceiling lifts.
Performance Period	FY 2019
Date Revised	February 15, 2018
PICOC Summary	
Problem	BOEM-authorized activities add unwanted noise to the ocean, which can have impacts on a wide variety of marine life. This presents a complex scientific and regulatory challenge to BOEM and its many stakeholders. Gaining access to the best available and most recent scientific information can also be challenging on this issue given its international focus.
Intervention	Gaining an understanding of the latest research and management approaches in this field is key for BOEM to remain a leader in its field and fulfill its mission of safe and responsible energy development. Access to and supporting the sharing of information is central for BOEM to meet this demand.
Comparison	There is no other comparable conference in scope
Outcome	Supporting and attending this one-of-a-kind international conference is critical for BOEM's acoustic team and helps to identify BOEM as a strong participant in the discussion, development, and solutions to the underwater noise issue.
Context	This Conference occurs once every three years, and this time it will be held in The Hague, Netherlands in summer 2019.

BOEM Information Need(s): Anthropogenic noise continues to be a significant environmental concern for BOEM and many of its stakeholders. It is a central issue across all program areas and regions. There is a constant need for BOEM to not only support further research on this topic, but also to gain access to the latest scientific and management information.

Background: This conference occurs every three years, and is the only conference of its kind in the world. The presenters are in the top of their fields and are on the cutting-edge of new technology and research to address these issues. It provides excellent information on scientific progress and regulatory strategies in different jurisdictions, as well as access to domestic/international colleagues and stakeholders highly engaged on this issue. Results may identify specific research needs for BOEM or suggest potential mitigation and management strategies.

Objectives: Support of and participation in this conference allows BOEM to disseminate its own research and management information as well as reinforce its role as a key player on this issue.

Methods: N/A

Specific Research Question(s): N/A

References:

Information from the last conference can be found here: http://www.aquaticnoise2019.org/2016/about_dublin.html

Short summary of 2016 conference: Erbe, C., Sisneros, J., Thomsen, F., Hawkins, A., and Popper, A. (2016). Overview of the Fourth International Conference on the Effects of Noise on Aquatic Life. *Proceedings of Meetings on Acoustics*: 27.

Published book of extended abstracts from the 2013 conference: Popper, A., Hawkins, A. (2016). The Effects of Noise on Aquatic Life II. New York: Springer.

Title	Identification and Characterization of Mini Biological Hotspots Associated With Methane Seeps in the Northern Gulf of Mexico
Administered by	Headquarters
BOEM Contact(s)	Guillermo Auad, Guillermo.Auad@boem.gov Alexis Lugo Fernandez, Alexis.Lugo.Fernandez@boem.gov)
Procurement Type(s)	Competitive Cooperative Agreement
Approx. Cost	$600 (in thousands)
Performance Period	FY 2019–2022
Date Revised	November 1, 2017
PICOC Summary	
Problem	Potential disruption of physical/chemical/biological processes in areas of elevated primary productivity by platform presence.
Intervention	Analyze existing sonar data, gather observations of local productivity to characterize areas with intense bubbling activity.
Comparison	Seep vs. no seep situation b) platform vs. no platform c) seep simulation
Outcome	Identification and characterization of locations where the presence of methane seeps leads to significant higher levels of primary productivity
Context	Northern Gulf of Mexico 200 m to 2000 m

BOEM Information Need(s): BOEM needs to identify areas of high primary productivity. At least chlorophyll, temperature, salinity and sonar data need to be analyzed to identify areas of enhanced primary productivity and therefore consider protective measures to limit or prevent industry activity at those locations.

Background: Areas of methane seeps in the northern Gulf of Mexico are typically 2–4 km in diameter. They emit methane bubbles that generate localized upwelling bringing nutrient-rich, saline, cold waters to higher levels in the water column. D'Souza et al. (2016) showed that one such seep area has about three times the primary productivity than areas without seeps, at subsurface levels (at about 80 m deep). This availability of nutrients enables higher productivity levels and favors secondary productivity.

Objectives: a) Identify number of methane seeps areas from existing sonar data to detect raising bubbles, b) Characterize them in terms of temperature, salinity, size (of plume), rate and regime (constant or intermittent), c) Estimate the contribution of these areas to the total productivity of the same water column and of the northern Gulf of Mexico, d) Based on the findings obtained, identify knowledge gaps and areas for future intervention, e.g., mitigation.

Methods: Use existing sonar data (available at no cost from NOAA) to identify seep locations, and based on these results, test the hypothesis that methane seeps lead to increased productivity. Use existing observational data and gather new observations (if

necessary) to achieve the objectives above, in particular, quantifying productivity levels in high-bubbling areas. Remote sensing and/or *in situ* observations would also be useful. If possible compare productivity levels near platforms that are located near methane seep areas, i.e., bubbling areas.

Specific Research Question(s):

1. How many methane seeps can existing sonar data identify? What is the average productivity associated with each one of these seeps?

2. How productivity levels between seep areas and adjacent areas without seeps compare?

3. Are man-made structures negatively impacting primary productivity levels?

4. What is the added contribution of these mini-hotspots to the overall primary productivity of the northern Gulf of Mexico at the seasonal and annual timescales?

References:

D'Souza, N.A., Subramaniam, A., Juhl, A.R., Hafez, M., Chekalyuk, A., Phan, S., Yan, B., MacDonald, I.R., Weber, S.C. and Montoya, J.P., 2016. Elevated surface chlorophyll associated with natural oil seeps in the Gulf of Mexico. *Nature Geoscience*, *9*(3), pp.215-218.

Title	Incorporating the Seascape Paradigm in Monitoring Marine Ecosystems, a Next Step for the Marine Biodiversity Observation Network (MBON)
Administered by	Headquarters
BOEM Contact(s)	James Price, james.price@boem.gov ; Jonathan Blythe, jonathan.blythe@boem.gov
Procurement Type(s)	Interagency agreement
Approx. Cost	$1,750 (in thousands)
Performance Period	FY 2019–FY2023
Date Revised	May 07, 2018
PICOC Summary	
Problem	The problem addressed herein is how to obtain greater realism in environmental impact assessments. Specifically, how can BOEM move beyond assessing impacts to individual organisms and populations and look more comprehensively (realistically) at environmental impact?
Intervention	Building on the accomplishments of three marine biodiversity demonstration studies, this study will support and enhance a long-term marine ecosystem-scale monitoring effort derived in part from the demonstration projects.
Comparison	Although impact assessments on individuals and populations will continue to be important, much is lost by not also assessing impacts to ecosystems. With observational tools like environmental DNA, satellite-tracked animal tags, satellite remote sensing combined with habitat use models, it has become more practical to observe changes to whole ecosystems with possible adverse impacts from human activities.
Outcome	BOEM will have benefit of long-term monitoring of ecosystem health directly and indirectly through the proxy of biodiversity.
Context	Territorial waters of the United States will be the focus of long-term ecosystem monitoring.

BOEM Information Need(s): Adverse environmental impacts from offshore energy development can be of a transient (acute) nature or persistent (chronic). They can accrue through multiple exposures over extended periods of time subsequently manifesting as cumulative effects. They can be constrained geographically or be wide spread. And, they can be impacting on a few individual organisms or on populations, or they can have chain-reaction effects spreading throughout entire ecosystems. Given the wide range of temporal and spatial exposures and possible adverse consequences, BOEM needs to monitor change in the marine environment as continuously and as widely as is practical to perform the most comprehensive (realistic) environmental impact assessments. This is particularly true in the Arctic, where apparent rapid climate change necessitates being able to differentiate between natural variability and human-caused variability, useful in other areas as well. This study will enhance BOEM's knowledge of ecosystem-scale changes in the marine environment thereby improving BOEM's environmental impact assessments.

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

Background: In 2014, BOEM, together with NASA (Biological Diversity, Earth Science Division), and NOAA (Integrated Ocean Observing System [IOOS] Program Office) initiated three demonstration projects to develop ways (methods and standards) to measure biodiversity across all taxa (microbes to whales) in selected ecosystems (Chukchi Sea, Santa Barbara Channel, and the Monterey Bay and Florida Keys National Marine Sanctuaries). Later, some activities in the Flower Garden Banks National Marine Sanctuary were included. In addition, the projects were tasked to work together to develop general strategies to measure biodiversity across ecosystems and to explore ways to interface with other biodiversity projects nationally and internationally. The projects created an MBON website (http://www.marinebon.org/) to share new developments and to interface with other potential collaborators. In addition, they established an MBON data portal at http://mbon.ioos.us/ (expanded here) for data sharing and easier access to closely related data sets and developed tools for data visualization to serve resource managers, such as the MBON Explorer and Infographics tools (http://mbon.marine.usf.edu/).

The MBON partners are also contributing to the development of a global MBON, working closely with the Group on Earth Observations Biodiversity Observation Network (GEOBON) (http://geobon.org/), the Global Ocean Observing System (GOOS), and the international Ocean Biogeographic Information System (OBIS). These three groups signed a letter of agreement in the fall of 2016 committing to a globally coordinated and sustained ocean observing system (found here).

Additionally, the MBON partners contributed to several other related projects such as coral health research at the Flower Garden Banks sanctuary and the production of a global map delineating ecological marine units (EMUs) as distinct physical environments by the U.S. Geological Survey and the Environmental Systems Research Institute (ESRI) (details can be found here, here, and here).

An underlying motivation for the partnerships mentioned above has been the need to pull together many different kinds of observations to better characterize and more fully understand the functioning of marine ecosystems. Borrowing from the terrestrial concept of landscapes, the new paradigm of seascapes is evolving (Kavanaugh, et al., 2016) and offers a conceptual framework to merge oceanographic dynamics with marine ecology to better characterize and understand marine ecosystems. By combining satellite remote sensing, animal tagging, marine ecosystem models, ship-based measurement, genomic techniques, and advanced autonomous measurements, we now can evaluate distributions, processes, and spatiotemporal patterns of organisms and populations that reflect large variations from plankton to megafauna in mobility, life span, range, and behavior. This multivariate approach has been successful in marine habitat use modeling looking at populations of individual species. Generalizing this approach via the seascapes paradigm offers the prospect of a more detailed and more realistic characterization of marine ecosystems and understanding their underlying dynamics. This in turn will enhance real time monitoring and better adaptive

management of marine ecosystems (i.e. better impact assessments and formulation of mitigation strategies).

Objective: The purpose of this study is to advance ecosystem monitoring / biodiversity observing methods using the seascapes paradigm of merging many multivariate data sets with oceanographic and ecological dynamics. This would include the integration of information about individual species obtained from the Animal Telemetry Network, repeated shipboard or aircraft surveys of presence/absence, passive acoustic monitoring for same, eDNA sampling and analyses, animal tags, etc..

Methods: This study will co-fund one or a few multi-year (likely 3- to 5-year) projects designed to achieve the objective. This will be done through a competitive National Oceanographic Partnership Program (NOPP) process and will be co-funded by the three Federal agencies that initiated the MBON demonstration projects. NASA has committed to fully matching BOEM's funding of $1,750,000 ($350,000 in each of five years), and NOAA has committed $850,000 ($170,000 per year) plus in-kind support via US IOOS and NOAA's Coastwatch program (https://coastwatch.noaa.gov/cw_html/index.html), which will operationally provide NOAA satellite imagery to the funded projects and to the scientific community, including BOEM, afterwards. The Office of Naval Research has committed to provide $50,000 to $100,000 per year for the duration of the project(s). Additional funding will be sought from other interested agencies.

Specific Research Question: Enhancing ecosystem monitoring / biodiversity observing methods using the seascapes paradigm of merging many multivariate data sets with oceanographic and ecological dynamics

References:

Kavanaugh, Maria T., et al., 2016. *Seascapes as a new vernacular for pelagic ocean monitoring, management and conservation*. *ICES Journal of Marine Science*, Volume 73, Issue 7, 1 July 2016, Pages 1839–1850, https://doi.org/10.1093/icesjms/fsw086

Title	Understanding Potential Economic Impacts to Commercial Fishing From Offshore Wind Energy Facility Construction and Operation
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Amy Stillings, amy.stillings@boem.gov Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	TBD: University, Interagency partner, Contractor
Approx. Cost	$500 (in thousands)
Performance Period	FY 2019–2021
Date Revised	February 21, 2018
PICOC Summary	
Problem	Fishermen are concerned that cumulative offshore wind energy development will limit their ability to make a living from the ocean
Intervention	Characterize commercial fishing activity within wind energy leases within the regional context; Describe ability and potential impacts of commercial fishers to fish in alternative locations within the larger fisheries management plan environment
Comparison	Not applicable
Outcome	Understand the cumulative economic impact to fisheries from offshore wind development on the Atlantic OCS
Context	North and Mid-Atlantic

BOEM Information Need(s): Building off previous work by NOAA and others, BOEM needs to develop one or more economic impact models that can evaluate a proposed construction and operation plan (COP) and cumulative impacts. As part of National Environmental Policy Act (NEPA) assessments, BOEM must estimate potential economic impacts of offshore wind development to the commercial fishing industry. This information will be used for leases being developed off the coast of New Jersey, New York, Massachusetts, Maryland, Virginia, Delaware, and Rhode Island, of which at least six COP environmental impact statements will be under way in the next five years. Based on conflicting information provided by the fishing community and offshore wind developers, BOEM needs to improve our understanding of impact producing factors (e.g., fishing gear compatibility, effectiveness of mitigation options).The model(s) will evaluate changes in costs and revenue if vessels adjust fishing locations due to construction and operation of offshore wind facilities within a cumulative impact framework.

Background: BOEM has issued 13 offshore wind energy leases in southern New England and the Mid-Atlantic. Conflicts with fishing is a known challenge when siting leases and though efforts were made to minimize space-use conflicts, fishermen are concerned about potential economic loss to their livelihood (NEFMC, 2016; FSF et al. v Jewell, 2016). National Oceanic and Atmospheric Administration (NOAA) data indicates

that more than $10 million in federally permitted commercial fish revenue may be annually harvested from BOEM leases off the East Coast (Kirkpatrick et al., 2017). Examples of potential models exist for some fisheries undergoing a management strategy evaluation (Kukendall et al., 2017). However, several fisheries that may be impacted by offshore wind development are lacking information that is essential to model development, such as characterization of fishing behavior. Uncertainty still exists regarding potential mitigation options (VA CZM, 2016; MAFMC BMP Workshop, 2014).

BOEM published the results of a NOAA report (Kirkpatrick et al., 2017) that discussed the potential exposure of commercial fishing revenue through creation of a database that combined commercial fishing vessel trip reports and observer data to model the likely spatial location of where fish were harvested and linked that spot on the ocean with the received revenue from seafood dealer reports (DePiper, 2014). NOAA found that fish harvest revenue and potentially affected groups of fishermen (e.g., gear type, ports, target species) varied greatly between lease areas. Rhode Island Department of Environmental Management (RI DEM) has tested an alternative methodology using vessel monitoring systems with similar fisheries characterization results (RI DEM 2017). The next step is to conduct impact modeling to help understand how the identified fisheries, ports, and fishing gear groups might actually be impacted by proposed activities. For instance, studies in the Irish North Sea (Gray et al., 2016) suggest that highly mobile fishing gear, such as bottom trawls, may not be able to fully utilize the area within a wind facility and public comments to BOEM suggest that certain U.S. fisheries (e.g., groundfish) will have limited areas to fish due to closures called for in fishery management plans.

Objectives: Improve BOEM's ability to conduct economic assessments for wind energy development's impact on commercial fisheries through:

- Enhanced understanding of the impact producing factors (e.g., gear compatibility; mitigation) and best practices of how other agencies determine cumulative effects

- Identification of economic impacts under different development scenarios, accounting for fisheries that vary over space and time and variation in underlying assumptions

- An enhanced spatial understanding through better representations of variation in gear, transit and fishery closures given different development scenarios

Methods:

- Review and synthesize information on various approaches to cumulative impact assessment on commercial fishing, with recommendations for incorporation into BOEM's approach cumulative impact assessments on commercial fishing and provide recommendations for incorporation into BOEM documents.
- Assess NOAA's most recent spatial data of commercial fishing revenue and recent Vessel Monitoring System (VMS) data to assess fisheries revenue over space and

time and develop a tool that will allow BOEM to estimate potential economic impacts based on varying assumptions.

- Develop relevant maps of gear-type usage, probable transit routes, and fishery closure information to help assess and communicate the direct and cumulative impacts from offshore wind development.
- Develop models, such as a location-choice model, to understand potential costs and benefits of vessels adjusting fishing locations in response to offshore wind energy development. The model tool should be flexible to allow the modification of input parameters surrounding:
    - Scenarios related to gear compatibility, biomass changes, mitigation options
    - Fisheries, port, gear type, vessel size, and individual permit level
    - Focused at a site-specific COP level and cumulatively
- Conduct workshops with fishing industry and wind energy developers to discuss data generation and mitigation options and vet assumptions and methodology with commercial fishing community.

Specific Research Question: What is the individual and cumulative economic impact of offshore wind energy development on Atlantic commercial fisheries?

References:

DePiper, Geret. June 2014. "Statistically Assessing the Precision of Self-reported VTR Fishing Locations." NOAA Technical Memorandum NOAA Tech Memo NMFS-NE-229. National Marine Fisheries Service. http://www.nefsc.noaa.gov/publications/tm/tm229

Fisheries Survival Fund (FSF) et al. v Jewell, 2016 . Case No. 1:16-cv-02409 (D.D.C)

Gray, M., Stromberg, P-L., Rodmell, D. 2016. 'Changes to fishing practices around the UK as a result of the development of offshore windfarms – Phase 1.' The Crown Estate, 121 pages. ISBN: 978-1-906410-64-3

Kirkpatrick, A.J., S. Benjamin, G.S. DePiper, T. Murphy, S. Steinback, and C. Demarest. 2017. Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic. Volumes I & II. U.S Dept. of the Interior, Bureau of Ocean Energy Management.

Kukendall et al. 2017. Management strategy evaluation for the Atlantic surfclam (Spisula solidissima) using a spatially explicit, vessel-based fisheries model. NOAA Fish. Bull. 115:300–325.

Mid-Atlantic Fishery Management Council Best Management Practices Workshop (MAFMC BMP Workshop). 2014. https://www.boem.gov/MAFMC-Offshore-Wind-Workshop

New England Fishery Management Council (NEFMC). 2016. Letter to James Bennett from Thomas Nies. Re: Comments to the NY Lease Environmental Assessment.

Rhode Island Department of Environmental Management (RI DEM). 2017. Spatiotemporal and Economic Analysis of Vessel Monitoring System Data within Wind Energy Areas in the Greater North Atlantic. http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/RIDEM_VMS_Report_2017.pdf

Virginia Coastal Zone Management Program (VA CZM Program). 2016. Collaborative Fisheries Planning for Virginia's Offshore Wind Energy Area. BOEM, Office of Renewable Energy Programs. OCS Study BOEM 2016-040.

Title	Evaluation of Potential Electromagnetic Field (EMF) Effects on Fish Species of Commercial or Recreational Fishing Importance
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	TBD
Approx. Cost	$300,000
Performance Period	FY 2019–2020
Date Revised	February 23, 2018
PICOC Summary	Write one or two sentences for each of the following elements, as appropriate.
Problem	Fishermen are concerned that EMF from cables may affect coastal fish behavior and the fisherman's ability to catch fish.
Intervention	The study will identify the commercial and recreation fish and evaluate their potential for being impacted by electromagnetic fields. This will include examining studies globally where cables are already present.
Comparison	Comparisons could be made between areas with cables and areas without.
Outcome	The study will address public concerns about the EMF from cables affecting their ability to catch certain fish species.
Context	The study will focus on fish species of importance in the Mid-Atlantic nearshore environment.

BOEM Information Need(s): Offshore wind development includes the use of cables, both interarray and to export electricity from the facility to shore. The cables will emit EMF that may affect sensitive fish species. This study will look at the specific concerns raised by the public about fish species of importance to recreational fishermen (e.g. striped bass, flounder) and their potential interactions with EMF. BOEM will use this information to address the concerns in the relevant sections of EISs prepared to evaluate projects in the Mid-Atlantic.

Background: Offshore wind development requires the use of cables to transport the electricity from the individual turbines to an electrical service platform and from the platform to shore through an export cable. The inter-array cables use alternating current while the export cable may be either alternating or direct current. Even with shielding and burial, these cables can produce both electric and magnetic fields that extend some distance into the water column. BOEM funded a literature review that evaluated the potential for EMF to affect species (Normandeau et al., 2011) that identified elasmobranchs and decapods as having the greatest potential for effect as well as a lack of knowledge about the effects of high voltage direct current cables. BOEM funded several studies to address the interactions of decapods with cables, including the recent study *Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables*

(Hutchison et al., 2018), which updated the literature search of Normandeau et al. 2011. In addition, direct measurements and a review of EMF from cables was conducted in Europe (Thomsen, et al., 2015). This study will address species of specific concern to recreational fishermen and include telemetry data not previously analyzed.

While the effects of EMF are extensively studied, results of these studies are not well communicated to address specific questions raised by the public. In particular, recreational fishermen are not a cohesive group with clear opportunities to communicate. Also, individuals and communities are interested in local species of importance that were not identified as species of significant concern. To address these concerns with the latest science requires identification of the species of interest and evaluation by experts. Clear communication is also needed about existing cables and observed effects or lack of effects.

Objectives: The objective is to evaluate whether EMF impact important recreational fish species.

Methods: Using existing information about electromagnetic fields, existing cables around the world, and key species of interest to recreational fishermen, evaluate the potential effects of EMF on the fisheries. The study may involve identifying local species of interest to recreational fishermen in the Long Island communities, specifically species identified by the New York Department of Environmental Conservation. Communication materials will be developed about EMF, existing cables, and potential for interactions with the identified species of importance. The discussion may extend to known cables that cross major rivers and other observations about fields from bridges. Should a reasonable concern about the potential effects of EMF on key fish species be identified, then a proposed methodology for field work will be included.

Specific Research Question(s): Will EMF from the export cable prevent recreational fishermen along Long Island Sound from catching fish?

References:

Hutchison, Z., P. Sigray, H. He, A.B. Gill, and J. King, 2018. Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-003.

Normandeau, Exponent, Tricas, T and Gill, A. 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study.

Thomsen, F, Gill, AB, Kosecka, M, Andersson, M, Andre, M, Degraer, S, Felegot, T and Wilson, B. 2015. MaRVEN – Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy. Final Study Report. European Commission RTD-KI-NA-27-738-EN-N.

Title	Understanding of Atlantic Sturgeon Migratory Patterns – Integrating Telemetry and Genetics
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	Interagency Agreement
Approx. Cost	$500 (in thousands)
Performance Period	FY 2019–2020
Date Revised	February 23, 2018
PICOC Summary	
Problem	BOEM-authorized projects may impact ESA-listed Atlantic sturgeon. Information regarding the origin of Atlantic sturgeon on the Atlantic OCS will aid in consultations under the ESA.
Intervention	This study would synthesize existing telemetry data with genetic assignments (e.g. Distinct Population Segments and river of origin).
Comparison	Existing data treat all five Distinct Population Segments (DPS) equally.
Outcome	The outcome will be a better understanding of Atlantic sturgeon DPS that may be impacted by BOEM activities.
Context	BOEM has learned a lot about Atlantic sturgeon offshore habitat through investments in telemetry arrays. The next step is to better understand where the sturgeon that are found offshore come from via genetic analysis.

BOEM Information Need(s): This information is necessary for BOEM's Office of Renewable Energy Programs and Marine Minerals Program to meet its obligations under the National Environmental Policy Act, and the Endangered Species Act.BOEM ESA consultations currently assume that BOEM-approved projects affect all five Atlantic sturgeon DPS more or less equally in the marine mixing zone along the entire Atlantic coast. Understanding the genetics of the telemetered fish will enable BOEM and NMFS to better understand the DPS that are actually affected and improve the ESA consultations.

Background: Atlantic Sturgeon are managed as five DPSs but commonly occur in mixed aggregations in the offshore marine environment. The extent of mixing within the five Distinct Population Segments (DPS) within the marine mixing zone is not well understood. The mixing, nor coastal migration patterns cannot be uniform because sturgeon return to the natal spawning rivers at different times (Balazik and Musick 2015). Thus, the impacts of BOEM-authorized projects, such as offshore wind energy development, would be expected to differ among DPSs across space and time. A better understanding of when and where each DPS of Atlantic Sturgeon occurs will allow BOEM and NMFS to characterize, reduce, and mitigate risks based on the status of each DPS rather than all DPSs equally in the marine mixing zone. Since 2015 BOEM has invested in fish telemetry projects from the New York Bight to Virginia with an

emphasis on capturing seasonal offshore migration of Atlantic sturgeon. This effort has yielded a lot of information about seasonal movement of Atlantic sturgeon, but it has only been a partial picture without the genetic assignment. BOEM also entered into an interagency agreement with USGS (NT-15-x12) to develop a genetic library from Atlantic sturgeon obtained as part of BOEM-funded studies. This interagency agreement is now working to pilot the work proposed in this study profile.

Objectives:

- Relate Atlantic sturgeon tissue samples to telemetered sturgeon.
- Assign river of origin based on genetic assignment of telemetered sturgeon.

Methods: This project would use existing acoustic telemetry data compiled for Atlantic Sturgeon from the Atlantic Cooperative Telemetry (ACT) Network and federally-funded projects. Genetic assignment data will be generated by USGS using the latest baseline for the species, leveraging existing genotype data (874 telemetered individuals) and running additional samples (up to 1000 individuals) as necessary. Synthesizing this information, DPS-specific migration maps will be generated showing the seasonal patterns of Atlantic Sturgeon occupancy along the Atlantic coast. Spatial and temporal occurrence data from the telemetry data would be divided by DPS and life history stage. This information would then be compared to the location of proposed offshore wind energy projects to help characterize relative risk of projects to different DPS, life history stage of Atlantic sturgeon.

Specific Research Question(s): What is the relative risk of offshore wind energy projects to various Atlantic sturgeon DPSs and life history stages?

References:

Balazik MT, Musick JA (2015) Dual Annual Spawning Races in Atlantic Sturgeon. PLoS ONE 10(5): e0128234. https://doi.org/10.1371/journal.pone.0128234

Title	Movement Patterns of Fish in Southern New England
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	Interagency agreement with NOAA
Approx. Cost	$1,340 (in thousands)
Performance Period	FY 2019–2022
Date Revised	February 22, 2018
PICOC Summary	
Problem	Need to document distribution of commercially important fish in the area given future wind energy area development.
Intervention	This study would identify important spatial and temporal use of habitat by soniferous fish (e.g. cod, haddock, weakfish, croaker, and black sea bass) in BOEM lease areas. The study could potentially coincide with offshore wind construction activity as well.
Comparison	This initial phase of the study is proposed as a baseline study against which future studies can be compared post construction of offshore wind energy facilities. Depending on timing of construction this study could include comparisons to when construction occurs and post construction.
Outcome	The outcome will be a better understanding of soniferous fish usage of BOEM lease areas, potential change in fish behavior during construction, and further refinement of passive monitoring systems for monitoring fishery resources.
Context	The principal target for the investigation is commercially and recreationally important soniferous fish in the North and Mid-Atlantic Planning Areas.

BOEM Information Need(s): BOEM-permitted renewable energy activities may result in the temporary behavior modification (e.g. displacement, feeding, spawning, communication) of fish due to noise and construction activities as well as the modification of fish habitat from the construction of offshore wind facility foundations and installation of power cables. Studies of fish movement in lease areas can help BOEM identify important habitat over multiple seasons in order for BOEM to understand habitat usage and potential impacts to fish habitat from authorized activities. These assessments are necessary pursuant to obligations under the Outer Continental Shelf Lands Act, the Endangered Species Act, the National Environmental Policy Act, and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: Although other lease areas are not excluded from consideration, the priority area for this study is southern New England. Construction and Operations Plans for projects in southern New England are being submitted in 2018. Southern New England is a very important area for fishing and fish, specifically soniferous fish (e.g. cod, haddock, weakfish, croaker, and black sea bass) . The Atlantic cod is of critical

importance due to its overfished status and need to rebuild the stock. Although there is some information on the fish utilization and fish movement on Cox Ledge, there is still a lot that is not known. This study would help fill information gaps. Whereas there have been four fish telemetry projects awarded in the Mid-Atlantic, there have not been any fish telemetry studies awarded in the important southern New England area where three offshore wind projects are currently being proposed. This information will aid in baseline evaluation and monitoring of construction impacts.

Objectives: The objective of this is to provide baseline information about important commercial fish species in the southern New England area to address potential changes as a result of offshore wind development. Specifically:

- Identify important spatial and temporal use of habitat by soniferous fish (e.g. cod, haddock, weakfish, croaker, and black sea bass) in BOEM lease areas.
- Evaluate efficacy of autonomous vehicles as a real time detection and monitoring tool.

Methods: This study would utilize autonomous underwater vehicles (AUVs) with a hydrophone tuned to acoustically detect soniferous fish in BOEM lease areas continuously (one deployment per month) over an initial 12 month period. The second and third 12-month periods would focus AUV activity over areas identified in the first year of surveys to further resolve spatial and temporal use of biologically active areas. By having the study extend into 2021 there are increased chances that the study will coincide with offshore wind construction activities. This study could be expanded to include an acoustic tagging program, or at a minimum include an acoustic tag receiver in addition to the hydrophone on the AUV to detect previously tagged fish. This would likely benefit information on Atlantic sturgeon which are actively tagged with long-lived transmitters. Very little is known about Atlantic sturgeon use of the Cox Ledge area. Half of the fourth year would be for analyzing and developing a final report.

Specific Research Question(s): This study answers important questions regarding the location and timing of fish aggregations and general movement patterns in BOEM lease areasin order to understand the spatial and temporal resolution of impacts from offshore wind energy construction and operation.

References:

McGuire et al. 2016. Ecosystem Studies of Atlantic Cod Spawning Aggregations in Relation to Fisheries Interactions Using Novel Active and Passive Acoustic Approaches. NOAA Satonstall Kennedy Grant Program Award Number: NA14NMF4270027.

Urazghildiiev, I.R., and Van Parijs, S.M. 2016. Automatic grunt detector and Recognized for Atlantic cod (Gadus morhua). Journal of the Acoustical Society of America, 139(5): 2532-2540.

Title	Atlantic Marine Assessment Program for Protected Species III
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Desray Reeb, desray.reeb@boem.gov
Procurement Type(s)	Interagency agreement
Approx. Cost	$9,000 (in thousands)
Performance Period	FY 2019–2024
Date Revised	February 21, 2018
PICOC Summary	
Problem	Broad-scale and long-term data on protected species in the Atlantic are limited. Collection of these data are essential in order to understand the potential effects of BOEM-related activities on these species relative to long-term climatological changes in the environment..
Intervention	Aerial observations, shipboard observations and oceanographic sampling, telemetry and passive acoustic monitoring can be used to collect ecological data, covering all major species of interest.
Comparison	This study will build upon the 10 years of baseline data collected previously and provide a comparative data set with which to assess the potential effects of changing environmental conditions and BOEM-related activities on offshore species of interest in the Atlantic.
Outcome	To understand and differentiate between the potential effects of changing environmental conditions and BOEM-related activities on offshore species of interest in the Atlantic.
Context	Halifax, Nova Scotia to the southern tip of Florida, from the coastline to the US EEZ.

BOEM Information Need(s): Long-term, broad-scale ecosystem-based studies are needed in order to provide updated scientific information on the status of the Atlantic ecosystem for NEPA and ESA consultations, especially when considering potential impacts from BOEM-related activities.

Background: Atlantic Marine Assessment Program for Protected Species (AMAPPS) was initially conceived as a long-term research and monitoring program, partnering with the US Fish and Wildlife Services, National Marine Fisheries Service and the US Navy. A new potential partner could be Fisheries and Ocean Canada. The first 5-year phase ended in FY2015 and the second phase ends in FY 2019. Data collected in association with AMAPPS I developed a better understanding of the distribution and characteristics of the species of interest in the Atlantic, as well as the Atlantic oceanic environment itself. Strong annual variability was detected in the NE Atlantic (Palka et al., 2017). Moving forward it is imperative to continue this broad-scale ecological data collection, as well as some fine-scale focus on areas and species of interest. These data are needed in order to detect any climatological or other effects on this ecosystem that

may be happening with or without the influence of BOEM-related activities on the Outer Continental Shelf.

Objectives: To collect broad-scale and site-specific ecological data to enable the identification of possible climatological trends and/or potential effects to marine protected species in the US Atlantic, as well as the potential stressors, including the highly endangered North Atlantic right whale.

Methods: Standard line transect surveys from aerial and vessel-based platforms, potentially using drone technology; oceanographic sampling of the water column using standardized techniques; passive acoustic monitoring using appropriate hydrophone recorders, arrays and analytical software. Telemetry tagging and/or suction cup tagging for species of interest.

Specific Research Question(s):

1. What is the trend in environmental variability along the Atlantic?
2. Can changes in species distribution or behavior be attributed to any BOEM-related activities or other factors?
3. A. Where and when are protected species, for example, North Atlantic right whales and sea turtles, detected?
   B. Why are they located in these areas?

References:

Davis, G.E., Baumgartner, M.F., Bonnell, J.M., Bell, J., Berchok, C., Thornton, J.B., Brault, S., Buchanan, G., Charif, R.A., Cholewiak, D., Clark, C.W., Corkeron, P., Delarue, J., Dudzinski, K., Hatch, L., Hildebrand, J., Hodge, L., Klinck, H., Kraus, S., Martin, B., Mellinger, D.K., Moors-Murphy, H., Nieukirk, S., Nowacek, D.P., Parks, S., Read, A.J., Rice, A.N., Risch, D., Širović, A., Soldevilla, M., Stafford, K., Stanistreet, J.E., Summers, E., Todd, S., Warde, A., and Van Parijs, S.M. 2017. Sci Rep. 2017 Oct 18;7(1):13460. doi: 10.1038/s41598-017-13359-3.

Pace, R.M, Corkeron, P.J and Kraus S.D. 2017. State-space mark-recapture estimates reveal a recent decline in abundance of North Atlantic right whales. Ecology and Evolution. DOI: 10.1002/ece3.3406.

Palka, D.L., Chavez-Rosales, S., Josephson, E., Cholewiak, D., Haas, H.L., Garrison, L., Jones, M., Sigourney, D., Waring, G. (retired), Jech, M., Broughton, E., Soldevilla, M., Davis, G., DeAngelis, A., Sasso, C.R., Winton, M.V., Smolowitz, R.J., Fay, G., LaBrecque, E., Leiness, J.B., Warden, D.M., Murray, K. and Orphanides, C. 2017. Atlantic Marine Assessment Program for Protected Species: 2010-2014. US Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. OCS Study BOEM 2017-071. 211 pp.

Title	Hydrodynamic Modeling and Particle Tracking in the U.S. Mid-Atlantic Bight
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Jennifer Draher, jennifer.draher@boem.gov Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$1,000 (in thousands)
Performance Period	FY 2019–2020
Date Revised	January 30, 2018
PICOC Summary	
Problem	Offshore wind construction projects have the potential to alter local and regional physical oceanographic processes
Intervention	Hydrodynamic and particle tracking models will be utilized to assess how the introduction of commercial scale offshore wind energy facilities affect local and regional hydrodynamics under average seasonal conditions.
Comparison	These models will be used to demonstrate oceanographic conditions prior to offshore wind construction, post-installation of a single facility, and post full build-out of all current offshore lease areas, using representative turbine array layouts.
Outcome	To understand the potential and cumulative impacts to physical oceanography and transport processes due to commercial-scale build-out of offshore wind.
Context	Modeling efforts will cover the U.S. Mid-Atlantic Bight, focusing on regions offshore Rhode Island and Massachusetts.

BOEM Information Need(s): BOEM needs to understand potential changes in physical oceanographic processes, both local and regional, that may affect organic and inorganic transport patterns. BOEM also has a need to adequately assess individual and cumulative impacts of offshore wind projects as part of impact assessments pursuant to the National Environmental Policy Act and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: BOEM has issued 13 offshore commercial wind energy leases in southern New England and the Mid-Atlantic. Stakeholders have expressed concerns in regards to the alteration of oceanographic transport patterns in the Mid-Atlantic Bight between Cape Hatteras and Cape Cod as a result of offshore wind construction projects. In order to address these concerns, BOEM needs to be prepared to accurately assess potential changes in hydrodynamic flows resulting from the build-out of one or several 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 (Segtnan and Christakos, 2015) . Less understood are the cumulative impacts of large and multiple projects on regional circulation patterns. This is especially important in relation to how changes in flow may impact the transport of

juvenile fish and larvae to and from habitats used at different life stages and the transport of nutrients and sediments throughout the region.

A previous BOEM-funded study (Chen et al., 2016) examined the potential impacts of a representative wind energy facility offshore southern New England on particle transport during storm conditions using the Finite Volume Community Ocean Model (FVCOM). Since the conclusion of this study, more precise facility layouts have been proposed and interest in potential impacts due to average seasonal conditions and the cumulative impacts of multiple offshore wind facilities have been expressed.

