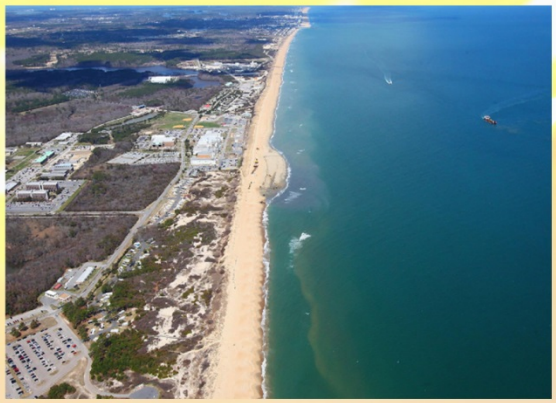
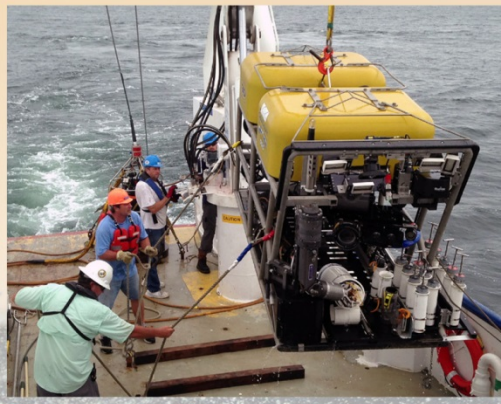
Bureau of Ocean Energy Management | **Environmental Studies Program**

Studies Development Plan 2018–2020





BOEM
Bureau of Ocean Energy Management

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CHAPTER 1 OVERVIEW

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; sand, gravel, and other minerals.

1.1.2 Environmental Science Program (ESP) Vision & Background

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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.

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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, mandated after 1978 by Section 20 of the Outer Continental Shelf Lands Act (OCSLA), to produce research needed for decision support. 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 is mandated 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 are to provide time series and data trend information for identifying significant changes in the quality and productivity of those environments and to identify the causes of these changes. The ESP has provided over $1 billion for research to this end since its inception in 1973.

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. The ESP, together with environmental assessment and regulation, constitute BOEM's environmental program and ensures 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 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. Annual planned funding for the ESP is currently $35.7 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 2016 (Figure 1):

- 43% of funds went to Federal agencies
- 28% to academic institutions
- 24% to private organizations
- 4% to State government agencies
- 1% to other researchers

The subject matter allocation of funds over fiscal years (FY) 2012–2016 (Figure 2):

- 32% habitat and ecology
- 27% marine mammals and other protected species
- 11% physical oceanography
- 11% fate and effects
- 9% social sciences and economics
- 6% information management
- 4% air quality

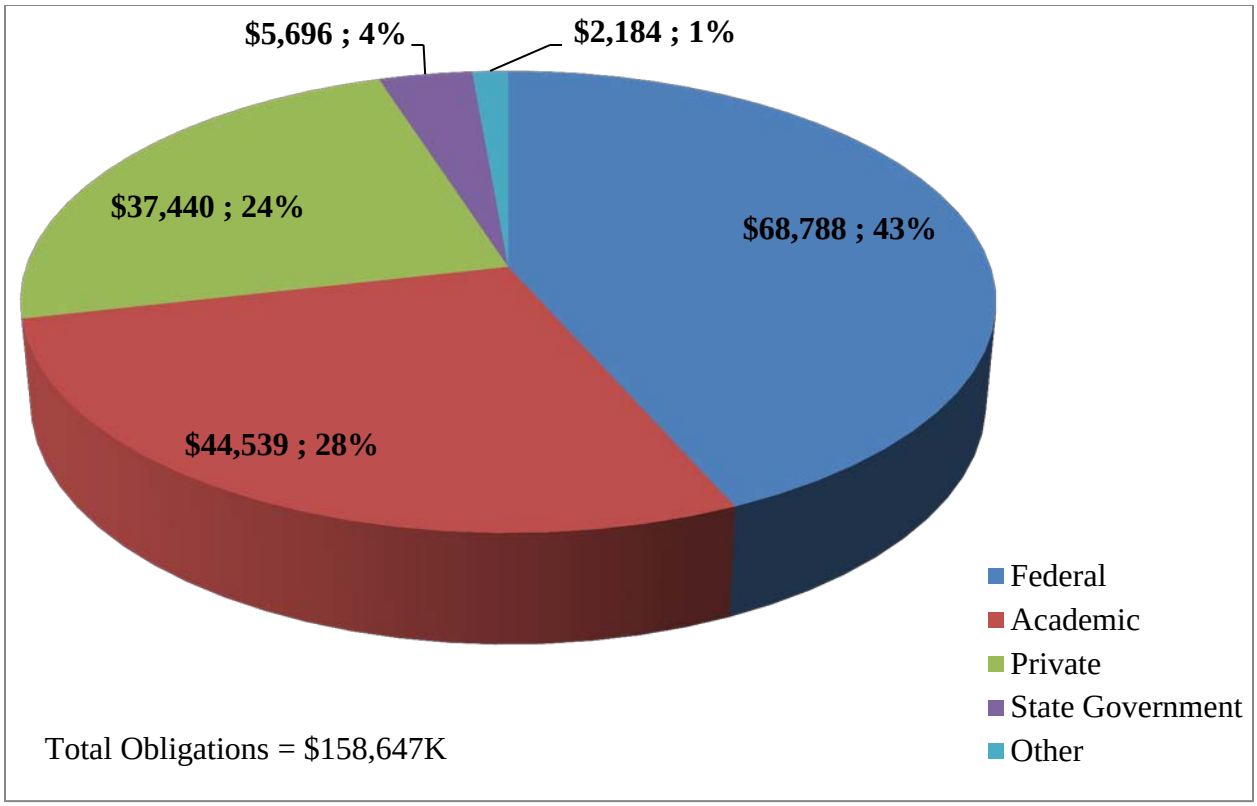

Figure 1. ESP expenditures for FY 2012–2016 by vendor type. Dollars in thousands.

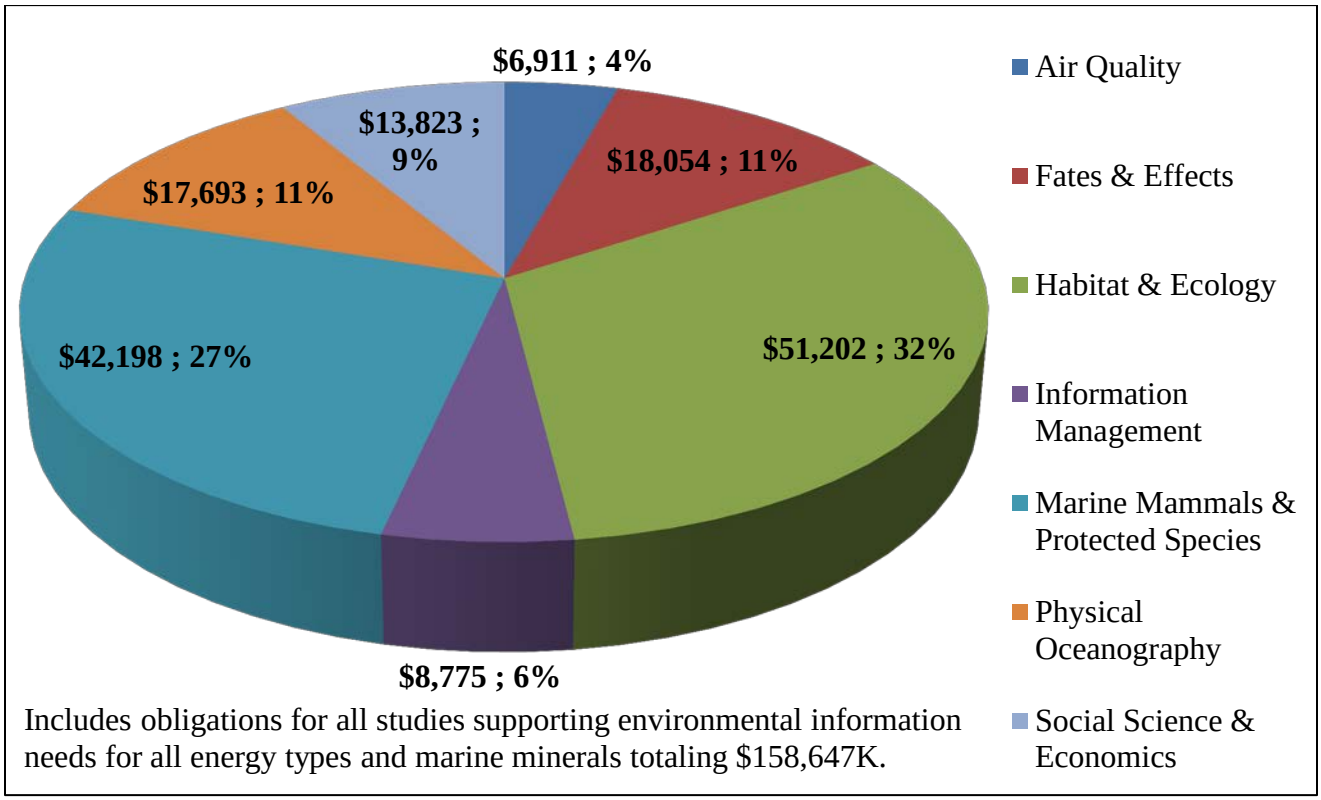

Figure 2. ESP expenditures for FY 2012–2016 by discipline. Dollars in thousands.

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 2018 or FY 2019 are included in Appendix I, and the study profiles for each region are included in Appendix II. 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: http://www.boem.gov/Current-Research-Ongoing-Environmental-Studies/. 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

2. **Affected Resources:** Information on the status, trends, and resilience of potentially impacted natural and cultural resources and socioeconomic qualities

    - 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 shipwrecks and submerged 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. All study profiles must articulate the study's relevance and importance to BOEM decision making, as well as the level of need that must be considered in setting priority. This criterion accounts for the urgency of information and is intended to provide for a reasonable level of support in each region and across BOEM's three programs: oil and gas, renewable energy, and marine minerals.

2. **Contribution to Existing Knowledge:** Studies must be designed to contribute 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 a sound research concept (including questions asked), design, and methodology. This does not require a high level of detail such as would be provided in specific proposals to carry out the work, but the basic proposal concept, design, and methodology must be sound.

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 towards 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 towards more comprehensive understanding of those topics in the 5–10 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 to understand the uncertainty and risk to the environment 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 issues* and impacts:

- 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). Input is requested from BOEM's program and regional offices, and priorities are collaboratively developed. Previous to 2015, external review of project priorities was provided by the OCS Scientific Committee, an independent group of experts established by the Secretary of the Interior under the Federal Advisory Committee Act. In 2015, BOEM replaced this committee with a National Research Council (NRC) standing Committee on Offshore Science and Assessment (COSA). COSA convenes experts from academia, industry, and other organizations to provide independent, technical input on issues of interest to BOEM's environmental science and assessment responsibilities. BOEM is excited about this new partnership with the NRC and the strategic science direction it can provide for the Bureau's environmental research program.