Objectives: To assess how the construction of multiple offshore wind energy facilities in the Mid-Atlantic Bight will affect local and regional hydrodynamics under average seasonal conditions and the resultant impact on circulation and sediment, nutrient, and larval transport. The results from this study will be used to evaluate the need for and the formation of mitigation measures.

Methods: The intent of the proposed study is to build upon knowledge gained during prior studies by refining the analysis methods and expanding on the scope. This study will include a desktop review of existing related studies, particularly those from Europe, that have been released since the completion of BOEM's previous study and a statistical analysis of particles of interest (*i.e.*, larval species and sediment grain sizes). This study will also incorporate average 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 particle tracking. The wind wake model will be used to estimate the change in surface wind velocities for input into a high resolution (est. 10 m resolution in the immediate area of the turbines), three-dimensional ocean circulation model capable of resolving small-scale physical processes throughout the water column. The particle tracking model will be an individual-based model used to release and track particles representing sediment, nutrients, and larvae. The particle tracking model will be capable of representing different particle characteristics such as size, location and timing of release, and location and duration in the water column.

The prospective model domain is an area covering the four current lease areas offshore Rhode Island and Massachusetts, with potential for additional task orders covering the Mid-Atlantic region from New York to North Carolina. The depth range of the model will be limited to 100m or less.

Example scenarios include an initial condition absent any wind energy facilities, a realistic layout of a single project, and a realistic layout of multiple projects. Additional scenarios may include layouts of varying turbine sizes (6–15 MW turbines) 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. Information from the model should also permit an assessment of the susceptibility of sediment in Wind Energy Areas (WEAs) to

resuspension as a result of offshore wind facility construction and operation. Models should be grounded in empirical evidence from the region(s) assessed, such as acoustic Doppler current profiles, wind measurements, and geophysical data including surficial sediment and bathymetry, which should be available from existing partners/projects.

Specific Research Question(s):

1. How do offshore wind energy facilities affect local and regional hydrodynamic processes such as currents and mixing rates in the Mid-Atlantic Bight?
2. What will be the cumulative impacts of a full build-out of all current offshore wind lease areas in the Mid-Atlantic Bight on regional hydrodynamic processes?
3. How will these changes affect the transport of sediment, nutrients, and larvae during average seasonal conditions?

References:

Ole Henrik Segtnan, Konstantinos Christakos, 2015. *Effect of Offshore Windfarm Design on the Vertical Motion of the Ocean.* Energy Procedia, Volume 80, Pages 213–222, ISSN 1876-6102, http://dx.doi.org/10.1016/j.egypro.2015.11.424. (http://www.sciencedirect.com/science/article/pii/S1876610215021566)

Changsheng Chen, R. C. Beardsley, J. Qi and H. Lin, 2016. *Use of Finite-Volume Modeling and the Northeast Coastal Ocean Forecast System in Offshore Wind Energy Resource Planning*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. BOEM 2016-050. 131pp

Title	Integrated Analysis of Marine Wildlife At-Sea Survey and Tracking Data to Inform Planning for Energy Development on the OCS
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger, david.bigger@boem.gov
Procurement Type(s)	Interagency agreement with NOAA possibly USGS
Approx. Cost	$400 (in thousands)
Performance Period	FY 2019–2021
Date Revised	NA
PICOC Summary	
Problem	NEPA analyses require a description of the affected environment. However, integrating the findings of multiple studies into a concise and succinct description of the affected environment can be challenging, especially if the studies used drastically different data collection methodologies (e.g., observer surveys vs. radio telemetry).
Intervention	Quantitatively integrate data from observers and radio telemetry into a common map.
Comparison	Compare integrated results to maps made separately by each method.
Outcome	Higher resolution and more robust species distribution maps; an approach that is repeatable for taxa in other BOEM regions
Context	This study will use existing and readily accessible survey data and telemetry data collected from three species (northern gannet, red-throated loon, and surf scoter) on the Atlantic OCS.

BOEM Information Need(s): BOEM needs species distribution and abundance information to assess the risks of energy development to avian species. BOEM uses information from a combination of sources such as the maps of the relative distribution and abundance of seabirds derived from surveys, telemetry studies, and tracking of seabird movements. Rather than relying on the results from a single methodology, combining results across platforms could reduce uncertainty in species distributions and thus strengthen assessments of the potential impacts of energy development (oil, gas, and renewables) to sensitive seabird species for NEPA analyses and ESA consultations.

Background: BOEM has funded numerous studies in multiple geographic regions to establish baseline information about the distribution of marine species. The types of data collected and analyzed in those studies have generally fallen into one of two categories: at-sea survey data or electronic tracking data. Each of these data types has particular advantages and limitations. At-sea baseline survey data cover large geographic areas that can be targeted through survey design, and have been collected for decades. However, baseline survey data provide only instantaneous counts of animals in the survey locations at the time of the surveys, and the costs and logistics of surveys

limit the number of surveys that can be conducted over time. Electronic tracking data provide continuous information about the movements of individuals over time, and can elucidate information about spatial distribution that is difficult to obtain from a limited number of surveys. However, due to costs and logistics electronic tracking data are often limited to a subset of the population. Although at-sea survey data and tracking data have generally been collected and/or analyzed separately, there are instances where both types of studies are conducted simultaneously and with considerable overlap (e.g., the DOE Mid-Atlantic baseline study and the diving bird study on the Atlantic OCS). Merging these data types using a unified modeling framework will reduce uncertainty and conflicting interpretations of results, and thus ultimately improve BOEM's description of the affected environment and risk assessments. The general approach will be also be expanded to include species data in the Pacific Region on the California coast and/or Hawaii.

Objectives: Improve the distribution and abundance species distribution maps through integration of different data collection methodologies.

Methods: Recent advances in statistical modeling make it possible to integrate telemetry data and observer survey data to density estimates (e.g., Tenan et al., 2017). This study will use a similar approach and apply it to data collected at sea. This study will use existing data to develop the approach.

The data sources will include telemetry data from the BOEM-funded multi-year study of three diving bird species (northern gannet, red-throated loon, and surf scoters) in the Mid-Atlantic where dozens of birds from each species were tagged each year (Spiegel et al., 2017). The observer survey data will come from wildlife surveys conducted on the Mid-Atlantic OCS during the same time period (Williams et al. 2015). This data set has thousands of georeferenced bird observations from aerial and boat based surveys. BOEM is in possession of both data sets. If appropriate, additional observer survey data sets from BOEM-funded studies on the Atlantic may be used, too (e.g. FWS AMAPPs aerial surveys, MassCEC surveys).

Statistical modeling will be used to estimate the spatial distributions using both data types simultaneously while properly accounting for the different characteristics of the two data types (see Tenan et al. 2017). The products will be robust species distribution maps of species distributions built on data from diverse platforms. Additionally, the study will identify minimum data requirements for the approach and potential species (avian, sea turtle, marine mammal, and fish) and datasets by BOEM region for the approach.

Specific Research Question(s):

1. How do we integrate data collected with different methodologies?
2. How integrating data from multiple sources (telemetry and survey data) may improve our ability to identify areas where species are and are not on the OCS.

References:

Spiegel, C. S., Berlin, A. M., Gilbert, A. T., Gray, C. O., Montevecchi, W. A., Stenhouse, I. J., Ford, S. L., Olsen, G. H., Fiely, J. L., Savoy, L., Goodale, M. W., and Burke, C. M. 2017. *Determining fine-scale use and movement patterns of diving bird species in Federal waters of the mid-Atlantic United States using satellite telemetry*. U.S. Department of the Interior, Bureau of Ocean Energy Management, OCS Study BOEM 2017-069. Sterling, VA. 260 pp. https://www.boem.gov/espis/5/5635.pdf

Tenan, S., Pedrini, P., Bragalanti, N., Groff, C., and Sutherland C. 2017. *Data integration for inference about spatial processes: A model-based approach to test and account for data inconsistency*. PLoS ONE 12(10): e0185588. https://doi.org/10.1371/journal.pone.0185588

Williams, K., E. Connelly, S. Johnson, and J. Stenhouse. 2015. Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf (2012-2014). Report by Biodiversity Research Institute. pp 814. https://tethys.pnnl.gov/publications/wildlife-densities-and-habitat-use-across-temporal-and-spatial-scales-mid-atlantic

Title	Workshop to Identify a Scientific Monitoring Framework for Protected Species in Atlantic Wind Energy Areas
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker, kyle.baker@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$60 (in thousands)
Performance Period	FY 2019
Date Revised	February 26, 2018
PICOC Summary	
Problem	The Mid-Atlantic region is expected to undergo considerable offshore wind development over the next decade. Consultations under the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and other permitting processes are poor mechanisms and to develop the complex details needed for offshore energy monitoring plans. Rather, monitoring plans should be developed with stakeholder input prior to regulatory permitting processes that will inform the ESA, MMPA, and NEPA. There is a large amount of uncertainty regarding the environmental impacts of this nascent industry. A framework will need to include continued stakeholder input. Monitoring frameworks and data management systems are needed to evaluate the environmental effects of this new industry on a regional level. The framework will ensure consistency to monitor project-specific impact assumptions that will be identified through existing processes.
Intervention	It is important for BOEM to identify standardized monitoring protocols and data management systems to monitor the effects of offshore wind energy development on highly migratory protected species in the Mid-Atlantic. Thus the framework will identify appropriate project-level and regional monitoring issues that can be consistently implemented through through existing processes such as COPS, NEPA, and ESA/MMPA consultations.
Comparison	A number of studies under BOEM's Environmental Studies Program (e.g., AMAPPS and MassCEC surveys) and other efforts such as acoustic and digital aerial surveys by New York State Energy Research and Development Authority (NYSERDA) provide a large amount of baseline data against which pre- and post-construction comparisons can be made to detect any environmental changes due to offshore wind development.
Outcome	The primary outcome of the workshop to establish the foundations for a monitoring framework for protected species and offshore wind facilities in the Mid-Atlantic region. The framework will build off existing databases, analytical methods, and data management systems that will inform the strategy that may be implemented through regulatory processes to meet BOEM's responsibilities under OCSLA, ESA, MMPA, and NEPA.
Context	Mid-Atlantic (NY to the Carolinas): BOEM held a best management practices workshop in March 2017 to discuss the current science, practices, and management issues surrounding protected species and offshore wind

	development on the North and Mid-Atlantic Outer Continental Shelf (OCS). One of the results from the BMP workshop was lessons learned from coordination from our European partners that a strategic framework that coordinates regional research efforts, standardizes protocols, and addresses both local and regional impacts of concern would have been extremely beneficial so multiple projects can be compared rather than treated independently. The workshop panel also recommended BOEM establish a monitoring framework to provide the necessary guidance to stakeholders. Another result of the BMP workshop is a right whale research workshop planning by MassCEC to address a research framework for baseline whale monitoring off MA. Current efforts will further inform the development of a broader monitoring strategy and data management system as proposed in this workshop for the Mid-Atlantic. The Mid-Atlantic is more important habitat for sea turtles, migratory whales (identified as a cumulative impact of concern for right whales), as well as small cetaceans. A monitoring framework will provide BOEM that necessary information to evaluate project-specific and cumulative level impacts, and directly address the uncertainty regarding habitat impacts and habitat utilization from the numerous projects expected in the Mid-Atlantic OCS Wind Energy Areas.

BOEM Information Need(s): There is limited information on the impacts of offshore wind facilities. Most studies are from European waters and have mostly focused harbor porpoises and seals. There is virtually no information available on the impacts of construction and operation of wind facilities on large whales, sea turtles, and listed species of fish that occur on the Atlantic OCS. There is a significant data gap and high level of uncertainty that needs to be addressed as this new industry develops on the Atlantic OCS. Considering that development of offshore wind in these regions is new and that all impact analyses to date are based on many assumptions and predictions, a critical BOEM information need is to develop the strategic monitoring framework to appropriately test these assumptions so that effective mitigation and adaptive management strategies can be implemented.

Background: In March 2017, BOEM convened a workshop in Silver Spring, MD, on 'Best Management Practices for Atlantic Offshore Wind Facilities and Marine Protected Species' to help determine marine wildlife surveying and monitoring techniques for offshore wind energy siting and construction activities. The workshop included a number of stakeholders and invited panel presentations and discussions. Much useful information was provided and discussed as a precursor for the next steps needed for this proposed workshop. To continue and build off the BMP workshop outcomes, the main purpose of this workshop is to develop that monitoring framework that will coordinate project-specific and regional monitoring and research efforts.

Objectives: A monitoring framework will ensure that controversial issues such as right whales, habitat utilization, and the reef effect on sea turtles and small cetaceans are adequately addressed. A strategy will provide guidance for BOEM and its lessees to meet all environmental monitoring responsibilities. For example, the BMP workshop recommended right whale concerns be addressed, but also identified stocks of bottlenose dolphins, harbor porpoises, and other species such as sea turtles that require further attention in a monitoring strategy. The 2–3 day workshop will result in a report summarizing workshop discussions, findings, conclusions, and recommendations for an

Atlantic Offshore Wind Monitoring Strategy for protected marine species. Identify and assess the most efficient, reliable, and cost-effective means for monitoring the effects of offshore wind development on marine protected species in the North and Mid-Atlantic Outer Continental Shelf (OCS). The objectives include developing a framework for long-term monitoring over the lifetime of offshore wind energy projects.

Methods: Workshop terms of reference may include a review of the March 2017 workshop findings; identifying objectives for approaches and practices most likely to facilitate BOEM fulfilling its mandate and industry carrying out its environmental responsibilities; a winnowing of key ideas into tangible at-sea monitoring and other protocols; and identifying next steps that are practicable to implement a regional strategy for the Atlantic. In as much as there are potential short- (e.g., interannual) (Campbell et al. 2015) and long-term (e.g., decadal) (Silber et al., 2017) shifts in marine species distribution and abundance, 'practices' will need to be sufficiently pliable to allow for the integration of new information and to revise monitoring strategies as needed. Therefore, workshop terms might also seek to specifically incorporate an adaptive management strategy in cooperation with other interested agencies and environmental NGOs to review, update, and identify monitoring priorities annually as new technologies and new information become available.

Specific Research Question(s):

1. What are the priority questions for the effects of offshore wind development for protected species in the North and Mid-Atlantic Wind Energy Areas?
2. What are the current monitoring methods and research questions needed to address priority issues?
3. What are the project oversight mechanisms, data management, and analysis mechanisms (e.g., the National Fish and Wildlife Foundation, Federal memorandum of understanding [MOU], Joint Industry Project, etc.?
4. What are the costs associated with implementing the monitoring strategies?

References:

Campbell, G.S, L. Thomas, K. Whitaker, A.B. Douglas, J. Calambokidis, and J.A. Hildebrand. 2015. Inter-annual and seasonal trends in cetacean distribution, density and abundance off southern California. Deep Sea Research Part II: Topical Studies in Oceanography. 112:143-157. https://doi.org/10.1016/j.dsr2.2014.10.008

Silber, G.K., M.D. Lettrich, P.O. Thomas, J.D. Baker, M. Baumgartner, E.A. Becker, P. Boveng, D.M. Dick, J. Fiechter, J. Forcada, K.A. Forney, R.G. Griffis, J.A. Hare, A.J. Hobday, D. Howell, K.L. Laidre, N. Mantua, L. Quakenbush, J.A. Santora, K.M. Stafford, P. Spenser, C. Stock, W. Sydeman, K. Van Houtan, and R.S. Waples. 2017. Projecting marine mammal distribution in a changing climate. Frontiers in Marine Science. 20 December 2017. https://doi.org/10.3389/fmars.2017.00413

Title	Fish Auditory Thresholds – Part 2 Field Component
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	Interagency agreement with NOAA; Cooperative Agreement
Approx. Cost	$1,000 (in thousands)
Performance Period	FY 2020–2022
Date Revised	February 22, 2018
PICOC Summary	
Problem	This study is principally addressing fisheries resource impacts from offshore wind energy development and thus not only addresses impacts to the fishery resource itself, but on the U.S. private and public sectors that rely on the resource for commercial and recreational use, respectively.
Intervention	This study would evaluate the physical and physiological impact to fish and/or mollusks during construction of an offshore wind energy facility.
Comparison	This second phase project will compare field measurements to lab-based results.
Outcome	The outcome will be a better understanding of the physical, physiological, and behavioral impacts to fish associated with offshore wind construction activity.
Context	The principal target for the investigation is commercially important fish in the North and Mid-Atlantic Planning Areas, principally black sea bass and longfin squid. The percussive action of pile-driving offshore wind foundations has the potential to induce physical or behavior impact to fish. This study will evaluate that potential in a field setting.

BOEM Information Need(s): The information from this study will help in BOEM's environmental assessments under the National Environmental Policy Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

Background: Auditory thresholds for some commercial fish species have been established while for some species such as black sea bass data are lacking. Black sea bass in particular support valuable commercial fisheries in the North, Mid, and South Atlantic Planning Areas. Black sea bass show affinity for certain habitats within the wind energy lease areas and are thus not a temporary resident of these lease areas. In addition, black sea bass produce sounds, such as grunts and thumps, which have been associated with feeding and escape. Commercial and recreational fishermen have expressed concern that noise produced during sub-bottom surveys, pile-driving, and operation of renewable energy facilities may have a negative effect on the behavior of black sea bass ranging from catchability to long-term reproductive success. This species is known to utilize mid-frequency acoustics (100–1000 Hz) which may be used to communicate during spawning and feeding but their sensitivities to anthropogenic sounds such as pile-driving noise, and their behavioral responses to them, is not

understood. Sounds that could lead to Acute orchronic sub-lethal effects may be generated as a result of offshore wind development. Black sea bass could be vulnerable because they are known to use acoustic cues to communicate and because their habitats overlap within renewable energy lease areas. If feasible, other priority species, such as squid, identified in the Normandeau 2012 (BOEM Contract # M11PC00031) may be evaluated. This study is divided into two parts. Part one is a laboratory study awarded as an interagency agreement with the National Oceanic & Atmospheric Administration's (NOAA's) Northeast Fisheries Science Center in 2017 and this profile describes part two, which is the companion field study.

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

Methods: The methodology would be field studies to evaluate behavioral and physiological effects evaluating behavior and habitat use during sound exposure. The exact methodology will be influenced by the results of phase 1 of the study. However, generally the likely methodology could include the following: mesocosm observations, videography, Adaptive Resolution Imaging Sonar (ARIS)/Dual-frequency Identification Sonar (DIDSON) (*e.g.*, ARIS Explorer 1200) monitoring applications, or other appropriate monitoring technologies.

Specific Research Question(s):

1. Does sound generated during offshore wind construction affect important fish species like black sea bass and squid?
2. At what amplitude do pile-driving or other project sounds induce a behavioral response?
3. At what amplitude do these sounds lead to physiological damage to the auditory system?

References:

Normandeau Associates, Inc. 2012. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. A Workshop Report for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 72 pp. plus Appendices.

Hawkins, A. D., and Popper, A. N. A sound approach to assessing the impact of Underwater noise on marine fishes and invertebrates. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsw205.

Title	Southern New England Ichthyoplankton and Juvenile Fish Survey
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	Interagency agreement with NOAA
Approx. Cost	$700 (in thousands)
Performance Period	FY 2020–2021
Date Revised	February 22, 2018
PICOC Summary	
Problem	This study is principally addressing fisheries resource impacts from offshore wind energy development and thus not only addresses impacts to the fishery resource itself, but on the U.S. private sector that relies on the resource for commercial use.
Intervention	This study would identify important spatial and temporal occurrence of larval fish and shellfish in BOEM wind energy lease areas.
Comparison	This initial phase of the study is proposed as a baseline study against which future studies can be compared post construction of offshore wind energy facilities.
Outcome	The outcome will be a better understanding of the movement of the pelagic/larval life stage of important commercial fish species as they move through and/or settle within BOEM lease areas. Information from this study is important to in the context of how ocean currents may change as a result of offshore wind construction.
Context	The principal target for the investigation is commercially important fish and shellfish in the North and Mid-Atlantic Planning Areas, principally Atlantic sea scallop and longfin squid.

BOEM Information Need(s): This information will aid BOEM in characterizing planktonic larvae distribution throughout Southern New England/New York Bight (SNE/NYB) that support valuable commercial fisheries for the purpose of environmental impact assessments of offshore wind energy project operation in order to meet obligations under Outer Continental Shelf Lands Act, the Endangered Species Act, the National Environmental Policy Act, and the Magnuson-Stevens Fishery Conservation and Management Act. The Southern New England/New York Bight area receives scallop larvae transported from Georges Bank and hosts spawning squid (both of high commercial importance), among other fishes at various life stages. It is important to characterize the species that depend on the current flows to reach habitat important for recruitment to the commercial fisheries

Background: BOEM fisheries stakeholders have identified their concerns regarding the potential disruption of larval transport and even larval growth due to the construction and operation of offshore wind facilities. This concern is particularly acute for longfin squid and Atlantic sea scallop in the SNE/NYB area that encompasses 5

renewable energy lease areas between New York and Massachusetts. This would provide critical information on the distribution and habitat use of juvenile and larval fish and shellfish, and how those distributions overlap with renewable energy lease areas.

Objectives: Provide updated information on the seasonal distribution and habitat use of juvenile fish and larvae in SNE/NYB lease areas.

Methods: Cross-shelf bottom trawl surveys would be conducted seasonally for two years. Each station on the transect would collect hydrodynamic, plankton, and juvenile fish information. Additionally, at each of the juvenile trawl transect stations the total biomass of longfin squid eggs will be measured, with subsamples collected for biological analysis. Squid paralarvae (or juveniles), scallop larvae, and other species collected in plankton tows will also be provided for identification and data analysis. Understanding habitat use during the early juvenile stage will also allow for better assessment of anthropogenic impacts on finfish, squid, and scallop across all life stages. Data would be compared to existing survey information collected by the NMFS Northeast Fisheries Science Center.

Specific Research Question(s): This study answers important questions regarding pre-construction cross-shelf movement of pelagic-stage fish. Results of this survey will inform the needs for additional and/or post-construction monitoring requirements.

Title	Monitoring the Behavioral Ecology of Sea Turtles in Ecologically Dynamic North Atlantic Foraging Grounds
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Kyle Baker, kyle.baker@boem.gov
Procurement Type(s)	IA
Approx. Cost	$1,500 (in thousands)
Performance Period	FY 2020–2024
Date Revised	February 26, 2018
PICOC Summary	
Problem	The Mid- and North Atlantic region is predicted to undergo rapidly changing ecological baselines (Barton et al. 2016). It is important to understand the changing baselines in order to effectively monitor potential implications associated with BOEM's renewable energy, conventional energy, and marine minerals activities in the Atlantic region.
Intervention	It is important for BOEM to understand the movements and behavior of sea turtles in the Mid and North Atlantic in relation to ocean conditions. Rapidly changing baselines could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish, etc.) which could ultimately affect the primary foraging areas, movements, and behavior of sea turtles.
Comparison	Data from this study could facilitate a comparison of predicted changes to loggerhead behavior associated with future changing oceanic conditions and dynamics. This information will be compared to the current baseline information and the potential implications of BOEM program activities occurring in the Atlantic.
Outcome	The primary objectives are to examine sea turtle movements and foraging behavior compared to changing baseline conditions in the Mid and North Atlantic regions to improve BOEM assessments, monitoring of the effects of program activities, and cumulative impacts assessment in the Atlantic. This information is important for planning, implementing, and monitoring the effects of BOEM actions in the Atlantic.
Context	The Mid- and North Atlantic. Loggerheads are the most abundant species of sea turtle in the Atlantic and may serve as a sentinel species for environmental change. Loggerheads strongly influenced by temperature regimes, have highly plastic behaviors, and feeding both in the water column and the benthos that are sensitive to ecological changes.

BOEM Information Need(s): BOEM needs to acquire information on sea turtle movements, foraging behaviors, and ocean conditions (e.g., water temperature profiles recorded on diving animals)that can be analyzed to correlate the behavioral ecology of sea turtles to lower trophic and environmental variables (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish, etc.). The information will be used for decision making under the National Environmental Policy Act documents and Endangered Species Act. It will provide needed information

to assess how future ocean conditions and dynamics are influencing the cumulative effects of BOEM activities in the Atlantic.

Background: The water temperature of the Northeast U.S. Shelf is expected to increase far more rapidly than most of the rest of the oceans. Sea turtle behavior and diet change with temperature and prey distribution. Loggerheads are an important and prevalent species in the Atlantic (Winton et al. 2018) and are likely to respond quickly to rapidly changing environmental conditions. A successful loggerhead turtle behavioral ecology program has arisen as a result of survey data collected over the last 7 years associated with the Atlantic Marine Assessment Program for Protected Species (AMAPPS), but effort is limited by competing for vessel resources and time for other focal species. AMAPPS primarily supports aerial and shipboard line transect surveys for sea turtles (and marine mammals). The behavioral ecology program that has arisen is currently sustained by collaborative partnerships that have no secure funding for the continuance of the program.

A long-term data set is needed to monitor baseline changes in sea turtle behavior over a period of predicted changes to ocean conditions. This study would ensure a robust long-term loggerhead behavioral dataset for the dynamically changing baseline in the Atlantic, including the anticipated increase of renewable energy, marine minerals, and conventional energy programs. This study differs from and complements AMAPPS in that the utility of a separate dataset would be extremely important to evaluating behavioral changes that may result from changing ecosystem conditions, and the potential conservation and recovery consequences of those changes on sea turtles. The information is critical to understand the behavioral context of both fine- and broad-scale changes observed in the distribution and abundance of sea turtles.

Partners in the existing sea turtle research include the Northeast Fisheries Science Center (NEFSC), the Southeast Fisheries Science Center (SEFSC), and non-AMAPPS funded collaboration with the Coonamessett Farm Foundation (CFF), Virginia Aquarium & Marine Science Center, Canadian Department of Fisheries and Oceans, and others. This independent collaboration has several successful components including over 150 tags deployed thus far, but continued effort and rigor of the program is not guaranteed.

Objectives: To evaluate behavior of loggerhead sea turtles and opportunistic tagging of other sea turtle species over an extended period of time.

Methods: Sea turtle movements and foraging behavior will be analyzed over broad areas of the Mid and North Atlantic regions through satellite-linked telemetry tags that collect and transmit location, temperature and depth information. Sea Mammal Research Unit tags have been the most successful tags for this type of research with sea turtles, but other tags may also be used. Environmental data in habitat areas can also be analyzed with climate change models and satellite, oceanic data buoys, and baseline surveys conducted collaboratively with the data collection and analysis under AMAPPS.

A five-year program is proposed, with funding at about $300K per year. Behavioral data collected from tagged animals, coupled with ROV data on selected turtles to verify

behavioral activity of tagged sea turtles (Smolowitz et al 2015, Patel et al 2016), are an effective method to monitor behavior of sea turtles over time. Loggerheads will be prioritized because there are thousands of loggerheads in the Greater Atlantic Region, have a greater return on effort, have summer foraging residency, which represents an important component of loggerhead growth and survival. Other species may be opportunistically tagged and monitored. The behavioral data will be maintained in a NMFS maintained Oracle database developed from previous work.

Specific Research Question(s):

1. How do sea turtle movements and foraging behaviors change in response to different ecological conditions within any given year?
2. How do sea turtle movements and foraging behaviors differ between years and changing ecological conditions?
3. How is the ecology of sea turtle migration and foraging habitats changing over time concurrent to trends observed in distribution and abundance?

References:

Barton, A., A. Irwin, Z. Finkel, and C. Stock. 2016. Anthropogenic climate change drives shift and shuffle in North Atlantic phytoplankton communities. Proceedings of the National Academy of Sciences of the United States of America 113(11):2964-2969.

Patel, S., K. Dodge, H. Haas, and R. Smolowitz. 2016. Videography reveals in-water behavior of loggerhead turtles (*Caretta caretta*) at a foraging ground. Frontiers in Marine Science 3:1-11.

Smolowitz, R., Patel, S., Haas, H., and S. Miller. 2015. Using a remotely operated vehicle (ROV) to observe loggerhead sea turtle (*Caretta caretta*) behavior on foraging grounds off the mid-Atlantic United States. J. Exp. Mar. Bio. Ecol. 471:84–91. doi:10.1016/j.jembe.2015.05.016

Winton MV, Fay G, Haas HL, Arendt M and others (2018) Estimating the distribution and relative density of satellite-tagged loggerhead sea turtles using geostatistical mixed effects models. Mar Ecol Prog Ser 586:217-232. https://doi.org/10.3354/meps12396

Title	Predicting Future Seabird Distributions on the Atlantic Outer Continental Shelf (OCS)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	David Bigger, david.bigger@boem.gov
Procurement Type(s)	Interagency agreement with NOAA
Approx. Cost	$400 (in thousands)
Performance Period	FY 2020–2022
Date Revised	2/26/2018
PICOC Summary	
Problem	Seabird distributions may shift within a 70 year lease due to regional changes in oceanographic conditions.
Intervention	This effort would combine naturally predicted changes in oceanographic conditions to predict marine bird range shifts.
Comparison	Current species distributions will be compared to future predicted distributions.
Outcome	Information on shifts in seabird distributions over the next 70 years; and an approach that is repeatable using other taxa and in other BOEM regions.
Context	This study will use existing and readily accessible avian survey and oceanographic data in the Atlantic OCS.

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

Background: To inform cumulative effects analyses for NEPA, information is needed to describe the impacts of past, current, and future activities on a natural resource. BOEM, with its partners, is working to conduct field surveys and use advanced modeling techniques to describe the current distribution and abundance of dozens of seabird species on the OCS. Yet, it is common knowledge that seabird distributions do change regionally over decades (e.g., northern gannets on the Atlantic OCS have shifted more inshore since the 1980's; Viet et al. 2011). BOEM leases for energy development can span many decades (e.g., 30 years for wind energy and up to 70 years [from lease sale to end of production] for oil and gas). During the life of a lease, the distribution of some seabird species may naturally shift into or out of existing or future lease areas. Knowing when and where these natural shifts in species distributions are likely to happen will help inform cumulative effects analyses for NEPA and biological assessments for ESA.

Knowledge of marine bird distributions on the Atlantic OCS is critical to planning, leasing, and environmental assessments related to offshore energy development. Predictive maps of marine bird occurrence and abundance, based on statistical models fit to large observational data syntheses, have proven extremely useful in BOEM's energy planning and assessment efforts on the Atlantic OCS over the past 5 years. To date, modeling of marine bird distributions and abundance on the Atlantic OCS has focused on predicting the long-term average (multi-decadal average) distribution of seabirds based on syntheses of historical and contemporary wildlife survey and environmental/oceanographic data. These "hindcast" models have been very useful for wind energy planning area design.

Objectives: Describe how the distribution of several (6–10) seabird species may shift in or out of existing and potential lease areas within the next 70 years.

Methods: The study will use a similar approach as the methods used to create seasonal distribution and abundance maps of key avian species along the Atlantic (see Winship et al. 2018). These models use a combination of habitat and oceanographic variables and other information to predict the seasonal distribution of almost 50 seabird species on the Atlantic OCS (similar models are being used in other BOEM regions).

Several seabird species will be selected based on the strength of the relationship to oceanographic conditions, conservation status, and their distribution relative to leasing areas. This effort would combine predicted changes in oceanographic conditions to predict marine bird range shifts. The output will be a time series prediction illustrating shifts in seabird distributions over the next 70 years. The timescale matches the predicted timeline of offshore energy development on the OCS. The information products will be specifically tailored to be incorporated into future NEPA analyses of energy development on the Atlantic OCS. The general approach could be expanded to include marine mammals and/or other BOEM regions.

Specific Research Question(s): How do naturally predicted changes in oceanographic and atmospheric variables change the distribution of seabirds on the Atlantic OCS?

References:

Winship, A.J., B.P. Kinlan, T.P. White, J.B. Leirness, and J. Christensen. 2018. *Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning: Final Report*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2018-010. xxx+XXX pp.

Title	A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker, brian.hooker@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$300 (in thousands)
Performance Period	FY 2020–2021
Date Revised	February 23, 2018
PICOC Summary	
Problem	This study is would address the problem of not understanding what acoustically active fish are present in passive acoustic monitoring datasets. .
Intervention	This study would develop an acoustic catalog of fish sound to be used in analyzing passive acoustic data.
Comparison	NA
Outcome	The outcome will be a better understanding of passive acoustic monitoring data.
Context	BOEM currently collects passive acoustic data for a variety of research and monitoring needs. Unfortunately the data is only used for detecting a few marine mammals when it could be used for detecting sound-producing fish as well.

BOEM Information Need(s): BOEM needs to understand potential behavioral, physical, and physiological impacts to fish from offshore wind construction. One means of accomplishing this is by the establishment of a library of fish sounds to allow for analysis of existing submarine acoustic recordings and developing fish-specific acoustic detectors to monitor movement and identify important habitat areas via a non-invasive means. This information in turn will aid in environmental impact during industry activities attempting to maintain National Environmental Policy Act (NEPA) and Magnuson-Stevens Fishery Management Conservation and Management Act compliance.

Background: Ocean passive acoustic recording has primarily focused on marine mammals, due to their broadly protected status. Acoustic recording has been demonstrated to be effective on acoustically monitoring fish populations as well. However, those species of fish that have been identified to produce sounds have not been well documented, and on many long-term marine acoustic recordings, many sounds are recorded that are likely produced by fishes, but the species identity is unclear. As many as 50–70% of the fish species along the U.S. Atlantic coast are potentially capable of producing sounds, but only a small number have been well documented. Fish sounds that emerge during these recordings create clutter when

trying to identify marine mammal sounds, but the lack of species-specific identity limits their utility in terms of understanding the biology of fish populations, as well accounting for their occurrence in whale surveys.

Many fish species produce species-specific acoustic calls in courtship and aggression that are strongly tied to seasonal patterns of movement and reproduction. The ability to remotely monitor changes in their normal behaviors allows them to serve as bioindicators of anthropogenic impacts and environmental changes. Understanding (1) which species of fishes are producing sounds and (2) the time of year that they vocalize, allows for passive recording of fish bioacoustics to serve as a mechanism to detect changes in nearshore marine ecosystems. Fish acoustic behavior is strongly affected by anthropogenic noise, including seismic air guns and ship traffic. Additionally, the frequency range of ship propeller noise overlaps with the fundamental frequency component of many fish sounds, creating a masking effect of fish calls. Once a baseline pattern of fish calling is established, effects of increased ship traffic or ordinance deployment on fish behavior and the environment may be more accurately and efficiently evaluated.

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

Objectives:

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

Methods: A team of fish sound experts would be assembled to survey the research community for which species have been recorded, since many fish species' sounds exist in personal research collections. The list of acoustically active or hypothesized focal Atlantic fish species would be identified, and additional sounds would be captured

through a combination of *in situ* observations or captive recordings in different locations. Recording efforts would focus on known spawning or aggregation sites of different species, and local marine laboratories with appropriate facilities for recording fish in captivity. All sounds would be digitally recorded and maintained in an online data catalog to maintain high quality audio standards. Sounds from different behavioral contexts (spawning, aggression, feeding) would also be collected and identified.

Specific Research Question(s): This study will allow for a deeper evaluation of existing passive acoustic datasets and fine tune acoustic detectors so that specific fish or fish groups can be passively monitored during offshore wind construction and operation.

References:

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

Title	NY Bight Fish, Fisheries, and Sand Features: Improving Knowledge of Demersal and Benthic Organisms' Habitat Use, Impacts of Dredging, and Time Series of Recovery of Regional Offshore Sand Sources
Administered by	Marine Minerals Program
BOEM Contact(s)	Deena Hansen (Deena.Hansen@boem.gov)
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement (TBD)
Approx. Cost	$175 (in thousands)
Performance Period	FY 2019–2021
Date Revised	March 2, 2018
PICOC Summary	
Problem	The benthic environment in the NY Bight, both physical and biological features, will be potentially affected by future dredging activities (expected in the near future); this in turn will affect fishermen if landings are impacted.
Intervention	If we better understand the environmental setting, we can improve our NEPA analyses of impacts, as well as consultations that recommend mitigations. Collecting data before dredge events also provides a baseline with which to compare post-dredging data.
Comparison	This study leverages previous efforts by reviewing and compiling data sources, and identifying gaps in knowledge.
Outcome	We expect to identify existing data and needs of the NY Bight ecosystem, including sand features, benthic infauna, fish composition, and fisheries dependence across seasons and years, to inform future field efforts.
Context	The study area would include potential sand resource areas under BOEM's jurisdiction (i.e., >3 nm from shore) but no more than 50 m deep off of NY and NJ in the NY Bight.

BOEM Information Need(s): Better understanding of demersal and benthic organisms' use of habitats and sand features in the Mid-Atlantic is important for BOEM's Marine Minerals Program (MMP) to inform and evaluate the use of potential sand borrow areas in Federal waters. BOEM anticipates that multiple sites may be accessed in Federal waters of the New York Bight (NYB; waters off of New Jersey and New York), in part to address the Army Corps of Engineer's projected sand deficiency for completing vital Federally authorized shore protection projects in the next 5 years. BOEM's current cooperative agreements with New York and New Jersey have gathered data on sand resources and resulted in delineations of potential borrow areas offshore in the NYB. Since dredging on the NYB OCS has been infrequent relative to other regions, research on biological activity, biophysical coupling, and geomorphology will complement the geophysical and geotechnical data, and strengthen NEPA analyses that consider the potential effects of dredging.

Background: Limited information exists on the ecological function and biological significance of sand waves, ridges, swales, shoals, and other OCS features in the New

Jersey and NYB, especially as it relates to dredge-related disruptions. Dredging activities under BOEM's jurisdiction generally occurs from 3 to 9 nautical miles (nm) from shore. The NYB is inhabited by a diverse community of fishes and invertebrates, with both resident and transient species. Many of these species are economically important to commercial, recreational, and charter fishing industries. Additionally, strong seasonal fluctuations in abiotic factors are often linked to changes in biological diversity. Therefore the potential effects and recovery of sand dredging on ecosystem health and the abundance of fish and invertebrate communities may vary spatially and temporally. This research also aligns with State and regional research priorities that aim to identify and assess offshore sand resources, and improve sediment resource management strategies.

Objectives: Goals include identifying and obtaining baseline data on the seafloor morphology, seabed and substrate sedimentary texture, and the diversity and abundance of demersal and benthic organisms which rely on sand habitats, specifically around potential sand resources off the NYB, from 3–9 nm offshore. The study should review all studies and data collection efforts focused on biological activity and succession in these areas. The results of this effort should then be leveraged for any future studies to highlight issues and inform methodology.

Specific objectives include reviewing studies focused on invertebrates, especially ecologically and economically significant shellfish, both demersal and pelagic fish species, and the presence of basal autotrophs. Of interest is data on species abundance, size composition, and distribution across the spatial continuum from the air-sea interface to the sea-sediment interface, in order to understand mesoscale and microscale habitat use, species assemblages, biodiversity, and habitat associations. Data collected through time should be identified, so that seasonal changes might be observed. Finally, gaps in knowledge and recommendations for study prioritization should be included.

Methods: Region-specific studies and dataset should be reviewed for relevance and availability. Datasets of interest include multibeam or sidescan backscatter geophysical surveys that monitor seafloor morphology and characterize benthic substrate; biological data from grab samples, clam dredges, and trawl surveys; vibracore data of substrate; water column profiles that measured current flow and direction and water chemistry (e.g., temperature, salinity, pH, dissolved oxygen, turbidity, chlorophyll); direct observations from video cameras or remotely operated vehicles; acoustic surveys; and tagging.

Once this data is identified (and compiled, when available), the review will also note knowledge gaps and needs to inform potential follow-on field efforts.

Specific Research Question(s): What are the specific research questions this study proposes to address? If there is more than one question, use a numbered list.

1. How can BOEM best assess cumulative effects within the framework of environmental assessments?

2. What is the effect of habitat or landscape alteration from BOEM-regulated activities on ecological and cultural resources?
3. How will future ocean conditions and dynamics amplify or mask effects of BOEM-regulated OCS activities?
4. What affected resources, measures, and systems are best used for long-term monitoring?

Title	Fine-scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico
Administered by	Marine Minerals Program
BOEM Contact(s)	Jessica Mallindine, jessica.mallindine@boem.gov
Procurement Type(s)	Interagency Agreement
Approx. Cost	$500 (in thousands)
Performance Period	FY 2019–2021
Date Revised	January 29, 2018
PICOC Summary	
Problem	Fine-scale information pertaining to sea turtle behavior in the Gulf Mexico is lacking. These data are needed to inform site-specific management decisions.
Intervention	Acceleration data loggers (ADL) will be embedded with a depth-logging satellite tag and very high frequency (VHF) transmitter. This package will be placed on sea turtles at select locations within the Gulf of Mexico and will provide fine-scale behavior data at various portions of the water column.
Comparison	1) Fine-scale data vs. course depth data collection, 2) Utilization of new ADL technology, 3) Behavior comparisons among seasons 4) Geographic/Habitat-based differences in behavior.
Outcome	This project will provide fine-scale dive analyses to inform in-water aggregations of subadult, juvenile, and adult marine turtles in the Gulf of Mexico. Fine-scale movement and habitat use patterns will directly inform BOEM on management strategies throughout its programs and support other ongoing BOEM studies.
Context	Gulf of Mexico OCS and adjacent coastal waters

BOEM Information Need(s): Fine-scale information on dive profiles and activity patterns is lacking for sea turtles in Gulf of Mexico waters. BOEM needs detailed information on dive profiles and behavior of turtles in the water column, and availability correction factors for species abundance estimation. Combining fine-scale dive information with genetic analyses, population demographics, health and foraging studies will allow BOEM to address information gaps as identified through National Environmental Policy Act (NEPA) and Endangered Species Act (ESA) Section 7 consultations. These data would be used to inform management decisions related to Protected Species monitoring, decommissioning activities, and significant sediment resource extraction operations particularly in relation to assessing dredging entrainment risk and sea turtle relocation trawling mitigations. This study will be conducted in collaboration with US Geological Survey (USGS) as they possess the expertise and permits required from NMFS to collect biological samples and tag turtles.

Background: Deployment of satellite tags capable of logging dive data on turtles captured in sea turtle relocation trawling projects is currently underway (BOEM/USGS

Interagency Agreement M15PG00032). The current BOEM/USGS project is collecting a robust data set on habitat-use and dive profiles of both immature and mature endangered Kemp's ridleys and threatened loggerheads of both sexes. However, there is a need to go beyond the relatively coarse depth-bin data summaries provided by satellite tags and calculate fine-scale dive profiles and activity budgets especially at the sites of dredging operations, which pose risk to sea turtles through entrainment by hopper dredges. Despite the impressive body of research available on sea turtle movements, there is still little known about their fine-scale activities and behavior that would inform the efficacy of trawling mitigations and assess the potential risk of lethal entrainment during dredging operations. ADLs can provide such fine-scale data, either directly from turtles upon recapture or by affixing a pop-off 'package' that can be retrieved at-sea after a defined period of time on the animal. In particular, ADLs provide a means for assessing turtle behavior at a much finer scale than dive data alone allowing scientists to empirically measure body movements and orientation. Acceleration data are especially informative when viewed in the context of other ADL-recorded data (depth and temperature) as well as locational data from simultaneously attached satellite tags. Depth-logging satellite tags can provide precise location data on individual movements and use of various portions of the water column. However, ADLs provide a means for assessing turtle behavior at a much finer scale than dive data alone, specifically allowing scientists to empirically measure body movements and orientation.

Objectives: Expand upon ongoing research leveraging sea turtle relocation trawling associated with hopper dredge operations and site-specific contracted trawl operations to tag sea turtles. Data collected will provide fine-scale diving information to inform management decisions related to trawling and hopper dredge operations, particularly when evaluating dredge entrainment risk. The results would link three BOEM projects by providing detailed information on dive profiles and behavior of turtles within the water column as well as establish aerial correction factors (ACFs) to support other BOEM information needs (e.g., GOMMAPPS).

Methods: Once a sea turtle is captured during trawling, a satellite tag and ADL packages will be deployed and set to record triaxial acceleration at 30 Hz, depth at 1 Hz, and temperature at 0.033 Hz. ADLs will be paired with VHF transmitters and Smart Position and Temperature tags. These tags would be secured in a hydrodynamic, custom-made syntactic foam float. The ADL package will be secured to a nylon mesh base using monofilament or plastic cable ties and a galvanic timed release. After a set period of time, the galvanic release will dissolve in seawater, releasing the ADL package and allowing it to float to the surface for recovery. Released tags will be detected using a hand-held VHF receiver and a PTT-finder, and then retrieved by vessel. These high resolution data can be used to identify and quantify specific behaviors using fast-Fourier transforms, wavelet-analysis, and k-means clustering techniques.

Specific Research Question(s): This project will answer questions related to: (1) In-water aggregations of subadult, juvenile and adult marine turtles; (2) Determine fine-scale movement and habitat use within the Northern Gulf of Mexico; (3) Provide supporting data and analysis for other ongoing BOEM studies.

Title	Sediment Evolution Following Beach Fill Construction: A Literature Review and Technical Workshop
Administered by	Marine Minerals Program
BOEM Contact(s)	Doug Piatkowski, douglas.piatkowski@boem.gov
Procurement Type(s)	Competitive Cooperative Agreement
Approx. Cost	$250 (in thousands)
Performance Period	FY 2019–2020
Date Revised	January 29, 2018
PICOC Summary	
Problem	Where, how, and when is sediment moving during and following beach construction compared to natural conditions (including storm events) and how does this movement relate to valued habitat and sediment best management practices.
Intervention	In collaboration with partner agencies, develop a concept plan that identifies and prioritizes the key questions, appropriate data collection methods, numerical modeling, etc. to address this complex problem on a regional scale
Comparison	This study will consist of a literature and data synthesis and technical workshop that will promote collaboration and inform the construct of future field work initiatives
Outcome	A concept plan coordinated with national and regional planning groups to leverage multi-agency resources to holistically address the identified problem within a regional context
Context	Atlantic and GOM OCS and adjacent coasts

BOEM Information Need(s): The Bureau of Ocean Energy Management (BOEM) needs to better understand the dynamics of sediment dredged from the Outer Continental Shelf (OCS) and placed on beaches along the Gulf of Mexico and Atlantic coasts to inform future decisions related to noncompetitive negotiated agreements (NNA) and support prudent management of the resource. This information will inform BOEM's environmental compliance responsibilities by helping to discern effects of beach fill sediments on adjacent habitat compared to an unnourished system. This information is needed to support ongoing Endangered Species Act Section 7 consultations (*e.g.*, protected coral species, green sea turtles, piping plovers) and will inform future project design specifications and mitigations. This information will also support the stewardship responsibility of the Marine Minerals Program (MMP) by optimizing use of OCS sediment, a valuable economic resource for coastal infrastructure and habitat restoration projects.

Background: BOEM's MMP science strategy is centered around responsible management and stewardship of finite sediment resources on the OCS. To date, BOEM has conveyed over 145 million cubic yards (MCY) of sediment on Gulf and Atlantic coast beaches; however, its long-term fate is not clear. Understanding sediment dispersal

pathways following construction is a complex question that has been raised by multiple stakeholders to inform future coastal management decisions. However, a collaborative and comprehensive strategy has not yet been identified for how to best address this need.

To date, the Florida Department of Environmental Protection (FDEP) and other State and Federal agencies have been formulating biological monitoring and mitigation requirements based on an engineering calculation to estimate the project's "Equilibration Toe of Fill" (ETOF) (Kosmynin et. al., 2016). ETOF is an empirically based calculated distance, incorporating local wave climate and sediment textural properties, to estimate the cross-shore project "footprint" and to quantify impacts to adjacent habitat. For project planning purposes it is currently assumed that habitat located inshore of the ETOF is negatively impacted due to direct burial or sedimentation impacts. However, the efficacy of using ETOF for quantifying impacts has been questioned by coastal managers.

A comprehensive analysis of sediment transport processes using empirical data collection (*e.g.*, geophysical surveys, geochemical tracers, sediment particle tracers) and numerical modeling is required to fill critical data gaps and answer the questions: "Where, how, and when is sediment moving following beach fill construction compared to natural conditions (including storm events) and how does this movement relate to valued habitat." However, robust field initiatives to appropriately study these questions are significant, costly, and require extensive collaboration to leverage data. Multi-agency collaboration is needed to develop a concept plan that identifies and prioritizes the key questions, appropriate field sampling methods, numerical modeling, *etc.* to address this complex problem. This study will build upon and leverage data from previously completed and ongoing BOEM study investments (*i.e.*, borrow area optimization [NT-15-03], sediment sorting [NT-15-05], *etc.*), and will inform short- and long-term MMP planning decisions.

Objectives: This study aims to develop a concept plan for how to:

1. Study nearshore sediment transport rates, processes, and inferred transport pathways
2. Monitor movement of sediment size fractions relative to metocean conditions
3. Collect empirical data for model calibration and/or validation

This concept plan will be shared with national and regional planning groups (*i.e.*, National Oceanographic Partnership Program [NOPP], Gulf of Mexico Alliance, *etc.*) to leverage multi-agency funds for future field work initiatives to: (1) gather empirical datasets to aid calibration and validation of predictive sediment transport models, (2) improve predictions on sediment budgets, (3) identify sources and sinks as well as the magnitude, and (4) rates and processes of overall sediment dynamics.

Methods: Supporting information relevant to the stated research questions will be gathered and synthesized from current BOEM documents and other ongoing research performed by external stakeholders. Following the literature and data synthesis, key stakeholders and technical experts will be identified to participate in a technical

workshop. The goals of the technical workshop will be to: (1) document existing state of knowledge and available information from the synthesis and solicit input from technical stakeholders; (2) determine key parameters that should be measured, monitored, and/or quantified for input to and validation of numerical models and to inform conceptual models; (3) select appropriate numerical and statistical models and determine data inputs needed for those models; and (4) develop a concept plan and identify/leverage existing project data where parameters have been or will be measured.

Specific Research Question(s): How does the addition of new sediment and altered shoreface geometry affect natural sediment dynamics and dispersal processes relative to adjacent habitat and over what period of time?

References:

Kosmynin, V., L. Edwards, J. Peterson, and B. Biggs. 2016. Standard Operation Procedures for Nearshore Hardbottom Monitoring of Beach Nourishment Projects. Florida Department of Environmental Protection, Division of Water Resource Management.

Managing Dredging Impacts by Optimizing the Use of Sand Resources: https://marinecadastre.gov/espis/#/search/study/100097

Sediment Sorting During Coastal Restoration Projects: Implications for Resource Management, Environmental Impacts, and Multiple Use Conflicts: https://marinecadastre.gov/espis/#/search/study/100165

Title	Impacts of Sedimentation and Drivers of Variability in the Boulder Patch Community, Beaufort Sea
Administered by	Alaska OCS Region
BOEM Contact(s)	Lorena Edenfield, lorena.edenfield@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$750 (in thousands)
Performance Period	FY 2019–2022
Date Revised	May 10, 2018
PICOC Summary	
Problem	The Boulder Patch provides complex and unique habitat and supports high biodiversity in an area of considerable oil and gas interest, which includes the proposed construction of Liberty Island (less than half a mile away). Impacts of industry activity may smother/bury/kill productive biological area, but mitigation measures may be possible.
Intervention	This study will conduct a monitoring program to examine long-term drivers of community variability during Liberty development activities. In addition, it will test possible mitigation measures using common industry materials to "reseed" or replace habitat lost due to Liberty Island development activities.
Comparison	The post-development community structure will be compared against historic data to assess impacts of oil and gas (O&G) activity. Further, artificial substrate will be compared to buried boulders to test efficacy of using industry materials to mitigate development impacts.
Outcome	Results will include defined spatial gradients and temporal trends in environmental conditions, benthic community structure, and kelp production in the Boulder Patch community; evaluation of the effect of sediments on Boulder Patch community; and assessment of test artificial substrates as possible habitat mitigation.
Context	Liberty Development and Production Island construction, Beaufort Sea

BOEM Information Need(s): Impacts to the Boulder Patch from proposed gravel island construction were identified by local communities as a concern during scoping for Liberty Island. Information about how development activities and other disturbances affect Boulder Patch organisms will inform potential future NEPA and Essential Fish Habitat (EFH) analyses for island construction in the Beaufort Sea. Potential mitigation measures will be explored, and may be incorporated in future analyses.

Background: The Boulder Patch, which is located close to the proposed Liberty Development Project (less than a half a mile away), is an area of hard bottom substrate uncommon to the region. Its high biodiversity supports tightly linked food webs, and connects to higher trophic levels such as fishes, seals, and polar bears. It is highly vulnerable to both natural and anthropogenic disturbances. Spatial isolation of boulder fields and slow development of benthic communities limits ecosystem recovery from

disturbances. Previous BOEM-sponsored studies have shown that recovery in this area from disturbances can take a decade or more to resolve (Konar 2007 and 2013). Resiliency to anthropogenic disturbances is unknown, yet critically important to understand in maintaining ecological integrity. Sediment collecting on the hard bottom rocky habitat could slow community recovery even more through burial and smothering rather than whole organism removal, as the hard substrate would no longer be available to colonizers. This proposed study builds on previous work and provides an opportunity to assess possible ecological effects of environmental disturbances before and during the construction of a gravel island. Future lease sales in the Beaufort Sea are expected. This study provides invaluable information about impacts of gravel island construction on complex, specialized habitat and will assess potential mitigation measures.

Objectives:

- Define spatial gradients and temporal trends in environmental conditions, benthic community structure, and kelp production in the Boulder Patch community
- Evaluate the effect of sediments and nearby island construction on Boulder Patch community
- Test artificial substrates as possible habitat mitigation.

Methods: Monitoring of Boulder Patch habitat will occur before and during Liberty Island construction. Biological and physical data collected will include: kelp production, salinity, depth, temperature, depth, pH, irradiance, turbidity, fish and invertebrate presence, and stable isotopic trophic structure. Data collected during island construction can be contrasted with historic data. Artificial colonization substrates will be assessed and compared to existing Boulder Patch habitat using typical island materials. Recolonization will be assessed from settling plate experiments and reciprocal transplant manipulations of cobbles.

Specific Research Question(s):

1. What physical and chemical factors affect spatial distribution and abundance of kelp in the Boulder Patch?
2. What are the production and community composition responses of kelp in the Boulder Patch to year-round variations in light availability and oceanographic conditions?
3. How do invertebrate and fish use of under ice habitat in the Boulder Patch vary over time?
4. What is the effect of sedimentation on resilience and the abundance and distribution of Boulder Patch biota under winter and summer conditions?
5. What are potential mitigation and monitoring methods to minimize lost Boulder Patch habitat through replacement or substitute substrates?

References:

Konar, B., 2007. Recolonization of a high latitude hard-bottom nearshore community. Polar Biology 30.5: 663-667.

Konar, B., 2013. Lack of recovery from disturbance in high-arctic boulder communities. Polar Biology 36.8: 1205-1214.

Title	Landfast Ice in the Beaufort and Chukchi Seas
Administered by	Alaska OCS Region
BOEM Contact(s)	Warren Horowitz, warren.horowitz@boem.gov
Procurement Type(s)	Contract, Interagency agreement, Cooperative Agreement
Approx. Cost	$1,700 (in thousands)
Performance Period	FY 2019–2023
Date Revised	May 2, 2018
PICOC Summary	
Problem	Landfast ice is used as a platform for subsistence hunting and potentially for wintertime activities related to oil and gas exploration and development in the Beaufort Sea and Chukchi Sea. Understanding of the extent, stability, and seasonality of landfast ice is important for its safe use, but available data is quite old and conditions have been changing rapidly in recent years. Updated information about landfast ice extent and duration is also needed to validate coupled ice-ocean models used in BOEM's Oil Spill Risk Analysis (OSRA).
Intervention	This study will analyze landfast ice data interpreted by the National Weather Service (NWS) for the U.S. Arctic and produce improved estimates of minimum, mean, and maximum extents over time. Contributions of physical forcing mechanisms to changes in landfast ice will also be evaluated.
Comparison	The results will document changes in landfast ice cover over time.
Outcome	The analysis will document the role of physical forcing mechanisms on landfast ice extent and duration, offer information for validation of coupled ice-ocean circulation models, and improve understanding of the existing environment to support National Environmental Policy Act (NEPA) analyses.
Context	Beaufort Sea, Chukchi Sea

BOEM Information Need(s): Improved understanding of changes in landfast ice extent and stability is needed to provide context for interpretation of changing subsistence patterns and inform reviews and decision making regarding oil and gas exploration and development plans involving on-ice activities. In addition, BOEM needs information about under ice circulation, including the influence of local freshwater river discharges, and the extent of landfast ice over time to validate coupled ice-ocean circulation models used to support OSRA.

Background: Offshore landfast ice can be used as a platform during potential winter oil and gas exploration or development, as well as subsistence activities. Ongoing environmental change in the Arctic has altered the extent, stability, and seasonality of the landfast ice along the U.S. Arctic coast and updated information is needed to facilitate planning and ensure the safety of on-ice activities. The monthly minimum, mean, and maximum landfast ice extents along the Beaufort Sea coast were last quantified by Mahoney et al. (2012), but these data were collected up to 2008 and are more than 10 years old. Landfast ice extent is interpreted by the National Ice Center on

a weekly basis (U.S. National Ice Center, 2018), whereas the NWS Alaska Sea Ice Program (ASIP) interprets landfast ice extent on the shelf areas surrounding Alaska on a daily basis (National Weather Service, 2018). The higher spatial and temporal resolution of these products will provide better understanding of ice stability and how storms and other physical processes influence landfast ice extent.

Documentation of the extent of landfast ice will also support validation of results from coupled ice-ocean circulation models used to support trajectory analyses for OSRA. In the Arctic, the oil spill trajectory analysis must adequately represent how the movement of oil would be influenced by the presence of fixed, landfast ice.

Previous work by Weingartner and Kasper (2011) used idealized analytical and numerical models to examine the effects of spatially variable landfast ice cover on under ice circulation. The results demonstrate that circulation under landfast ice cover is profoundly different from ice-free shelf circulation. Buoyancy forced experiments also showed that a landfast ice cover alters the behavior of a buoyant plume considerably, spreading it further offshore than in the ice-free scenario. A recent publication by Weingartner et al. (2017) found similar results in their analysis of observations collected between 1999 and 2006 in Stefansson Sound. Results from this new study will provide additional context to these findings.

Objectives:

- Assess and document the landfast ice extent in the Beaufort Sea and Chukchi Sea at a higher temporal resolution and determine how it has changed over time.
- Evaluate how changes in landfast ice relate to local and regional changes in temperature, pressure, and major storms, as well as to global climate shifts.

Methods: Researchers will compile a time series of landfast ice data for the Beaufort Sea and Chukchi Sea from interpreted sea ice data available from the NWS ASIP from 2008 through 2022. Results will be analyzed to produce a climatology that includes daily, weekly, monthly minimum, mean, and maximum landfast ice extent and to evaluate the changes in landfast ice over time. Researchers will compile and evaluate available hydrographic data and other physical data, including freshwater river discharge, on the central Beaufort Sea shelf. These data will be supplemented with additional moorings (est. 4–5) that will collect temperature, salinity, ice thickness, and ice velocities, mostly beneath the landfast portion of the sea ice. Researchers will use these data to examine the physical forces that drive changes in seasonal and interannual landfast ice extents, including large breakout events. Local and traditional knowledge from coastal communities along the Chukchi Sea also will be considered when identifying conditions associated with freeze-up, formation of landfast ice, and major breakouts linked to storm events.

Specific Research Question(s):

1. How has landfast ice extent in the Beaufort Sea and Chukchi Sea changed over time?

2. How has the stability and seasonal duration of landfast ice in the U.S. Arctic been altered in recent decades and what can be inferred about its use as a platform for on-ice activities, including subsistence hunting and oil and gas exploration and development?
3. How is landfast ice affected by physical forcings, including the winter and springtime under ice circulation in the central Beaufort Sea, freshwater discharges from rivers in the area, variations in hydrography, and storms? Is this relationship changing over time?

References:

Mahoney, A., Eicken, H., Shapiro, L., Gens, R., Heinrichs, T., Meyer, F., and Gaylord, A., 2012. *Mapping and characterization of recurring spring leads and landfast ice in the Beaufort and Chukchi Seas*, OCS Study BOEM 2012-067. University of Alaska Coastal Marine Institute, Fairbanks, Alaska.

National Weather Service, 2018. Webpage: https://www.weather.gov/afc/ice (accessed May 8, 2018)

U.S. National Ice Center, 2018. Webpage: http://www.natice.noaa.gov (accessed May 8, 2018)

Weingartner, T., Danielson, S. L., Potter, R. A., Trefry, J. H., Mahoney, A., Savoie, M., Irvine, C., Sousa, L., 2017. *Circulation and water properties in the landfast ice zone of the Alaskan Beaufort Sea*, Continental Shelf Research 148:185-198.

Weingartner, T. and Kasper, J. L., 2011. *Idealized modeling of circulation under landfast ice*, OCS Study BOEMRE 2011-056. University of Alaska Coastal Marine Institute, Fairbanks, Alaska.

Title	Alaska Coastal Marine Institute
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$5,000 (in thousands)
Performance Period	FY 2019–2024
Date Revised	May 10, 2018
PICOC Summary	
Problem	The BOEM Environmental Studies Program needs applied scientific studies required for making responsible decisions for managing energy and marine mineral resources on the U.S. Outer Continental Shelf (OCS).
Intervention	Scientific information collected for leasing, exploration, and development decisions tends to be more readily accepted by the local and regional populace if the studies are conducted by well-known and scientifically respected local experts and institutions.
Comparison	Through the CMI, BOEM will obtain high quality scientific research to meet the shared goals of BOEM and the State of Alaska at substantial savings due to the one-to-one cost match requirement.
Outcome	The CMI program will use the highly qualified, scientific expertise at local levels to collect and disseminate environmental information needed for OCS oil and gas and renewable energy decisions; address local and regional OCS-related environmental and resource issues of mutual interest; and strengthen the BOEM-State partnership in addressing OCS oil and gas information needs.
Context	All Alaska OCS planning areas.

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

Background: The CMI is cooperative program between BOEM and the University of Alaska, with State of Alaska participation, began in 1993 with the goals of updating and expanding our understanding of OCS environmental information and addressing future needs related to the offshore oil and gas program in Alaska. This large program of scientific research is guided by framework issues related to potential future lease sales and other oil and gas-related actions in the Alaska OCS Region. Beginning in 2016, the

CMI instituted a program of Student Research Awards, which provide up to $25,000 in funding for up to three student-led projects each year. Through an established cost-sharing arrangement, the CMI is expected to leverage additional scientific results and logistics capability at levels comparable to the BOEM contribution of $1,000,000 per year. Typically, five to seven new projects are funded each year.

Objectives: The Framework Issues which guide the CMI are:

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

Methods: A proposal process is initiated each year with a request for letters of intent to address one or more of the Framework Issues. The proposals are requested from university researchers and other scientific researchers in State agencies. A Technical Steering Committee, made up of scientific representatives of the cooperators, reviews letters of intent and proposals to be evaluated for possible funding. External peer reviews may be requested for new projects. Each CMI project produces a final report that is publicly disseminated through the BOEM website. Principal investigators also give presentations at a scheduled annual CMI Science Review, scientific conferences, and various public meetings.

Title	Synthesis of Current Environmental Literature for OCS Planning Areas in the Northern Gulf of Alaska
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Contract or Cooperative Agreement
Approx. Cost	$150 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 10, 2018
PICOC Summary	
Problem	The recently released 2019–2024 National Outer Continental Shelf (OCS) Oil and Gas Leasing Draft Proposed Program identifies lease sales in 11 OCS planning areas that have not been considered for leasing in decades. Collation of available environmental information is needed to support analyses under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), etc. for these lease sales and other activities regulated by BOEM.
Intervention	Completing a regionally based literature search and synthesis of environmental information.
Comparison	Results from this award will provide a resource to help guide BOEM NEPA analysts in locating the reference information they will need.
Outcome	The project would produce an annotated bibliography of relevant literature and a summary report documenting the current environment for various resources.
Context	Gulf of Alaska, Kodiak, and Shumagin OCS Planning Areas

BOEM Information Need(s): The 2019–2024 National OCS Oil and Gas Leasing Draft Proposed Program identifies lease sales in 14 Alaska OCS planning areas. These lease sales will require NEPA analyses of the existing environment and potential impacts from possible future oil and gas exploration and development activities. The last lease sale in the Gulf of Alaska Planning Area occurred in 1981, and no lease sales have occurred in the Kodiak and Shumagin Planning Areas. BOEM requires updated information to support NEPA analysis and documentation for the proposed lease sales in these areas.

Research in the northern Gulf of Alaska by a broad array of organizations—including the the National Oceanic & Atmospheric Administration (NOAA), Alaska Department of Fish & Game, Exxon Valdez Oil Spill Trustee Council (Gulf Watch) and academia—has produced an extensive body of literature that can be synthesized to support NEPA analysis for potential future lease sales in the Shumagin, Kodiak, and Gulf of Alaska OCS Planning Areas.

Background: The northern Gulf of Alaska exhibits a productive ecosystem supported by a dynamic ocean circulation that disperses marine life and nutrients from deeper waters across the continental shelf. The diverse biological communities support some of the most productive fisheries in the United States. Bays and estuaries represent important nursery habitats for young fishes, and feeding grounds for seabirds and marine mammals.

This region is rapidly changing due to climate warming. Sea temperatures have been anomalously warm, and process studies have provided data that illustrates sustained periods of warming can change the trophic structure of the ecosystem, reducing energy to upper trophic level juvenile fishes, leading to increased winter mortality. Recent and ongoing field work and modeling by NOAA and others suggests that the manifestations of warming in the Gulf of Alaska ("The Blob", El Niño, toxic algal blooms, small-copepod-dominated community, cetacean die-offs, and temperate and tropical fish species collected off Alaska's coasts) will continue highlighting the need for continued research and monitoring of conditions and emergent events.

Objectives: Describe the current environmental understanding of the northern Gulf of Alaska.

Methods: Researchers will conduct a careful literature search and compilation of all relevant information on the environment and resources of the Gulf of Alaska, Kodiak, and Shumagin Planning Areas in the northern Gulf of Alaska.

Specific Research Question(s): What is the current status of physical, biological, social, and economic resources in the northern Gulf of Alaska?

Title	Underwater Sound Signatures and Propagation for OCS Activities Permitted by BOEM
Administered by	Alaska OCS Region
BOEM Contact(s)	Chris Crews, christopher.crews@boem.gov Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Contract, Interagency Agreement, or Cooperative Agreement
Approx. Cost	$125 (in thousands)
Performance Period	FY 2019–2020
Date Revised	May 10, 2018
PICOC Summary	
Problem	Newer, more accurate acoustic harassment criteria for marine mammals requires greater accuracy in NEPA analyses. No standardized source of noise spectra characteristics is available that links with accompanying datasets.
Intervention	This study would collate baseline information regarding noise from sources associated with human activities, especially oil and gas exploration and development. A search will be conducted of white and gray literature produced by government, private sector, non-governmental, and academic entities.
Comparison	The results will support analyses to discriminate anthropogenic noise sources and noise generated by the natural environment and biological sources.
Outcome	The project will produce a dataset of sound metrics for noises from a variety of sources associated with oil and gas exploration and development activities.
Context	The results will be relevant to all Outer Continental Shelf (OCS) planning areas

BOEM Information Need(s): BOEM needs information about noise from sources associated with oil and gas exploration and development activities to inform noise impacts analyses that meet the newer noise impact thresholds criteria issued by NMFS in 2016. Results will support noise impacts analyses at all levels of NEPA, and in Endangered Species Act (ESA) Section 7 consultations.

Background: Newer, more accurate acoustic harassment criteria for marine mammals requires greater accuracy in NEPA analyses. Historically, the sound metric of decibels (dB re 1 µPa) has been used in NEPA analyses, without serious consideration of the frequencies involved, or if marine mammals were capable of detecting such noises. These relationships are now being addressed in newer NEPA documents produced by BOEM; however, no standardized source of noise spectra characteristics is available that links with accompanying datasets.

Objectives: The goal of this study will develop a consolidated source of information that provides BOEM analysts with a basic tool to analyze the effects of anthropogenic noise on marine mammals in the Alaska OCS in support of NEPA.

Methods: Researchers will collect existing noise production data found in journal publications and gray literature reports produced by government, private sector, non-governmental, and academic entities. Efforts will focus on noises from different types of seismic surveys and drilling; anchor handling; vessel, aircraft and hovercraft traffic; on-ice activities; ancillary activities; subsea pipeline installation; etc. Specifically, collected data will include the metrics of frequency, dB re 1 µPa, and dB SEL24, etc., and any other relevant metrics to support analysis of potential impacts from noise to marine mammals and other biota. Results will be presented in a final report, with the accompanying datasets in tabular format.

Specific Research Question(s):

1. What information is available regarding noise from sources associated with oil and gas exploration and development activities?
2. Given the existing knowledge on increased vessel traffic, what is the associated increase in anthropogenic noise?
3. What is the associated ecosystem response, in particular marine mammals?

Title	Monitoring the Cross Island Subsistence Whale Hunt for Effects from Liberty Development and Production, Central Beaufort Sea, Alaska
Administered by	Alaska OCS Region
BOEM Contact(s)	Chris Campbell, chris.campbell@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$350 (in thousands)
Performance Period	FY 2019–2024
Date Revised	May 10, 2018
PICOC Summary	
Problem	Iñupiaq Eskimo traditional knowledge states that bowhead whales deflect from anthropogenic noise. Nuiqust hunters engage in subsistence harvest of bowhead whales at Cross Island, which is downstream from the proposed Liberty development. Whalers are concerned that noise associated with construction activities and vessel and aircraft traffic at the site will cause bowheads to deflect from Cross Island since they potentially will encounter anthropogenic noise from Liberty when they migrate from east to west. This could result in lower than usual success in harvesting, more difficulties in whaling, and negatively affect cultural practices, sharing networks, and important community celebrations where bowhead is primarily served to elders and other residents.
Intervention	This study will monitor the annual bowhead whale hunt at Cross Island, identify any source of disturbance, and identify whaling hunters' scouting tracks and locations of strikes and landings. In addition, the study will document the harvest and processing of whales, the hunters' traditional and local knowledge (TK/LK), and other external drivers such as weather, wind, sea states, and ice conditions.
Comparison	Whaling at Cross Island has been documented through collection of Global Positioning System (GPS) data since 1999. Results from this study will be evaluated against that baseline.
Outcome	This study will provide documentation of any changes in number and distribution of bowhead whales available for harvest, as well as changes in the whales' behavior (specifically increased skittishness).
Context	The area surrounding Cross Island in the Beaufort Sea Planning Area

BOEM Information Need(s): The Bureau of Ocean Energy Management (BOEM) has a continuing, ongoing need to monitor Cross Island whaling activities for potential impacts from oil and gas-related activities on the Outer Continental Shelf (OCS). Information obtained from this study will inform BOEM and BSEE about potential temporal and special conflicts between subsistence use and activities associated with proposed oil and gas development activities at Liberty, including marine vessel passage, excavation, drilling and construction. The information will also inform future National Environmental Policy Act (NEPA) analysis and documentation related to potential

future lease sales, as well as potential future exploration plans and development and production plans (DPPs). This information includes new data on potential effects of anthropogenic noise on subsistence whaling activities, TK/LK regarding migrating bowhead whale behavior, and possible effects of presence or absence sea ice on the whale hunt.

Background: The DPP for the Liberty Development Project proposes an offshore gravel island with a pipeline to land. The facility will be constructed southeast of Cross Island, whence Iñupiat subsistence bowhead whale hunters launch their annual fall hunt for bowhead whales. Subsistence whalers have expressed reservations about potential effects to the bowhead whale hunt, because Liberty lies southeast of Cross Island, and in the fall bowheads migrate from the east to the west. The concern, based on TK/LK, is that anthropogenic noise emanating from the Liberty site will affect the whales, causing them to deflect and reduce their prospects for successful harvests. This study will renew the long-term ethnographic monitoring effort of subsistence whaling activities, incorporating TK/LK about bowhead whales, as well as real time information about proximity of sea ice to GPS recorded whaling tracks. This study will build upon prior efforts to document the effects of the development at Northstar on Cross Island subsistence conducted between 2001 and 2012 under the multi-disciplinary Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) project and its continuation (cANIMIDA) (Galginaitis, 2014).

Objectives:

- Evaluate variation in Cross Island subsistence whaling over time
- Assess whether OCS oil development activities at Liberty are likely to result in changes to bowhead whale subsistence hunting practices, or to hunting success at Cross Island

Methods: This study continues the methods established during the ANIMIDA and cANIMIDA projects. It calls for systematic observations and discussions with local informants about: a) number of whales taken; b) GPS location of whale sightings and strikes, with direction and distance from Cross Island; c) number of crews, composition of crews, total number of crew; d) periodic "census" of whaling participants on Cross Island; e) duration of whaling season by active days; f) timing of whaling; g) length of trips and area searched while whaling; h) records of catch per unit effort; i) observations of whaling participants; j) real time records of the location of sea ice relative to Cross Island; k) collection of TK/LK regarding bowhead whale and hunting practices; and l) weather, wind, and sea states. Recorded data will be presented in an annual report using tabular information on harvest levels and locations of subsistence resources taken on or near Cross Island, with hard copy maps showing the locations of subsistence whaling activities.

Specific Research Question(s):

1. Would subsistence whaling activity and whale behaviors in the vicinity of Cross Island be affected by offshore oil and gas development at Liberty? If so, in what ways?