1.3 Areas of Focus

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; and

- **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.

1.3.1 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 2016).

1.3.2 Renewable Energy

The Energy Policy Act of 2005 (EPAct; P.L. 109-58) amended OCSLA to add renewable energy to DOI's (and BOEM's) development and environmental protection responsibilities. There is 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 14 active leases along the Atlantic coast from Massachusetts to North Carolina.

1.3.3 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.

1.3.4 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 52 leases since 1995 and conveyed rights to approximately 140 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 300 miles of the Nation's coastline, protecting billions of dollars of infrastructure, as well as important ecological habitat.

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.

1.4 ESP's Core Values

The ESP is guided by four main principles:

(1) studies conducted by BOEM must be use inspired so that determined results may be applied towards 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; and
(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.

1.4.1 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 knowledge with the objective to inform decisions on practical problems. Scientific research that is use-inspired is designed with a view to advance broader fundamental understanding of phenomena being examined together with providing answers to specific questions needed for management decisions.

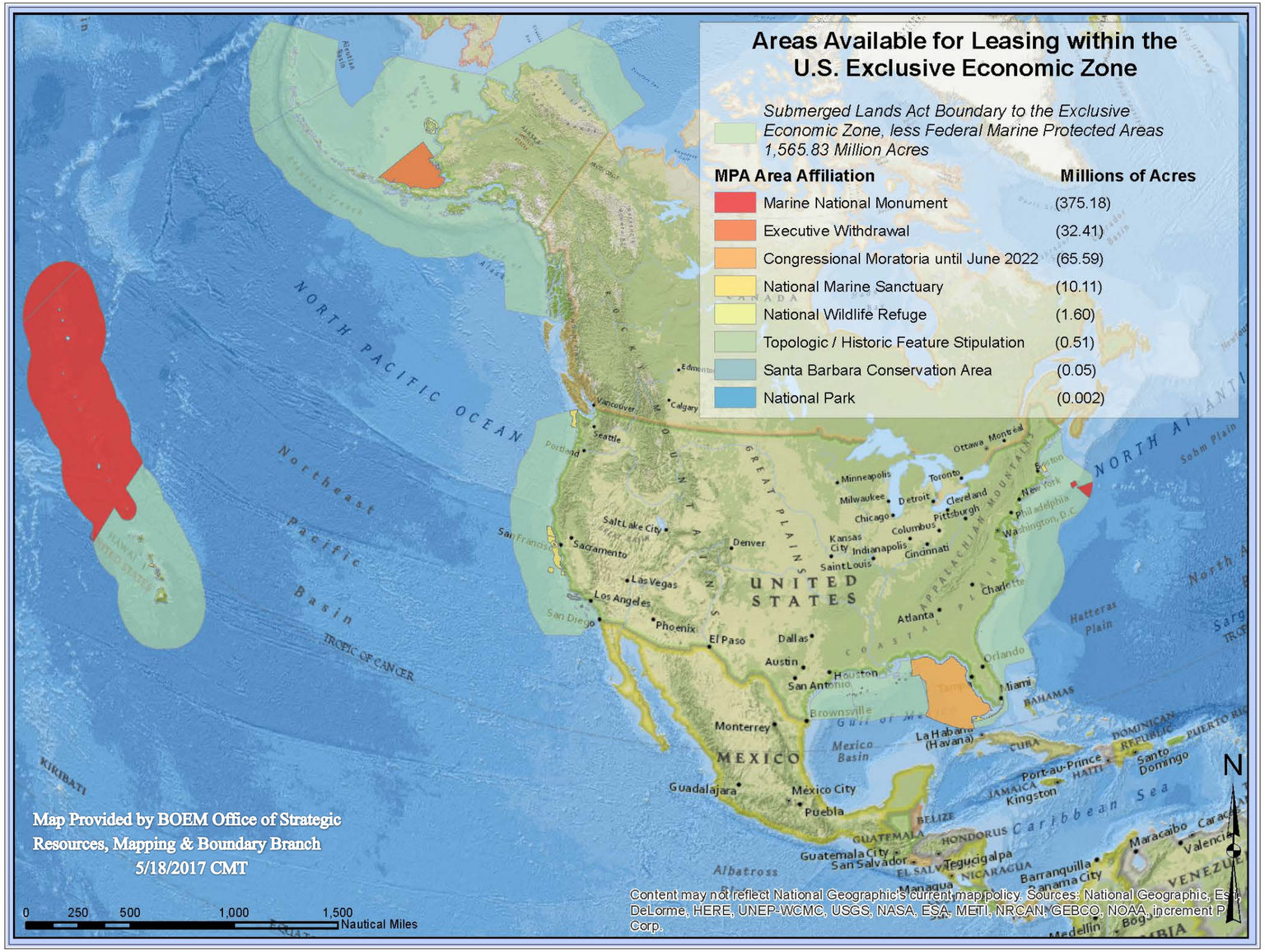

Figure 3. Areas available for leasing within the U.S. EEZ[1]. The Mapping and Boundary Branch, within the Leasing Division of the BOEM Office of Strategic Resources, generated this geospatial map. All data used for the map came from authoritative sources (National Oceanic and Atmospheric Administration [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.).

[1] 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.

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1.4.2 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 towards 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. Under DOI's Renewable Energy High Priority Performance Goal (HPPG), ESP also reports the percentage of environmental studies that support renewable energy information needs (including hybrid studies that benefit renewables) in a given FY. In FY 2015, the ESP exceeded the established targets for ESP-PAT and HPPG metrics.

1.4.3 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 nongovernmental scientists
- Review and critical input by Scientific Review Boards or Modeling Review Boards
- Scientific peer review of final reports
- Publication in peer-reviewed technical and/or scientific journals

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

1.4.4 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.

1.4.5 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: http://www.boem.gov/Current-Research-Ongoing-Environmental-Studies/. 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.

1.4.6 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.

CHAPTER 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 2016). 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 2016) or other NEPA analyses and associated consultations led to the development of this year's nine study profiles.

The nine study profiles, in order of rank, are as follows:

1. **Vulnerability of Communities in Close Proximity to Outer Continental Shelf (OCS) Programs Support Infrastructure and Activity**

   The development of the analyses of environmental potential impacts associated with the national Five Year Oil and Gas Leasing Program identified a clear need for data gathering relative to impacts to social science and environmental justice from BOEM permitted activities. This proposed study seeks to 1) comply with environmental regulations and Executive Orders (EO): 12898-*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* and 13175-*Consultation and Coordination with Indian Tribal Governments*; 2) support its responsibility to manage public resources in an environmentally sound manner; 3) identify baseline conditions used in making current and future policy decisions in Federal waters adjacent to coastal communities; and 4) analyze changes in baselines in these communities near potential OCS activity. This study seeks a better understanding of baseline vulnerabilities at the community level for the national program. BOEM environmental justice analyses thus far has focused on a single subset of the population and has not yet looked at the relationship between populations of low, median, and high income levels within communities. A comprehensive study of how all parts of the community interact in relation to shared resources provides essential data for a robust environmental justice analysis. Results from this research will support future BOEM decision documents and community outreach efforts, using the best available science on vulnerable and potentially affected coastal communities in nearest proximity to oil and gas extraction in Federal waters.

2. **Compendium on Oil Spill Science**

   This proposed study spans multiple resource areas and seeks to 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 oil spills and remediation efforts. This synthesis effort is needed to identify long-term, cumulative impacts that are then used in making current and future management decisions and to comply with environmental regulations and guidance. In addition to addressing information needs for cumulative impact assessments, this study would shed light on what affected resources, measures, and systems are best used (or not used) for long-term monitoring. This information is important to consider when analyzing post-spill research and applying it to cumulative impact assessments within our NEPA analyses.

3. Developing a Roadmap to Maximize Natural Capital and Maintain Natural Infrastructure in Energy and Mineral Planning

This proposed study intersects with several areas of BOEM's information needs. Natural capital refers to the services that nature provides to humans and arises from the maintenance and use of these "ecosystem services." The natural capital found on the OCS provides a wide variety of services, including energy, species, and habitats that support commercial fishing, waters, and beaches that drive tourism, sand and gravel for beach restoration, and places that hold cultural and spiritual significance. This ecosystem services approach would assist BOEM in considering the impacts of its activities on all environmental resources as a system rather than in a traditional piecemealed framework. This broader scale methodology would allow for an improved understanding of the effects of multiple impacting activities on multiple resource areas. Exploring an approach that considers how an ecosystem and the services it provides may be altered as a result of BOEM activities leads to a clear understanding of the potential resilience, or lack thereof, of these natural systems. In addition, an ecosystem services approach is a *de facto* examination of cumulative effects, because it would provide a consistent, quantitative framework within which BOEM could examine all uses of the OCS, including BOEM decisions, and how they impact the ecosystem services provided by the offshore, nearshore, and coastal systems. This study will set the stage for a robust accounting of natural capital in BOEM decision making by establishing a "roadmap" that will identify ways to (1) facilitate improved stakeholder relationships by demonstrating what the tradeoffs are of BOEM actions *vs.* no BOEM actions, (2) drive transparency in how BOEM decisions might affect other uses of the OCS by allowing a better accounting of how stakeholder interests are impacted by BOEM activities, and (3) develop a framework or recommended methodology for moving beyond the traditional qualitative approaches to addressing impacts that BOEM uses currently. Developing a path for an ecosystem services approach will allow BOEM to engage stakeholders in meaningful way, effectively synthesize spatial data for environmental analyses, and potentially reduce conflict related to multiple uses of the OCS.

4. Catalog of Seabird Colonies

To acquire baseline data for assessment analyses, this study proposes to use an updated version of the Colonial Waterbirds Database to update breeding colony locations and to

answer questions specifically regarding population dynamics, foraging ranges, persistent foraging areas, and diets of seabirds while attending colonies on the OCS. Colonies function as ecological indicators of marine ecosystems, and we propose to determine whether population perturbations at colonies are a local occurrence or whether they point to region-wide synchrony. Goals and products of the seabird catalog align with NEPA, in that it will house breeding population and production estimates of endangered seabirds, as well as mapping past and present colony locations.

5. Archaeological Investigations in Support of Development of Energy and Mineral Resources on the U.S. Outer Continental Shelf (OCS)

The balance of development with environmental and cultural resources protection is a cornerstone to BOEM's mission. This proposed study seeks to minimize impacts to archaeological sites without unnecessarily constraining development. To meet our mission, BOEM needs to gather additional information on previously identified geophysical targets that may potentially represent archaeological sites eligible for listing on the National Register of Historic Places, which will assist in addressing information needs with not only our NEPA analyses, but also our Section 106 review requirements. At present, BOEM requires developers to avoid all geophysical targets (side scan sonar contacts and magnetic anomalies) that may potentially represent an archaeological resource. 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; ground truthing of these targets is necessary for confirmation. BOEM has funded studies in the Atlantic to ground truth geophysical targets, which resulted in confirmation that up to one-half of the targets BOEM buffers for avoidance—thereby denying development—are not actually archaeological resources deserving protection [(Carrier, Hoffman, et al. 2016); (Carrier, Hoyt, et al. 2015); (Carrier, Pulkkinen and Heinz, Recognizing Geomagnetic Storms in Marine Magnetometer Data: Toward Improved Archaeological Resource Identification Practices 2016)]. By confirming the presence of these sensitive resources or confidently clearing the areas BOEM considers its areas of highest resource potential for development, the agency will be using the best available science in decision making, effectively contributing to the American economy and its energy security, supporting diversification of energy efforts, and increasing access to development of the OCS while reducing risk of environmental impact.

6. Mortality Risk for Whale and Basking Sharks During Energy and Mineral Operations

With respect to the effect of habitat or landscape alterations on ecological resources, as specified in the Strategic Science Questions, this study proposes to address the alterations that occur from the placement of platforms along the OCS. Large-bodied, lower trophic-level feeding sharks, such as whale sharks and basking sharks, aggregate and spend a significant amount of time at, or just below, the ocean's surface. In addition, they appear to congregate around man-made structures such as platforms. Cumulative impacts may be occurring due to the surface aggregating tendency of these sharks and their subsequent

exposure to ship strike, gear entanglement, and oil spills. Multiple geophysical surveys, offshore energy construction, and associated vessel traffic intersect with known aggregations of these species. Information from this study, focused on whale sharks, will better quantify the risk of the interactions associated with energy and mineral development and will provide information needed for cumulative effects assessments. The study proposes to leverage both existing and emerging technology in order to achieve more effective results, including utilizing inertial measurement tags to describe the fine scale behavior of whale sharks and then comparing those movements with ship traffic that is available from land- and satellite-based automatic identification system (AIS) receivers.

7. Bureau of Ocean Energy Management (BOEM) Graduate Student Award for Applied Scientific Research

OEP seeks to acquire the best available data to inform BOEM decisions and encourages the development of innovative yet cost-effective research methodologies to acquire the information it needs. 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 through this study will have the reciprocal value of providing BOEM with 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 OCS.

8. Enhanced Marine Stewardship with Citizen Science SCUBA Diving

Resource development and production activities overseen by BOEM have the potential to impact areas of marine recreation and tourism, including those within marine protected areas. A number of such areas are frequented by the recreational SCUBA diving community, but there is no systematic mechanism for BOEM to collect, analyze, respond to, and benefit from these divers' unique *in situ* observations of the waters BOEM is tasked with managing. We propose this study to pilot a Citizen Science effort to instrument recreational divers, collect their observations, and analyze these data for changes in the local ecosystem (*e.g.*, unexpected, infrequent, unusual, or health-related events) so that, thus informed, BOEM may better respond to observed conditions (*e.g.*, by modifying access or activities permitted at the sites).

9. Understanding the Socio-cultural Context of Commercial Fishing

In the next few years, BOEM expects to undertake NEPA analyses to inform decisions related to approval of construction and operation plans for at least three offshore wind facility leases. In turn, State governments, Congressional representatives, and other stakeholders have expressed the need to understand the potential economic impact to the commercial fishing industry from offshore wind. To more fully answer their questions, we propose this study to better understand how captains of vessels determine fishing locations. This study aims to enhance our understanding of the socio-cultural underpinnings of location-choice decisions made by commercial fishers. This

information will enhance the efficacy of BOEM's economic impact model, which requires a simplification of decision-making inputs, by assessing the socio-cultural considerations of fishing communities. This understanding will support NEPA assessments by informing the viability of project alternatives and mitigation options.

2.2 Alignment with Strategic Science Questions

The Headquarters studies proposed for FY 2018–2020 tie in with seven of the nine Strategic Science Questions posed in the ESP Strategic Framework. All of these studies address information important to the BOEM decision-making process. Table 1 shows how the proposed Headquarters studies are aligned with BOEM programs and the Strategic Science Questions.

Table 1. Alignment of BOEM ESP studies proposed for FY2018 by Headquarters with BOEM Programs and Strategic Science Questions.

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 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	Vulnerability of Communities in Close Proximity to Outer Continental Shelf (OCS) Programs Support Infrastructure and Activity	✓	✓	✓						✓			
2	Compendium on Oil Spill Science	✓			✓		✓						✓
3	Developing a Roadmap to Maximize Natural Capital and Maintain Natural Infrastructure in Energy and Mineral Planning	✓	✓	✓	✓			✓	✓			✓	✓
4	Catalog of Seabird Colonies	✓	✓	✓									
5	Archaeological Investigations in Support of Development of Energy and Mineral Resources on the U.S. Outer Continental Shelf (OCS)	✓	✓	✓	✓			✓				✓	
6	Mortality Risk for Whale and Basking Sharks During Energy and Mineral Operations	✓	✓	✓	✓			✓				✓	
7	Bureau of Ocean Energy Management (BOEM) Graduate Student Award for Applied Scientific Research	✓	✓										
8	Enhanced Marine Stewardship with Citizen Science SCUBA Diving	✓	✓										
9	Understanding the Socio-cultural Context of Commercial Fishing		✓							✓			

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CHAPTER 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 basic 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 (Figure 5) in 2021 (a lease sale in Cook Inlet was also held on June 21, 2017 as part of the 2012–2017 Program). The 2017–2022 Proposed Program did not include lease sales in the Chukchi Sea (Figure 6) or Beaufort Sea (Figure 7) Planning Areas. On April 28, 2017, President Trump signed an E.O. directing the Secretary of the Interior to give full consideration to revising the schedule of proposed oil and gas lease sales to include additional lease sales in these three Planning Areas. In response, BOEM is initiating development of a new Five-Year OCS Oil and Gas Leasing Program.

Furthermore, the Beaufort Sea Planning Area currently has 42 active leases from previous lease sales. On July 12, 2017, BOEM conditionally approved an Exploration Plan (EP) submitted by Eni US Operating Company, Inc. proposing to conduct drilling into leased OCS areas from an existing gravel island located in State waters.

Figure 4. Alaska OCS Region Planning Areas.

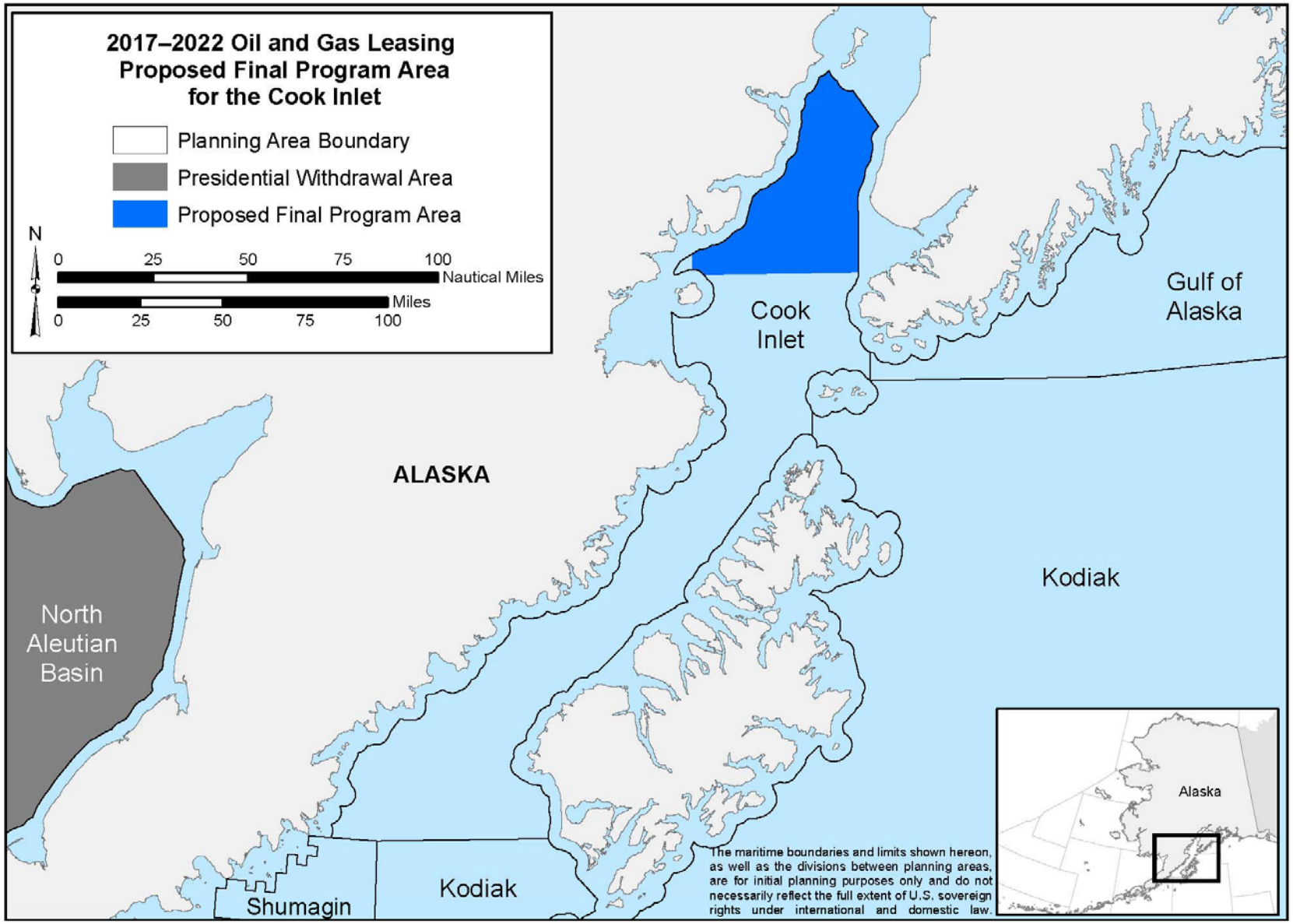

Figure 5. Cook Inlet Planning Area.