2. Do the whales become skittish and more difficult to harvest, and if so, what behaviors comprise “skittishness” and how long does it take for whales to resume normal behavior?

3. Do the whales dive or deflect, and if so, for how long and how far? How long does it take for whales to resume normal behavior?

4. Did these alterations in behavior increase the level of effort or seem to limit the ability to harvest the quota of whales? Did it result in placing whalers in hazardous conditions? Please describe.

5. What TK can be documented regarding typical whale migratory whale behavior?

References:

Galginaitis, M., 2014. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, AK. OCS Study, BOEM 2013-212. 208 pp.

Title	Range-Wide Distribution of Cook Inlet Beluga Whales (*Delphinapterus leucas*) in the Winter
Administered by	Alaska OCS Region
BOEM Contact(s)	Carol Fairfield, carol.fairfield@boem.gov
Procurement Type(s)	Interagency Agreement
Approx. Cost	$200 (in thousands)
Performance Period	FY 2019–2022
Date Revised	May 2, 2018
PICOC Summary	
Problem	There is limited information available regarding the current spatial and temporal distribution of the critically endangered Cook Inlet beluga whale (CIBW) population. In particular, the most recent information regarding the winter range of the CIBW population is more than 15 years old.
Intervention	A wide-ranging aerial survey for CIBW in winter that could be augmented with passive acoustic monitoring (PAM) recorders to aid in winter detections of beluga whales.
Comparison	NOAA Fisheries conducts biennial summer surveys for this species, but the last winter aerial survey for CIBW was flown in 2002 (Rugh et al. 2004). BOEM is collaborating with NOAA Fisheries to conduct winter aerial surveys in March & November 2018. Expansion of this effort will allow the agencies to gain a much deeper understanding of the habitat needs for this critically endangered species and develop appropriate mitigation measures to afford maximum protection, while allowing oil and gas activities in leased areas.
Outcome	This project will produce updated information regarding the winter range of the CIBW population.
Context	Cook Inlet Planning Area

BOEM Information Need(s): Updated information on the wintering locations of CIBW will aid BOEM in developing more effective and precise spatial and temporal mitigation measures to help minimize potential impacts from oil and gas activities on the Outer Continental Shelf (OCS) in Cook Inlet. Results from this study will support National Environmental Policy Act (NEPA) analyses for Cook Inlet Lease Sale 258 (2021) and other future Cook Inlet lease sales, as well as for future exploration plans (EPs) and/or development and production plans (DPPs) that may result from Cook Inlet Lease Sales.

Background: CIBW may be adversely affected by routine operations associated with oil and gas exploration and development, including seismic surveys, drilling, production, and shipping (Small et al. 2017). The areas leased in Cook Inlet Lease Sale 244 at least partially overlap with CIBW critical habitat and some are in the vicinity of major anadromous streams which are important foraging areas for beluga whales.

There is little information regarding the current spatial and temporal distribution of the critically endangered CIBW population. NOAA Fisheries conducts biennial summer surveys for this species. The last winter completed aerial survey for CIBW was flown in 2002 (Rugh et al. 2004), though BOEM is collaborating with NOAA Fisheries to fly two 5-day winter surveys in 2018 and with potential in 2019. There has been a considerable contraction in the summer range (Shelden et al. 2015), as aerial surveys and satellite tagging studies have shown the majority of whales now occupy the areas of upper Cook Inlet in the summer. Satellite tagging studies on 18 animals (Shelden et al. 2015), together with presence/absence PAM (Castellote et al. 2016), show CIBW appear to still occur within the OCS historic range for this species in the winter, as do preliminary results of the March 2018 survey.

The most recent abundance estimate of 340 CIBW (CV = 0.08, 95% CI 291-398, Nmin = 318) in June 2014 (Shelden et al. 2015) falls within the range of abundance estimates from the last 10 survey years (278–375 whales). This is down from an historical estimate of 1,300 in 1979. NOAA Fisheries designated the CIBW population as depleted under the MMPA in 2000, subsequently listing this population as an endangered species in 2008 under the ESA.

Objectives:

- Identify distribution and hot spots for CIBW throughout their winter range
- Assess winter spatial and temporal extent of CIBW in Cook Inlet, including OCS areas
- Make recommendations on precise spatial and temporal mitigation measures for CIBW

Methods: NOAA Fisheries is conducting a three-year (2018–2020) winter aerial survey program in upper Cook Inlet. BOEM may partner with NOAA Fisheries to expand these winter aerial surveys to lower Cook Inlet. Winter surveys through upper and lower Cook Inlet would occur four times a year, in October, November, February, and March in 2019–2020. The lower Cook Inlet survey would extend from East Forelands south to Homer on the east side and from West Forelands south to Kamishak Bay on the west side, as Nikiski (in close proximity to the Forelands) and Homer were identified as operating bases for exploration and development activities for Cook Inlet Lease Sale 244, and would cover the historic range of this species. At least initially, lower levels of OCS-related activity are expected during December and January, and the available daylight is limited, thus surveys are not planned during those months. Protocols for aerial surveys of CIBW have been well developed (Shelden et al. 2013) and will be followed using a twin-engine, high-wing platform with bubble windows at the right- and left-forward observer positions and a 6- to 8-hour flying time. Surveys may be augmented by deploying PAM moorings strategically placed throughout Cook Inlet with locations based on prior studies (Castellote et al. 2016), as funding permits.

Specific Research Question(s): What is the current winter range of the critically endangered CIBW population? Are there seasonally important hot spots of distribution?

Are results from aerial surveys in CI enhanced from the synoptic use of PAMs to determine winter habitat use?

Additional Information: NOAA's National Marine Fisheries Service will co-fund this study with $100,000 per year in FY 2019 and again in 2020.

References:

Castellote, M., R. J. Small, J. Mondragon, J. Jenniges, and J. Skinner. 2016. Seasonal distribution and foraging behavior of Cook Inlet belugas based on acoustic monitoring. Alaska Department of Fish and Game, Final Wildlife Research Report, ADF&G/DWS/WRR-2016-3, Juneau.

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Shelden, K. E., K. T. Goetz, D. J. Rugh, D. G. Calkins, B. A. Mahoney, and R. C. Hobbs. 2015. Spatio-temporal changes in beluga whale, Delphinapterus leucas, distribution: results from aerial surveys (1977-2014), opportunistic sightings (1975-2014), and satellite tagging (1999-2003) in Cook Inlet, Alaska. Mar. Fisheries Review, 77(2):1-32.

Shelden, K. E. W., D. J. Rugh, K. T. Goetz, C. L. Sims, L. Vate Brattström, J. A. Mocklin, B. A. Mahoney, B. K. Smith, and R. C. Hobbs. 2013. Aerial surveys of beluga whales, Delphinapterus leucas, in Cook Inlet, Alaska, June 2005 to 2012. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-263, 122 p.

Small, R. J., B. Bros, M. Hooten, M. Castellote, J. Mondragon. 2017. Potential for spatial displacement of Cook Inlet beluga whales by anthropogenic noise in critical habitat. Endangered Species Research 32:43-57.

Title	Model-Based Essential Fish Habitat Descriptions for Arctic Cod, Saffron Cod and Snow Crab in the Alaskan Arctic
Administered by	Alaska OCS Region
BOEM Contact(s)	Lorena Edenfield, lorena.edenfield@boem.gov
Procurement Type(s)	Interagency Agreement or Cooperative Agreement
Approx. Cost	$125 (in thousands)
Performance Period	FY 2019–2020
Date Revised	May 10, 2018
PICOC Summary	
Problem	Current understanding of the Arctic Fisheries Management Plan (FMP) target species habitat distribution is inadequate to define EFH to the level required to fully identify and address potential habitat impacts from anthropogenic disturbances.
Intervention	This project will update EFH descriptions for Arctic FMP species using current, comprehensive data.
Comparison	Modeling strategies and outputs will be compared to the current EFH designations to look for areas of refinement.
Outcome	Model-based EFH designations will be produced with life stage information, where available, to update current habitat distributions.
Context	Beaufort and Chukchi Seas

BOEM Information Need(s): This project will conduct species distribution modeling to improve the descriptions of habitat use by key Arctic species. The resulting refined habitat maps and descriptions by life stage will strengthen BOEM's impact assessments during EFH and NEPA analyses associated with Arctic resource development activities.

Background: EFH definitions for the three species (Arctic, saffron cod, and snow crab) covered under the Arctic FMP are qualitative and based on presence-absence data. Commercial fishing is prohibited in the Arctic Management Area, but the habitats of these three ecologically important species may be subjected to non-fishing effects, necessitating increased understanding of their current habitat distributions.

Species distribution models can be used to identify important habitat characteristics that influence spatial patterns in abundance and may provide insight into changes in species distribution. Specifically, the species distribution models can be used to link habitat characteristics to species occurrence and catch per unit effort (CPUE) data from surveys (including several BOEM-funded studies). The ultimate goal of this project is to refine the EFH text and maps for juvenile, adult and possibly larval life stages of Arctic cod, saffron cod and snow crab for the next five-year EFH revision (target date 2021).

Objectives:

- Identify habitat characteristics most important to distributions and habitat suitability of larval (if data is available), juvenile and adult Arctic cod, saffron cod and snow crab.
- Refine map and text descriptions of EFH for Arctic cod, saffron cod and snow crab based on species distribution models.

Methods: Researchers will use two types of species distribution models that have been used to define EFH for groundfish in the Gulf of Alaska, Bering Sea and Aleutian Islands (Laman et al. 2017, Pirtle et al., 2017, Turner et al. 2017). First, maximum entropy (MaxEnt) models will be applied, incorporating presence-only data and habitat covariates to predict habitat suitability. In cases where data from large-scale surveys are available and CPUE is recorded, generalized additive models (GAMs) will be used to predict abundance.

As most biological surveys have occurred during the ice-free season (i.e., summer) in the Arctic, the proposed models will describe EFH during the summer. Previous survey data from 1972–2015 will be compiled and supplemented with recent survey data from the nearshore Beaufort Sea and the productive Barrow Canyon as it becomes available. When available, researchers will use length data, von Bertalanffy growth curves, and maturity data to separate juveniles from adults and model the life stages separately. Length-based gear selectivity curves may be used to convert CPUE data for Arctic cod between gear-types to create a more comprehensive dataset for modeling abundance. For species distribution models, habitat covariates to be considered include productivity, bathymetry characteristics, sediment types (Jenkins 1997; dbSEABED), currents, temperature, and salinity (Curchitser et al. 2013). Other habitat covariates will be considered, such as bathymetry-derived seafloor terrain metrics, biogenic habitat features, and occurrence of prey. Model fitting procedures will be used to identify the most important habitat characteristics to be used in the best-fit models.

Specific Research Question(s): Utilize distribution models to update maps and text descriptions for Arctic cod, saffron cod, and snow crab EFH?

References:

Curchitser, E.N., Hedstrom, K., Danielson, S., and Weingartner, T., 2013. Adaptation of an Arctic Circulation Model. U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Studies Program, Headquarters, Herndon, VA. OCS Study BOEM 2013-202. 82 p.

Jenkins, C. J., 1997. Building offshore soils databases. Sea Technol., 38, 25-28.

Laman, E. A., Rooper, C. N., Rooney, S. C., Turner, K. A., Cooper, D. W., and Zimmermann, M., 2017. Model-based essential fish habitat definitions for Bering Sea groundfish species. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-357, 265 p

NPFMC (North Pacific Fisheries Management Council), 2009. Fishery management plan for fish resources of the Arctic management area. ⟨http://www.npfmc.org/ wp-content/PDFdocuments/fmp/Arctic/ArcticFMP.pdf⟩

Pirtle, J. L., Shotwell, S. K., Zimmermann, M., Reid, J. A., and Golden, N., 2017. Habitat suitability models for groundfish in the Gulf of Alaska: Deep Sea Research Part II: Topical Studies in Oceanography, Gulf of Alaska Special Issue 2, article in press.

Turner, K., Rooper, C. N., Laman, E. A., Rooney, S. C., Cooper, D. W., and Zimmermann, M., 2017. Model-based essential fish habitat definitions for Aleutian Island groundfish species. U.S. Department of Commerce., NOAA Tech. Memo. NMFS-AFSC-360, 239 p.

Title	Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbls
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Contract or Cooperative Agreement
Approx. Cost	$200 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 10, 2018
PICOC Summary	
Problem	BOEM NEPA analysts require reference information regarding the potential effects of moderately-sized spills on the physical, biological, social, or economic resources on the OCS. However, much of the literature regarding smaller spills of 1,000 to 20,000 barrels is buried in the gray literature or conference proceedings and not easily accessible to the analysts.
Intervention	A literature search focusing on small to medium size spills between 1,000 to 20,000 bbl in volume and their impacts on these environments would be very helpful to BOEM analysts for future National Environmental Policy Act (NEPA) analyses of the Outer Continental Shelf (OCS).
Comparison	Scaling of impacts from much larger oil spills may not provide an accurate representation to support analysis of effects from smaller spills.
Outcome	The project will identify available literature that defines the locations and impacts to human, physical, and biological environments of small to medium size spills.
Context	All OCS planning areas

BOEM Information Need(s): Bureau of Ocean Energy Management (BOEM) needs information about oil spills, including particular oil types and volumes, and their impacts under specific environmental variables to allow NEPA analysts to make refined evaluations regarding potential impacts from large (≥1,000 bbl) crude and refined oil spills.

Background: The relationship between BOEM Outer Continental Shelf (OCS) activity and oil spills is a common question; and public concern about oil spills is heightened due to the potential impacts on sensitive resources. However, many of the most well studied oil spills (e.g., *Exxon Valdez* and *Deepwater Horizon*) are orders of magnitude larger than the median OCS spill sizes which are used for NEPA impact assessment. Analysts must use these impacts and scale them to spills of much smaller volumes and duration. Much of the literature regarding smaller spills of 1,000 to 20,000 barrels is buried in the gray literature or conference proceedings. Further, as new BOEM analysts begin their careers, the use of the older literature, although still valuable, is being lost to the archives.

Objectives:

- Synthesize documentation regarding impacts to biological, social, or economic resources from crude and refined oil spills ranging from 1,000–20,000 bbl in volume.

- Provide a systematic synthesis for use in impact assessment.

Methods: Researchers will conduct a careful literature compilation of all relevant information on crude and refined oil spills of 1,000–20,000 bbl in size since approximately 1970. Sources consulted will include not only formally published scientific literature but also so-called "gray literature", information available from the Internet, and information developed through limited appropriate personal contacts. After conducting an extensive and thorough review of the peer-reviewed and gray literature, researchers will prepare an annotated bibliography of information regarding effects and impacts of crude and refined oil spills of 1,000–20,000 bbl in size. Products will include a written synthesis of impacts and degree of recovery from crude and refined spills of 1,000–20,000 bbl in size discussing environmental and physical variables derived through the extensive review.

Specific Research Question(s): What is the range of environmental effects from oil spills of 1,000–20,000 bbl in size?

Title	Oil Spill Occurrence Estimators for Offshore and Onshore Cook Inlet and Onshore Alaska North Slope Spills
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley, heather.crowley@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$225 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 10, 2018
PICOC Summary	
Problem	Petroleum hydrocarbon spill data for analyses, including the number, volume, and likelihood of such petroleum hydrocarbon spills, is needed to support the assessment of potential impacts under the National Environmental Policy Act (NEPA).
Intervention	Disparate petroleum hydrocarbon spill data will be collected into a systematic collation of data for mathematical analyses.
Comparison	A suite of objective methodologies will provide estimates of petroleum hydrocarbon spills needed for NEPA analyses.
Outcome	This project will deliver regionally specific estimates of the occurrence of small oil spills for Cook Inlet and the Beaufort and Chukchi Seas.
Context	Beaufort Sea, Chukchi Sea, Cook Inlet

BOEM Information Need(s): The oil spill risk analysis is a cornerstone to regional Environmental Impact Statements (EISs), environmental assessments (EAs), and oil spill-contingency planning. Oil spill issues constitute a substantial portion of public comments submitted on lease sale or development and production EISes and exploration plan (EP) or geophysical and geological EAs in the Alaska Outer Continental Shelf (OCS) Region. Oil spill occurrence rates specific to Alaska derived from this study will be used by Alaska Outer Continental Shelf (OCS) Region staff to estimate small oil spill occurrence (<1,000 bbl) in preparing NEPA documents for future Cook Inlet, Beaufort Sea, or Chukchi Sea lease sales, as well as for Exploration Plans (EPs) and Development and Production Plans, and in reviewing oil spill contingency plans for OCS and coastal facilities.

Background: The Bureau of Ocean Energy Management (BOEM), Alaska OCS Region uses various datasets and models to estimate the number, volume and likelihood of large (≥1,000 bbl) and small (<1,000 bbl) spills occurring. These estimates are used to evaluate potential oil spills from a proposed OCS action and derive an impact determination for NEPA analyses. The OCS spill occurrence rates used in non-Arctic BOEM NEPA analyses are based on historical Gulf of Mexico and Pacific OCS platform, pipeline, or worldwide tanker crude oil spill rates (ABS Consulting Inc., 2016). Since

2000, the Alaska OCS Region has incorporated Alaska North Slope spills (Robertson et al., 2013) in the analyses.

Objectives:

- Develop relative spill occurrence estimator(s) suitable for use for onshore and offshore small oil spills on the Alaska North Slope using an appropriate exposure variable.

- Develop relative spill occurrence estimator(s) suitable for use for onshore and State offshore for small and large oil spills in and adjacent to Cook Inlet using an appropriate exposure variable.

Methods: Investigators will conduct a preliminary meeting to discuss acceptable statistical methods in consideration of historical statistical approaches, BOEM rationales for estimating oil spill occurrence rates, and possible sources of variance. The discussion will include: methods for deriving historical spill frequencies from Alaska North Slope and Cook Inlet spill records; exposure variables for spill frequency such as pipeline miles, volume of throughput, age, and well years; implications for using different exposure variables; limitations of the spill records; and recommended standard data format for exposure variables and accident data.

The investigators will update oil spill occurrence estimates previously calculated for the North Slope (Robertson et al., 2013). They will collect, examine, and reconcile crude and refined oil spill records and cleanup reports for the North Slope for spills ≥1 bbl from industry, U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), U.S. Department of the Interior (DOI), Bureau of Land Management (BLM), BOEM, BSEE, U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (USDOT, PHMSA), and Alaska Department of Environmental Conservation (ADEC) datasets through 2019. Exposure data for Alaska North Slope will be collected and the number of wells, flow, and pipeline miles by year provided when available. The investigators will also calculate accident frequencies for small spills and perform appropriate statistical analyses, including trend analysis. Results will be collated into an electronic database in a standard format.

Similarly, the investigators will collect, examine, and reconcile crude and refined oil spill records and cleanup reports for the onshore and offshore Cook Inlet region for spills ≥1 bbl from industry, USCG, EPA, DOI, BLM, BOEM, BSEE, U.S. Fish & Wildlife Service, USDOT PHMSA, and ADEC data sets through 2019.into an electronic database in a standard format. Exposure data for Cook Inlet region will be collected and the number of wells, flow, and pipeline miles by year provided when available. The investigators will also calculate accident frequencies for small spills and perform appropriate statistical analyses, including trend analysis. Results will be collated into an electronic database in a standard format.

Specific Research Question(s): What are the respective frequencies of oil spills on the Alaska North Slope and Cook Inlet?

References:

ABS Consulting Inc., 2016. 2016 Update of Occurrence Rates for Offshore Oil Spills. Arlington VA: Prepared by ABS Consulting Inc. for USDOI, BOEM/BSEE. 95 pp.

Robertson, T. L., Campbell, L. K., Pearson, L., and Higman, B., 2013. Oil spill occurrence rates for Alaska North Slope crude and refined oil spills. Report to Bureau of Ocean and Energy Management. OCS Study BOEM 2013-205.

Title	Synthesis of Current Environmental Literature for OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Islands
Administered by	Alaska OCS Region
BOEM Contact(s)	Heather Crowley; heather.crowley@boem.gov
Procurement Type(s)	Contract, Interagency Agreement, Cooperative Agreement
Approx. Cost	$250 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 10, 2018
PICOC Summary	
Problem	The recently released *2019–2024 National Outer Continental Shelf (OCS) Oil and Gas Leasing Draft Proposed Program* identifies lease sales in 11 OCS planning areas that have not been considered for leasing in decades. Collation of available environmental information is needed to support analyses under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), etc. for these lease sales and other activities regulated by BOEM.
Intervention	Completing regionally based literature searches and syntheses of environmental information.
Comparison	Results from this award will provide resources to help guide BOEM NEPA analysts in locating the reference information they will need.
Outcome	The project would produce annotated bibliographic information of relevant literature and two or more summary reports documenting the current environment for various resources.
Context	Hope Basin, Norton Basin, St. Matthew-Hall, Navarin Basin, Aleutian Basin, Bowers Basin, St. George Basin, and Aleutian Arc OCS Planning Areas

BOEM Information Need(s): The *2019–2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program* identifies lease sales in 14 Alaska OCS planning areas that will require NEPA analyses of the existing environment and potential impacts from possible future oil and gas exploration and development activities. No lease sales have occurred in planning areas within the Bering Sea since the mid-1980s. BOEM requires updated information to support NEPA analysis and documentation for the proposed lease sales in these areas.

Research in the Bering Sea and Aleutian Islands supported by a broad array of organizations—including the National Science Foundation, BOEM, National Oceanic & Atmospheric Administration, Alaska Department of Fish & Game, North Pacific Research Board, and academia—has produced an extensive body of literature that can be synthesized to support NEPA analysis for potential future lease sales in OCS Planning Areas in Hope Basin, the Bering Sea, and the Aleutian Arc.

Background: The region extending from the Aleutian Islands through the Bering Sea to the Bering Strait and Hope Basin is very productive and ecologically diverse. In addition, the Bering Sea is economically and culturally important, supporting some of the largest and most valuable commercial fisheries in the United States as well as sustaining important subsistence harvests for local residents. Physical and biological changes have been observed in these areas in recent years. Marine mammals, birds, and fish are shifting where they eat, bear their young, and make their homes in response to changes in sea ice extent and duration (Ashjian et al. 2012)

Objectives: Describe the current environmental understanding of Hope Basin, the Bering Sea and the Aleutian Islands.

Methods: Researchers will conduct a careful literature search and compilation of all relevant information on the environment and resources of Hope Basin, the Bering Sea, and the Aleutian Islands. Two or more reports and accompanying annotated bibliographies will be produced for sub-regions of this large area in consideration of ecosystems and planning area boundaries.

Specific Research Question(s): What is the current status of physical, biological, social, and economic resources in the ecosystems of Hope Basin, the Bering Sea and the Aleutian Islands?

References:

Ashjian, C. J., Harvey, H. R., Lomas, M. W., Napp, J. M., Sigler, M. F., Stabeno, P. J., Van Pelt, T. I. (eds.), 2012. *Understanding Ecosystem Processes in the Eastern Bering Sea*. Special Issue of Deep Sea Research Part II: Topical Studies in Oceanography. Volumes 65-70, Pages 1–316.

Title	Generation of Synthetic Audiograms by Applying Finite Element Modeling to Computerized Tomography (CT) Scans for Baleen Whales – Phase 1
Administered by	Alaska OCS Region
BOEM Contact(s)	Carol Fairfield, carol.fairfield@boem.gov Erica Staaterman, erica.staaterman@boem.gov
Procurement Type(s)	Contract or Interagency Agreement
Approx. Cost	$500 (in thousands)
Performance Period	FY 2019–2023
Date Revised	May 2, 2018
PICOC Summary	
Problem	Specific information on the hearing capabilities (i.e. audiogram) of many marine mammals remains unknown due to the logistical constraints when studying large and/or elusive ocean dwelling mammals.
Intervention	This study will use CT scans and numerical modeling techniques to provide audiograms for marine mammals for which a skull with the associated auditory features are present.
Comparison	Results would be compared to the existing low-frequency hearing function used in the 2016 NMFS acoustic criteria.
Outcome	This study will advance our understanding of hearing in baleen whales and pinnipeds and allow calculation of the pathways through which a marine mammal can be exposed to a sound. Until we know the hearing range of each marine mammal species, the need for, and efficacy of, mitigation measures remains unknown.
Context	Results from this study will be relevant to all OCS Regions and planning areas

BOEM Information Need(s): BOEM needs information on the effect of anthropogenic ocean noise on marine mammal behaviors and demographics to identify and mitigate potential environmental noise impacts from oil and gas activities. Such information will also assist other agencies in their decision making processes related to the MMPA and ESA. Information from this study will inform analyses under NEPA to develop EIS and EA documents for future OCS lease sales, G&G survey permits, EPs and DPPs. Better data on hearing ranges may be used to adjust assumptions in models used to determine take under the MMPA, and will be very useful in developing effective mitigation methods as the results of this study dictate.

Background: As the Arctic ice pack continues to diminish, vessel traffic and and other anthropogenic activities are expected to increase, and the potential for effects from noise associated with these activities becomes increasingly important. The overlap in acoustic bandwidths of the anthropogenic sound with the frequency ranges of a particular marine mammal is an important consideration for evaluating potential effects of noise

on marine mammals. Information is needed related to the hearing abilities of baleen whales, many of which are endangered, and may be needed for pinnipeds, although studies on the latter are currently being prepared for publication. Given the size, behavior, and distribution of many marine mammals, there are challenges with directly evaluating the hearing of these species. Currently, frequency ranges can be: (a) quantified through inference that the animal can hear the sounds they generate, (b) based on the morphology of the hearing apparatus, or (c) focused on behavioral reactions to sounds. Recent work by Cranford and Krysl (2015) illustrate a mechanism to generate synthetic audiograms for an animal by applying finite element modeling tools to X-ray CT scans. By scanning the entire head, they create a model that depicts all of its morphological features; this model is then subjected to sound fields from different directions to observe the way that the ear responds. This method allows investigators to create an audiogram for a species, such as a large whale, that is otherwise impossible to measure in a tank or in the field. For baleen whales, this method has shown that the skull itself acts as a pathway for transmitting low-frequency sounds from the environment into the ear.

The ultimate goal of this project is to derive hearing sensitivity and sound reception mechanisms in baleen whales in Phase 1, by analyzing CT scans with a finite element model to visualize what occurs when sound interacts with the anatomy of a skull.

Objectives: The objective of Phase 1 of this study is to evaluate if scanning only the skull will produce sufficient results or if the entire head, including the soft tissue, is required. If the technique is successful, the costs of generating audiograms from skulls in museums, and from subsistence and stranding events will be significantly reduced, and great progress will be made on obtaining much needed audiograms for additional marine mammal species that might be affected by oil and gas or renewable activity throughout the entire U.S. OCS.

Methods: This study will conduct further validation of finite element model outputs, using only bone and ligaments, which can be obtained from properly prepared museum specimens, using humpback and/or gray whale skulls available in one of the California museums. Given the wealth of information available on humpback (and to a lesser extent gray) whale vocalization, it is believed this will demonstrate the audiogram can be developed using only the bone and associated ligaments. This would substantially decrease the logistics and costs of having to use intact skulls with the soft tissues, etc. Alternatively, skulls with and without the soft tissue may need to be tested to determine the efficacy of this bone/ligament only methodology.

Future phases of the planned multi-staged approach for achieving the goal include:

- Scanning the entire head or skulls (if Phase 1 is validated) of additional species currently available in research collections or available from strandings and subsistence harvests. This will provide additional information needed to determine placement of electrodes for AEP measurements.

- Develop procedures for conducting AEP on stranded animals, including: development of an appropriate transducer (portable speaker to reproduce sounds

< 1kHz), testing of appropriate size and placement of subcutaneous needles, and establish a training program for stranding volunteers.

Specific Research Question(s):

1. What range of sound frequencies can be heard by baleen whales and pinnipeds?
2. Can the method described by Cranford and Krysl (2015) be modified to use only the skull rather than the entire head of the specimens?

References:

Cranford, T.W., P. Krysl. 2015. Fin Whale sound reception mechanisms: Skull vibration enables low-frequency hearing. PLOS ONE/DOI:10.1371/journal.pone.0116222. 17pp.

National Marine Fisheries Service. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

Title	Red-throated Loons and their Fish Prey in the Beaufort Sea as a Biomonitor for Ecosystem Health
Administered by	Alaska OCS Region
BOEM Contact(s)	Rick Raymond, richard.raymond@boem.gov
Procurement Type(s)	Intra-agency Agreement (USGS)
Approx. Cost	$600 (in thousands)
Performance Period	FY 2020–2023
Date Revised	May 10, 2018
PICOC Summary	
Problem	Population declines appear to have been accelerating in marine fish-dependent birds in the Beaufort Sea. Given that existing data has demonstrated that adult red-throated loons have high survival rates, the negative population trend suggests that reproductive success is poor. Their clutch sizes appear stable, implying an inability of red-throated loon parents to acquire sufficient prey resources for their young, either from numerically few prey or from prey of insufficient nutritional quality. Reasons for the lack of sufficient available prey may include changing water temperature regimes or turbidity or distance from the coast (flight costs are high). Presence of existing and proposed energy development activities may also impact fish while further increasing flight costs to gather fish prey, as suggested by evidence of the lack of habituation of loons to related disturbances (Schwemmer et al. 2011; Furness, 2015).
Intervention	This study proposes to build an energy budget for red-throated loons to evaluate how availability of fish prey, quality of fish prey, flight distance, and dive duration required to capture fish prey affect the ability of loons to successfully raise young. The data to build an energy budget would be a combination of new field studies on loon feeding ecology (i.e., data collection on flight paths, fatty acid signatures and nutritional value of fish used by loons, etc.) and collaborative use of ongoing BOEM-sponsored studies examining the local prey fish communities in the same area.
Comparison	This study proposes two study sites—one near the Liberty prospect and a second site distant from Liberty but in a similar ecological setting elsewhere along the Beaufort Sea coastline. Similar data collection would occur concurrently at both sites and within the broad domain of the aforementioned fish studies. If replicated in later years (e.g., after Liberty is in production), then a follow-up study would enable the strongest type of experimental design (e.g., a BACI design: Before-After-Control-Intervention).
Outcome	The study anticipates detecting differences in the nutritional quality of fish prey species available to and consumed by red-throated loons. Further, by using data on relative abundance of forage fishes, will evaluate for effects of any nutritional deficits for the birds on their ability to successfully raise young. Future NEPA analyses of cumulative effects or potential disturbances in the area will consider any identified ecological limit in how far loons will travel to capture sufficient prey for their young.
Context	Near shore and offshore Beaufort Sea

BOEM Information Need(s): BOEM requires information to assess cumulative impacts on Arctic marine fish-eating species due to disturbance around industrial facilities, ecological changes in in near shore environments, or accumulation of contaminants exposure. Information from this study will support BOEM in assessing whether red-throated loons are behaviorally impacted by industrial activities and assessing if near shore fish communities are sufficiently abundant and of adequate nutrition to enable loons to be reproductively successful. This information will help to monitor for effects from proposed construction at Liberty and inform BOEM analysts and decision makers in relation to NEPA cumulative effects analyses and documentation for future lease sales, EPs, and DPPs.

Background: The population decline of red-throated loons in northern Alaska has accelerated, suggesting that conditions are changing in the near shore environment. Red-throated loons require marine fish prey to feed both themselves and their chicks. Given their predilection for marine fish of high fat content, populations of red-throated loons are sensitive to the abundance and nutritional value of fish prey. Previous studies from other geographic regions have shown that some keystone fish species are critical to enabling red-throated loon breeding success. Also, the energy density of fish prey varies across time, corresponding with changes in oceanographic conditions and changes in species availability. Flight costs to capture fish are very high, and thus perturbations that impel loons to change their travel routes may have energetic consequences that could be ecologically significant, such as decreased reproductive success.

Objectives:

- Identify whether fish-dependent birds exhibiting recent population declines nesting near the Beaufort Sea coast are able to provision enough food resources from marine waters to enable them to successfully raise young.
- Assess the amount of energetic expenditure red-throated loons require to raise one versus two chicks (loons lay two eggs, and often can only raise one chick).
- Assess above information (i.e., reproductive energy budget) for two sites, including the vicinity of planned Liberty development where disturbance to chick-provisioning is anticipated.

Methods: This work will leverage information from and be conducted in the same season and region of the Beaufort Sea coast as the ongoing BOEM-USGS partnership "Nearshore fish surveys in the Beaufort Sea: Examining long-term community change and the role of nearshore habitats." Researchers will attach satellite transmitters to adult loons during nesting or chick rearing to allow tracking of flight patterns and estimation of energetic costs of travel from nests to foraging sites. A sensor will also be attached to the leg that identify if it is in the water and at what depth. Small fat biopsies and fatty acid analysis will provide taxa-specific prey information and fish captured by collaborators will enable analysis of the nutritional value of fish by species and size. Researchers will use a model to integrate how flight costs, diving costs, fish dietary quality, and fish abundance influence breeding success of loons, and how breeding success may in turn affect population changes. Available data from northwest Alaska in 2009-2010 (Rizzolo, Schmutz, and Speakman, 2015) will support comparative analysis.

Specific Research Question(s):

1. What is the current energetic value of various nearshore fish prey?
2. How do the energetic costs associated with obtaining marine fish for chicks affect the reproductive success of loons?
3. Is reproductive success related to population decline of red-throated loons?

References:

Furness, R.W. 2015. A review of red-throated diver and great skua avoidance rates at onshore wind farms in Scotland. Scottish Natural Heritage Commissioned Report No. 885.

Rizzolo, D.J., Schmutz, J.A., and Speakman, J.R. 2015. Fast and efficient: postnatal growth and energy expenditure in an Arctic-breeding waterbird, the red-throated loon (Gavia stellata). The Auk 132(3):657-670.

Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V. and Garthe, S., 2011. Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. Ecological Applications, 21(5), pp.1851-1860.

Title	Arctic Cod Winter Spawning Survey
Administered by	Alaska OCS Region
BOEM Contact(s)	Lorena Edenfield, lorena.edenfield@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$650 (in thousands)
Performance Period	FY 2020–2024
Date Revised	May 10. 2018
PICOC Summary	
Problem	Information is unavailable about spawning timing and locations for this keystone Arctic species
Intervention	This project will sample Arctic cod during suspected spawning season using previously unavailable methods.
Comparison	This project will provide baseline information to update and confirm suspected spawning locations for Arctic cod.
Outcome	Identify spawning locations and timing for Arctic cod.
Context	Beaufort and Chukchi Seas

BOEM Information Need(s): Arctic cod are a keystone species in the Arctic food web, and occur in Chukchi Sea and Beaufort Sea Planning Areas. Basic life history information, such as spawning time and locations, is limited due to accessibility issues during ice-covered months. The under-studied winter season and the currently uncertain location of suspected Arctic cod spawning, egg, and larval habitat is of increasing public concern. This information is especially important for NEPA and Essential Fish Habitat (EFH) analyses, including analysis of the potential effects of spilled oil trapped and held for many months under ice.

Background: Thick ice cover during three-fourths of the year restricts access for scientific studies and limits our understanding of Arctic cod ecology. Arctic cod fill an essential ecosystem role by consuming small prey and in turn providing a food resource for larger fishes, birds, marine mammals, and to the Arctic residents subsisting on those animals. Open-water surveys in the Beaufort and Chukchi Seas have found larger cod size and abundance near the continental slope, suggesting that spawning cod may be associated with the slope or the nearby ice edge. Spawning locations and spawning stock size are uncertain, but current research funded by the North Pacific Research Board (NPRB) is attempting to identify possible spawning locations for Arctic and saffron cod through oceanographic currents and specific hatch dates of individual fish. The recent development of nets that can fish directly under the ice simplifies the logistical challenges of capturing fish in winter habitats. It may be possible to leverage existing work through NPRB's Arctic Integrated Ecosystem Research Program (Arctic IERP) to fulfill BOEM information needs about cod early life history traits. The potential overlap of Outer Continental Shelf (OCS) exploration and development areas with possible

Arctic cod spawning and rearing sites is an issue of concern for stakeholders. Oil spills, though unlikely, could have far-reaching effects on the food web should vulnerable areas and life stages of this keystone species be affected.

Objectives:

- Validate survey methods adapted for use in Arctic ice-covered areas.
- Identify spawning times and locations for Arctic cod along the continental shelf and slope in the Beaufort and Chukchi Seas.
- Increase understanding of relationships among winter fish ecology, trophic interactions, and oceanographic conditions in this region.

Methods: This study will conduct under ice sampling in close collaboration with scientists from the Alfred Wegener Institute (AWI) in Germany who have demonstrated successful use of the Surface and Under-Ice Trawl (SUIT) (van Franeker et al., 2009) to sample zooplankton and fish under sea ice. Initial sampling will be conducted at suspected cod spawning sites in the U.S. identified through literature review and a current NPRB modeling effort. Once survey methods have been validated, subsequent sampling will use a targeted approach based on initial data collection, indigenous knowledge, and NPRB modeling to identify specific spawning locations.
This study would contribute additional ship time to existing research efforts. Planned operations of the ice strengthened R/V *Sikuliaq* in the northern Bering Sea, Chukchi Sea, and western Beaufort Sea during spring 2019, as part of the NPRB's Arctic IERP, may provide an opportunity to add dedicated cruise days for initial U.S. sea trials of the SUIT. Collaboration with other U.S. and Canadian agencies will be pursued for subsequent focused sampling to take advantage of the economy of scale. Ice breaker capability may be required to extend the study to some suspected spawning locations.

Specific Research Question(s):

1. Is it possible to sample cod under the ice in winter from a research vessel using a towed net?
2. Where and when do Arctic cod spawn in the Beaufort and/or Chukchi Seas?
3. How would potential oil spills in ice-covered conditions impact early life stage cod?

References:

van Franeker, J. A., H. Flores, and M. Van Dorssen. 2009. The Surface and Under Ice Trawl (SUIT). In H. Flores, editor. Frozen Dessert Alive—The Role of Sea Ice for Pelagic Macrofauna and its Predators, PhD thesis, University of Groningen. pp.

Title	Acoustic Detection of Critically Endangered North Pacific Right Whales Off Kodiak, Alaska
Administered by	Alaska OCS Region
BOEM Contact(s)	Carol Fairfield, carol.fairfield@boem.gov
Procurement Type(s)	Interagency Agreement, Cooperative Agreement
Approx. Cost	$1,000 (in thousands)
Performance Period	FY 2020–2024
Date Revised	May 11, 2018
PICOC Summary	
Problem	The eastern population of the North Pacific right whale occurs in areas of the Gulf of Alaska potentially affected by oil development activities in Cook Inlet, as well as potential future lease sales in the Cook Inlet, Kodiak , and Gulf of Alaska OCS Planning Areas.
Intervention	The year-round occurrence of right whales will be assessed through detections by passive acoustic recorders deployed in multiple locations off Kodiak Island.
Comparison	The results of this study will be compared to the results of BOEM's oil spill trajectory modeling efforts, which indicated that North Pacific right whales could be affected by a potential oil spill in Cook Inlet.
Outcome	This project will provide new baseline information regarding the habitat use of North Pacific right whales near Kodiak.
Context	What are the circumstances and/or geographic domain(s)?

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

Background: The eastern population of the North Pacific right whale is critically endangered, with abundance likely only in the tens of whales. Basic information on current abundance, trend and distribution of this stock are needed. While new information on right whale distribution has come from NOAA surveys of the Bering Sea, there has been very little effort in the Cook Inlet, Kodiak and Gulf of Alaska (GOA) Planning Areas. Almost no survey coverage of the offshore waters of the GOA that were habitat for right whales as recently as the 1960s when the Soviet Union was conducting illegal whaling activities. In July 2017, a North Pacific right whale was documented in the GOA between Sand Point and Kodiak at Kilokak Rocks.

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

Objectives: This project will evaluate the current occurrence of right whales in the GOA around Kodiak Island. This will provide additional baseline information on this critically endangered species' occurrence in these planning areas, which would be needed to develop appropriate mitigation measures should leasing occur in this geographic area.

Methods: In collaboration with NOAA, long-term passive acoustic recorder moorings will be deployed to provide year-round data on right whale spatial and temporal occurrence as well as ambient noise measurements. Density estimation may also be possible from these single-recorder moorings using novel passive acoustic methods. Researchers will analyze acoustic data from these recorders to refine knowledge of the spatial and temporal occurrence of right whales in the GOA around Kodiak Island and near to the species' designated Critical Habitat on Albatross Bank. Recordings may also be analyzed for information related to other species and inclusion of additional sensors on the moorings will be explored. Recorders will be deployed for two or three years, with a scheduled maintenance each year.

Specific Research Question(s): What is the temporal occurrence year-round of critically endangered North Pacific right whales in areas potentially affected by activities associated with oil and gas exploration and development in the Cook Inlet and Kodiak OCS Planning Areas?

Title	Arctic Marine Biodiversity Observing Network (AMBON) on Alaska's Arctic Outer Continental Shelf (OCS)
Administered by	Alaska OCS Region
BOEM Contact(s)	Rick Raymond, richard.raymond@boem.gov
Procurement Type(s)	Interagency Agreement or Cooperative Agreement
Approx. Cost	$5,000 (in thousands)
Performance Period	FY 2020–2025
Date Revised	May 10, 2018
PICOC Summary	
Problem	Present and future oil and gas development on the OCS of the Beaufort and Chukchi Seas have potential effects on the marine ecosystem. This could disturb essential ecosystem services in the Arctic, including sustainable subsistence practices of indigenous peoples.
Intervention	Long-term ecological studies that monitor marine ecosystems are needed to help us discern and understand patterns and changes in composition and function, and to separate impacts due to human activities from environmental change. Biodiversity observing at the appropriate scale has proven to be a practical tool to help identify vulnerable and resilient regions within ecosystems of the Arctic.
Comparison	Effects will be evaluated via long-term data that allow an assessment of impacts from development against the backdrop of known natural variability. The range and patterns of natural variability, and relationships to environmental drivers, can only be discerned from long-term data collection.
Outcome	Continuation of existing biodiversity observing programs will provide the necessary information on ecosystem structure and diversity, variability, and resilience to external drivers. Outcomes include provision of publicly accessible data for informing decision making on development, fishing, and shipping, for assessing climate patterns, and optimizing monitoring strategies.
Context	Beaufort Sea and Chukchi Sea Planning Areas

BOEM Information Need(s): BOEM needs a comprehensive yet rigorous monitoring system for the OCS in the Arctic to help discern and understand patterns and changes in composition and function, and to separate impacts due to human activities from environmental change. Results from this project will inform NEPA analyses and decision making related to future lease sales in the Beaufort Sea and Chukchi Sea.

Background: Biological and physical measurements that characterize ecosystem status and trends inform decision making in the context of resource extraction and climate change. Long-term observations of the ecosystem, preferably over decades, and ideally across trophic levels from microbes to marine mammals, are needed to improve understanding of ecosystem dynamics and better assess possible anthropogenic effects against a naturally variable system. A strong focus on biodiversity, including taxonomic,

genetic, and functional diversity is recommended (Duffy et al. 2013). Diversity can be a gauge of system resilience and functional complexity because high levels of biodiversity promote ocean health and secure the multiple functions and services the oceans provide (Palumbi et al. 2009). Thus, managing resources in ways that conserve existing marine biodiversity will support appropriate ocean energy management (Geijzendorffer et al. 2016). This strategy also aligns with broader national and international goals of determining comprehensive, long-term biodiversity measures (e.g., U.N. Convention on Biological Diversity; Anderson et al., 2017; U.S. Arctic Research Commission 2016).

The work proposed here builds on the pilot development of the AMBON in the Chukchi Sea (ending in 2019), which is part of a national Marine Biodiversity Observing Network. AMBON also links to the Distributed Biological Observatory (DBO), which coordinates long-term monitoring of biologically productive regions in the Arctic. This observing network concept is tested and ready to expand to the Beaufort Sea as OCS energy development is undertaken.

Objectives:

- Build on the initial AMBON efforts to extend long-term biodiversity observing to the Beaufort Sea OCS.
- Design a strategic biodiversity observing program for the interconnected Chukchi and Beaufort OCS.
- Optimize data management and accessibility through collaboration with the U.S. IOOS.

Methods: The project will sample biodiversity of all ecosystem components (microbes, plankton, benthos, fishes, seabirds, marine mammals) with concurrent physical-chemical measurements along a fixed station grid with multiple transects crossing the Beaufort shelf. Lines could include the DBO6 line at 152°W, the area of Simpson Lagoon, and the DBO7 line near Camden Bay (west of Mackenzie River outflow). Several transects from the initial AMBON in the Chukchi Sea (e.g., DBO3, ML1, ML4) could be maintained for continuity and to capture the dynamic connection between the Chukchi and the Beaufort Sea. Lines will be occupied every other year with data management through the Alaska Ocean Observing System (AOOS), a regional IOOS node.

Specific Research Question(s):

1. What are the regional patterns of biodiversity on the Alaska Arctic shelves?
2. How do they influence ecosystem complexity and function?
3. How do they inform energy resource management?

References:

Anderson, K., Ryan, B., Sonntag, W., Kavvada, A., and Friedl, L., 2017. Earth observation in service of the 2030 Agenda for Sustainable Development. Geo-spatial Information Science. http://dx.doi.org/10.1080/10095020.2017.1333230.

Duffy, J.E., Amaral-Zettler, L.A., Fautin, D.G., Paulay, G., Rynearson, T.A., Sosik, H.M., and Stachowicz, J.J., 2013. Envisioning a marine biodiversity observation network. Bioscience, 63(5), 350-361.

Geijzendorffer, I.R., Regan, E.C., Pereira, H.M., Brotons, L., Brummitt, N., Gavish, Y., Haase, P., Martin, C.S., Mihoub, J.B., Secades, C., and Schmeller, D.S., 2016. Bridging the gap between biodiversity data and policy reporting needs: an Essential Biodiversity Variables perspective. Journal of Applied Ecology, 53(5), 1341-1350.

Palumbi, S.R., Sandifer, P.A., Allan, J.D., Beck, M.W., Fautin, D.G., Fogarty, M.J., Halpern, B.S., Incze, L.S., Leong, J.A., Norse, E., and Stachowicz, J.J., 2009. Managing for ocean biodiversity to sustain marine ecosystem services. Frontiers in Ecology and the Environment, 7(4), 204-211.

U.N. Council on Biological Diversity. Strategic Plan For Biodiversity 2011-2020 and the Aichi Biodiversity Targets; https://www.cbd.int/decision/cop/?id=12268 (accessed 3/1/2018).

U.S. Arctic Research Commission and Arctic Executive Steering Committee, eds. 2016. Supporting Arctic Science: A Summary of the White House Arctic Science Ministerial Meeting, September 28, 2016, Washington, DC. United States Arctic Research Commission, Arlington, VA, 78 pp.

Title	Subsistence Mapping and Traditional Knowledge Studies for Five Cook Inlet Communities: Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek
Administered by	Alaska OCS Region
BOEM Contact(s)	James Lima, james.lima@boem.gov
Procurement Type(s)	Sole-source Contract
Approx. Cost	$200 (in thousands)
Performance Period	FY 2020–2022
Date Revised	May 10, 2018
PICOC Summary	
Problem	Subsistence communities living along Cook Inlet could be affected by onshore and offshore resource development. The information that is available to address subsistence use areas and associated traditional knowledge (TK) is either limited to one-year snapshots or dates to the 1980s.
Intervention	Subsistence mapping and TK fieldwork in five of the communities along Cook Inlet was collected for the Alaska LNG [liquified natural gas] Project, but the information was never completely analyzed or published due to the stoppage of the project.
Comparison	Subsistence use area information is presented by species for the 10 year time period (2005–2014) and for the most recent year for which data is collected. This design creates a time series which allows comparison of changing harvest patterns over time and also provides a baseline for future comparisons.
Outcome	This study will provide documentation of recent (e.g., 2005–2014) subsistence use areas and associated TK, describing the current status of subsistence availability, harvest amounts, harvest effort, and health and quality of subsistence resources.
Context	Cook Inlet Subsistence communities

BOEM Information Need(s): OCS Lease Sale 244 in 2017 leased 14 blocks in the Cook Inlet Planning Area and exploration activities are contemplated on those blocks. Lease Sale 258 is scheduled for 2021 under the 2017–2022 Five-Year Program, and the recently released 2019–2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program proposes Cook Inlet OCS Sales in 2021 and 2023. This study will provide information for the description of the existing environment and analysis of direct and cumulative effects for the economy, subsistence, social systems, commercial and sport fishing, and tourism and recreation in the NEPA analyses that accompany these OCS actions. A similar study documenting subsistence activities in the North Slope Borough (Stephen R. Braund & Associates 2009) was invaluable in completing similar NEPA analyses for the Beaufort Sea and Chukchi Sea OCS activities.

Background: In 2013, the Alaska LNG Project commenced subsistence and TK baseline studies for communities potentially affected by the proposed natural gas pipeline from the North Slope to Kenai Peninsula, Alaska. As part of this effort, Stephen R. Braund and Associates (SRB&A) conducted subsistence mapping and TK studies with 735 individuals in 24 communities, including communities along Cook Inlet (Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek) that could be potentially affected by the Alaska LNG Project. In 2016, after fieldwork in these communities had been completed, the Alaska LNG Project halted all studies and the information from these communities was never fully analyzed and published.

Objectives: This study would complete the data analysis and reporting begun for the Alaska LNG Project for the six communities of Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek to provide updated information regarding these communities' subsistence use areas and TK.

Methods: BOEM will engage with SRB&A to reinitiate contact with the six study communities to coordinate the final publication and review of the subsistence mapping and TK efforts from the Alaska LNG Project. Researchers will complete the data analysis and mapping efforts for these communities. After the communities are given an opportunity to review the final results, researchers will produce a final study report and associated maps for each community.

Specific Research Question(s):

1. For all subsistence resources, what subsistence use areas, patterns, and intensity of use for Nanwalek, Port Graham, Seldovia, Nikiski, and Alexander Creek have been used in recent years (2005–2014)?
2. What are the active harvester and elder TK observations regarding subsistence availability, harvest amounts, harvest effort, and health and quality of subsistence resources?

References:

Stephen R. Braund & Associates, 2009. *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow*. OCS Study MMS 2009-003. Prepared for the U.S. Department of the Interior, Minerals Management Service, Anchorage, Alaska. 349 pp.

USDOI, BOEM, 2016. Alaska Outer Continental Shelf, Cook Inlet Planning Area, Oil and Gas Lease Sale 244 Final EIS. OCS EIS/EA BOEM 2016-069. Alaska OCS Region. Anchorage, AK.

USDOI, MMS, 2003. Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199 Final EIS. OCS EIS/EA MMS 2003-055. Alaska OCS Region. Anchorage, AK.

Title	Kenai Peninsula Borough Economy, 2007 to 2017
Administered by	Alaska OCS Region
BOEM Contact(s)	James Lima, james.lima@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$225 (in thousands)
Performance Period	FY 2020–2022
Date Revised	May 10, 2018
PICOC Summary	
Problem	The Kenai Peninsula Borough is the area that bears the preponderance of costs and benefits of OCS development in the Cook Inlet Planning Area. The diverse communities of the area have been experiencing unprecedented changing economic conditions including an ongoing State-wide recession.
Intervention	The study will provide a qualitative and quantitative profile of the borough and its constituent villages, towns and cities over the study period. Information on the change will come from primary and secondary sources in relation to trends in the State of Alaska. Information on the changes will come from primary and secondary sources such as comprehensive land use and zoning plans, census data, etc. This typology was used to distinguish effects between these types of communities in previous studies (Fall, et al. 2001) and BOEM Environmental Impact Statements for Cook Inlet (USDOI, MMS 2003; USDOI, BOEM 2016).
Comparison	The trend study will provide data to facilitate further comparison of the effects on communities in NEPA analyses.
Outcome	Documentation on the changes in the economic conditions of the Kenai Peninsula Borough and constituent communities during the study period.
Context	The Kenai Peninsula Borough adjacent to the Cook Inlet Planning Area

BOEM Information Need(s): OCS Lease Sale 244 in 2017 leased 14 blocks in the Cook Inlet Planning Area and exploration activities are contemplated on those blocks. Lease Sale 258 is scheduled for 2021 under the 2017–2022 Five-Year Program, and the recently released 2019–2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program proposes Cook Inlet OCS Sales in 2021 and 2023. This study will provide information for the description of the existing environment and analysis of direct and cumulative effects for the economy, subsistence, social systems, commercial and sport fishing, and tourism and recreation in the NEPA analyses that accompany these OCS actions. A similar study of the North Slope Borough Economy (Northern Economics, Inc. 2006) was invaluable in completing similar NEPA analyses for the Beaufort and Chukchi Sea OCS activities.

Background: Updated baseline information is needed on the economy and institutions of the Kenai Peninsula Borough (KPB) and its constituent communities (villages which are primarily subsistence-based economies, towns which are primarily commercial

fishing-based economies and cities which have diverse economies that nonetheless are dominated by oil and gas extraction). Existing information is collected and reported by a number of public-sector entities and tends to be aggregated at the borough-level. That level of analysis does not provide the finer detail to analyze community-level effects. The study period captures major changes that have been experienced because of declining oil and gas revenues.

Objectives:

- Describe the structure of the KPB and constituent communities and how it has changed from 2007 to the 2017, including: in- and out-migration, demographic trends, institutional analyses of local and regional entities, revenues and expenditures of the borough
- Evaluate the role of the regional Alaska Native Claims Settlement Act (ANCSA) Regional and Village Corporations in the KPB as a force for economic development and delivery of public services
- Identify how the KPB and its communities, ANCSA Village Corporations, tribal entities and others used revenues from the oil and gas industry and establish a comparative basis for assessing economic effects of upcoming onshore and offshore oil and gas activity

Methods: Researchers will assemble existing data sources to synthesize a quantitative and qualitative description of KBP economy by sector (for example, recreation and tourism, commercial fishing, oil and gas), borough revenues and expenditures for each year of the study period, classifying local government services by level and department and other major categories. Using the typology of village, town, and city, they will describe how the KPB and local governments have adapted to the decline in revenues and how individuals, households, and communities have responded to changing conditions. Data from KPB, the State of Alaska and other organizations will be used to describe the structure of the economy (private, public, nonprofit sectors including the regional and village Alaska Native Corporations) from 2007 to 2017. Results will identify employment by sector of the economy and employer. An analysis of local jobs and the types of jobs and out-migration and in-migration of workers will include description of the flexibility of jobs in relation to subsistence and commercial fishing. Reviews with local industry, fishing, and tribal interests will also be coordinated as needed.

The study will note changes in the structure of the principle components of the economy including oil and gas, commercial fishing, and recreation and tourism. Researchers will make a quantitative and qualitative description of KBP borough revenue and expenditures for each year of the study period, classifying local government services by level and department and other major categories. The study will describe how the KPB and local governments have adapted to the decline in revenues and how individuals, households, communities have responded to changing conditions. Data from KPB, the State of Alaska and other organizations will be used to describe the structure of the KPB economy (private, public, nonprofit sectors including the regional and village Alaska Native Corporations) from 2007 to 2017. Results will identify employment by sector of

the economy and employer. An analysis of local jobs and the types of jobs and out-migration and in-migration of workers will include description of the flexibility of jobs in relation to subsistence and commercial fishing. Reviews with local and tribal officials will also be coordinated as needed.

Specific Research Question(s): What is the structure of the economy of the KBP and communities and institutions and how has it changed and adapted during the focus period of the study?

References:

Northern Economics, Inc., 2006. North Slope Economy 1965 to 2005. OCS Study MMS 2006-020. Prepared for U.S. Department of the Interior, Minerals Management Service, Anchorage, AK. 224 pp.

USDOI, BOEM, 2016. Alaska Outer Continental Shelf, Cook Inlet Planning Area, Oil and Gas Lease Sale 244 Final EIS. OCS EIS/EA BOEM 2016-069. Alaska OCS Region. Anchorage, AK.

USDOI, MMS, 2003. Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199 Final EIS. OCS EIS/EA MMS 2003-055. Alaska OCS Region. Anchorage, AK.

Title	Atlantic Coastal Ambient Air Quality Monitoring Program
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Cholena Ren, cholena.ren@boem.gov
Procurement Type(s)	Interagency Agreement
Approx. Cost	$2,000 (in thousands)
Performance Period	FY 2019–2023
Date Revised	April 30, 2018
PICOC Summary	
Problem	Background concentrations of criteria air pollutants at the shoreline in the Atlantic coast are lacking prior to oil and gas development. Therefore, the impacts from new incremental emissions cannot be estimated.
Intervention	Ambient air quality equipment placed at selected monitoring sites along the shoreline will measure and monitor the criteria air pollutant concentrations over 3–4 years.
Comparison	Baseline pollutant concentrations should be compared to NAAQS to assess air quality before OCS activities. These observations will be used in the future to understand how emissions emitted by OCS activities in a developed area affect the air quality onshore and reliability of the observing network.
Outcome	Use the measured criteria air pollutant concentrations to determine compliance with the NAAQS at the shoreline
Context	North Atlantic, Mid-Atlantic, South Atlantic

BOEM Information Need(s): BOEM needs to determine if activities authorized under the Outer Continental Shelf Lands Act (OCSLA) are in compliance with National Ambient Air Quality Standards (NAAQS). OCSLA, under section 5(a)(8), requires compliance with the NAAQS pursuant to the Clean Air Act (42 U.S.C. 7401 et. seq.).

Background: NAAQS cover six common criteria air pollutants that are considered harmful to the public. Monitoring information is important for conducting environmental assessments for the National Environmental Policy Act (NEPA) and to help BOEM determine compliance with NAAQS. Determining trends in air quality will demonstrate how emissions are changing over time as Atlantic oil and gas is being developed and potential impacts from OCS activities. Information from monitors can also contribute to State's ambient air monitoring data and U.S. Environmental Protection Agency (USEPA) air quality monitors app that are used by the general public. It is not well understood in the Atlantic Region if the potential emissions generated by future OCS activities could cause air quality impacts on adjacent States. BOEM has not taken any actual measurements of air pollutant concentrations and it would be ideal to start collecting data prior to the development of the Atlantic to help BOEM determine compliance with NAAQS. There are few monitoring stations located near the shoreline; none of those stations located in New Hampshire, Rhode Island, New York, New Jersey,

Delaware, Maryland, North Carolina, and Georgia measure nitrogen dioxide (NO_2) which is the most frequently highest emitted air pollutant reported in an OCS plan in Gulf of Mexico. Furthermore, those few stations are typically located near major highways or industrial sites which severely limit their usefulness as contributions from offshore oil and gas would not be discernable compared to these neighboring industrial contributions. In total near the shoreline along the Atlantic, USEPA reported only 12 active monitors for NO_2, 16 monitors for particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$), 16 monitors for sulfur dioxide (SO2), 34 monitors for ozone, 7 monitors for carbon monoxide (CO), 2 monitors for lead (Pb), and 10 monitors for particulate matter less than 10 micrometers in diameter (PM_{10}). Thus, further data is needed to support BOEM's mission critical activities for NEPA analysis. The Clean Air Act Amendments gave regulatory authority on the OCS to the USEPA. BOEM would consult with USEPA in the design of this study so results would also support USEPA's regulatory needs including the protection of air quality related values at Class 1 areas. Data from the study can be useful for renewable projects.

Objectives: Determine criteria air pollutant concentrations that will be used to establish a baseline prior to OCS oil and gas activities.

Methods: This project would use USEPA approved Federal Reference Methods and Federal Equivalent Methods to measure the criteria air pollutant concentrations in order to determine compliance with NAAQS. Thus these methods have buy-in from the air science community. The USEPA Air Sensor Guidebook will also be used to guide in the development and use of air sensors. Air pollutants measured would include nitrogen dioxide (NO_2), carbon monoxide (CO), particulate pollution (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), lead (Pb), and ozone. Potential collaborations with the USEPA and adjacent States would be considered. One monitoring station would potentially be located each in South Carolina, Georgia, Virginia, New Jersey, New York, Massachusetts, Maine, North Carolina and Florida. Compatibility with existing monitoring stations will be considered. A site assessment would be performed to determine placement of stations.

Specific Research Question(s):

1. Where should the monitoring stations be placed at and why?

2. What are the criteria air pollutants concentrations at the shoreline?

3. What are the temporal and spatial trends of the criteria air pollutants concentrations?

4. Are the measured criteria air pollutants at the shoreline in compliance with the NAAQS pre-oil and gas exploration, development, and production?

References:

https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=5f239fd3e72f424f98ef3d5def547eb5&extent=-146.2334,13.1913,-46.3896,56.5319

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

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

https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=277996&simpleSearch=1&searchAll=air+sensor+guidebook

Title	Fact Book Update: Onshore Oil and Gas Infrastructure to Support Development in the Atlantic OCS Region
Administered by	Atlantic OCS Region
BOEM Contact(s)	Sindey Chaky, sindey.chaky@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$300 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 1, 2018
PICOC Summary	
Problem	BOEM's 2019–2024 National OCS Oil and Gas Leasing Draft Proposed Program (DPP) expanded OCS proposed leasing to include the entire Atlantic region creating an urgent need for more information regarding infrastructure to support offshore oil and gas exploration, development and production.
Intervention	This effort will update an existing study in the Atlantic (Dismukes 2014) to expand coverage to the entire U.S. Atlantic coast.
Comparison	Trends and outlook for development in the Atlantic region will be compared with the Gulf of Mexico Region (GOMR) because much of the initial support and labor will originate from the GOMR.
Outcome	Information gathered as a part of this fact book update will be used in BOEM scenario development and environmental impact analyses required by the National Environmental Policy Act (NEPA).
Context	Atlantic coast States from Maine to the Florida Keys.

BOEM Information Need(s): The study will help BOEM understand the existing onshore infrastructure in the Atlantic region that may be used for oil and gas activities and the capacity of this infrastructure to support new offshore oil and gas energy projects. Infrastructure data is critical to the assessment of the types and scale of onshore OCS-related effects, particularly during project development (e.g., labor demand or land loss from new infrastructure construction). These data are also critical to determining the likely location of project effects. The study will identify the onshore communities where the supporting infrastructure is and will be located and where many of the environmental and most of the socioeconomic impacts from offshore projects are likely to take place. The DPP for the new National Oil and Gas Leasing Program proposed to open the entire Atlantic OCS for oil and gas development. With this renewed interest in traditional oil and gas development in the Atlantic region, BOEM must prepare to address socioeconomic issues in its environmental analyses and environmental justice determinations as required by OCSLA, NEPA, CZMA, and the CEQ.

Background: The essential element of all offshore energy development is the supporting infrastructure in coastal areas of the region. Onshore infrastructure allows

for the development of offshore oil and gas facilities. This is the vector for the majority of onshore ecological and socioeconomic effects which derive from construction / expansion, location, operations, and staffing. The specific characteristics of the various types of support infrastructure are critical to impact assessment. In the Atlantic region, BOEM expects that initially a portion of the support activities will come from the GOMR. This study would help identify potential expansions and retrofits of existing facilities that could be needed outside of the coastal areas of the Atlantic Region.

Dismukes 2014 describes infrastructure in the Mid-Atlantic region that could be useful for oil and gas development. It also projects how other needs would be met for such development, including current trends and the future outlook for each type of infrastructure. It was modeled after a series of fact books in the GOMR that described a wide range of existing onshore infrastructure supporting offshore activities in the Gulf of Mexico, including: platform fabrication yards; shipbuilding and shipyards; ports, support and transport facilities; waste management facilities; pipelines; pipe coating yards; natural gas processing plants; natural gas storage facilities; refineries; petrochemical facilities and electric power infrastructure, and various support sectors (The Louis Berger Group 2004, Dismukes 2010 and Dismukes 2011). These fact books cover a standardized set of topics for each facility type including: an introduction, a description of the infrastructure and a typical facility, industry characteristics, a review of regulations governing facility operations, and an examination of industry trends and outlooks. The most recent GOMR Infrastructure fact book (Dismukes 2011) is being updated by an ongoing study, *Update to GOM Fact Book Data and Analysis*.

Objectives: The objective of this study is to provide BOEM with a greater understanding of critical information regarding the capacities and locations of oil and gas infrastructure that is crucial for planning, decision making, management, and environmental assessment purposes in the OCS Atlantic region.

Methods: Methods employed for this study will include: literature review, data collection from public sources, open-ended discussions with key industry representatives, and analysis and synthesis of the collected data. The research, report, and Geographic Information System (GIS) database design of this proposed study will mirror the Atlantic Fact Book (Dismukes 2014) in structure, but expand the geographic area to include all of the Atlantic coastal States not included in the original effort. It will focus on identifying and locating infrastructure in the new areas and identify changes in the original study area. Also, the study will reassess the definition of "port" and its relationship to "support and transport facilities." This is a particularly important issue since ports are key vectors of effects and port capacity is critical to scenario development. Finally, the study will develop more detailed descriptions of a each kind of facility that include siting and construction as well as operations.

Specific Research Question(s):

1. What onshore infrastructure currently exists that could support OCS oil and gas leasing, exploration and development in the Atlantic region and where is it located?
2. What types of new infrastructure will be needed and where?

3. For each infrastructure type, what are the ideal locations, construction, operation and physical characteristics?
4. What regulations apply to the facility operations at the various infrastructure types?
5. What are the current oil and gas industry trends and outlook?
6. What onshore communities host or may host supporting infrastructure and where would many of the environmental and socioeconomic impacts be likely to occur?

References:

Dismukes, D. 2014. Onshore oil and gas infrastructure to support development in the MidAtlantic OCS Region. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2014-657. 360 pp.

The Louis Berger Group, Inc. 2004. OCS-related infrastructure in the Gulf of Mexico fact book. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2004-027. 234 pp.

Dismukes, D.E. 2010. Fact book: Offshore oil and gas industry support sectors. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEMRE 2010-042. 138 pp.

Dismukes, D.E. 2011. OCS-related infrastructure fact book. Volume I: Post-hurricane impact assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2011-043 and 2011-044. 372 pp. and 163 pp., respectively.

Title	Estimating the Economic Impacts of Atlantic Oil and Gas Activities
Administered by	BOEM Gulf of Mexico Region
BOEM Contact(s)	Mark Jensen (mark.jensen@boem.gov)
Procurement Type(s)	Contract
Approx. Cost	$150 (in thousands)
Performance Period	FY 2019–2021
Date Revised	February 7, 2018
PICOC Summary	
Problem	BOEM needs to estimate the economic impacts of potential oil and gas activities in the Atlantic Ocean, and BOEM lacks information relating to fiscal impacts and other issues.
Intervention	This study will build upon modeling tools developed in completed and ongoing studies to develop an impact model for the Atlantic.
Comparison	Economic estimates will be developed by analyzing oil and gas capital and operating expenditures, the geographic distributions of these expenditures, and the economic and policy structures of affected regions.
Outcome	This study will yield standard economic impact estimates, such as jobs, labor income, and value-added.
Context	BOEM's Draft Proposed Program entails leasing in various Atlantic planning areas, which necessitates analyses of the associated economic impacts.

BOEM Information Need(s): BOEM's 2019-2024 National OCS Oil and Gas Leasing Draft Proposed Program includes lease sales in all Atlantic planning areas. BOEM needs information regarding the economic impacts of these Atlantic lease sales for Five-Year Program documents and for lease sale NEPA documents. In particular, BOEM needs information regarding the number of jobs supported, and the amounts of labor income and value-added generated, in areas affected by Atlantic lease sales.

Background: BOEM has historically used region-specific versions of the modeling framework MAG-PLAN to estimate the economic impacts of offshore oil and gas activities. Kaplan et al. (2016) describes the most recent version of MAG-PLAN for the Gulf of Mexico, while Kaplan et al. (2017) developed an initial version of MAG-PLAN for the Atlantic. In September 2017, BOEM procured the study "Estimating the fiscal, spending, and profit impacts of offshore oil and gas activities" (Industrial Economics, 2017), which is improving BOEM's estimates of the economic impacts of oil and gas activities in the Gulf of Mexico. In particular, Industrial Economics (2017) is incorporating improved measures of the economic impacts arising from government revenues, as well as other methodological and data improvements. This study is also building the software capabilities to extend the model's analyses to the Atlantic (and other regions) if BOEM so chooses.

Objective: To improve BOEM's estimates of the economic impacts of Atlantic oil and gas lease sales.This study will improve BOEM's estimates of the economic impacts of potential lease sales in Atlantic planning areas by updating the agency's economic model to include the Atlantic. With this updated model, BOEM will be able to estimate standard economic impacts, such as jobs, labor income, and value-added (the latter refers to the contribution to Gross Domestic Product).

Methods: This study would apply the economic modeling framework being developed for the Gulf of Mexico (Industrial Economics, 2017) to the Atlantic. This includes developing frameworks to analyze the impacts of government revenues and industry profits. This will also entail improving BOEM's existing framework for analyzing the impacts of industry spending, for example by developing an improved approach for estimating the geographic distributions of expenditures. Translating the work being done for the Gulf of Mexico to the Atlantic Ocean would allow for consistency among modeling frameworks, and would leverage the work already in progress. This project would likely take the form of a modification to the existing study contract. The additional funding would be used to assess differences between Gulf of Mexico and Atlantic activities. For example, there would be some differences in the exploration and development plans, tax structures, and the geographic distributions of impacts. This project will also build upon the analysis of Atlantic activities in Kaplan et al. (2017), which should keep overall project costs low.

Specific Research Question(s):

What would be the economic impacts (i.e. jobs supported, labor income, value-added) in certain areas due to Atlantic oil and gas lease sales?

References:

Industrial Economics. 2017. Awarded contract M17PC00016: Estimating the fiscal, spending, and profit impacts of offshore oil and gas activities.

Kaplan MF, Marvakov J, Meade B, Ertis D. 2016. MAG-PLAN GOM 2016: economic impact model for the Gulf of Mexico. New Orleans, LA: US Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. (OCS Study BOEM 2016-072.) 129 pp.

Kaplan MF, Marvakov J, Meade B, Ertis D. 2017. MAG-PLAN Atlantic 2016: economic impact model for the Atlantic Program Area. New Orleans, LA: US Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. (OCS Study BOEM 2017-008). 104 pp.

Title	Coastal Maine Land Use
Administered by	GOMR
BOEM Contact(s)	Victoria Phaneuf, Victoria.phaneuf@boem.gov
Procurement Type(s)	Contract, Cooperative Agreement
Approx. Cost	$350 (in thousands)
Performance Period	FY 2019–2021
Date Revised	February 9, 2018
PICOC Summary	
Problem	Land use in coastal Maine is poorly understood. This hinders BOEM's ability to assess potential impacts of OCS and renewables activity on coastal communities.
Intervention	This baseline study will investigate and document land use in coastal Maine, with attention to environmental justice communities.
Comparison	This project will identify, describe, and analyze land use in coastal Maine and suggest areas needing further analysis.
Outcome	A baseline understanding of contemporary land use patterns, and information on the need for and focus of further analysis.
Context	Coastal Maine counties.

BOEM Information Need(s): BOEM relies on up-to-date scientific data to make National OCS Program and OCS and renewables management decisions and to complete its pre- and post-lease environmental analyses. While much of this data exists for coastal Maine, it is dispersed in diverse forms. BOEM needs access to information on coastal demographic, economic, and social factors associated with land use to complete the environmental analyses and environmental justice determinations required by OCSLA, NEPA, CZMA, the CEQ, and Executive Orders 12898 and 12175. For areas that may see future OCS or renewables development, baseline information collected here will contribute to these initial analyses and decisions and will serve as the foundation for monitoring and analysis of changes as activity occurs.

Background: The State of Maine has officially requested inclusion in the 2019–2024 National OCS Program and is evaluating plans to develop an offshore wind farm (Turkel 2018, Woodard 2018). Maine has not had OCS oil and gas or renewables development to date. As social and economic effects of OCS and renewables activity occur onshore, BOEM requires a better understanding of social and economic factors in coastal areas in order to prepare its environmental analyses of these effects. One key factor that will influence how these effects are felt in local communities is land use. Land use practices may encourage or curtail development of OCS and renewable activities, including support activities onshore. Patterns of land use including land ownership; zoning; laws, ordinances (i.e., light pollution), and plans; housing utilization and vacancy rates; and groupings of industries will all shape how new OCS or renewable energy activity will

influence life in coastal communities. Also, ethnic, linguistic, and cultural minorities and low-income populations may have distinct cultural or economic relationships with coastal lands; they require special attention in this kind of analysis. The population of coastal Maine is predominantly White, non-Hispanic, with a wide range of economic characteristics (U.S. Census Bureau 2016). Coastal Maine encompasses rural and urban areas, with a mix of Federal, State, tribal, and private land. The region includes wilderness areas, parks, recreational areas, seasonal and permanent housing, agriculture, commercial and recreational fishing infrastructure, military bases, and manufacturing. In summary, coastal land use in Maine is complex and the range of influences, benefits, or impacts communities may experience as offshore development occurs will be determined in part by these pre-existing factors.

Objectives: This study aims to provide a broad understanding of land use in coastal Maine as a foundation for future research and analysis. Specifically, it will:

1. Identify and analyze the range of land use patterns in coastal Maine, with attention to areas likely to see changes in land use from OCS or renewable activities.
2. Identify areas with environmental justice populations with distinct land use practices or who would be particularly vulnerable to land use changes.
3. Provide enhanced geospatial understanding of the relationships between communities, land use, and vulnerability.
4. Increase understanding of future research and monitoring needs.
5. Identify areas that would warrant inclusion in a future research and monitoring program.