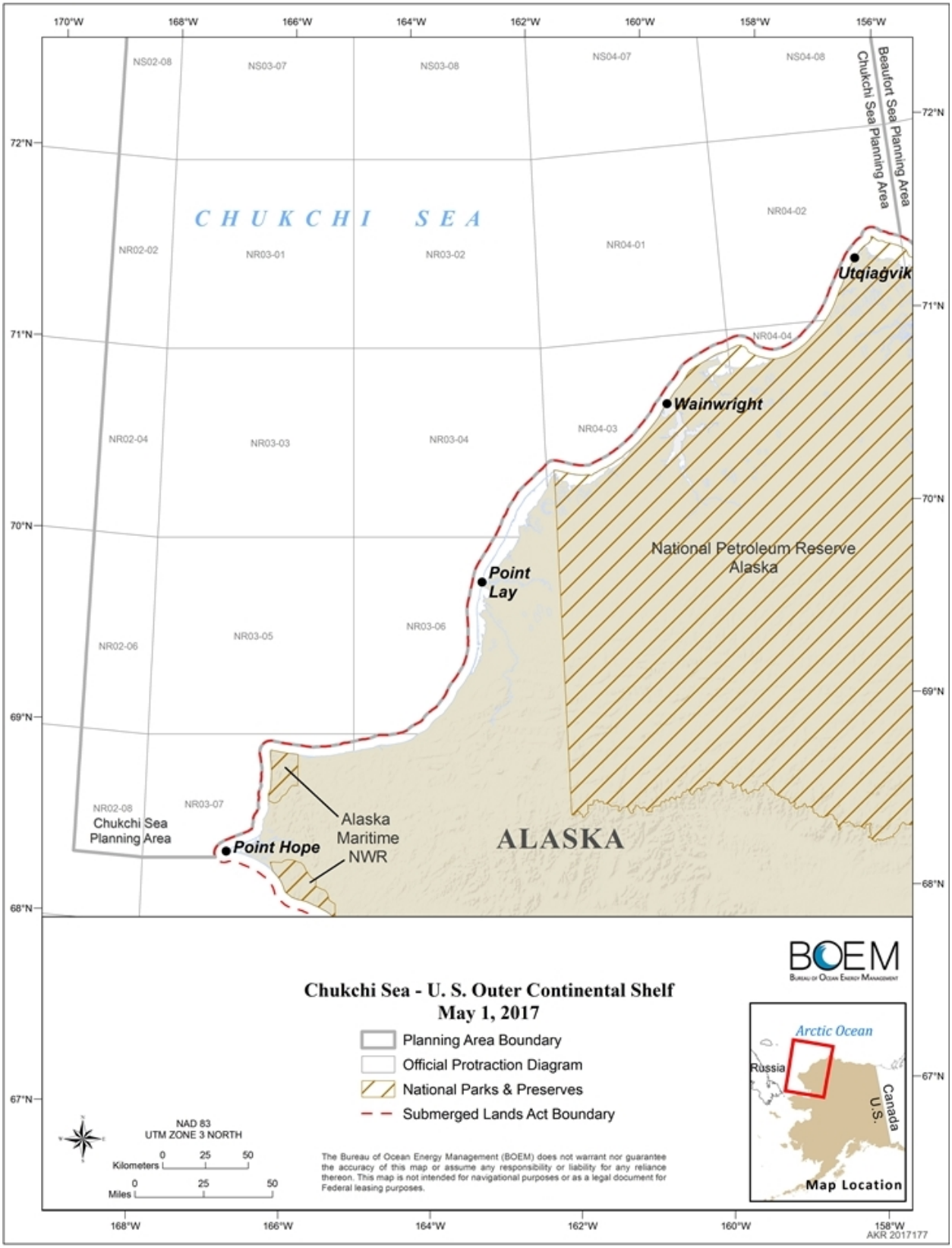

Figure 6. Chukchi Sea Planning Area.

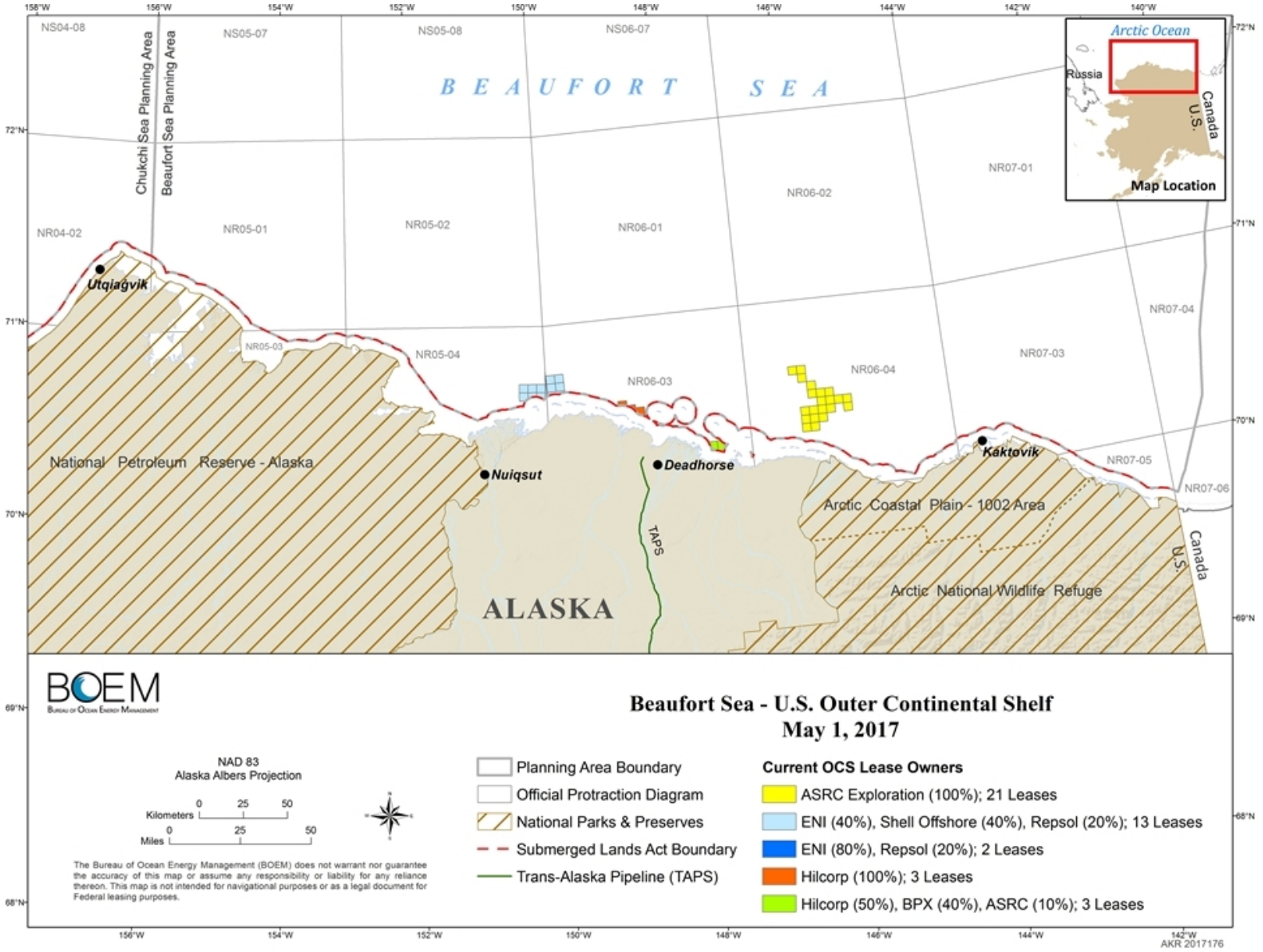

Figure 7. Beaufort Sea Planning Area.

BOEM is currently preparing an 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 prospect is located in the central Beaufort Sea about 6 miles east of the existing Endicott Satellite Drilling Island. Additional EPs or DPPs may be submitted for existing leases in the future.

Northstar is a joint Federal/State of Alaska production unit located in the Beaufort Sea about 12 miles northwest of Prudhoe Bay. The six producing Federal wells fall under Bureau of Safety and Environmental Enforcement (BSEE) regulatory authority, whereas the State wells fall under the oversight of the Alaska Department of Natural Resources, Division of Oil and Gas. Production started in 2001 and peaked in 2004. Total production of crude oil through June 2017 is more than 168 million barrels, with the Federal portion comprising more than 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 and Chukchi Seas, conducting interim baseline research and monitoring for trends in diverse fields of interest. Most of the projects exhibit complex, multilateral collaborations, with explicit inter-disciplinary 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.

In response to Hilcorp's submission of their DPP for Liberty and the potential for submission of additional plans, BOEM will continue its focus on the Beaufort Sea. 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. A better understanding of trophic and community structure in nearshore habitats in the Beaufort Sea is also needed to support evaluation of resiliency of fish and invertebrate populations under changing environmental conditions. Additionally, 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; and obtaining further baseline information about subsistence use of lower Cook Inlet.

No interest exists at this time regarding development of marine mineral or renewable energy resources on the OCS offshore the State of Alaska. The Alaska Region, however, is currently developing a partnership with the University of Alaska Fairbanks, NOAA, and USFWS to integrate and extend offshore environmental feasibility studies sufficient to fully assess the economic viability of wave energy projects in Yakutat and other areas of coastal Alaska. 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 2018. The studies proposed for the Alaska Region address one or more of the strategic science questions and inform a broad repertoire of knowledge. Table 2 contains a matrix indicating the intersection 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 Coastal Marine Institute (CMI), and how the CMI studies intersect with each of the strategic questions.

Tables of proposed studies for the Alaska Region are included in Appendix I. Profiles for these proposed studies are provided in Appendix II.

Table 2. Alignment of Proposed FY 2018 Alaska OCS Region Studies with BOEM Programs and Strategic Science Questions.

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 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**?	REGION QUESTIONS: What role will **OCEAN CURRENTS AND SEA ICE** play in distribution of anthropogenic pollutants near exploration and development prospects?	How are ocean currents and biota affected by **REDUCED SEA ICE CONDITIONS**?	How do cold temperatures and presence of sea ice **ALTER THE FATE OF SPILLED OIL**?
1	Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbl	✓					✓							✓		✓
2	Environmental Resource Areas: Using Habitat-Based Density Models and Tagging Data for Analysis of Biological Resources	✓			✓							✓	✓		✓	
3	Range-wide Distribution of Cook Inlet Beluga Whales (*Delphinapterus leucas*) in the Winter	✓						✓					✓			
4	Coastal Marine Institute	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Impacts of Sedimentation on the Boulder Patch Community, Beaufort Sea	✓			✓			✓	✓			✓	✓	✓		
6	Oil Spill Occurrence Estimators for Offshore and Onshore Cook Inlet and Onshore Alaska North Slope Spills	✓					✓						✓			
7	Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty Final Development and Production Plan	✓			✓		✓			✓		✓	✓			
8	Circulation Processes and Landfast Ice Dynamics on the Central and Western Beaufort Sea Shelf	✓							✓					✓	✓	
9	Benthic Invertebrate Resources and Trophic Ecology of Fishes in the Nearshore Beaufort Sea	✓			✓			✓		✓			✓		✓	
10	Levels of Polycyclic Aromatic Hydrocarbons (PAHs) and Other Contaminants in Tissues of Animals Collected in Cook Inlet	✓			✓		✓									
11	Updating Status and Trends of Seabirds and Forage Fish in Lower Cook Inlet	✓			✓			✓					✓			
12	Subsistence Mapping and Identification of Intensity of Use of the Land- and Seascape by Old Believers of Lower Cook Inlet, Alaska	✓			✓			✓		✓						
13	Generation of Synthetic Audiograms by Applying Finite Element Modeling to Computerized Tomography (CT) Scans for Baleen Whales, Belugas, and Pinnipeds	✓	✓	✓	✓	✓						✓	✓			

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CHAPTER 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.