Methods: A literature and data review will be conducted of a wide range of sources including: Federal and State government databases and publications; academic, media, and trade press publications; commercial sources, and other industry-related information such as trade associations and press announcements. Key informant discussions will be conducted to obtain needed information or contact communities not sufficiently described in the review of relevant literature and data sources. GIS data will be compiled, analyzed, and mapped to illustrate patterns of land tenure, land use, and key demographics.

Specific Research Question(s):

1. What are the predominant land uses in coastal Maine and patterns in which they appear?
2. In what areas are local populations particularly susceptible to changes in land use, and why?
3. What are the primary laws, ordinances, and regulations that will affect development of onshore OCS and renewable energy support services?

4. What areas should BOEM consider for additional study and why (e.g., unique character, representative of broader trends, historic importance, disappearing communities)?
5. What methods are most appropriate to gathering baseline information on these questions in frontier areas?

References:

Turkel, Tux. 2018. "Effort to build offshore wind industry in Maine may hinge on 73 cents." Portland Press Herald. April 1. Internet website: https://www.pressherald.com/2018/04/01/effort-to-build-offshore-wind-industry-in-maine-may-hinge-on-73-cents/ Accessed April 27, 2018.

U.S. Census Bureau, Population Estimates Program (PEP). 2016. Maine. Quick Facts. Internet website: https://www.census.gov/quickfacts/fact/table/ME/PST045216 Accessed February 7, 2018.

Woodard, Colin. 2018. "LePage's support for offshore drilling may undermine effort to exempt areas off Maine." Portland Press Herald. January 14. Internet Website: https://www.pressherald.com/2018/01/14/lepages-support-for-offshore-drilling-may-undermine-effort-to-exempt-areas-off-maine/ Accessed February 2, 2018.

Title	Understanding the Recreational Uses of OCS Infrastructure
Administered by	BOEM Gulf of Mexico Region
BOEM Contact(s)	Mark Jensen (mark.jensen@boem.gov)
Procurement Type(s)	Contract, cooperative agreement, or interagency agreement
Approx. Cost	$300 (in thousands)
Performance Period	FY 2019–2021
Date Revised	February 6, 2018
PICOC Summary	
Problem	BOEM has insufficient information regarding the recreational uses of offshore oil and gas infrastructure. This is a particularly important issue given the scale of platform-based fishing, and because of decommissioning trends.
Intervention	This study will entail the development of a spatial tool, as well as exploratory research to determine the usefulness of a standardized survey.
Comparison	This is a baseline study that will examine geographic and time trends.
Outcome	To improve BOEM's knowledge of the baseline environment, to assist in predicting routine and cumulative impacts, and to improve policy decisions.
Context	Recreational uses of offshore platforms are evolving due to technology, economic forces, and government policies.

BOEM Information Need(s): Offshore recreational activities, such as fishing and diving, are important to the social and economic frameworks of many communities along the Gulf Coast. However, the existing literature does not adequately describe the extent to which these recreational activities are dependent on OCS infrastructure. In addition, technological advances, socioeconomic changes, and regulatory changes have likely changed patterns of recreational behavior since a prior BOEM study regarding this issue (Hiett and Milon, 2002). This study will obtain improved information regarding the recreational uses of OCS infrastructure.

The information obtained from this study will improve BOEM's pre-lease and post-lease NEPA analyses. For example, this study will allow BOEM to more accurately estimate the distances from shore that BOEM activities and recreational activities interact. This study will also improve BOEM's cumulative analysis of overall decommissioning trends, as well as broader BOEM analyses of recreational impacts. In addition, BOEM plans to develop a programmatic environmental impact statement (PEIS) regarding decommissioning activities; this study would provide important information to that PEIS. This study will also inform decisions regarding which structures should be maintained through Rigs-to-Reefs programs. Finally, this study would support public outreach efforts and essential fish habitat consultations.

Background: Offshore recreational activities, such as fishing and diving, are important to the social and economic frameworks of many communities along the Gulf Coast. Hiett

and Milon (2002) provided information regarding the overall levels of fishing and diving near oil and gas platforms; they also estimated the economic impacts originating from expenditures by these fishermen and divers. However, that study was based on 1999 data, which is becoming dated. It also did not examine certain subcategories of these activities, such as the scales of recreational fishing and diving that occurred in state versus Federal waters, or site-specific determinants of recreational uses of OCS infrastructure.

Since the Hiett and Milon (2002) study, there have been various changes and events that could have altered recreational behavior along the Gulf Coast. For example, improved offshore communications, better safety technologies, and improved navigational aids have allowed the OCS to become increasingly accessible to anglers and divers. Public awareness of the oceans, environmental impacts, and ocean dynamics may have altered the levels of ecotourism and other recreational activities. Furthermore, the costs associated with recreational activities, as well as the structure of the U.S. economy as a whole, have evolved in recent years. Finally, the number of offshore platforms has been declining, and those that are being installed are generally in deeper waters where they are less accessible to recreational users. Fishermen, divers, government agencies, and industry participants would benefit from information regarding the changed landscape so they can plan and adjust their behavior.

Objectives:

1. To understand the general nature and parameters of the recreational use of platforms (e.g., estimated number and types of users, spatial characteristics—extent, distance from shore, clustering, proximity to other structures, attributes of high use platforms, scale of use/# of platforms in use).

2. Provide insight on the utility and execution of further study into the nature of platform-based recreational fishing.

Methods: Due to a pressing need for information to be included in the decommissioning PEIS, this study will entail methods that can yield results quickly, while laying the groundwork for a potential future larger-scale study. This study will use multiple methods. First, it will conduct a limited number of interviews (individually or through a workshop) with recreation industry participants and government officials. Second, it will complete a literature review and compile existing relevant data. For example, the Louisiana Department of Wildlife and Fisheries recently took over responsibility (from the National Marine Fisheries Service) for Louisiana recreational fishing data; this study will explore the potential insights of this new data. Third, it will also develop visual representations of how platforms and other artificial reefs correlate with measures of recreational fishing. Fourth, it will examine the appropriateness of a larger-scale, OMB-approved survey effort that would allow more quantitative estimates to be developed. Finally, this study will develop suggestions for the initial steps such a survey effort would take, including the possibility of leveraging existing data collection efforts, and would develop potential survey questions.

Specific Research Question(s):

1. What are the overall scales, geographic extents, and site-specific determinants of recreational uses of offshore oil and gas infrastructure?
2. To what extent can existing information sources address these questions?

References:

Hiett, R.L. and J.W. Milon. 2002. Economic impact of recreational fishing and diving associated with offshore oil and gas structures in the Gulf of Mexico: Final report. OCS Study MMS 2002-010. U.S. Dept. of the Interior, Minerals Management

Title	Wind Tunnel Experiments for Offshore Oil and Gas Platform Downwash
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Chester Huang; chester.huang@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$250 (in thousands)
Performance Period	FY 2019–2021
Date Revised	January 3, 2018
PICOC Summary	
Problem	What are the effects of an oil or gas platform structure on the characteristics of the air flow and a plume. Offshore platforms affect the characteristics of the air flow and plume and consequently the dispersion of pollutants. There is also a lack of data on downwash algorithms to be used in air dispersion modeling for shallow water cases.
Intervention	Perform wind tunnel experiments with different types of oil or gas platform or drillship to identify the building wake effect on the plume behavior from that platform or drillship.
Comparison	The observations will be compared with those cases without the presence of an oil platform structure and with available field observations.
Outcome	The air flow and the plume in the wake and downwind area should be measured and estimated. The new insights will be used to improve the downwash algorithms used in air quality modeling studies.
Context	Central, Western, and Eastern Gulf of Mexico.

BOEM Information Need(s): In order to improve overwater dispersion modeling, the Bureau of Ocean Energy Management (BOEM) needs to perform wind tunnel experiments to characterize offshore oil or gas platform or drillship downwash. This study will conduct the wind tunnel experiments to gather the downwash information which will be applied to improve the algorithms used in air quality modeling for impacts assessments.

The Outer Continental Shelf Lands Act (OCSLA) requires compliance with the National Ambient Air Quality Standards (NAAQS) pursuant to the Clean Air Act (CAA). The CAA also gives BOEM regulatory authority for air quality on the OCS in areas westward of 87°30'W longitude in the Gulf of Mexico. BOEM's regulations at 30 CFR 550 subpart B cite the U. S. Environmental Protection Agency (USEPA) modeling guidelines stating, "when BOEM requires air quality modeling, you (the lessee) must use the guidelines in [USEPA] Appendix W of 40 CFR part 51 with a model approved by the Director". Hence, it is important that these overwater models realistically portray dispersion to adequately assess air quality impacts, as required under regulations. The platform downwash is a component of air dispersion modeling which will affect the predicted downwind criteria pollutant concentrations.

Currently, because of technological advances and striving to improve offshore modeling impacts, BOEM is considering replacing the USEPA's older Offshore and Coastal Dispersion Model Version 5 (OCD, 1989) air quality model, with the American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee's Dispersion Model (AERMOD) for short-range air dispersion modeling. Air pollution dispersion models have been designed mostly for use in onshore environments for onshore conditions. The USEPA has suggested that platform downwash is one area that BOEM studies to improve AERMOD for offshore applications.

Background: Over the past decade or more, BOEM and its predecessor agencies have engaged in an extensive research program on air quality. Current program needs are derived from three main sources; better estimates of the impact of emissions resulting from offshore oil and gas activity to air quality, the preparation of updated air quality regulations, and concerns collected during NEPA scoping meetings and public comments. Examples of our recent research include *Air Quality Modeling in the Gulf of Mexico Region* (GM 14-01), and *Testing and Evaluation of AERMOD Using AERCOARE and MMIF Meteorological Outputs Representative of the OCS* (NT-12-04). As a result of these investigations, future work is recommended to better understand platform downwash and the marine and coastal areas, which should improve the accuracy of the modeling and thus the OCS impacts. With more stringent NAAQS in place, such as the 1-hour SO_2 and NO_2 standards with which facilities must comply, there has been an increased focus on the need to improve AERMOD's performance in modeling building downwash (Tyler Fox, USEPA). Without the study of the offshore building downwash and the updated algorithm, USEPA would not approve the AERMOD model for all cases for the offshore applications.

Objectives: This study is to conduct the wind tunnel experiments to obtain information on oil or gas platform or drillship downwash to improve air quality modeling. A meteorological wind tunnel is often used to simulate the air flow and air dispersion in the atmospheric boundary layer.

The information obtained from the wind tunnel measurements is to understand the atmospheric process, characterizing the structure of the atmospheric boundary layer for air quality modeling and model validation. Specific objectives will include, but are not limited to:

- Conduct plume downwash experiments at a small scale from a few oil and gas platforms or drillship and in a meteorological wind tunnel, using structures that resemble oil and gas platforms or drillship. The field tracer experiments are also proposed

- Conduct wind tunnel experiments for flow visualization

- Collect data for dispersion modeling and model validation

Methods: The approaches for this study are to conduct wind tunnel experiments. The wind tunnel experiments will be conducted under various atmospheric conditions. The

specific methods include: (a) Perform meteorological wind tunnel experiments to understand downwash fluid dynamics of typical oil and gas platforms or drillship, length of influence and relevant dispersion parameters at small scale (order of 2 km), (b) Perform wind tunnel experiments for flow visualization, and (c) Deliverable: data collection, data archive, and final report

Specific Research Question(s):

1. How does the air flow and air concentrations change in the presence of oil or gas platform structure or drillship?

2. Can BOEM improve the algorithms for platform downwash in AERMOD?

References:

Dispersion of Emissions from Offshore Oil Platforms – A Wind-Tunnel Modeling Evaluation. American Petroleum Institute. 1220 L Street, Northwest Washington, D.C., 20005. 1984.

Tyler Fox, Memorandum to EPA Regional Modeling Contacts: EPA White Papers on Planned Updates to AERMOD Modeling Systems, US Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. September 19, 2017. https://www3.epa.gov/ttn/scram/models/aermod/20170919_AERMOD_Development_White_Papers.pdf

Title	An Analysis of Seafloor Impacts on the Gulf of Mexico Outer Continental Shelf (OCS) for Adaptive Management Strategies
Administered by	GOM OCS Region
BOEM Contact(s)	Scott Sorset, Scott.Sorset@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$160 (in thousands)
Performance Period	FY 2019–2022
Date Revised	May 03, 2018
PICOC Summary	
Problem	BOEM scientists need a comprehensive understanding of the scope and scale of impacts to OCS seafloor resources
Intervention	A reference manual that documents common industry activities compared to the range, scale, and extent of seafloor impacts. This will be used by reviewers to unify impact assessments.
Comparison	Accuracy and precision of avoidance measures from various SMEs will be variable as compared to having a unified and comprehensive guide of scale and extent of common seafloor impacts
Outcome	A reference tool that will produce more precise mitigations based on specific seafloor impact scenarios
Context	Industry activities under BOEM review by the Gulf of Mexico Region

BOEM Information Need(s): What is needed is a single, updatable reference guide of industry practices that impact the seafloor. This study will document and explain the various types of seafloor impacts generated by Gulf of Mexico Region (GOMR) OCS activities in both descriptive and scaled visual reference; an estimated 1–2 pages per impact source. As currently envisioned, this guide could easily be expanded to encompass impacts that take place within other regions or in the Gulf version when a new and unusual technology review is completed by the post-lease NEPA group. The Bureau of Ocean Energy Management (BOEM) manages a complex range of activities across the spectrum of oil and gas infrastructure and marine mineral extraction in the Gulf of Mexico. Many of these regulated and permitted activities have direct impacts to the seafloor. Agency Subject Matter Experts (SMEs) are often left trying to piece together a picture of the scale and extent of seafloor impacts for each post-activity National Environmental Policy Act (NEPA) review they receive.

Background: BOEM's comprehensive site-specific review process for compliance with NEPA and NHPA requires a practical understanding of general oil- and gas-related industry practices. Many of the SMEs rely on the experience of others or are required to make "Requests for Information" to the operators that can often slow the permitting process. These SMEs are experts in their scientific fields, but none are oilfield engineers with the requisite field experience to know the scale and extent of every industry activity

that takes place in the Gulf of Mexico; nor are they expected to be. What is needed is a guide that provides a scale and context to industry activities under Agency review to assist to assist employees of all experience levels in understanding seafloor impacts to the resource for which they are responsible. Understanding these impacts would assist BOEM by leading to more effective and efficient strategies for protecting natural and cultural resources when doing NEPA and National Historic Preservation Act (NHPA) assessments.

Objectives: The study's objective is to create a simple guide explaining how typical industry activities impact the seafloor and the types of equipment that are involved. Such an analysis will expedite BOEM's mandated assessments under NEPA and NHPA and provide SMEs with understanding sufficient to suggest new mitigations or alternatives to common practices that could reduce harm from seafloor impacts.

Methods: The guide will describe, analyze, and illustrate the various ways common offshore industry activities are completed. In addition to analyzing impacts from the common types of equipment that are utilized, the report will include information like:

1) Four-dimensional (4-D) Seismic Ocean Bottom Cable Node deployment and recovery.
    - Example: What happens if the cable is snagged on a shipwreck or coral outcrop? What alternative methods available that could reduce these impacts?
2) Various barge types and their anchors.
    - Example: How would you conduct catenary calculations to determine where anchor cables would hit the bottom, and what is a cable's respective drag distance? Is there an equally effective method that reduces or eliminates the need for the use of anchors?
3) Descriptions of various rigs and the bottom impacts from each.
    - Example: What are the dimensions of a 4 ton anchor? Would an alternative anchor type, such as a suction pile anchor, provide equivalent control with a smaller impact area? How are the anchors deployed?
4) Pipeline laydown and recovery methods and impacts.
    - Example: How many and what size anchors does a Dive Support Vessel use? Could a Dynamically positioned vessel be used in shallow water just as effectively?
5) Impacts from platform decommissioning activities.
    - Example: How far past the required area for site clearance do trawlers often go when removing seafloor debris? Is there a more effective trawl method that would minimize the area of seafloor scour?

Specific Research Question(s): What is the specific range, scale, and extent of seafloor impacts from BOEM reviewed industry activities?

Title	Preliminary Study: GOMR Coastal Ambient Air Quality Monitoring Program
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Cholena Ren, cholena.ren@boem.gov
Procurement Type(s)	Contract and/or Interagency Agreement
Approx. Cost	$400 (in thousands)
Performance Period	FY 2019–2023
Date Revised	April 30, 2018
PICOC Summary	
Problem	Concentrations of criteria air pollutants are lacking at the northern Gulf of Mexico's shoreline.
Intervention	Criteria air pollutant concentrations will be measured and monitored at a determined shoreline site.
Comparison	Observed criteria pollutants will be compared to air quality model predictions and to NAAQS standards.
Outcome	Evaluate the feasibility of installing a monitoring station and using the criteria air pollutant concentrations data to determine compliance with the NAAQS at the shoreline, validate BOEM's modeling results, and provide recommendations to an expanded study.
Context	Central Gulf of Mexico, Western Gulf of Mexico

BOEM Information Need(s): BOEM needs to determine if activities authorized under the Outer Continental Shelf Lands Act (OCSLA) are in compliance with National Ambient Air Quality Standards (NAAQS). OCSLA, under section 5(a)(8), requires compliance with the NAAQS pursuant to the Clean Air Act (42 U.S.C. 7401 et. seq.).

Background: NAAQS cover six common criteria air pollutants that are considered harmful to the public. Monitoring information is important for conducting environmental assessments for the National Environmental Policy Act (NEPA) and to help BOEM evaluate air quality model predictions that have been used to determine compliance with the NAAQS. Determining trends in air quality will help determine whether emissions from oil and gas facilities are contributing factors. Information from the monitors could also contribute to the State's ambient air monitoring data and U.S. Environmental Protection Agency (USEPA) air quality monitors app that are used by the general public. It is not well understood if the emissions generated by OCS activities cause air quality impacts on adjacent States. Though BOEM has conducted modeling studies, BOEM has not taken any actual measurements of air pollutant concentrations to confirm the validity of those models and to directly determine compliance with NAAQS. There are only a few monitoring stations located near the shoreline of the Gulf of Mexico; none of those stations located in Louisiana measure nitrogen dioxide (NO_2) near the shoreline which is the most frequently modeled air pollutant in an OCS plan. Furthermore, those few stations are typically located near major highways or industrial

sites which severely limit their usefulness to BOEM as contributions from offshore oil and gas would not be discernible compared to these neighboring industrial contributions. In total near the shoreline of Mississippi, Alabama, Louisiana, and Texas, USEPA has reported only four active monitors for ozone and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$), two monitors for NO_2, one monitor for sulfur dioxide (SO2), and no active monitors for carbon monoxide (CO), lead (Pb), and particulate matter less than 10 micrometers in diameter (PM_{10}).

Objectives: This study will evaluate the feasibility of a coastal NAAQS monitoring study and provide recommendations to design an expanded study.

Methods: This project will research factors that contribute to a successful monitoring study such as equipment selection and siting, data quality and cost, and looking at the compatibility with existing monitoring stations. The field monitoring task would use USEPA approved Federal Reference Methods and Federal Equivalent Methods. The USEPA Air Sensor Guidebook will also be used to guide in the development and use of air sensors. Air pollutants measured would include nitrogen dioxide (NO_2), carbon monoxide (CO), particulate pollution (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), lead (Pb), and ozone. Depending on the instrument these monitors can come equipped with solar panels and meteorological sensors. Potential collaborations with adjacent States, Fish and Wildlife Service, and National Parks Service would be considered. One station would be located in Louisiana for one year. A site assessment would be performed to determine placement of station. Collected data will be evaluated as to the success of the design and research questions. An additional monitoring station would be considered depending on funds. Coordination with the platform downwash study would be considered.

Specific Research Question(s):

1. What logistical issues exist and how can they be managed to successfully establish a coastal monitoring station?

2. Where should this one monitoring station and future monitoring stations be place at?

3. What are the criteria air pollutants concentrations and temporal and spatial trends at the shoreline?

4. What are the main factors contributing to variability?

5. Are the measured criteria air pollutants at the shoreline in compliance with the NAAQS?

6. What is the accuracy and variability of BOEM's predictive models based on this preliminary study results?

Title	OCS-Related Transportation Infrastructure in Louisiana and Texas
Administered by	GOM OCS Region
BOEM Contact(s)	Sindey Chaky, Sindy.Chaky@boem.gov
Procurement Type(s)	Contract, Cooperative Agreement
Approx. Cost	$350 (in thousands)
Performance Period	FY 2019–2921
Date Revised	September 15, 2017
PICOC Summary	
Problem	BOEM does not have current information on onshore transportation associated with OCS activities, especially roads, railroads, and waterways.
Intervention	This study will document and analyze onshore transportation associated with OCS activities.
Comparison	This study will expand BOEM's knowledge of onshore OCS-related infrastructure to include transportation.
Outcome	BOEM will acquire maps, usage estimates, and analyses of key onshore transportation routes.
Context	Coastal counties and parishes in Texas and Louisiana with transportation infrastructure supporting offshore oil and gas exploration, development and production.

BOEM Information Need(s): BOEM requires a better understanding of onshore transportation associated with OCS activities in order to fulfill its environmental analysis obligations under OCSLA, NEPA, and the CZMA. Onshore transportation systems are critical to OCS activities, and the associated support sectors and activities are substantial inputs to the social and economic onshore consequences of the Leasing Program. Specifically, the agency needs maps and, where possible, usage estimates of major rail, road, and water transportation routes used to support OCS activities. The data will be incorporated into the BOEM MAG-PLAN model and used to support environmental analyses of infrastructure, economics, and social factors.

Background: The social and economic consequences of OCS activities occur onshore; many are associated with onshore infrastructure used to support offshore petroleum exploration, development and use. A great deal of BOEM socioeconomic research has focused on documenting and mapping the major types of OCS onshore support infrastructure, such as ports, fabrication, ship and pipeyards, heliports, and refineries; describing and documenting the industries and activities associated with these infrastructure types; and describing and documenting travel to and from offshore platforms. While BOEM's efforts include transportation systems that link shore to the OCS, they have not systematically addressed the onshore transportation web: the roads, railroads and waterways used in support of OCS-related activities.

The inshore transportation system supports OCS activities by allowing the movement of products among intermediate consumers (e.g., from a factory to platform fabricator) and to the final consumers. Because of the substantial demand for goods generated for OCS-related activities (e.g. pipes and umbilicals, drilling muds), inshore OCS-related transportation sectors, most notably the trucking sector, are also large. Many offshore workers commute long distances to work, which generates additional demands on transportation infrastructures. Much of this OCS-related activity is "intermodal;" equipment, materials, supplies, and people are brought to coastal areas by road, railroad, or waterway and then, are moved offshore after being transferred to a different mode of transportation at ports and heliports or transformed into vessels and platforms in fabrication and shipyards. Just as the offshore side of this system raises assessment issues, the land side does as well, often due just to the scale of the demand and the fact that transportation infrastructure may have its types of socioeconomic problems, some of which may become more pressing as deepwater developments continue to concentrate support-related activities into fewer ports.

Objectives: This study seeks to understand the shore-side part of this intermodal transportation system by focusing on three of its commercial elements: transportation by truck, transportation by water, and transportation by rail. For each of these commercial elements, it seeks a clear picture of the system in terms of economic sectors (i.e the industries involved) and geography (i.e. flows of traffic).

Methods: This study will describe the industry sectors associated with each of the three transportation types in terms of organization, size, employment, industry trends, relationship to the Gulf petroleum industry and offshore oil. This study will identify and map the major onshore transportation routes used for offshore support including highways and key road connections, railroad trunk lines and key service spurs, and canals and other waterways. When appropriate, it will estimate levels of use for components of the systems. For each type of infrastructure, it will identify the various choke points (places where the transportation system is limited and/or the demands on it are high) where offshore has caused problems (e.g., LA 1). Primary and secondary information will be collected from a wide range of sources including: Federal and State government databases, media and trade press publications, commercial sources, and other industry-related information such as trade association-specific publications and press announcements.

Specific Research Question(s):

1. How does the shore-side part of the OCS-related intermodal transportation system function, specifically looking at: transportation by truck, transportation by water, and transportation by rail?
2. For each of these commercial elements what are the economic sectors and industries involved?
3. What is their geography, and what are the flows of traffic? Where are there choke points where transportation needs are close to or exceed the infrastructure?

Title	Meeting the Challenge: Developing Baseline Data Collection and Action Plans
Administered by	GOM OCS Region
BOEM Contact(s)	Victoria Phaneuf, Victoria.Phaneuf@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$225 (in thousands)
Performance Period	FY 2019–2021
Date Revised	December 1, 2017
PICOC Summary	
Problem	BOEM needs an enhanced ability to understand socioeconomic trends and the socioeconomic impacts of catastrophic events in the GOMR.
Intervention	Research and document best practices in socioeconomic monitoring and research on catastrophic events.
Comparison	Compare socioeconomic monitoring and rapid-response research protocols to identify best practices.
Outcome	BOEM will gain information and analysis necessary for its development of monitoring and catastrophic event research protocols.
Context	Catastrophic events in the GOM have highlighted the need for a long-term socioeconomic monitoring program and rapid-response protocols. Regional staff are currently developing these capabilities.

BOEM Information Need(s) to be Addressed: BOEM's social science research program is not organized to respond quickly to catastrophic events with studies of their socioeconomic impacts. As a result, how these events affect communities and the oil industry is poorly understood. This knowledge gap hinders BOEM's ability to analyze catastrophic spill impacts in NEPA documentation, as recommended by the CEQ (2010), and to conduct cumulative analysis under NEPA. Additionally, long-term monitoring on the human environment is mandated in OCSLA and would contribute to National OCS Program development, NEPA analysis of the cumulative effects of OCS activity, and provide a baseline for understanding the impacts of catastrophic events. BOEM does not have a socioeconomic monitoring program or rapid-response research protocol. In order to fill these two knowledge gaps, BOEM needs: 1) a protocol for socioeconomic research in case of a catastrophic event, and 2) a socioeconomic monitoring program. GOMR staff are working to develop a monitoring program and a rapid-response research protocol. This study will support that effort.

Background: Catastrophic events that relate to OCS activities in the GOM, including oil spills and hurricanes, while rare, can have significant and complex socioeconomic impacts. The low rate of occurrence combined with the immediacy of their impacts mean that research efforts are difficult to plan in advance. These research efforts must rely on existing baseline data if they are to illustrate changes resulting from an event.

Such research is difficult to incorporate into existing agency and university studies models that require months or years of planning and contracting before a study can begin. For these reasons, most of the existing research on catastrophic events did not incorporate baseline data or data on immediate impacts. For example, during the *Deepwater Horizon* spill in 2010, BOEM was the only Federal agency that responded with a study of the socioeconomic impacts as they were occurring (Austin et al. 2014). This was not planned in advance: BOEM was fortunate enough to have a seasoned team of contractors conducting fieldwork in the area and could quickly redirect the research. In years following the spill, considerable resources were devoted to understanding the disaster's impacts (NAS 2017), but could not make up for their lack of baseline knowledge and early, sustained data collection.

Rapid-response research protocols exist (*i.e.*, NHC 2017, NIEHS 2017). These protocols are not suited to BOEM's needs because they cover many kinds of disasters and therefore have a steady stream of research opportunities. BOEM's interest is focused on catastrophic events related to its OCS activities. The rarity of such events presents challenges to program and study development and funding not addressed by existing rapid-response protocols.

Although BOEM's geographic focus presents challenges, it also offers an opportunity: socioeconomic monitoring of affected areas would provide baseline information that much rapid-response research lacks. For BOEM, systematic collection of baseline data is already desired to support a holistic understanding of the cumulative impacts of OCS activity. If carefully designed, this will also provide information necessary to studying the impacts of rare events.

Objectives: GOMR staff are working to outline a socioeconomic monitoring protocol and rapid-response research plan. This study will provide expert and technical support by identifying best practices for this research. The objectives for this study are:

1) To identify best practices for designing and enacting a long-term monitoring plan to collect key background data to support research effort on catastrophic events in the GOM.

2) To identify and assess existing protocols for socioeconomic rapid-response research and suggest adaptations to meet BOEM's needs.

Methods: This study will review and analyze existing socioeconomic rapid-response research programs, protocols, and theories to synthesize relevant research and identify best practices for developing a studies program designed to collect baseline information and conduct socioeconomic research on catastrophic events.

Specific Research Question(s):

1. What existing protocols and best practices suit BOEM's research needs for understanding catastrophic events?

2. What baseline data should be collected as part of a long-term monitoring plan to support this effort?

References:

Austin, D., B. Marks, K. McClain T. McGuire, B. McMahan, V. Phaneuf, P. Prakash, B. Rogers, C. Ware, and J. Whalen. 2014. Offshore Oil and the Deepwater Horizon: Social Effects on Gulf Coast Communities. BOEM 2014-617 and BOEM 2014-618. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region.

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National Academy of Sciences (NAS). 2017. Gulf Research Program. Online: http://www.nationalacademies.org/gulf/about/index.html. Accessed January 18, 2017.

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National Institute of Environmental Health Sciences (NIEHS). 2017. NIH Disaster Research Response (DR2). Online: https://dr2.nlm.nih.gov/protocols. Accessed January 18, 2017.

Title	Baseline Monitoring of Avian Activity and Offshore Structure Interactions
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Dave Moran, dave.moran@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$650 (in thousands)
Performance Period	FY 2019–2022
Date Revised	February 15, 2018
PICOC Summary	
Problem	The negative, positive, and overall net effects of offshore structures affecting rest and foraging versus collision of nocturnally migrating bird species of conservation concern need to be identified. Measurements would be used to calculate impact on relative abundances which would be extrapolated to any resultant impact at the global or landscape level depending on whether a species occurs globally or occurs in a specific landscape.
Intervention	For offshore structures in the Gulf of Mexico (GOM), numbers of birds stopping over, attracted but flying by, aggregating, or nocturnally circling (circulating)will be measured. Birds may be feeding on insects attracted to lights (a positive effect) but probably will only do this in the last hour before dawn; or they may be colliding. Numbers engaging in such behavior or having such collision events will be measured during spring migration when birds may be fatigued after trans-Gulf migration or may be prompted by hunger and the onset of dawn to stop and feed.
Comparison	This study will measure the baseline of effects of offshore structures on migrating birds related to resting, foraging, and collisions, rather than measuring a comparison.
Outcome	The net effect of birds stopping over may be positive. That would promote continued use of attracting white lights and would make installation of new attracting structures with their standard white light color beneficial to bird species of conservation concern. However, the net effect may be negative creating a need for potential mitigation (for example, changing colors of much of the lighting to stop attraction).
Context	Bird species of conservation concern that are trans-Gulf nocturnal migrants and distributed throughout the western hemisphere or at a somewhat smaller scale.

BOEM Information Need(s): Information regarding offshore avian activity is needed to provide a better understanding of possible interactions between birds and offshore structures associated with oil and gas activity. Impacts to birds that cause injury or mortality should be avoided, minimized, or mitigated per the Migratory Bird Treaty Act, Executive Order 13186, and the NEPA (National Environmental Policy Act) process.

Background: Millions of birds migrate each year with many crossing the GOM to reach their destinations. In the 1990s, MMS supported a study by Russell (2005) that reported birds that were visually detected from certain oil/gas platforms and included seasonal timing and interactions with the associated structures and variables including weather. This report provided information that was a first attempt to find out about interactions with structures and further study is needed to build on what was captured in the Russell study; avian interactions with offshore structures and trans-Gulf activity should be studied further. This study, proposing both day and night investigation, complements the previous study. That is because the previous study was mostly done during the daytime by observers who needed to sleep at night when most passerine birds migrate and circulate. The previous study included assessment of the cause of death or body condition of birds found on the structures, which is beyond the scope achievable with the sensors proposed in this study. This study will use modern technology such as avian acoustic detectors so a baseline of avian activity in the offshore environment will be better quantified.

Objective: This study will assess attraction followed by rest, collision, or (during the hour before dawn when migrating passerines begin to feed) foraging on insects attracted by lights.

Methods: Bird attraction, stopover, nocturnal circulation, collision, and rest will be assessed using autonomous recording technologies, such as Acoustic and Thermodynamic Offshore Monitoring System (ATOM) and x-band radar to obtain additional information that may be missed during visual and auditory observations. ATOM is capable of detecting bird flight calls and able to visually detect birds approaching offshore structures. ATOM is a fairly large system that uses solar panels for power, but could potentially use electrical power from offshore facilities. X-band radar is a potentially useful technology because it can detect nocturnal circulation and units are fairly compact. Performance-based acquisition will be used to let the contractor (with some input from the government) decide how to select the technology to be used to achieve what the government needs. Market research has already found a unique technology or innovative and unique use of a commercial item considered by the owner to be proprietary information not subject to disclosure by the government. Next-Generation Radar (NEXRAD or Nexrad), which is a network of 158 high resolution Doppler weather radars operated by the National Weather Service, will be used to determine large movements of birds during migration season. Environmental data, including weather and oceanographic parameters, will also be collected to supplement the analyses. Thus, a trained biologist would perform the needed equipment maintenance and provide validation of autonomous measurements while at the facility by providing visual observations during their visit. Industry may be likely to support access if they know that net impacts of offshore technology may be positive. Flying bats at night could create uncertainty of documenting nocturnal circulation in birds.

References:

Russell, R.W. 2005. Interactions between migrating birds and offshore oil and gas platforms in the northern Gulf of Mexico: Final Report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2005-009. 348 pp.

Title	Strategically Focused Support for Oil and Gas Activities in the Atlantic and Gulf of Mexico OCS Regions
Administered by	Gulf of Mexico OCS Region
BOEM Contact(s)	Sindey Chaky, sindey.chaky@boem.gov
Procurement Type(s)	IDIQ Contract
Approx. Cost	Not to Exceed $3,000,000 over 5 years
Performance Period	FY 2019–2023
Date Revised	February 8, 2018
PICOC Summary	
Problem	BOEM needs nimble research efforts that can quickly address issues in a competitive and evolving oil and gas extraction environment.
Intervention	Create a streamlined solution for providing answers to scientific questions within a more truncated timeframe than typical studies allow.
Comparison	Task orders prepared and executed under this contract will give BOEM more timely results than studies requisitioned in the traditional manner.
Outcome	This study will provide BOEM subject matter experts with a fresh toolbox to meet the Bureau's ever-changing scientific challenges.
Context	The Gulf of Mexico OCS region

BOEM Information Need(s): To pursue the efficient execution of the new National Oil and Gas Leasing Program, BOEM requires a mechanism to speed up the development and completion of analyses of socioeconomic and environmental impacts and of the varied organizational and operational changes within the offshore industry that are significant for immediate planning purposes. BOEM needs timely and focused information and analyses to support the Atlantic and Gulf of Mexico Region's environmental impact assessments. BOEM needs critical information, such as projections of gas processing facility new-builds and retrofits, for ongoing scenario development and impact analyses of OCS activities on land use, coastal infrastructure, employment demographics and environmental justice. This study will provide BOEM with reliable support for timely and substantive responses to rapidly changing situations and to the public concerns that they engender.

Background: The petroleum industry as a whole in the Gulf of Mexico Region (GOMR) has matured over several decades and is well developed, expansive, and deeply intertwined in the regional communities and economies of the coastal States. The offshore oil and gas industry changes, often in unanticipated directions. Recently this has included the removal of the Oil Export Ban; development of new facilities to export oil and liquid natural gas; rapid changes in the international business climate, business practices, industry reorganizations, mergers and outsourcing; advances in technology; and significant energy market shifts in response to the customary and often volatile

fluctuations in oil and gas prices. As a consequence, the onshore social and economic impacts of offshore energy development are also changing.

Objectives: The goal is for BOEM to be able to rapidly address issues that arise and require quick answers from experts when time constraints inherent in NEPA schedules do not allow for targeted study development, election to and placement on the National Studies List, and peer-reviewed research.

Methods: Methods may include but are not limited to: literature reviews, data collection from publicly available sources, targeted or guided conversations with industry officials, workshops, and statistical and econometric analyses. Task orders under this study will not employ any method that would require OMB clearance under the Paperwork Reduction Act.

Research activities will be detailed at the task order level and may include short-term, precise efforts as issues critical to impact assessments arise as well as longer-term projects. The identification of specific tasks to be addressed and resources to be allocated will be done as needed and may include the following activities:

- Developing specific forecasting components for BOEM NEPA scenario projections (e.g., helicopter trips, pipeline landfalls)
- Identifying socioeconomic consequences of changes occurring within the industry that affect long- and short-term planning, operations, labor demand, distribution, and/or activity levels.
- Providing trend analysis of a specific industry sector (e.g., geotechnical services), including the identification and evaluation of its socioeconomic consequences (e.g., technologies, capitalization, purchases, labor demands, and geographic distribution).
- Determining the immediate economic and social impacts from natural and human-caused emergency events (e.g., hurricanes, oil spills)
- Pinpointing social and economic consequences to communities, counties/parishes, county/parish aggregations from the operations of (or changes in the operations of) the industry or specific sectors of the industry at the community, county/parish, or State level.
- Conducting GIS analysis or developing maps of relevant geographic information, including infrastructure, socioeconomic data (population, income, race/ethnicity, employment, etc.).
- Conducting meetings or workshops to present and discuss findings of targeted research resulting from a task order under this contract.

Anticipated deliverables that may be produced under this study include, but may not be limited to, status reports, white papers, study reports, models, presentations, maps, field reports, databases, bibliographies, and literature reviews.

Specific Research Question(s):

1. How can we best create models to forecast helicopter trips in the GOMR, and what kind and level of helicopter activity might we be able to expect as the Atlantic Region (AR) is developed?
2. What do the service vessel construction and labor markets look like in the GOMR and how might they develop in the AR?
3. What are the recreational resources that span the AR and what space-use conflicts may arise from OCS activities as they relate to these identified recreational resources?

Title	BOEM-MARINe (Multi-Agency Rocky Intertidal Network)
Administered by	Pacific OCS Region
BOEM Contact(s)	Lisa Gilbane, lisa.gilbane@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$1,798 (in thousands) [$6 in Year 1 and $448 per year in Years 2–5 (in thousands)]
Performance Period	FY 2019–2023
Date Revised	March 2, 2018
PICOC Summary	
Problem	Active oil and gas operations can significantly impact rocky intertidal resources. Many sectors of the public visit and care strongly about his habitat because rocky shorelines are a sensitive habitat and home to a diversity of species, including the endangered black abalone. Monitoring rocky shores annually is the only way to determine if there are impacts caused from OCS operations and to be able to understand the cumulative impacts to this sensitive habitat.
Intervention	Continue to support long-term monitoring of this habitat. Statistical analyses show this protocol is a powerful way to detect change over time. Additional site-wide protocols are conducted to understand changes among sites. Prior efforts indicate that OCS oil and gas-related activities are not a primary impacting factor and that can be distinguished against several other anthropogenic effects.
Comparison	This program can only make regional comparisons by relying on monitoring outside of OCS activity areas, which is done with identical methods and funded by our 40 universities and agency partners. These data have also been utilized in BACI-based analyses of non-OCS oil spills, water pollution, and marine protected area assessments.
Outcome	Trends impacting rocky shore species, such as human trampling and disease, are expected to intensify along with continued oil and gas production. We will continue to monitor community metrics as well as the abundance and size-structure of protected species and key physical factors inside and outside of potential OCS-related impact areas. This design enables us differentiate OCS activities impacts from changing environmental conditions.The public engagement with this program will continue to be strong and results will directly inform NEPA and ESA consultations as well as significantly benefit the State of California.
Context	Southern California, Central California, Oregon BOEM's support of this program is an example of our long-term commitment to being environmental stewards on a topic that is important to the public and in areas at risk from OCS activities. It is important to continuing this program in the context of proposed expanded OCS leasing on the U.S. West Coast.

BOEM Information Need(s): Current and Planned Outer Continental Shelf (OCS) operations are very visible little more than three miles from shore and a strong public concern because of previous oil spills to this region. Tar naturally and regularly shows up on shorelines throughout California. As required from the OCS Lands Act, BOEM needs to regularly monitor vulnerable and sensitive resources adjacent to ongoing OCS activities. Rocky shore communities were chosen 20 years ago as key resources to monitor because they are rare and unique only to the three ocean-upwelling regions in the world. Also, multiple species are long lived and an important resource to many fishes, birds, and mammals.

BOEM and the State of California have needed rocky shore community metric data for evaluating oil spill impacts, water quality discharges, and adjacent Marine Protected Areas. We anticipate this type of information will continue to be needed for decommissioning and new leasing projects. BOEM has a specific continual need for black abalone count and size data as well as abalone habitat quality assessments for Endangered Species Act and Essential Fish Habitat consultations. This the only source of data available for the endangered black abalone on the mainland of California and in the past, these data were utilized for the listing, and establishment of critical habitat for black abalone (Miner et al. 2006).

Background: This study, Multi-Agency Rocky Intertidal Network (MARINe), provides funding to monitor all 32 BOEM long-term monitoring rocky shore sites, with 24 adjacent to OCS operations in California and 8 sites off the Oregon coast where an OCS offshore wave facility is planned. MARINe began formally in 1997 after the Exxon Valdez spill and the realization that oil spill impacts can only be assessed when baseline data are available. MARINe supports important Federal and State management decisions not envisioned in 1997. In addition to the black abalone endangered species listing described above, these data were critical to the State of California for analyses of non-OCS oil spills, water pollution, and Marine Protected Areas. MARINe needs to continue to facilitate detection of new trends, such as determining the 90 percent decline in ochre stars along the U.S. West Coast (Miner et al., 2018; Moritsch and Raimondi, in press).

MARINe is a cost-effective program that heavily relies on leveraged funds. Primary long-term partners include the State of California, the US Navy, and five National Park Service groups. BOEM only supports monitoring in areas adjacent to OCS activities but BOEM uses data collected from these partners as reference conditions. BOEM supports approximately one-third of the overall database and website costs. MARINe's shared methods and data pipeline are praised by the States and are used as a model for other ecological programs. The payoff of BOEM's long-term support is that rocky intertidal data on the U.S. West Coast can be accessed and analyzed by interested stakeholders. Analyses are not limited by access to data or constraints of joining separate methods. Although MARINe partners benefit, this structure also enables citizen groups to get involved, thus fostering positive interactions and facilitating learning opportunities with the public. MARINe jointly publishes 1–3 papers in scientific journals per year, averages 25–35 data requests per year, and averages 2,000 hits a month on its website.

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

- Determine the trend over time (in percent cover or counts sampled once a year) for selected species and communities in fixed plots at 32 sites along the U.S. West Coast.

- Determine the species diversity and other community and compare among sites.

- Measure size-structure (as a proxy for age class) of black abalone, owl limpets, and sea stars change over time and in response to punctuated impacts.

- Analyze communities and selected species near to and away from OCS activities in California and Oregon.

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

Data are placed in a common database and are accessible through graphing, downloads, and map visualizations, as well as through specific requests to the database manager. Improving public data access is a goal. Improved access is linked to data assurance measures; database management includes quality control measures for data entry such as updates to web and app-based forms and scripts to detect errors.

To ensure that future groups know which species MARINe sampled, the prior five-year effort successfully collected and archived representative species from each field group with the Smithsonian. This vouchering and archival effort will be continued at the remaining unsampled sites and species in California and in Oregon in coordination with partners pursuing eDNA library development. Improved quality assurance and control of this long-term program will also include better and public documentation of field and database protocols. BOEM continues to participate actively in the management and oversight of MARINe, to access the data critical to our ongoing operations, and to fulfill our responsibility to monitor OCS platforms and pipeline operations.

Specific Research Question(s):

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

References:

Miner, C.M., J.M. Altstatt, P.T. Raimondi, and T.E. Minchinton. 2006. Recruitment failure and shifts in community structure following mass mortality limit recovery prospects of black abalone. *Marine Ecology Progress Series*, Vol 327:107-117.

Miner, C.M., J.L. Burnaford, R.F. Ambrose, L. Antrim, H. Bohlmann, C.A. Blanchette, J.M. Engle, S.C. Fradkin, R. Gaddam, C.D.G. Harley, B.G. Miner, S.N. Murray, J.R. Smith, S.G. Whitaker, and P.T. Raimondi. 2018. Large-scale impacts of sea star wasting disease (SSWD) on intertidal sea stars and implications for recovery. *PLOS ONE*.

Moritsch, M. and Raimondi, P.T., In press. Reduction and recovery of keystone predation pressure after disease-related mass mortality. *Ecology and Evolution*.

Title	Supplemental Data Regarding the Behavioral Response of Rock Crabs to the EMF of Subsea Cables and Potential Impact to Fisheries
Administered by	Pacific OCS Region
BOEM Contact(s)	Lisa Gilbane, lisa.gilbane@boem.gov Donna Schroeder, donna.schroeder@boem.gov
Procurement Type(s)	Contract or Cooperative Agreement
Approx. Cost	$150 (in thousands)
Performance Period	FY 2019–2020
Date Revised	March 2, 2018
PICOC Summary	
Problem	BOEM requires information concerning the level of impacts from seafloor power cables on marine fisheries. Fishermen are concerned that electromagnetic fields (EMF) associated with renewable energy power cables will present an electrified fence on the seafloor that their resource will not cross. BOEM funded an earlier study that showed crabs can cross an electrified cable but the effectiveness of the experimental design should be confirmed.
Intervention	Conduct additional field surveys to supplement earlier work to verify and resolve experimental design of the initial study.
Comparison	Compare original conclusions with new conclusions that will be derived using supplemental data to determine if they are different
Outcome	EMF impacts to the crab West Coast fishery needs to be addressed and completely examined. This supplemental study enable a full discussion and will enhance the interpretation of the original work.
Context	All Pacific OCS planning areas (U.S. West Coast and Hawaii)

BOEM Information Need(s): BOEM requires information concerning the level of impacts from seafloor power cables on marine fisheries. Fishermen are concerned that EMF associated with renewable energy power cables will present an electrified fence on the seafloor that their resource will not cross. BOEM also needs scientific results can be interpreted clearly for decision making.

Background: BOEM funded a study, Potential Impacts of Submarine Power Cables on Crab Harvest (NSL #PC-14-02), designed to test the fear of crab fishermen that their target species will not traverse power cables, even in response to baited traps. Combined with the assistance of professional fishermen, submarine transmission cables that electrify communities and offshore oil platforms in the Pacific Region provided an opportunity to test frequency within which rock crab and Dungeness crab cross power cables. Results of this study show that crabs will indeed cross an electrified cable in response to a baited trap. However, in order to support a conclusion that electrified cables have “no impact” on these fisheries, BOEM needs to do additional work. It is possible that due to the design, the responses are confounded with other environmental

responses other than EMF. That issue needs to be clearly resolved in order to report a clear results, which is of interest to the fishing community.

Objectives: To verify the behavioral response of commercial crab species in the presence of electrified cables associated with renewable energy projects and controlling for environmental conditions.

Methods: Conduct field experiments that place baited traps up current at Santa Ynez Unit power cables and in a control area away from the cables offshore of Santa Barbara, California. This will be done by catching and holding rock crab, releasing crabs down current from power cables and at similar distance from control traps, and maintain traps, monitor, and record catch per fishermen's practice. Prior to the field work, a power analysis will determine the number of crabs, number of traps, and number of trials needed. Current direction and intensity will be measured throughout the experiment. EMF will be measured before and after the trials.

Specific Research Question(s): Do electromagnetic fields from subsea cables affect the behavior of commercially important rock crabs?

Title	Offshore Acoustic Bat Study Along Western U.S. Continental and Hawaiian Island Coastlines
Administered by	Pacific OCS Region
BOEM Contact(s)	David Pereksta, david.pereksta@boem.gov
Procurement Type(s)	Contract, Interagency Agreement, or Cooperative Agreement
Approx. Cost	$300 (in thousands)
Performance Period	FY 2019–2022
Date Revised	March 2, 2018
PICOC Summary	
Problem	A variety of bat species are known to seasonally occur offshore, but no systematic surveys have been conducted for them in the Pacific. These bat species are at risk from offshore energy development; particularly wind turbines.
Intervention	A systematic study of offshore acoustic bat activity along the western continental U.S. and Hawaiian coastlines, would help address key resource agency concerns in advance of anticipated coastal and offshore developments in this region.
Comparison	Collect new information regarding the temporal and spatial activities of migratory and non-migratory bat species in offshore and coastal areas of the Pacific.
Outcome	Provided Federal/State resource agencies and developers with key metrics to evaluate mortality risk associated with offshore wind energy development. Such data would boost our ability to manage risks to bats associated with offshore development by providing critical baseline data regarding the spatial and temporal occurrence of rare and otherwise vulnerable bat species within these western regions.
Context	All Pacific OCS planning areas (U.S. West Coast and Hawaii)

BOEM Information Need(s): BOEM needs to understand the temporal and spatial distribution of bats offshore of the Pacific coast of the U.S. and Hawaii to evaluate the effects of offshore wind energy development on them.

Background: A variety of bat species are known to seasonally occur offshore and have been documented at distances of as much as 805 km (500 miles) from coastal shorelines (Pelletier et al. 2013, Griffin 1940). Direct studies of offshore bat activity have nevertheless occurred only at scattered locations within the New England, Mid-Atlantic coast, and Great Lakes regions. These efforts, supported in part by the Department of Energy, involved a sustained, three-year deployment of acoustic bat detectors in a variety of remote coastal and offshore settings, including offshore islands, navigational structures, IOOS buoys, and NOAA research vessels (Peterson et al. 2016). This study yielded a wealth of new information regarding the temporal and spatial activities of migratory and non-migratory bat species, and provided Federal/State resource agencies

and developers with key metrics to evaluate mortality risk associated with offshore wind energy development. Long-distance migratory species such as hoary bats (*Lasiurus cinereus*), eastern red bats (*L. borealis)*, and silver-haired bats (*Lasionycteris noctivagans*) comprise most mortality at terrestrial wind farms and are known to regularly occur offshore based on the abovementioned acoustic surveys in the northeast. In addition, the documented mortality of Hawaiian hoary bats (*L. c. semotus*) at terrestrial wind farms on the Hawaiian Islands is occurring at a rate far exceeding that projected in environmental analyses and incidental take permits issued for those projects, which has raised concerns regarding this species offshore of the Hawaiian Islands (Hawaii DLNR 2016). A systematic study of offshore acoustic bat activity along the western continental U.S. and Hawaiian coastlines would help address key resource agency concerns in advance of anticipated coastal and offshore developments in this region. Such data would boost our ability to manage risks to bats associated with offshore development by providing critical baseline data regarding the spatial and temporal occurrence of rare and otherwise vulnerable bat species within these western regions.

Objectives: The objectives of this study are to 1) enhance the understanding of seasonal offshore bat migration activities offshore of the U.S. West Coast and Hawaii; 2) increase monitoring of seasonal bat activities in the Pacific to produce regional datasets; and 3) evaluate mortality risk from offshore energy development

Methods: A sustained, multi-year deployment of acoustic bat detectors in a variety of remote coastal and offshore settings, including offshore islands, navigational structures, IOOS buoys, oil and gas platforms, and NOAA research vessels. The study will incorporate logistical and technical lessons gathered during the DOE study conducted in the New England, Mid-Atlantic coast, and Great Lakes regions (Peterson et al. 2016) to support efficient and cost-effective methods to gather these data in support of meeting renewable energy objectives. Previously forged agency/NGO partnerships will be utilized where appropriate.

Specific Research Question(s):

Relative to potential wind energy development off the Pacific coast of the U.S. and Hawaii:

1. What is the temporal and spatial distribution of bats offshore of the Pacific coast of the U.S. and Hawaii?
2. What are the metrics to evaluate mortality risk associated with offshore wind energy development?

Title	The Ecological Status of Artificial Reefs Offshore California
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder, donna.schroeder@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$750–$850 (in thousands) [Matching funds $250, pending matching funds $250 (in thousands)]
Performance Period	FY 2019–2021
Date Revised	May 17, 2018
PICOC Summary	
Problem	Decision makers need information about how offshore projects that add significant amounts of hard substrate into the marine environment may be evaluated, managed, and potentially incorporated into an artificial reef program.
Intervention	Field surveys of natural and artificial habitats and subsequent analyses of survey data
Comparison	Comparisons among natural and artificial habitat types according to depth and biogeographic zone
Outcome	Evaluation criteria that can be used to inform reefing decisions by the State of California, BOEM, and BSEE; information about potential artificial reef consequences of offshore wind in the California Current System
Context	Southern California Planning Area

BOEM Information Need(s): Offshore energy development changes the distribution and abundance of local marine habitats and species via the introduction of artificial substrate. This "artificial reef" effect potentially modifies a variety of local and regional processes, including those that drive the ecological dynamics of managed, sensitive, or non-native species. Artificial reefs may also enhance certain human activities such as fishing or diving. Decision makers must therefore understand how offshore projects that add significant amounts of hard substrate into the marine environment may be evaluated, managed, and potentially incorporated into an artificial reef program. In the Pacific Region, habitat issues are of particular importance due to (1) the imminent decommissioning of oil and gas platforms, which may remove potentially important habitat for managed fish species, and (2) the introduction of new artificial habitat from floating offshore platforms.

Background: The National Fishing Enhancement Act of 1984 (NFEA; 33 U.S.C. 2101) was enacted to promote and facilitate efforts to establish artificial reefs in U.S. waters. The NFEA calls for the use of the best scientific information available to site, construct, and subsequently monitor and manage artificial reefs in a manner which will enhance fishery resources to the maximum extent practicable, minimize environmental risks,

and avoid conflicts with other stakeholders. To accomplish these goals the NFEA directed the formation of a National Artificial Reef Plan (NARP).

On the OCS, a departure from complete platform removal during decommissioning may be granted to a lessee if the remaining structure is incorporated into a state artificial reef program that complies with the NARP and satisfies the U.S. Coast Guard navigational requirements. In southern California, it remains undetermined to what extent platform habitat and other similar man-made structures (such as metal-hulled shipwrecks) contribute to regional scale ecological dynamics compared to natural substrates. This is due in part to the lack of a comprehensive understanding of the extent of man-made habitat available and variation in the quality of these habitats across the Southern California Bight (SCB). Because of the necessity of the State of California's acceptance of a reefed platform into their artificial reef program, current information needs include understanding the status of the current network of artificial habitats in California and determining how these artificial habitats are functioning in reference to nearby natural areas.

Objectives: The overall objective of this study is to evaluate the current status of artificial reef habitat in the Southern California Bight (SCB) to inform future National Environmental Policy Act (NEPA) analyses regarding the ongoing and proposed changes to marine habitats from offshore energy activities, and to provide guidance to assess and manage future artificial reef proposals and projects at a regional scale, especially Rigs-to-Reefs projects.

Methods: Using available information on the distribution of artificial reefs offshore southern California (e.g., Lewis and McKee, 1989), the physical state of artificial reefs will be determined using standard seafloor mapping techniques. Biological characteristics will be assessed using visual surveys via SCUBA divers, remotely operated vehicles, or submersibles. Sociological status (human use) will be assessed by summarizing recreational fishing data, direct observation, and by collecting new data via guided discussions with stakeholders. Similar data on selected nearby natural habitats will also be collected to provide a basis for comparison. The data collected will be analyzed using multivariate statistical methods (e.g., boosted regression trees) to identify characteristics of natural and artificial reefs associated with high productivity and resilience. Ecosystem services will also be analyzed.

Specific Research Question(s):

1. What is the physical, biological, and sociological status of planned and de facto artificial reefs in California, and are these reefs are functioning as intended?

2. Which physical, biological, or geographical features are important in determining the ecological status and productivity of these reefs?

3. What criteria should be used to evaluate future artificial reef proposals to determine environmental benefits and ecosystem services?

References:

Lewis, R.D., and K.K. McKee. 1989. A Guide to the Artificial Reefs of Southern California. California Department of Fish and Game, 72 p.

National Oceanic and Atmospheric Administration (NOAA). 1997. National Artificial Reef Plan (as Amended): Guidelines for Siting, Construction, Development, and Assessment of Artificial Reefs. 60 p. http://www.nmfs.noaa.gov/sfa/management/recreational/documents/narp_cover_3.pdf, downloaded January 24, 2017.

Schroeder, D.M. and M.S. Love. 2004. Ecological and political issues surrounding decommissioning of offshore oil facilities in the Southern California Bight. Ocean & Coastal Management 47:21–48.

Title	A 3-D Assessment of West Coast Continental Shelf Seabird Density: Species Composition at Different Heights above the Sea Surface
Administered by	Pacific OCS Region
BOEM Contact(s)	David Pereksta, david.pereksta@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$150 (in thousands)
Performance Period	FY 2019–2021
Date Revised	March 2, 2018
PICOC Summary	
Problem	Marine birds may be impacted by offshore wind turbines, including possible turbine avoidance and risk of collision. To date, assessments of potential impacts to marine birds have focused on quantification of spatial use of OCS waters.
Intervention	Combine at-sea seabird data and analyses indicating seabird flight characteristics as a function of wind strength, and models of the windscape in West Coast coastal and offshore areas. From these data, devise a 3-D model of seabird use of OCS waters and how it would be affected by winds.
Comparison	Show identified seabird hotspots not just in terms of species composition but also in vertical space use in strong wind conditions. In that regard, the seabird species composition would differ at different heights above the sea surface as a function of seabird flight behavior as affected by wind strength.
Outcome	Predicted species composition and densities of seabirds in coastal waters of the Pacific at several height strata above the ocean surface (e.g., 10, 30, 50 m), as a function of the 'windscape" as affected by wind speed at various rates: <20, 20-30 and >30 kts. Data will be binned into 5'x5' cells.
Context	All Pacific OCS planning areas (U.S. West Coast and Hawaii)

BOEM Information Need(s): BOEM needs to address potential seabird interactions with wind energy infrastructure off the U.S. West Coast and Hawaii, where the availability of at-sea seabird data are the most complete and intensive in U.S. waters. BOEM has a need to combine at-sea seabird data sets, data and analyses indicating seabird flight characteristics as a function of wind strength, and models of the windscape in West Coast coastal and offshore areas to show seabird hotspots not just in terms of species composition but also in vertical space use of seabirds in strong wind conditions.

Background: To date, most of the research on seabird spatial use of potential offshore wind project areas has been conducted in Europe, where the seabird species composition is quite different from that of the U.S. West Coast and where the conditions under which data were gathered were in 'moderate' winds (e.g., Cook et al. 2012; Johnston et al. 2013). In the European studies, the coastal species mix includes mostly ducks, loons, grebes, shags, gulls, terns and alcids. All of these species typically use

'flapping' flight in most wind conditions, which gives them more control over their flight trajectories compared to flight behavior that includes relatively extensive periods of gliding. Moreover, flappers typically fly just above the sea surface to exploit lower wind strengths found there, and easily avoid large objects, such as buoys, wind turbines and ships. Such research, while instructive, does not provide information on the wind conditions that most offshore seabirds experience, at least episodically, e.g. in storms or even in persistently strong winds, nor with respect to the species mix that is typical of the West Coast. In West Coast waters there is a much higher prevalence of gliding and flap-gliding species (pelicans, boobies, shearwaters, albatrosses, and fulmars) , whose behavior and height above the sea surface changes with wind strength (Ainley et al. 2015). Winds off the U.S. West Coast during the upwelling season typically reach 30–35 kts daily, greatly exceeding the wind conditions investigated off European shores. While such a wind regime is ideal for energy generation, it offers challenges to avoiding impacts to wildlife.

Objective: Predict the risk of seabirds within different flight style guilds to collision with offshore wind turbines in the Pacific in three dimensions.

Methods: Combine seabird densities and behavior, as a function of wind, with remotely sensed wind products derived from satellite scatterometers. From this information, make predictions about the risks involved among West Coast seabirds to wind turbines, developing a spatially explicit data layer that accounts for the frequency of strong wind events. This will enhance our ability to address the sensitivity of particular vulnerable species (e.g., soaring seabirds) and inform selection of ocean habitat for wind farm development. For the entire U.S. West Coast westward to the continental shelf break, Derive a geospatial index that incorporates the frequency of strong wind events (days per month and by wind direction; Miller et al. 2014), providing a 3-D picture of seabird occurrence as a function of wind.

Specific Research Question(s):

1. What are the siting risks associated with 3-D wind use among West Coast seabirds to collision with wind turbines?
2. Can we develop a spatially explicit data layer that accounts for the frequency of strong wind events that can be used to predict turbine-collision risk?

References:

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Johnston, A., A. S. C. P. Cook, L. J. Wright, E. M. Humphreys, and N. H. K. Burton. 2013. Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology 51(1):31–41.

Kinlan, B., A. Winship, R. Rankin, P. Miller, and J. Christensen. 2015. Applications of a model-based U.S. Atlantic coast-wide synthesis of at-sea marine bird distributions to ocean energy spatial planning. Abstract, Pacific Seabird Group, San Jose, California.

Title	Understanding Biological Connectivity Among Offshore Structures and Natural Reefs
Administered by	Pacific OCS Region
BOEM Contact(s)	Susan Zaleski, susan.zaleski@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$800 (in thousands)
Performance Period	FY 2019–2022
Date Revised	March 2, 2018
PICOC Summary	
Problem	How biologically connected are platforms to each other as well as mainland and Island Natural reefs. How does this connectivity influence non-indigenous species (NIS)? Would reefed platforms enhance the presence of NIS on natural reefs?
Intervention	Utilize genetic analyses to test connectivity hypotheses.
Comparison	Compare genetic results to oceanographic modeling to confirm/refute hypotheses of connectivity and ecological value for invertebrate communities.
Outcome	Utilize study results to inform National Environmental Policy Act (NEPA) reviews for decommissioning and siting of renewable energy facilities.
Context	All Pacific OCS planning areas (U.S. West Coast and Hawaii)

BOEM Information Need(s): BOEM needs to confirm/refute these hypotheses to have a definitive answer when conducting environmental reviews for decommissioning alternatives and potential marine renewable energy installations. This will also enable BOEM to comply with the duties of Federal agencies that are outlined in Section 2 of Executive Order 13112 (Invasive Species).

Background: Oceanographic modeling suggests various degrees of potential connectivity among Pacific Outer Continental Shelf (OCS) platforms, harbors, and natural habitat for invertebrate taxa with a representative range of planktonic larval durations (PLD) that provides a basis for hypothesis testing using genetic analyses (Simons et al. 2016). Particular taxa of interest include the NIS *Watersipora subtorquata*, with a very short PLD of 24 hours, and two native bivalves, a scallop and a mussel, both with PLDs of days to weeks. Dispersal of these invertebrate species to new sites occurs during the planktonic larval stage when they can be transported from a parent population to other artificial and natural habitats by ocean currents. The degree of exchange of these propagules between source and destination sites is a measure of habitat connectivity. Anthropogenic structures, such as offshore oil platforms and shipwrecks, provide novel attachment substrate for encrusting invertebrates, and it has been proposed that these structures increase habitat connectivity by serving as "stepping stones" that may increase the potential success of dispersal (Sheehy and Vik 2010; Adams et al. 2014). As such, artificial substrate may facilitate the establishment

and spread of NIS and other species by providing novel habitats where none existed previously, and may provide a source of larvae of native species such as the rock scallop and sea mussel to populations in natural habitats (Mineur et al. 2012).

Objectives: The overall objective of this study is to test hypotheses on biological connectivity among artificial and natural habitats using genetic markers.

Methods: To meet the overall study objectives, three tasks will be performed.

1) Use molecular markers to test the prediction that populations of species with short PLDs will be more similar genetically in habitats in close proximity than those farther apart, whereas, the genetic structure of native species will be more homogenous across sites.
    a. Scuba divers will sample NIS and native species on (a) oil and gas platforms, (b) harbors, (c) shipwrecks, and (d) nearby natural reefs in sufficient detail for the genetic analysis. Next-generation sequencing (NGS) technology will be used to profile genetic variation of the target species and genotypes will be determined by counting multi-sample alleles.

2) Estimate biological connectivity among anthropogenic structures and natural reefs using the data from task 1 and standard genetic connectivity estimates, and use these results to identify possible sources of larvae to platforms and natural reefs.
    a. These results will build on previous studies' predictions of potential connectivity developed from oceanographic and larval tracking modeling. This task will model larval dispersal pathways to and from oil and gas platforms, harbors, shipwrecks, and reefs and identify vulnerable steps in the life history of NIS that can be used to manage future colonization risk (see task 3). In addition it will assess the role that platforms may have as a source of scallop and mussel larvae to natural habitats.

3) Develop an early detection and rapid-response monitoring plan.
    a. Once the biological data have been collected and synthesized with other available information, the study will assess the effects of location and spacing of artificial structures on natural biological communities that will inform biological effects from spacing of potential renewable energy installations and develop an early detection and rapid-response plan. This plan may include managing point sources and vectors, and other potential actions. Finally, the study will examine potential Rigs-to-Reefs proposals and how they may affect the risk of NIS establishment to natural habitats.

Specific Research Question(s):

1. Is invertebrate species dispersal greater in the offshore than in the nearshore environment?

2. Are there distinct genetic structures on groups of offshore platforms, harbors, shipwrecks, and natural reefs for native and non-native species?
3. Is gene flow between populations more restricted for species with spatially limited planktonic dispersal?
4. Do the genetic structures lead to confirming specific pathways for non-native species introductions?
5. What are the effects of location and spacing of artificial structures on natural biological communities?

References:

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Title	California Deepwater Investigations and Groundtruthing (Cal DIG) II
Administered by	Pacific OCS Region
BOEM Contact(s)	Lisa Gilbane, lisa.gilbane@boem.gov Donna Schroeder, donna.schroeder@boem.gov
Procurement Type(s)	Interagency Agreement with USGS and/or NOAA
Approx. Cost	$1,250 (in thousands)
Performance Period	FY 2019–2022
Date Revised	March 2, 2018
PICOC Summary	
Problem	Seafloor habitats and the commercially important fish and invertebrates that utilize these habitats could be affected by leasing activities offshore California.
Intervention	The solution is to understand what types of habitats exist near potential BOEM activities and how fish and invertebrate species utilize these habitats based on correlations to selected species and abundances.
Comparison	We will select areas that give us the broadest range and variability in habitats that could exist within a geographic area relevant to BOEM renewable energy activities.
Outcome	Benthic communities and commercially important species will be identified and correlated with specific features, habitats, and environmental conditions.
Context	There are two potential domains: northern California OCS and south-central California OCS. One domain will be chosen by accessing data currently being collected, existing model outputs, and where the potential for leasing is highest.

BOEM Information Need(s): BOEM needs basic, regional data on the geology and biological community structure and use of the seafloor in many parts of the California OCS. The offshore of California has proven to be a region of competitive interest for the development of energy on the OCS. BOEM and the State of California are currently identifying potential lease areas after receiving notification of interest from several commercial companies for floating wind renewable energy development. The south-central area has been the primary target because an obsolete power plant at Morro Bay retains a connection to the California electrical grid. In addition, this area has been proposed as an area for new OCS oil and gas leasing, and currently has active oil production from OCS leases. Northern California is also of interest because it has the strongest wind resources in the state and a need for a local power source.

The seafloor in the two areas of potential development offshore California are focused on 300–1,100 m depths and contain seafloor areas which are valuable to commercial fisheries, unique coral and chemosynthetic seeps, and potentially other sensitive areas, which BOEM will need to consider in its decisions regarding leasing. Results from this study will provide a regional understanding of sensitive areas and use by selected fish

and invertebrate species. That regional context is needed to evaluate future applicants' site-specific surveys. This research will enhance understanding of the structure and function of significant biological communities and help BOEM define and delineate unique seafloor areas offshore California. Biologically based habitat use and characterization information will aid both renewable and conventional energy needs through National Environmental Policy Act (NEPA) documents and supporting consultation and analysis requirements under the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and the National Historic Preservation Act.

Background: Fish associations with habitat, and specifically corals, give mixed responses dependent on species and locations (Tissot et al. 2006, Auster 2005, Hourigan et al. 2017). For much of the shelf off of California, this habitat has also been impacted by bottom trawling, with some of that area then conserved over ten years ago (Hixon and Tissot 2007, Lindholm et al. 2015). Few visual surveys are available for the proposed areas of interest. The Long Term Ecological Research project has supported and supplemented the long-standing California Cooperative Oceanic Fisheries Investigations surveys in the southern portion of the proposed area focusing offshore Point Conception on mid and surface water oceanography and biological sampling. Inshore, the State of California has supported video surveys to evaluate the effects of Marine Protected Areas (Ortiz and Tissot 2008; Starr et al. 2008). Surveys to the south and in National Marine Sanctuaries in the general bathymetric range of 300–1,000 m documented diverse and sensitive habitat types including statistically significant populations of high-relief hard bottom substrates, hard and soft deepwater corals (Greene et al. 2003), and canyon-wall areas with a high diversity habitats (Hixon, Tissot and Pearcy 1991). Fisheries landings and 300 m resolution soundings data suggest similar canyons and features that support corals and high diversity exist in the area of interest.

BOEM and the U.S. Geological Survey (USGS) initiated geophysical surveys in the area of south-central California (20–35 mi offshore, 500–1,200 m water depth). That effort will assess regional hazards and create habitat maps by collecting regional bathymetry (10 m resolution) and reflectivity of the seabed, as well as ground truth-related sampling. Cal DIG I data are necessary and will be used to direct subsequent biological surveys for this proposed study. To the north, USGS is collecting geophysical data that will be needed to select habitat type for visual transect surveys. The deepwater environment offshore California is large and one cruise cannot yield the final answer to the question of seafloor use and ecology by commercially important fishes. However, the currently funded acquisition of sensor data, along with commitments to partner from USGS, NOAA, and the Monterey Bay Aquarium Research Institute (MBARI) make this the ideal time to define habitats and link those habitats with fish use and abundance, for an area that will inform BOEM decisions.

Objectives: The purpose of this study is to provide BOEM with a regional level characterization and relative use of seafloor (benthic) habitats to selected fish and invertebrate communities in anticipation of commercial energy installations.

1) Identify and map major geologic features and habitats of the seafloor.

2) Identify the distribution and abundance of benthic communities and selected commercially important fish and invertebrate species, which could include areas of fish refugia, deepwater coral communities, chemosynthetic areas, and historic properties (shipwrecks).

3) Assess relative habitat use and sensitivity of selected areas by comparing food-web ecology, coral age-structure, and genetic diversity across depths and environmental gradients.

Methods: BOEM and the State of California management will prioritize from multiple target areas discovered in Cal DIG I or USGS current mapping surveys. Biological and limited physical sampling are planned focusing primarily on remotely operated vehicles (ROVs) capable of performing high-definition visual surveys of roughly 20 days at sea and sampling at depths of 300–1,100 m. Physical measurements at the seafloor will include temperature, bottom sediment type, grain size, and currents, if possible. Multiple survey transects will be conducted to quantify invertebrate and demersal fish assemblages with the surficial geology (Blanchard et al. 2008). The ROV or submersible will also collect limited samples of coral and sponge species for taxonomic, genetic identification, isotopic testing, and submission to the Smithsonian Institution under an existing BOEM Agreement. Invertebrates in soft-bottom areas will be collected by grabs to identify rare or unique species assemblages. To the extent possible, archaeological investigation(s) will be conducted on potential historic shipwrecks encountered during the Cal DIG I surveys. Shipwreck encounters are a possibility because this was, and is, a frequent route to San Francisco from points south.

Substantial work is anticipated to process, analyze, and interpret collected data. Video will be viewed multiple times to quantify biological species, unique seafloor features, and possible historic properties. Species will be identified to appropriate taxonomic units and analyzed using statistical and multivariate analyses. A subset of species groups will inform Coastal and Marine Ecological Classification Standard Biota mapping classifications and existing habitat suitability models to create geospatial maps. End products will include community and distribution analysis of invertebrates and fishes, geospatial maps of biological habitats across the whole region, and identification of unique seafloor features. The contractor will produce a final written report that summarizes the analysis and interpretation as well as provide associated maps and databases.

Specific Research Question(s):

1. What are the major features and habitats of the seafloor relative to OCS leasing areas?
2. How do benthic communities and selected commercially important fishes utilize the seafloor habitat?
3. What is the relative connectivity of selected seafloor associated communities and start to assess their vulnerability to disturbance?

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Title	A Marine Biogeographic Assessment of the California Current Ecosystem
Administered by	Pacific OCS Region
BOEM Contact(s)	Greg Sanders, greg.sanders@boem.gov
Procurement Type(s)	Interagency Agreement
Approx. Cost	$550–$1,050 (in thousands) [Leveraged funds from NOAA $290–$580 (in thousands)]
Performance Period	FY 2019–2021
Date Revised	March 2, 2018
PICOC Summary	
Problem	Marine wildlife may be affected by offshore energy development along the Pacific coast. Understanding how wildlife as a whole may be affected is complicated by the diversity of wildlife resources, the scale of individual data collection efforts and differences in analytical approaches.
Intervention	Identify sources of wildlife data across multiple taxa, develop relationships with data partners, integrate data sources into a common spatial scale (GIS format), and develop predictive models that can be used for more comprehensive environmental analyses.
Comparison	Current environmental analyses are often inconsistent in their description of marine resources and it is difficult to grasp the interrelationships between taxa when data are not scaled or evaluated in a similar fashion.
Outcome	Development of a well-coordinated comprehensive and understandable reference, including standardized GIS products and consistently scaled data layers that are readily available for environmental analyses.
Context	The California Current ecosystem, which includes offshore areas of California, Oregon and Washington (i.e., all four OCS planning areas off the U.S. West Coast).

BOEM Information Need(s): A comprehensive marine biogeographic assessment of the California Current will expand BOEM's environmental assessment capabilities, identify information gaps and contribute toward understanding and management of activities that may affect the marine resources that share California Current ecosystem.