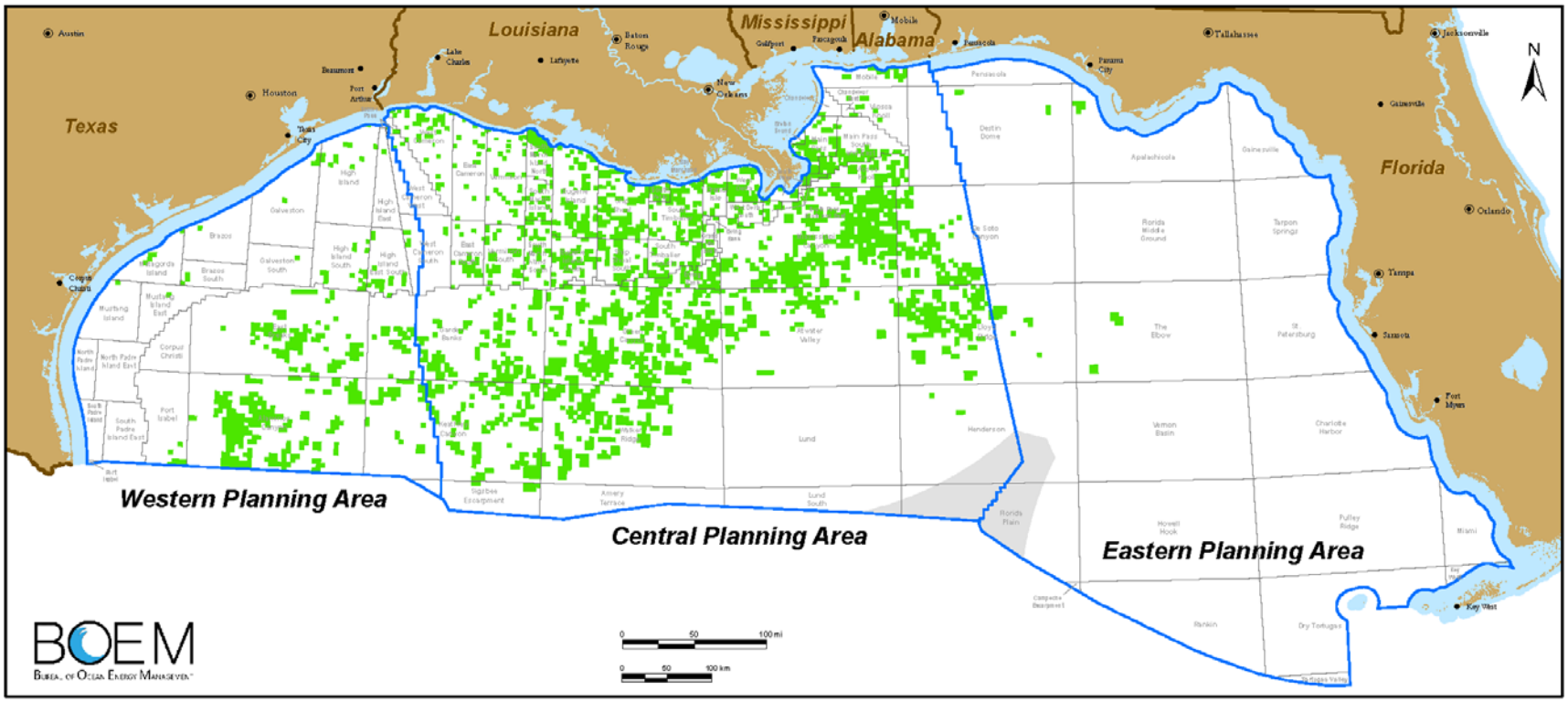
The environmental studies in the GOMR address issues from pre-lease through post-lease operations for conventional energy as well as marine minerals extraction from the OCS. In 1992, the former Minerals Management Service (MMS), now BOEM, entered into a partnership with the Louisiana State University (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, 2017, there are nearly 3,200 active oil and gas leases on the Federal OCS. More than 97% of these are located in the GOM (n= >3,000) (Figure 8). Within active leases, there are more than 2,600 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 final lease sale of the current 2012–2017 Five-Year program was held on March 22, 2017 and offered leases in the Central Planning Area. The new 2017–2022 five-year program proposes 10 region-wide lease sales in the GOM. Leases will be offered for bid in the Central Planning Area, Western Planning Area, and a portion of the Eastern Planning Area not under Congressional moratorium. The first lease sale of the 2017–2022 Five-Year program is scheduled for August 16, 2017 and will offer 73 million acres offshore Texas, Louisiana, Mississippi, Alabama, and Florida for oil and gas exploration and development. 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	457	2,582,802
Central	12,409	66,446,351	2,483	12,989,311
Eastern	11,537	64,357,859	37	200,670
Sub-Totals	29,186	159,381,023	2,977	15,772,783
CPA / EPA Shared Blocks*	(86)		(3)	
Totals	**29,100**	**159,381,023**	**2,974**	**15,772,783**

Active Lease
Exclusive Economic Zone
Northern Portion of the Eastern Gap
Planning Area Boundary

* CPA and EPA contain 86 shared blocks of which 3 are leased. These blocks are given both a CPA and EPA designation in the data which accounts for a higher block total.

Figure 8. GOM OCS Planning Areas and active oil and gas leases (May 1, 2017).

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 be a topic of continued study, even as 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 9) 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 10). These circumstances, access, and potential environmental resource conflicts are becoming more complex and deserving of rigorous and integrated environmental study, monitoring, and management.

Figure 9. Aerial photograph of Caminada Headland construction, September 6, 2013. Photo credit: Patrick M. Quigley (www.gulfcoastairphoto.com).

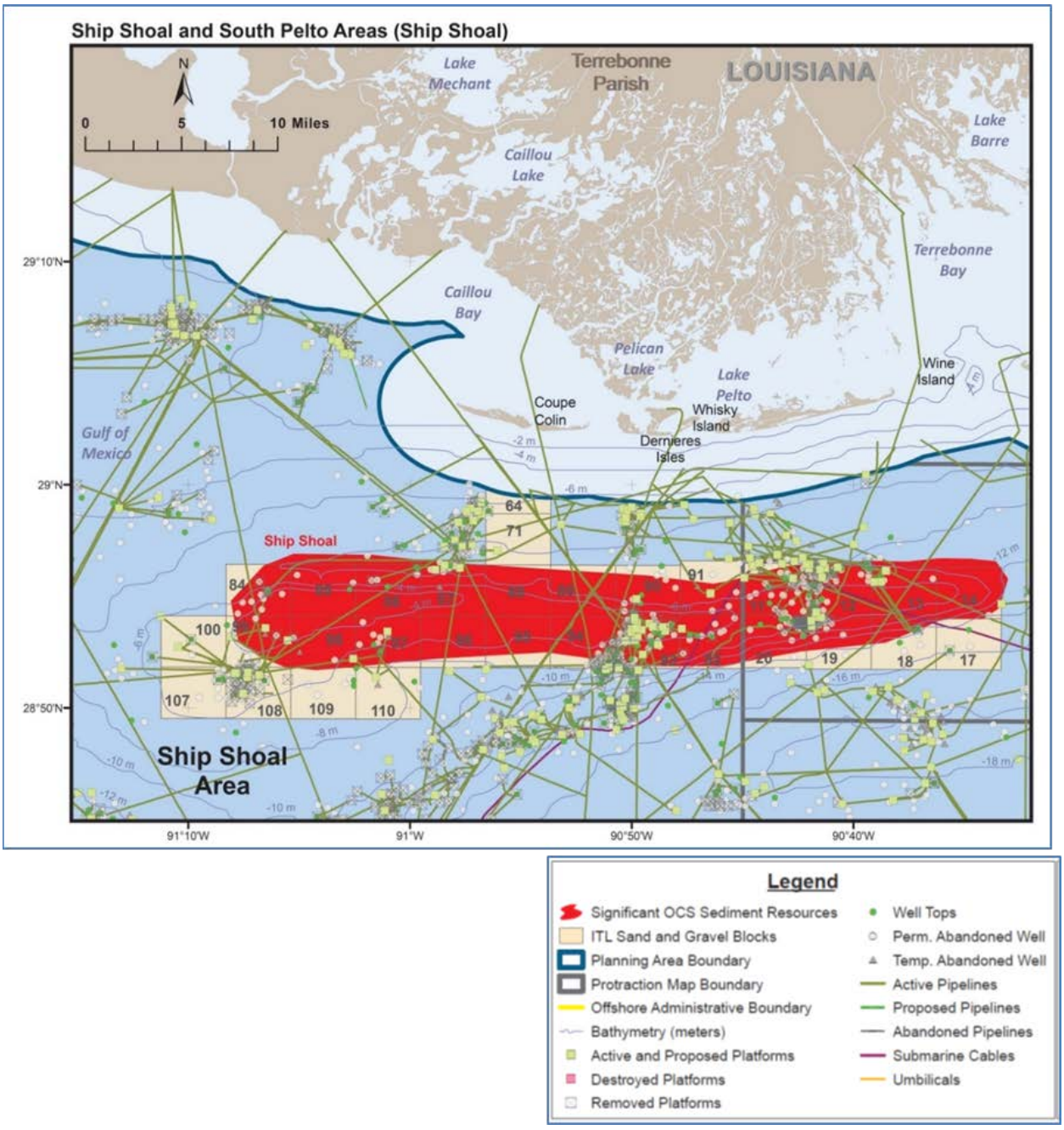


Figure 10. Complex competing use challenges with respect to oil and gas platforms, pipelines, and the Ship Shoal significant OCS sediment resources in the GOM.

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 I. Profiles for these proposed studies are provided in Appendix II.

4.2.1 Conventional Energy

The GOMR is proposing 17 study profiles for the FY 2018 NSL. 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, Physical Oceanography, Marine Mammals & Protected Species, or Social & Economic Sciences.

Table 3. Alignment of Proposed FY 2018 GOM OCS Region Studies with BOEM Programs and Strategic Science Questions.