Background: In 2016, BOEM determined that at least two parties, Trident Winds and Statoil Wind U.S., were interested in developing offshore wind resources in central California. Abundant wind resources offshore northern California are also likely to attract interest from wind energy developers in the future. In Oregon, Principle Power submitted an unsolicited wind lease request and Oregon State University is pursuing a research lease for a wave energy testing facility. In 2017, BOEM announced that it is considering options for new oil and gas leasing in the Pacific Region. All of these potential lease areas are located in one contiguous unit known as the California Current ecosystem.

The Pacific Region, BOEM has traditionally conducted literature reviews of available information and supported various baseline data collection efforts in areas being considered for offshore energy development. Recently, BOEM took a slightly different approach in Hawaii and partnered with NOAA to compile information and conduct preliminary analyses in the form of a biogeographic assessment (Costa and Kendal 2016). Like Hawaii, defining biogeographic patterns in the California Current ecosystem is an effective way to understand and visualize existing information about biological and physical resources. A marine biogeographic assessment assembles and synthesizes readily available existing georeferenced data that describe physical oceanography and the distribution and abundance of benthic habitats, cetaceans, seals, seabirds, reptiles, fish and invertebrates. Collectively, these GIS datasets will be used by BOEM to understand what information exists for marine resources found within State and Federal waters, identify knowledge gaps, and inform development of offshore energy resources along the Pacific coast.

Objectives: The primary purpose of this study is to provide BOEM analysts, their partners and the public with up-to-date and comprehensive georeferenced data for environmental reviews of offshore energy projects along the Pacific coast.

Methods: Specific tasks for this project include: 1) identification and acquisition of existing relevant, readily available physical, biological and ecological datasets for the California Current ecosystem including information about benthic habitats, cetaceans, seals, seabirds, reptiles, fish and invertebrates; 2) organization of data into a common spatial framework within GIS, and identification of information gaps in existing datasets and research activities; 3) synthesis of GIS data and development of maps depicting the spatial distribution of physical, biological and ecological data sets for the California Current ecosystem; 4) biogeographic analysis of available data to characterize species distributions, abundances and associated habitats; 5) preparation of a report summarizing methods and key findings, including relevant maps, figures, tables and appendices; and, 6) web publication of GIS data products and associated metadata.

This study will update and build upon biogeographic analyses that have already been completed for portions of the California Current ecosystem. Current and readily available existing physical, biological and ecological data sets will be obtained from groups actively working in the region (i.e., academic, government, consulting, nonprofit and other groups). Relevant datasets will be formatted and organized into a preliminary database management system to assess their quality and content. Once the datasets have been formatted and organized, maps will be developed depicting the spatial distribution of the physical, biological and ecological data. If the data allows, species abundances will also be mapped. The GIS data used to create these maps will be delivered to BOEM, along with metadata describing source, derivation and limitations of each GIS data layer, when possible. The quality of the final maps will depend on the quality, quantity and availability of data for analysis. Key ecologically important areas will be identified based on the following criteria: 1) the availability, completeness and limitations associated with specific datasets; 2) maps denoting the distribution and abundance of specific species; and 3) the distribution of biophysical habitats. All data will be integrated into a spatially explicit index in an attempt to evaluate overall spatial

patterns. A final report will be prepared describing key ecological patterns, linkages and locations highlighted by the project's quantitative and qualitative analyses. Finally, GIS products and metadata will be published to the web for all interested parties.

Specific Research Question(s):

1. How are trophic groups, families and species distributed spatially and temporally in the California Current ecosystem?
2. Where can offshore energy projects be located to maximize energy production and minimize potential impacts to the marine environment?
3. What significant gaps exist in our knowledge about of the physical, biological and ecological characteristics of the California Current ecosystem?

Reference:

Costa, B.M., and M.S. Kendal (eds.). 2016. *Marine Biogeographic Assessment of the Main Hawaiian Islands*. Bureau of Ocean Energy Management and National Oceanic and Atmospheric Administration. OCS Study BOEM 2016-035 and NOAA Technical Memorandum NOS NCCOS 214. 359 p.

Title	Evaluating Connectivity Among Hawaiian Fisheries and Potential Socio-Economic Impacts of Offshore Wind Energy Installations
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder, donna.schroeder@boem.gov
Procurement Type(s)	Contract or Cooperative Agreement
Approx. Cost	$180 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 17, 2018
PICOC Summary	
Problem	Given the ubiquity of fishing activities in virtually every part of the ocean, offshore renewable energy proposals often face strong opposition from some commercial fishing sectors.
Intervention	Guided discussions
Comparison	Social and economic characteristics of different fishing sectors unique to Hawaii
Outcome	Social and economic data, both qualitative and quantitative, on Hawaiian fisheries in an exportable database format, and an analysis of fisheries vulnerabilities and stakeholders' attitudes toward offshore wind projects
Context	Hawaii OCS

BOEM Information Need(s): The potential effects of wind energy installations to these fisheries may vary widely and include both positive and negative consequences. Local and popular understanding of these effects varies. Existing biases are likely to be largely negative and based on an incomplete understanding of potential renewable energy scenarios. Given the importance and the lack of up-to-date, general knowledge of the human dimensions of Hawaiian fisheries, BOEM needs to support a study to collect social, economic and logistical fisheries data, assess current attitudes toward offshore wind development in Hawaiian waters and evaluate the potential impacts to social and economic attributes of local fisheries. The timing of this effort is critical: Collecting these data substantially (five years) before any project is established enables BOEM and project proponents the best opportunity to understand the human environment in Hawaii and respond appropriately.

Background: Hawaiian fisheries are uniquely integrated into the local traditions, culture and economy of the State. These include subsistence fishermen operating strictly from shore as well as long-range, commercial-scale fisheries, and their participants' motivation includes, in many cases, a complex blend of cultural, subsistence and economic drivers. Some of these fisheries take place in waters far from the main Hawaiian Islands (Kauai, Oahu, Molokai, Lanai, Maui, Hawaii), but most depend on access to areas within a few tens of miles from their home port, including areas under

consideration for installation of offshore wind turbines. Critically, there is often no clear distinction between subsistence, cultural, recreational and commercial fisheries.

Objectives: The purpose of this study is to collect information on Hawaii's fisheries to enable early and effective outreach, and to inform impact analyses.

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

Studies of the potential social and economic effects of the installation and operation of offshore renewable energy technologies in the main Hawaiian Islands will be useful to BOEM. Such studies might involve gathering and synthesizing existing economic and infrastructure data for potentially affected fisheries, conducting structured discussions with key participants in Hawaiian fisheries and with resource agency representatives, and analyzing these data to identify opportunities for public outreach, compare alternative scenarios for offshore wind lease plans, comply with the National Environmental Policy Act (NEPA), and, ultimately, improve the likelihood of public support and the successful development of offshore wind energy resources in Hawaii.

The costs and complexity of collecting human dimensions data will be minimized by engaging knowledgeable and respected local fisheries representatives, and limiting formal surveys to community leaders and resource managers (Nelson and Kramer 2017, Kittinger et al. 2012). Some measure of community engagement is also expected to improve cooperation and data quality (Crane et al. 2017).

Specific Research Question(s):

1. What socioeconomic indicators are important in understanding changes to Hawaiian fisheries?
2. What are the potential beneficial and negative impacts of offshore wind farms to Hawaiian fishing communities?

References:

BOEM. 2015. Guidelines for providing information on fisheries social and economic conditions for renewable energy development on the Atlantic Outer Continental Shelf pursuant to 30 CFR Part 585. Bureau of Ocean Energy Management, https://www.boem.gov/Social-and-Economic-Conditions-Fishery-Communication-Guidelines/

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Kittinger, J.N., E.M. Finkbeiner, E.W. Glazier, and L.B. Crowder. 2012. Human dimensions of coral reef social-ecological systems. Ecol Soc 17(4):17.

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Title	Biofouling, Non-indigenous Species (NIS), and Ecological Value: Cataloging NIS Communities on Offshore Platforms to Inform Upcoming Decommissioning Decisions and Potential Renewable Energy Siting
Administered by	Pacific OCS Region
BOEM Contact(s)	Susan Zaleski, susan.zaleski@boem.gov
Procurement Type(s)	Cooperative Agreement
Approx. Cost	$500 (in thousands)
Performance Period	FY 2019–2021
Date Revised	March 2, 2018
PICOC Summary	
Problem	Unknown non-indigenous species (NIS) on offshore platforms. What is the extent of populations and could these organisms become invasive? Would reefed platforms enhance the presence of NIS on natural reefs?
Intervention	Catalog NIS on offshore platforms.
Comparison	Compare species composition among platforms and natural reefs as well as sources of NIS (e.g., ports/harbors).
Outcome	Utilize study results to inform National Environmental Policy Act (NEPA) reviews for decommissioning and siting of renewable energy facilities.
Context	All Pacific OCS planning areas (U.S. West Coast and Hawaii)

BOEM Information Need(s): TBOEM needs to understand NIS populations on offshore structures to utilize this information when conducting environmental reviews for decommissioning alternatives and potential marine renewable energy installations. This will also enable BOEM to comply with the duties of Federal agencies that are outlined in Section 2 of Executive Order 13112 (Invasive Species).

Background: Offshore platforms have multiple non-indigenous species as part of the biofouling community. It has been proposed that these structures increase habitat connectivity by serving as “stepping stones” that may increase the potential success of dispersal of NIS (Sheehy and Vik 2010; Adams et al. 2014). Many NIS are cryptic and have not been identified to the genus and species level. It is essential to understand the extent of NIS on offshore platforms and determine if they meet the invasive species definition when considering decommissioning options and potential marine renewable energy installations. This project would build upon previous work looking at one specific NIS (BOEM 2018a; Simons et al. 2016) and would work synergistically with the Smithsonian Institution’s archiving of species for BOEM activities (BOEM 2018b).

Objectives: better understand and manage the colonization of offshore energy infrastructure by NIS and their potential for spread to other artificial and native habitat.

Methods: To meet the overall study objectives, four tasks will be performed.

1) *Identify and quantify the existing distribution and abundance of non-native species on offshore oil and gas platforms.* Scuba divers will use underwater transects and scrape and photographic samples to document the relative abundance and depth distribution of NIS on oil and gas platforms. They will also voucher specimens of presumptive NIS.

2) *Engage taxonomic experts to assist with the identification/confirmation of NIS and other unknown invertebrates sampled from platforms*. Photographic sampling is useful in characterizing the abundance of morphologically distinct invertebrates, but more detailed study in the laboratory is required for the proper identification of many taxa that include sponges, sea squirts, tube dwelling worms, and anemones. Taxonomic specialists in invertebrate and macroalgae groups will be retained to assist in the identification/confirmation of invertebrates and macroalgae collected and vouchered from the platforms.

3) *Assess the larval connectivity of NIS among platforms and other artificial and natural habitat*. The potential dispersal of non-native species from platforms to other artificial and natural habitat can be estimated using oceanographic models and genetic analysis. Updated Regional Ocean Modeling System solutions are available that expand the southern California modeling domain (Dong et al. 2017). These solutions will be combined with larval tracking models and genetic data on NIS to estimate the potential dispersal of propagules among offshore platforms and between platforms and other artificial and natural habitat.

4) *Assess the effectiveness of mitigation measures that would prevent establishment of NIS in novel habitats*. Once the biological data have been collected and synthesized with other available information, the study will evaluate a number of simple mitigation measures that may be employed to manage NIS. Such measures may include (a) adjusting the schedule of platform maintenance operations that remove biofouling on submerged portions of the jacket so that they coincide with seasons not sensitive to NIS establishment, (b) growth abatement devices, (c) vector management, and (d) other potential actions. If applicable, the study will propose a monitoring plan for early detection and response for high-risk areas. Finally, the study will determine if a partial removal option in a rigs-to reefs proposal affects the risk of NIS establishment to natural habitats.

Specific Research Question(s):

1. Are NIS found throughout all platforms?
2. How connected are the NIS to other platforms, artificial structures and natural reefs?
3. What are effective mitigation measures for NIS on artificial structures?
4. How would a partial removal option in a rigs-to reefs proposal affects the risk of NIS establishment to natural habitats?

Title	Pacific Seabird Monitoring Network
Administered by	Pacific OCS Region
BOEM Contact(s)	Donna Schroeder, donna.schroeder@boem.gov David Pereksta, david.pereksta@boem.gov
Procurement Type(s)	Interagency Agreement and/or Cooperative Agreement
Approx. Cost	$1,750 (in thousands) [$100 (in thousands) for Year 1]
Performance Period	FY 2019–2023
Date Revised	May 17, 2018
PICOC Summary	
Problem	BOEM needs to document the status and trends of vulnerable seabird populations potentially affected by offshore energy projects, and to determine effectiveness of mitigation measures
Intervention	Investment in a regional and cost-effective monitoring program
Comparison	Population status and trends of vulnerable seabird species among different sites which are exposed to a range of impact risks
Outcome	Verify predicted outcomes of project-specific and cumulative impacts to vulnerable seabird populations
Context	All Pacific OCS planning areas (U.S. West Coast and Hawaii)

BOEM Information Need(s): The effectiveness of lease stipulations and mitigation strategies for seabirds needs to be confirmed via a cost-effective monitoring program that will elucidate regional population trends of vulnerable species, and be of sufficient power to discriminate between different sources of mortality (i.e. energy-related versus non-energy-related). This study will satisfy requirements for Endangered Species Act consultations, National Environmental Policy Act impact analyses, and address Migratory Bird Treaty Act concerns.

Background: Seabirds face numerous threats to survival; nearly a third of seabird species are at some risk of extinction (Croxall et al. 2012). Offshore energy development contributes to the hazards these species face. For example, oil spills are a well-known threat to seabird survival, and offshore wind turbines are a potential new source of avian mortality. In expanding the information base needed for management decisions, BOEM has first focused on synthesizing available knowledge and conducting large baseline surveys that describe the distribution and abundance of seabird populations on land (colonies) and at sea. From these surveys, mitigation measures may be developed to eliminate or reduce potential impacts from proposed offshore projects. The next step in a comprehensive environmental program is to monitor environmental outcomes of these mitigation measures using cost-effective methods. This study seeks to develop this next programmatic step by building upon two BOEM studies, including *Developing and Applying a Vulnerability Index for Scaling the Possible Adverse Effects of Offshore*

Renewable Energy Projects on Seabirds on the Pacific (Adams et al. 2017) and *Synopsis of Research Programs that can Provide Baseline and Monitoring Information for Offshore Energy Activities in the Pacific Region* (BOEM 2018).

Objectives: The objective of this study is to coordinate and support a monitoring program of vulnerable seabird species that will inform ongoing and prospective offshore energy projects in the Pacific Region.

Methods: In addition to using standard approaches to establish a useful monitoring program (e.g., statistical power analyses), new technologies will enable a consistent and exceptionally cost-efficient program for long-term monitoring: acoustic sensors (e.g., Borker et al. 2014) and satellite imagery (e.g., Fretwell et al. 2017).

Specific Research Question(s):

1) Using the *Vulnerability Index* and other sources of information, can we identify a suite of indicator seabird species suitable for monitoring the potential effects of offshore energy activities for each planning area within the Pacific Region?

2) Building upon information gathered by the *Synopsis of Research Programs*, can we coordinate and supplement ongoing efforts (including those that feature citizen science) to meet objectives for a draft monitoring program?

3) Which monitoring design is the most efficient to distinguish regional population trend modifications resulting from offshore energy projects compared to other factors such as dynamic oceanographic conditions, degraded ocean productivity, or fisheries bycatch?

4) What lessons can we derive from a pilot, three-year regional monitoring effort to refine baseline information and that can be applied to a long-term monitoring program designed to inform offshore energy?

References:

Adams, J., E.C. Kelsey, J.J. Felis, and D.M. Pereksta. 2017. Collision and displacement vulnerability among marine birds of the California Current System associated with offshore wind energy infrastructure (ver. 1.1, July 2017). U.S. Geological Survey Open-File Report 2016-1154 and Bureau of Ocean Energy Management OCS Study BOEM 2016-043, 116 p.

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Fretwell, P.T., P. Scofield, and R.A. Phillips. 2017. Using super-high resolution satellite imagery to census threatened albatrosses. Ibis, 159(3), p.481-490.

Title	Values and Beliefs Baseline for Offshore Wind Development in California
Administered by	Pacific OCS Region
BOEM Contact(s)	Sara Guiltinan, sara.guiltinan@boem.gov
Procurement Type(s)	Contract
Approx. Cost	$300 (in thousands)
Performance Period	FY 2019–2021
Date Revised	May 6, 2018
PICOC Summary	
Problem	BOEM lacks a comprehensive understanding of the diverse values and beliefs held by California stakeholders regarding offshore wind energy development. Values, beliefs, and their underlying drivers can lead to misconceptions of BOEM's role in facilitating OCS development decisions and discontent with associated outcomes and social impacts. BOEM's current lack of understanding hinders our ability to address stakeholder concerns in the offshore wind leasing process and environmental analyses.
Intervention	This study will enhance BOEM's understanding of California stakeholders and ability to address their interests by identifying the values and beliefs regarding offshore wind development held by of a range of political and community leaders in California, who will serve as proxies for their constituent groups. The study will identify and analyze the underpinnings and drivers of the leaders' values and beliefs regarding offshore wind.
Comparison	As this study is a baseline assessment to enhance BOEM's understanding, the comparison will be BOEM's improved understanding and application of the information in communications and decision making after the study.
Outcome	The predicted outcome of this study is detailed information from political and community leaders on their values and beliefs regarding offshore wind development, the reasons for their values and beliefs, and reasons for opposition to or support for development.
Context	Offshore renewable energy development in California

BOEM Information Need(s): BOEM needs detailed qualitative information on the values and beliefs held by Californians regarding offshore wind energy development and the underlying drivers of their value orientation. This information will help fulfill BOEM's responsibility to ensure stakeholders understand our processes and criteria for siting and leasing for offshore wind development, ensure that stakeholders' concerns are reasonably addressed, and manage potential conflict. California-specific information is needed to adequately address unique issues and drivers, such as the history of offshore oil and gas development in southern California, and how those may affect offshore wind values and beliefs. With the enhanced understanding provided through this study, BOEM will better tailor our communications and education materials to fill information gaps, correct any misinformation, and meaningfully address the drivers of stakeholders' value orientations. The enhanced understanding will also inform leasing decisions (e.g.,

Area Identification) and National Environmental Policy Act (NEPA) socioeconomic analyses. The study results may illuminate lease stipulations and mitigation measures that can increase stakeholder acceptance. Though the study will be specific to California, the themes and outcomes have broader utility, as this study may act as a pilot case for use elsewhere.

Background: BOEM and the State of California have begun planning for the identification of Wind Energy Areas offshore California. Recent stakeholder outreach efforts revealed some concerns among coastal communities, ocean users, and environmental NGOs about offshore wind projects (BOEM 2017). Value orientation toward offshore wind development in the Pacific Region have not been studied to date. The last study on offshore energy attitudes in the Pacific Region was in 1998 and focused on oil and gas (Smith 1998). There is a growing body of research on attitudes toward land-based wind energy in the U.S. and toward offshore wind energy in the Atlantic Region and abroad. Some of the research includes recommended actions to increase stakeholder acceptance of wind energy development decisions, which may be applicable to California, but more investigation is needed. Understanding the drivers of value orientation will improve BOEM's ability to mitigate stakeholder concerns if possible and minimize discontent with leasing outcomes caused by misconceptions or poor communication.

Objectives: Obtain qualitative information to enhance BOEM's understanding of the values and beliefs regarding offshore wind development and underlying reasons for value orientation from a range of political and community leaders in California, who would serve as proxies for their constituent groups.

Methods: The objectives of the study can be accomplished through a series of exploratory, open-ended conversations with California political and community leaders. Such conversations would allow freedom of discussion appropriate for this baseline assessment. Purposeful sampling would be used to identify the leaders that represent diverse stakeholder constituents. An initial group of leaders has already been identified through previous outreach efforts. Chain-referral sampling would be used to identify additional leaders. The conversations would be coded afterward to identify themes, and a qualitative analysis could be conducted to identify actionable results for BOEM.

Specific Research Question(s):

1. What are the values and beliefs about offshore wind development in California, and the underlying drivers for them?
2. What aspects of values and beliefs can be addressed by BOEM through our communications, leasing process, and NEPA analyses, and what aspects are outside of BOEM's control?

References:

BOEM. 2017. *California Stakeholder Outreach Interim Report*. Kearns and West. Retrieved Feb 14, 2018 from Bureau of Ocean Energy Management, State Activities (California): https://www.boem.gov/california/

Smith, E.R. 1998. *How Political Activists See Offshore Oil Development: An In-depth Investigation of Attitudes on Energy Development*. U.S. Department of the Interior, Minerals Management Service. OCS Study MMS 98-0042, 196 p.

Title	Deep Ocean Trails to Hawaii's Second Pearl Harbor
Administered by	Pacific OCS Region
BOEM Contact(s)	Dave Ball, david.ball@boem.gov
Procurement Type(s)	Interagency Agreement with NOAA
Approx. Cost	$925 (in thousands)
Performance Period	FY 2019–2021
Date Revised	March 2, 2018
PICOC Summary	
Problem	The affected environment includes the cultural and biological resources associated with World War II-era shipwrecks from the West Loch explosion and the greater maritime heritage of the Hawaiian Islands.
Intervention	A multi-disciplinary characterization and assessment of select target areas will be accomplished through geophysical survey and remotely operated vehicle (ROV) investigations.
Comparison	The study will characterize benthic maritime heritage features in specific areas critical to ecosystem management, assessing their historic/archaeological nature and their biological impact to the marine environment. This information will be compared with similar studies completed on the Gulf of Mexico and Atlantic OCS.
Outcome	The expected outcome is a more holistic understanding of deep sea historic sites and associated benthic communities off O`ahu, information that will be critical in NHPA and NEPA consultations related to offshore renewable energy.
Context	This study seeks to survey and characterize known and reported wreck locations associated with the historic WWII West Loch explosion, study associated benthic ecological communities, and fill baseline data gaps by locating previously unknown wreck sites within the project area south of O`ahu.

BOEM Information Need(s): BOEM, as a Federal permitting agency, is required under the National Historic Preservation Act (NHPA) of 1966, as amended, to consider the potential impacts of its permitted activities on cultural resources before issuing such permits. Information obtained from this study will assist BOEM and BSEE to comply with the Secretary of Interior's Standards for Federal Agency Historic Preservation Programs, which directs Federal agencies to provide for timely identification and evaluation of historic properties subjected to be affected by agency actions. In addition, this effort will help BOEM scientists to understand how anthropogenic inputs onto the deep seafloor are rendered bioavailable and subsequently colonized by benthic fauna. This understanding will support environmental assessments required by the National Environmental Policy Act (NEPA). Very little research has been done around the main Hawaiian Islands to investigate the role of historic shipwrecks in benthic community development, evolution, and sustainability.

Background: BOEM recently completed an interagency baseline study to identify known and potential underwater cultural heritage sites around the eight main Hawaiian Islands (NOAA Maritime Heritage Program 2017). In 2016, BOEM received unsolicited applications for development of offshore wind energy facilities off the southern end of the island of O`ahu (O`ahu South), where a number of known and reported historic shipwrecks are located. The O`ahu South call area encompasses a number of military wrecks that reflect major periods in naval history, including the technological advent of amphibious warfare and pivotal events during World War II. Such events include the devastating explosions that occurred at West Loch on May 21, 1944, when numerous amphibious ships were damaged, and at least 559 men were killed or wounded (also known as Hawaii's "Second Pearl Harbor"). Smaller vessels from these explosions have been identified in waters closer to shore. At least eight larger vessels were damaged in West Loch and sunk further out to sea. Some of these deep ocean wrecks have been located but not assessed; others have yet to be discovered. The area where they were sunk has not been fully surveyed, but the proximity of the located wrecks is highly suggestive. The search for, assessment, and interpretation of selected wrecks and potential wreck sites addresses the responsibilities outlined in the NHPA, NEPA, and Outer Continental Shelf Lands Act (OCSLA), but also provides significant benefits in other related disciplines, all of which directly address specific BOEM mandates.

Assessment of selected wrecks within the northwest portion of the O`ahu South call area will provide valuable archaeological and historical information on this little known WWII event, which is only now being more fully understood in its broader context, and contribute data for their potential nomination to the NRHP. Assessments will also provide for the surveying of deep ocean reef sites and associated benthic communities, supporting the understanding of their roles in the deepwater ecosystem of the O`ahu South area. BOEM has supported similar deepwater shipwreck reef projects in the Gulf of Mexico (2004–2008, "Archaeological and Biological Analysis of World War II Deepwater Shipwrecks in the Gulf of Mexico") and Atlantic regions (2010–2014, "Exploration and Research of Mid-Atlantic Deepwater Hard Bottom Habitats and Shipwrecks with Emphasis on Canyons and Coral Communities"). The selected wreck survey will also supplement the existing 2007–2012 University of Hawaii Undersea Military Munitions Assessment (HUMMA) of Sea Disposal Site Hawaii Number 5, which identified approximately 2,000 munitions south of the O`ahu coastline. This survey sought to bound, characterize, and assess the historic deepwater munitions sea disposal site to determine the potential impact of the munitions on the ocean environment and vice versa (Edwards et al. 2016), but only collected data from a portion of the O`ahu South area.

This project builds upon an existing collaboration between BOEM and NOAA (offices of Ocean Exploration and Research and National Marine Sanctuaries), as well as the University of Hawaii, to characterize benthic maritime heritage properties in specific areas critical to ecosystem management and assess their historic/archaeological nature and their biological impact to the marine environment. Such collaboration provides cost efficiencies in equipment and survey platforms.

Objectives: To survey and characterize known and reported wreck locations associated with the historic WWII West Loch explosion, fill baseline data gaps by locating

Methods: The project proposes to survey an area of the seafloor associated with a number of known and possible significant vessel losses, and defines project objectives based on three related disciplines:

- Archaeological component: (1a) to the extent possible, positively identify each vessel or target casualty and establish its type and date of construction, along with the extent of the debris field; (2a) determine each vessel's present condition and state of preservation, noting West Loch damage, subsequent sinking damage and site formation, and make observations relating to its future research potential; (3a) assess any environmental impacts caused by the wreck, and make observations relating to its rate of deterioration; (4a) analyze imagery along with historical documentation to determine potential eligibility to the NRHP; (5a) for vessels determined to be potentially eligible, prepare subsequent National Register nomination forms.

- Biological component: (1b) characterize the environment at each site (e.g., water depth, bottom sediment type, currents, etc.); (2b) determine the biological effects of wreck artificial reefs at the selected sites, including detailed imagery of marine species at a variety of scales; (3b) determine the extent of physical and biological modification of sediments in the immediate area of wreck sites compared to sediment conditions at sites distant from wreck areas. Sampling will include sediment coring close to and distant from wrecks to assess prevalence and speciation; (4b) conduct limited sampling of fauna attached to hard substrate for taxonomic and other potential analyses such as isotope studies; (5b) analyze imagery and sample collection to address spatial heterogeneity of any fouling community and motile fish and invertebrate association with wrecks.

- UXO (unexploded ordnance) component: (1c) identify spatial extent and distribution of munitions in the survey area in order to define the western disposal zone boundary; (2c) identify type of munition and corrosion status of munition, casing, etc.; (3c) document munition interaction with biological environment, marine species; (4c) data sharing with University of Hawaii (Applied Research Lab, SOEST etc.).

Specific Research Question(s):

1. What site formation processes have affected the condition of WWII wrecks in the proposed study area?

2. What role do historic shipwrecks off the coast of Hawai`i play in benthic community development, evolution, and sustainability?

3. What is the spatial distribution of WWII shipwrecks and UXO within the proposed study area?

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APPENDIX C: ABBREVIATIONS AND ACRONYMS

3-D	three-dimensional
4-D	four-dimensional
ACF	availability correction factor
ACT	Atlantic Cooperative Telemetry
ADCP	acoustic Doppler current profiler
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADL	acceleration data logger
AEP	auditory evoked potential
AI	Artificial Intelligence
AIS	automatic identification system
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMBON	Arctic Marine Biodiversity Observing Network
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
AR	Atlantic Region
ARIS	Adaptive Resolution Imaging Sonar
ASAMM	Aerial Surveys of Marine Mammals
ASAP	Atlantic Sand Assessment Program
ASIP	Alaska Sea Ice Program
ATOM	Acoustic and Thermodynamic Offshore Monitoring
AUV	autonomous underwater vehicle
AWI	Alfred Wegener Institute
BACI	Before-After-Control-Impact
bbl	barrels
Bcf	billion cubic feet
BESTT	Bureau of Ocean Energy Management Ecosystem Services Task Team
BLM	Bureau of Land Management
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CAAA	Clean Air Act Amendments
Cal DIG	California Deepwater Investigations and Groundtruthing
cANIMIDA	Continuation of the Arctic Nearshore Impact Monitoring in the Development Area
CARP	California Artificial Reef Program
CART	cultural and archaeological resources team
CEC	California Energy Commission
CEQ	Council on Environmental Quality

CESU	Cooperative Ecosystem Studies Unit
CFF	Coonamessett Farm Foundation
CFR	Code of Federal Regulations
CIBW	Cook Inlet beluga whale
CIRCAC	Cook Inlet Regional Citizens Advisory Council
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CMAQ	Community Multi-scale Air Quality
CMECS	Coastal and Marine Ecological Classification Standard
CMI	Coastal Marine Institute
CMS	Convention on Migratory Species
COA	Certificate of Authorization
COP	construction and operation plan
COSA	Committee on Offshore Science and Assessment
CPUE	catch per unit effort
CSIL	Cumulative Spatial Impact Layers
CT	computerized tomography
CTD	conductivity, temperature, and depth
CZM	coastal zone management
CZMA	Coastal Zone Management Act
DBO	Distributed Biological Observatory
DEM	digital elevation model
DES	Division of Environmental Sciences
DEVELOP	Digital Earth Virtual Environment and Learning Outreach Project
DIDSON	Dual-frequency Identification Sonar
DOE	Department of Energy
DOI	Department of the Interior
DPP	development and production plan
DPP	Draft Proposed Program
DPS	Distinct Population Segments
DWH	Deepwater Horizon
E.O.	Executive Order
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EMF	electromagnetic field
ENSO	El Niño Southern Oscillation
EOF	empirical orthogonal function
EP	exploration plan

EPA	Environmental Protection Agency
EPAct	Energy Policy Act of 2005
ERA	Environmental Resource Area
ESA	Endangered Species Act
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
ESP-PAT	Environmental Studies Program Performance Assessment Tool
ESRI	Environmental Systems Research Institute
ETOF	Equilibration Toe of Fill
EVOS	Exxon Valdez Oil Spill
EVOSTC	Exxon Valdez Oil Spill Trustee Council
FAA	Federal Aviation Administration
FDEP	Florida Department of Environmental Protection
FEM	finite element modeling
FGB	Flower Garden Banks
FGBNMS	Flower Garden Banks National Marine Sanctuary
FMP	Fisheries Management Plan
FPSO	floating production, storage, and offloading
FSF	Fisheries Survival Fund
FVCOM	Finite Volume Community Ocean Model
FWS	Fish & Wildlife Service
FY	fiscal year
GCCESU	Gulf Coast Cooperative Ecosystem Studies Unit
GCOOS	Gulf of Mexico Coastal Ocean Observing System
GeoJSON	Geographic JavaScript Object Notation
GHG	greenhouse gas
GIS	geographic information system
GOA	Gulf of Alaska
GOM	Gulf of Mexico
GOMR	Gulf of Mexico Region
GoMMAPPS	Gulf of Mexico Marine Assessment Program for Protected Species
GOMR	Gulf of Mexico Region
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GSM	Global System for Mobile communications
GUIS	Gulf Islands National Seashore
HF	high frequency
HFR	high frequency radar
HPC	high performance computing
HPPG	high priority performance goal

HRG	high resolution geophysical
HUMMA	Hawaii Undersea Military Munitions Assessment
HYCOM	Hybrid Coordinate Ocean Model
IA	interagency agreement
IAM	integrated assessment modeling
IDIQ	indefinite-delivery, indefinite-quantity
IERP	Integrated Ecosystem Research Program
IHA	Incidental Harassment Authorization
Inc.	incorporated
IOOS	Integrated Ocean Observing System
ITM	information transfer meeting
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
KPB	Kenai Peninsula Borough
LC	Loop Current
LCE	Loop Current eddies
LCI	Lower Cook Inlet
LCT	Landing Craft Tank
LF	low frequency
LiDAR	Light Detection and Ranging
LISI	Landfast Ice Stability Index
LLC	limited liability company
LME	large marine ecosystem
LMR	Navy's Living Marine Resources Program
LST	Landing Ship Tank
LSU	Louisiana State University
MAG-PLAN	Model of Alaska and Gulf using Impact Analysis for Planning
MARINe	Multi-Agency Rocky Intertidal Network
MBON	Marine Biodiversity Observation Network
MBTA	Migratory Bird Treaty Act
MCY	million cubic yards
MMbbl	million barrels
MMC	Marine Mammal Commission
MML	Marine Mammal Laboratory
MMP	Marine Minerals Program
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOA	Memorandum of Agreement
MODIS	Moderate Resolution Imaging Spectroradiometer

MRDF	Mississippi River Delta Front
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
n.d.	no date
NAAQS	National Ambient Air Quality Standards
NARP	National Artificial Reef Plan
NAS	National Academies of Sciences, Engineering, and Medicine
NASA	National Aeronautics and Space Administration
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NEXRAD	Next-Generation Radar
NFEA	National Fishing Enhancement Act of 1984
NGS	next-generation sequencing
NGO	non-governmental organization
NHC	National Hazards Center
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NIS	non-indigenous species
NJ	New Jersey
nm	nautical mile
NMFS	National Marine Fisheries Service
NNA	noncompetitive negotiated agreements
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NOSB	National Ocean Sciences Bowl
NPRB	North Pacific Research Board
NPS	National Park Service
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NSB	North Slope Borough
NSL	National Studies List
NWS	National Weather Service
NYB	New York Bight
O&G	oil and gas
OBIS-SEAMAP	Ocean Biogeographic Information System–Spatial Ecological Analysis of Megavertebrate Populations
OCS	Outer Continental Shelf

OCSEAP	Outer Continental Shelf Environmental Assessment Program
OCSLA	Outer Continental Shelf Lands Act
OEP	Office of Environmental Programs
OMB	Office of Management and Budget
OMI	Ozone Monitoring Instrument
ONR	Office of Naval Research
OpenCV	Open Source Computer Vision
OREP	Office of Renewable Energy Programs
OSRA	oil spill risk analysis
P.L.	Public Law
PAM	passive acoustic monitoring
PcoD	population consequences of disturbances
PEIS	programmatic environmental impact statement
PEP	Population Estimates Program
PHMSA	Pipeline and Hazardous Materials Safety Administration
PI	Principal Investigator
PICOC	Problem, Intervention, Comparison, Outcome, and Context
plc	public limited company
PLD	planktonic larval duration
PM2.5	fine particulate matter
PNNL	Pacific Northwest National Laboratory
PolSAR	polarimetric synthetic aperture radar
PRISM	Pacific Regional Investigations Survey and Monitoring
PSD	Prevention of Significant Deterioration
QA	quality assurance
QC	quality control
R/V	research vessel
RESTORE Act	Resources and Ecosystems Sustainability, Tourist Opportunity, and Revived Economics of the Gulf States Act of 2011
RODEO	Real-time Opportunity for Development Environmental Observation
ROV	remotely operated vehicle
ROW	rights-of-way
RPB	Regional Planning Body
RSM	Regional Sediment Management
SAB	South Atlantic Bight
SCB	Southern California Bight
SCUBA	self-contained underwater breathing apparatus
SDP	Studies Development Plan
SEFSC	Southeast Fisheries Science Center

Shell	Dutch Shell plc
SME	subject matter expert
SNE	Southern New England
SOEST	School of Ocean and Earth Science and Technology
SOO	Suspension of Operation
SOST	Subcommittee on Ocean Science and Technology
SPOT	Smart Position and Temperature
SSWD	sea star wasting disease
SUIT	Surface and Under-Ice Trawl
SWIM	Spatially Weighted Impact Model
T/D	temperature/depth
TK	traditional and local knowledge
TO	task order
U.S.	United States
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
UAMS	unmanned aerial monitoring system
UAS	unmanned aircraft systems
UAV	unmanned aerial vehicle
UAVSAR	Uninhabited Aerial Vehicle Synthetic Aperture Radar
UCSB	University of California, Santa Barbara
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UXO	unexploded ordinance
VGM	variable grid method
VHF	very high frequency
VIESORE	Visual Impact Evaluation System for Offshore Renewable Energy
WEA	Wind Energy Area
WRF	Weather Research and Forecasting
WWII	World War II

Department of the Interior (DOI)
The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management (BOEM)
The mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program
The mission of the Environmental Studies Program is 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. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM's Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).