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 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	Long-Term Coral Reef Monitoring at the Flower Garden Banks, Gulf of Mexico: 2019–2022	✓			✓								✓
2	Evaluating Potential Mudslide Impacts to Historic Shipwrecks	✓		✓					✓			✓	✓
3	Mapping the Late Pleistocene Landscapes of the Gulf of Mexico Through Three-Dimensional (3-D) Seismic Analysis	✓		✓								✓	
4	Wavelet Analyses of Acoustic Doppler Current Profiler Data from Outer Continental Shelf (OCS) Platforms	✓							✓			✓	
5	Synthesis of Potential Wind Turbine Interactions with Wildlife and Their Habitats in the Northern Gulf of Mexico		✓					✓					
6	Leveraging the National Energy Technology Laboratory's (NETL's) Offshore Integrated Assessment Modeling Tools & Methods for Assessing Oil Spill Risk				✓							✓	
7	Socioeconomic Impacts of Outer Continental Shelf (OCS) Infrastructure: Shifts in Recreational Behaviors	✓								✓			
8	Higher Order Analyses of the Bureau of Ocean Energy Management's (BOEM's) Lagrangian Data	✓							✓				
9	Preparing for Disaster: Developing Baseline Data Collection and Action Plans	✓			✓					✓			
10	The Visual Impacts of Outer Continental Shelf (OCS) Activities on Horn and Petit Bois Islands	✓			✓					✓			
11	Assessing Vessel Strike Risk to Sea Turtles at Port Fourchon, Louisiana	✓						✓				✓	✓
12	An Analysis of Seafloor Impacts on the Gulf of Mexico Outer Continental Shelf (OCS) for Adaptive Impact Mitigation	✓	✓	✓	✓			✓					
13	Improving Air Quality (AQ) Remote Sensing Products for Managing Applications in the Gulf of Mexico (GOM) Region	✓									✓	✓	
14	Wind Resource and Ecological Measurements to Inform Offshore Wind Feasibility in the Gulf of Mexico		✓					✓				✓	
15	Investigation of an 18th Century Shipwreck as an Analogue for Archaeological Resource Types on the Outer Continental Shelf (OCS)	✓		✓				✓					
16	Effect of Oil Contamination on Wetland Loss in Louisiana	✓			✓		✓	✓					
17	Deepwater Ecosystem Observations at the Stones Project in the Central Gulf of Mexico	✓			✓							✓	✓

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Seven profiles address the Strategic Science Question: *How can BOEM best assess cumulative effects within the framework of environmental assessments.* Studies such as "Long-Term Coral Reef Monitoring at the Flower Garden Banks, Gulf of Mexico: 2019–2022" and "Deepwater Ecosystem Observations at the Stones Project in the Central Gulf of Mexico" propose to continue or initiate long-term monitoring to collect environmental information that will inform cumulative impacts assessments. Other proposed studies will address oil spill modeling ("Leveraging the National Energy Technology Laboratory's (NETL's) Offshore Integrated Assessment Modeling Tools & Methods for Assessing Oil Spill Risk") and the effects of oil spills on wetlands ("Effect of Oil Contamination on Wetland Loss in Louisiana"). Continuing the theme of acquiring information about impacts from BOEM-permitted activities, one study proposes 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 ("Preparing for Disaster: Developing Baseline Data Collection and Action Plans") and examine the "The Visual Impacts of Outer Continental Shelf (OCS) Activities on Horn and Petit Bois Islands."

One profile addresses the Strategic Science Question: *What are the acute and chronic effects of exposure to hydrocarbons or other chemicals on coastal and marine species and ecosystems?* The "Effect of Oil Contamination on Wetland Loss in Louisiana" will examine actual impacts from oil contamination on Louisiana wetlands.

Six 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, "Synthesis of Potential Wind Turbine Interactions with Wildlife and Their Habitats in the Northern Gulf of Mexico," will compile existing information on migratory birds, bats, marine mammals, fish, and other sensitive species to identify information gaps in our understanding of potential wind turbine interactions. Results from this analysis will inform strategic planning as well as environmental assessments for potential future renewable energy development in the GOMR. Another study, "Wind Resource and Ecological Measurements to Inform Offshore Wind Feasibility in the Gulf of Mexico," is proposed to collect wind measurements and ecological data in areas of highest wind energy feasibility to inform strategic planning and wildlife-related mitigations for potential wind energy development in the GOMR. The study "Assessing Vessel Strike Risk to Sea Turtles at Port Fourchon, Louisiana" will calculate the risk of strikes from vessels associated with OCS activities in this heavily trafficked area. This information will inform Endangered Species Act (ESA) consultations for OCS activities. Two profiles will address direct impacts from BOEM-permitted activities; one will compile and analyze available information on seafloor-disturbing activities ("An Analysis of Seafloor Impacts on the Gulf of Mexico Outer Continental Shelf (OCS) for Adaptive Impact Mitigation") while a second study will examine coastal wetland loss as a result of oil contamination ("Effect of Oil Contamination on Wetland Loss in Louisiana"). Lastly, a new study proposes to investigate a recently rediscovered 18th century shipwreck found buried near the Chandeleur Islands, Louisiana as an analogue for historic, wooden-hulled shipwrecks that may be found on the OCS ("Investigation of an 18th Century Shipwreck as an Analogue for Archaeological Resource Types on the Outer Continental Shelf (OCS)"). BOEM seeks to acquire information about these types of buried archaeological sites to help inform analyses and mitigations related to BOEM-

permitted activities that disturb the seafloor (*e.g.*, drilling, pipeline installation, anchoring, dredging, *etc.*) as well as archaeological resources that may be buried beneath it.

Three profiles address the Strategic Science Question: *How will future ocean conditions and dynamics amplify or mask effects of BOEM-regulated OCS activities?* One study, "Evaluating Potential Mudslide Impacts to Historic Shipwrecks," will examine how mudslides may affect the movement of historic shipwrecks in mudflow-prone areas such as the Mississippi River Delta. BOEM assigns avoidance mitigations to potential archaeological resources (*e.g.*, 1000 ft. radius around a specific coordinate) in which no seafloor-disturbing activities may occur. If mudslide events are moving historic shipwrecks out of their currently prescribed avoidance area, BOEM may need to consider adaptive mitigations or modifications to survey requirements in these areas to address this phenomenon. In addition, industry will need to be informed if such hazards may affect their activities and existing infrastructure in the vicinity of these archaeological resources. Two profiles will focus on physical oceanographic data. The "Wavelet Analyses of Acoustic Doppler Current Profiler Data from Outer Continental Shelf (OCS) Platforms" study will analyze existing data on the variability of ocean currents at deepwater platforms to improve oil spill and other pollution risk assessments. The "Higher Order Analyses of the Bureau of Ocean Energy Management's (BOEM's) Lagrangian Data" study will conduct second order analyses of existing deepwater Lagrangian data to enhance BOEM's understanding of the Gulf's deepwater circulation at the basin scale. This information will supplement assessments and numerical modeling of the fate and dispersion of pollutants and organic particles, both horizontally and vertically.

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 study "Socioeconomic Impacts of Outer Continental Shelf (OCS) Infrastructure: Shifts in Recreational Behaviors" 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. Another study, "Preparing for Disaster: 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. The third study proposes to examine the "The Visual Impacts of Outer Continental Shelf (OCS) Activities on Horn and Petit Bois Islands." This study will determine visual impacts from existing OCS activities near the Gulf Islands National Seashore as well as determine visual impacts that could result from future OCS activities and identify potential mitigation measures.

One profile addresses the Strategic Science Question: *What are the BOEM-regulated industry impacts of air emissions to the human, coastal, and marine environment?* The study "Improving Air Quality (AQ) Remote Sensing Products for Managing Applications in the Gulf of Mexico (GOM) Region" proposes to create a methodology for utilizing National Aeronautics and Space Administration (NASA) Earth observing satellite data to monitor atmospheric pollutants in the GOM. These data will inform observations of the fate of emissions from OCS and terrestrial-based activities. In addition, unmanned aircraft systems and miniature air quality sensors will provide information to fill knowledge gaps and supplement satellite-acquired data.

Eight profiles address the Strategic Science Question: *How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?* Seven of the profiles were discussed above under other strategic questions and will focus on evaluating mudslide impacts to historic shipwrecks, wavelet analysis of data from acoustic Doppler current profilers (ADCPs) at OCS platforms, leveraging NETL's modeling tools and methods for oil spill risk assessment, improving air quality remote sensing products, establishing deepwater ecosystem observations at the Stones Project, wind resource and ecological measurements to inform offshore wind feasibility, and assessing vessel strike impacts to sea turtles at Port Fourchon. An eighth profile, "Mapping the Late Pleistocene Landscapes of the Gulf of Mexico Through Three-Dimensional (3-D) Seismic Analysis," proposes to analyze existing 3-D seismic data to map and identify Late Pleistocene landscapes on the GOM OCS. Additionally, the study will create a model to predict preservation potential of buried prehistoric archaeological sites within these submerged landscapes.

Finally, four profiles address the Strategic Science Question: *What affected resources, measures, and systems are best used for long-term monitoring?* The profiles were discussed above under other strategic questions and will focus on long-term monitoring in the Flower Garden Banks National Marine Sanctuary, evaluating potential mudslide impacts on historic shipwrecks, conducting deepwater ecosystem observations at the Stones Project, and assessing vessel strike risk to sea turtles at Port Fourchon.

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 (Table 4), for clarity and brevity, only the most pertinent question is linked to a given study. For FY 2018–2020, 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 (1) (*i.e.*, the effect of habitat alteration), the MMP is proposing the study titled "Evaluating Changes in Habitat Value and Function in Outer Continental Shelf (OCS) Sand Resource Areas Following Dredging Events." This study seeks to evaluate OCS borrow area design parameters and associated construction methodologies that may increase habitat value compared to pre-dredge conditions. While recognizing the existing body of literature and ongoing new research to develop refined mitigation strategies to avoid and/or minimize the "negative" effects of dredging, there may also be opportunities for "positive" effects through creation of post-dredging habitat change and improvements. Recent studies have suggested that modification of seafloor morphology may improve habitat conditions in some locations by increasing both surface area and creating new ecological niches, enabling rapid and/or improved biotic assemblage recovery, albeit with different biological communities. Different modes of recovery and community succession may likewise offset potential affects to higher trophic level organisms. Testing the hypothesis that alteration of the seabed in some OCS borrow areas may actually improve or modify ecological value is a paradigm shift from past study designs and has yet to be fully investigated. This information is vital in the future development and management of OCS mineral resources and will complement the ongoing

national sand resource inventory initiative in order to fully understand the individual and cumulative impacts of BOEM's actions on a regional scale and appropriately consider the tradeoffs of dredging finite sediment resources. Findings from this study would complement existing knowledge gained through the ongoing borrow area optimization study (NT-15-03) and the regional Essential Fish Habitat geospatial assessment and framework study (NT-16-09) to support science based decision-making and consideration of more comprehensive mitigation strategies. Potential cooperative support may be available from the USACE Engineering Research and Development Center, building on existing partnerships for dredge-related studies. This study is planned for execution in the GOM, but the results would be applicable program-wide for the MMP.

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.

Table 4. Alignment of Proposed FY 2018 GOM MMP Studies with BOEM Programs and Strategic Science Questions. The priority ranking is given with respect to the MMP's other Atlantic Studies (Table 8).

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 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**?
2	Fine-Scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico	✓		✓	✓		✓	✓				✓	
4	Evaluating Changes in Habitat Value and Function in Outer Continental Shelf (OCS) Sand Resource Areas Following Dredging Events			✓	✓			✓					

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CHAPTER 5 PACIFIC STUDIES

5.1 Introduction

BOEM's Pacific Region includes the OCS areas offshore California, Oregon, Washington, and Hawaii (Figure 11). 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 forty-four-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 2018–2020 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, Tribal governments, and representatives of Native Hawaiian communities. BOEM Pacific Region received and considered 19 study ideas from stakeholders, including universities, consultants, federal agencies (NOAA and Bureau of Land Management), and a State of California agency. Additionally, nine BOEM Pacific Region staff proposed 16 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 I and Appendix II).

5.1.1 Conventional Energy Activities

The current Five-Year OCS Oil and Gas Leasing Program proposes no new oil and gas lease sales for the Pacific Region (BOEM 2016). Nonetheless, oil and gas production occurs in Federal waters in the Southern California Planning Area and will continue for the foreseeable future. Production from 43 OCS oil and gas leases (Figure 12) is approximately 6.4 million barrels (MMbbl) of oil and 4.8 billion cubic feet (Bcf) of gas annually (D. Mayerson, personal communication, March 9, 2017). This is a recent, significant decrease in production due to the temporary shut-in of six platforms that previously accounted for more than 60% of the Region's oil and gas output. The shut-in was caused by a May 2015 break of an onshore pipeline that transported oil from these six platforms. Once repairs are completed, offshore production is expected to quickly increase to previous levels (*i.e.*, 17 MMbbl oil and 27 Bcf gas). On platforms unaffected by the pipeline break, production operations continue. Since offshore development in all active leases began decades ago, decommissioning activities are in the foreseeable future.

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, inter-agency working groups, and stakeholder outreach activities.

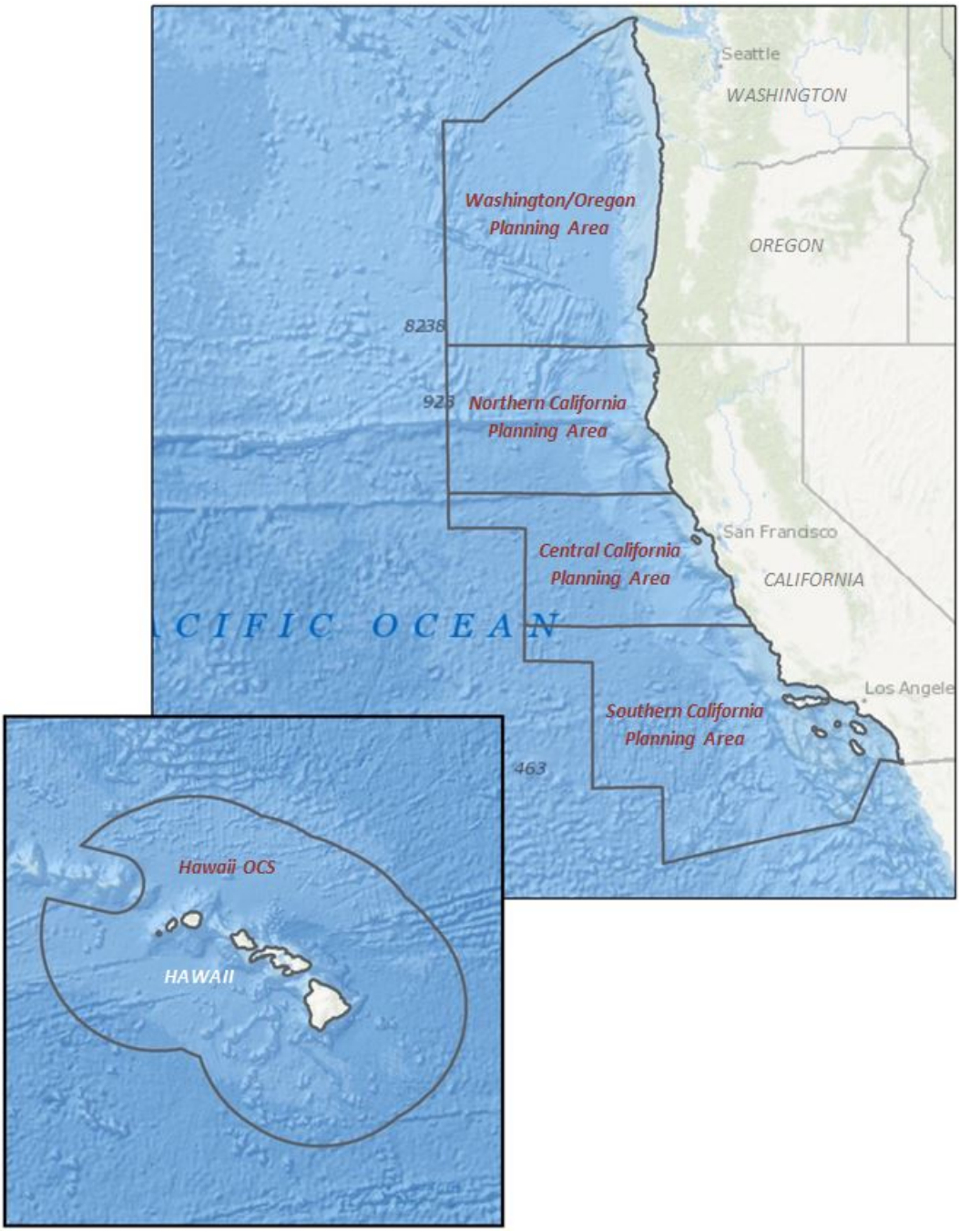

Figure 11. OCS planning areas in the Pacific Region.

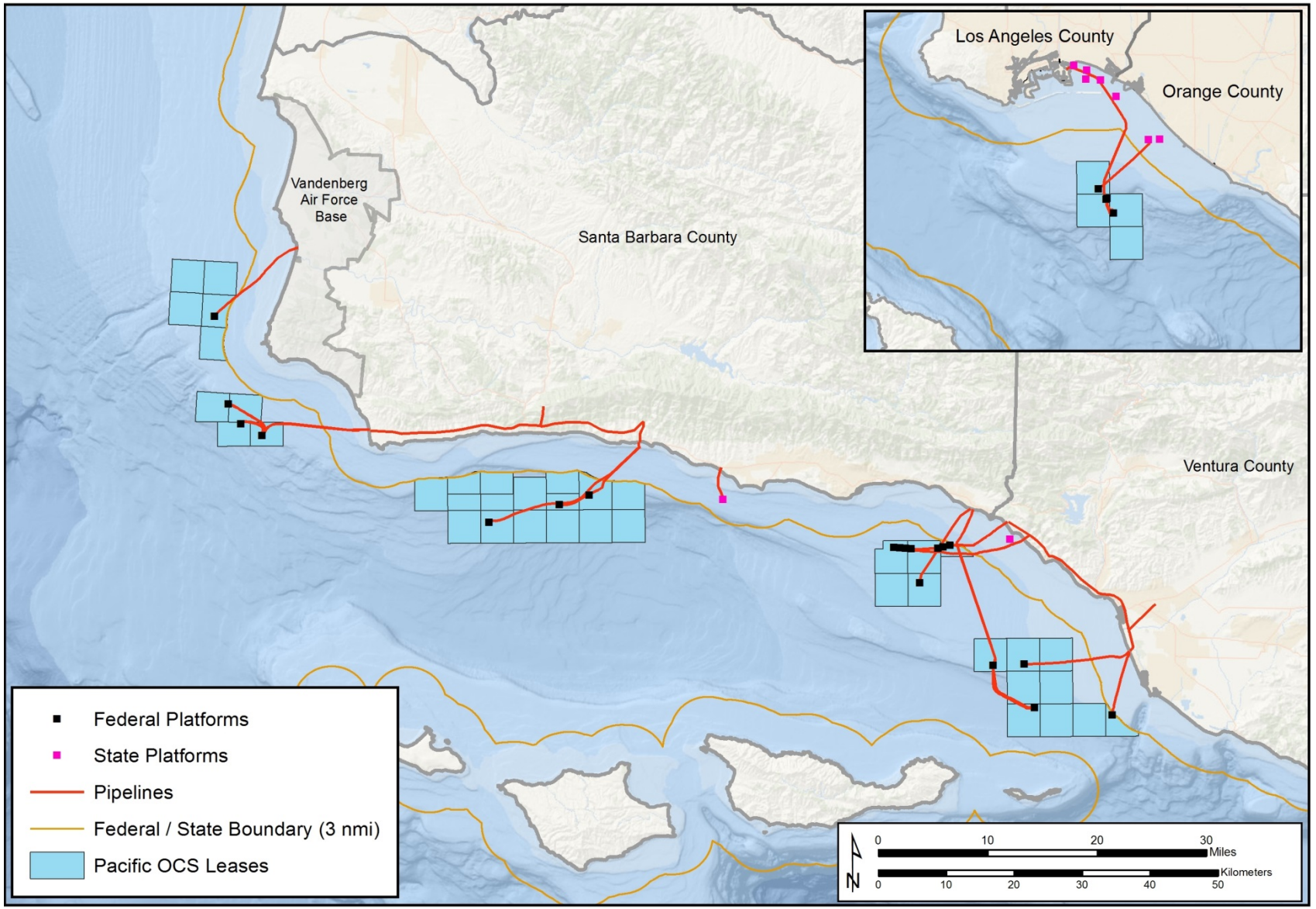

Figure 12. Oil and gas leases and facilities in the Pacific Region.

5.1.2 Renewable Energy Activities

Significant wind and wave potential along the U.S. West Coast and offshore Hawaii (Figure 13, Figure 14) 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 (Figure 15, Figure 17) and a wave energy project is proposed in the Oregon OCS (Figure 16). Additionally, seafloor cables on the OCS that transmit renewable energy originating from terrestrial sources is in the planning phase in Hawaii (Figure 18). 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.

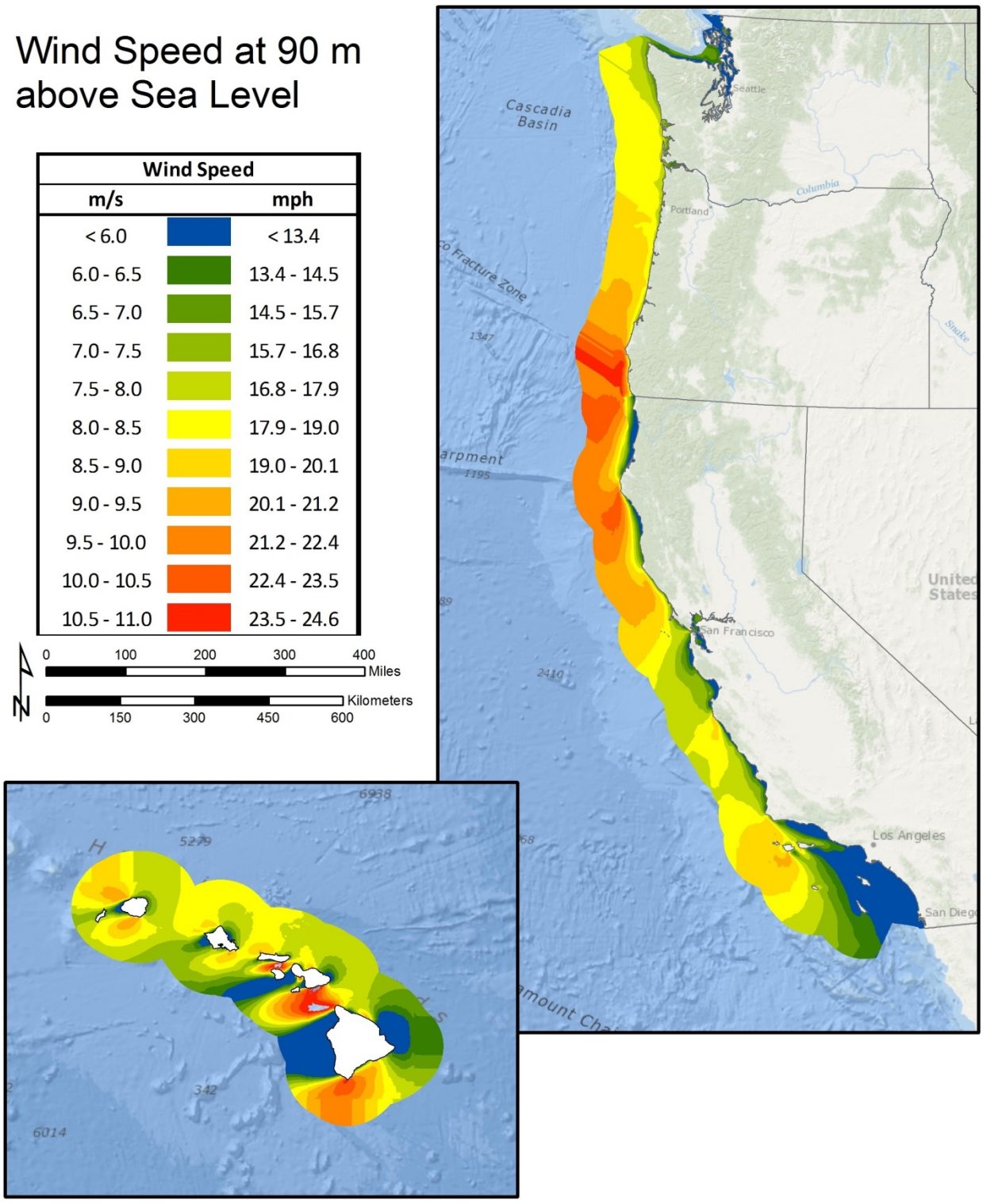

Figure 13. Annual average wind speed offshore the U.S. West Coast and Hawaii. Maps based on National Renewable Energy Laboratory's assessment of offshore wind energy resources (Schwartz, et al. 2010). Data available at https://maps.nrel.gov/wind-prospector.

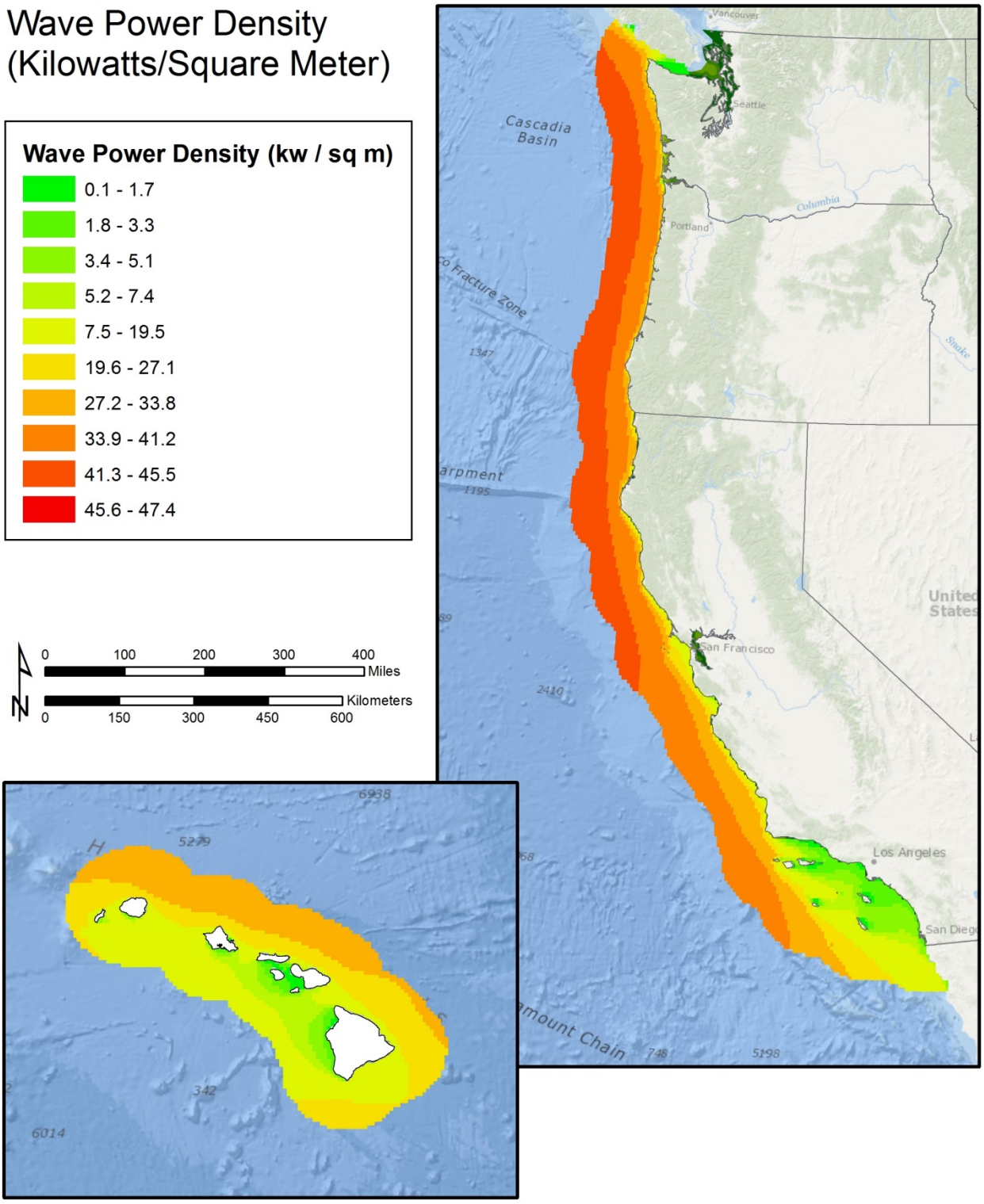

Figure 14. Annual average wave power density offshore the U.S. West Coast and Hawaii. Maps based on Electric Power Research Institute's assessment of ocean wave energy resources (EPRI 2011). Data available at https://maps.nrel.gov/mhk-atlas.

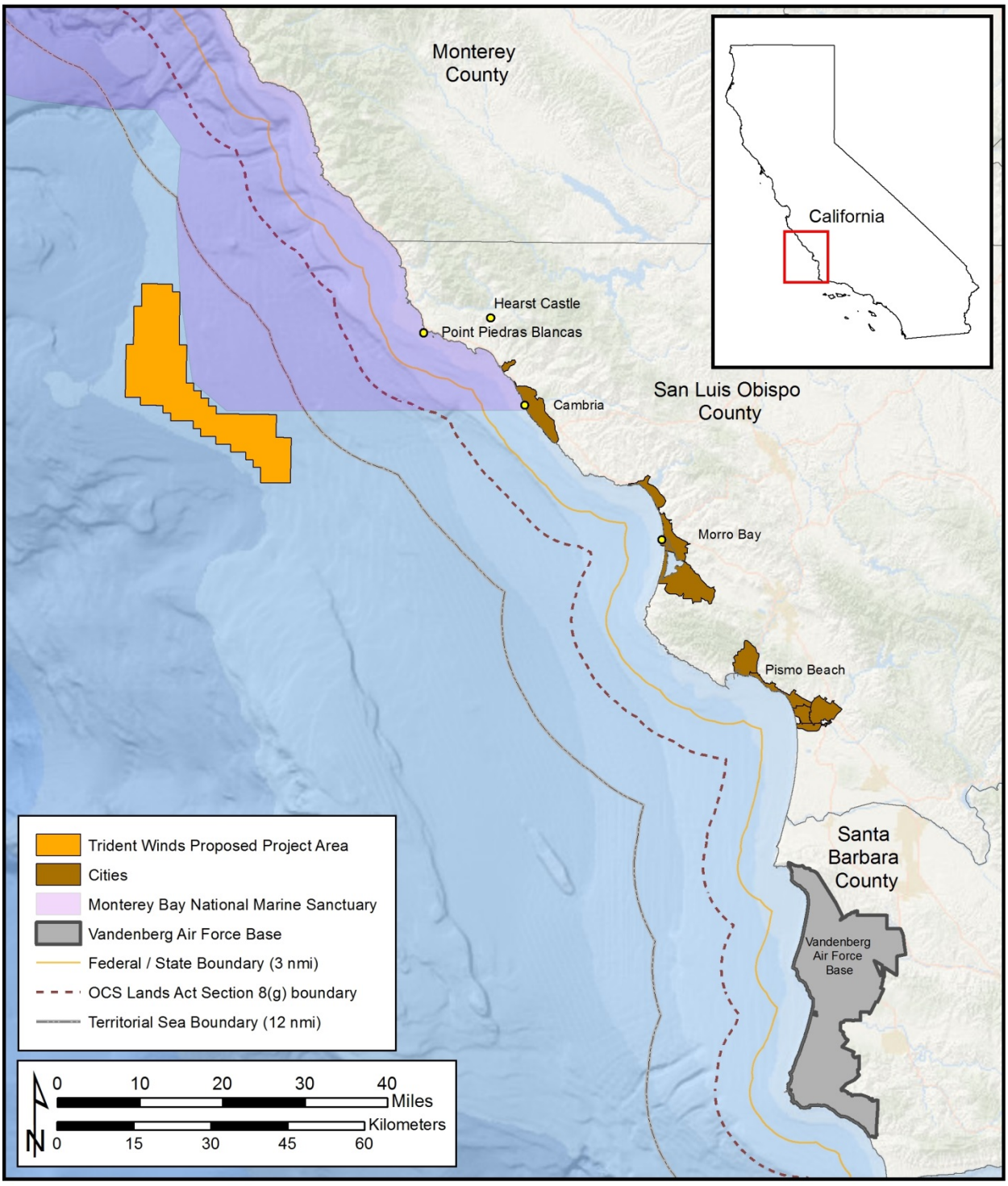

Figure 15. Proposed renewable energy project in the California OCS.

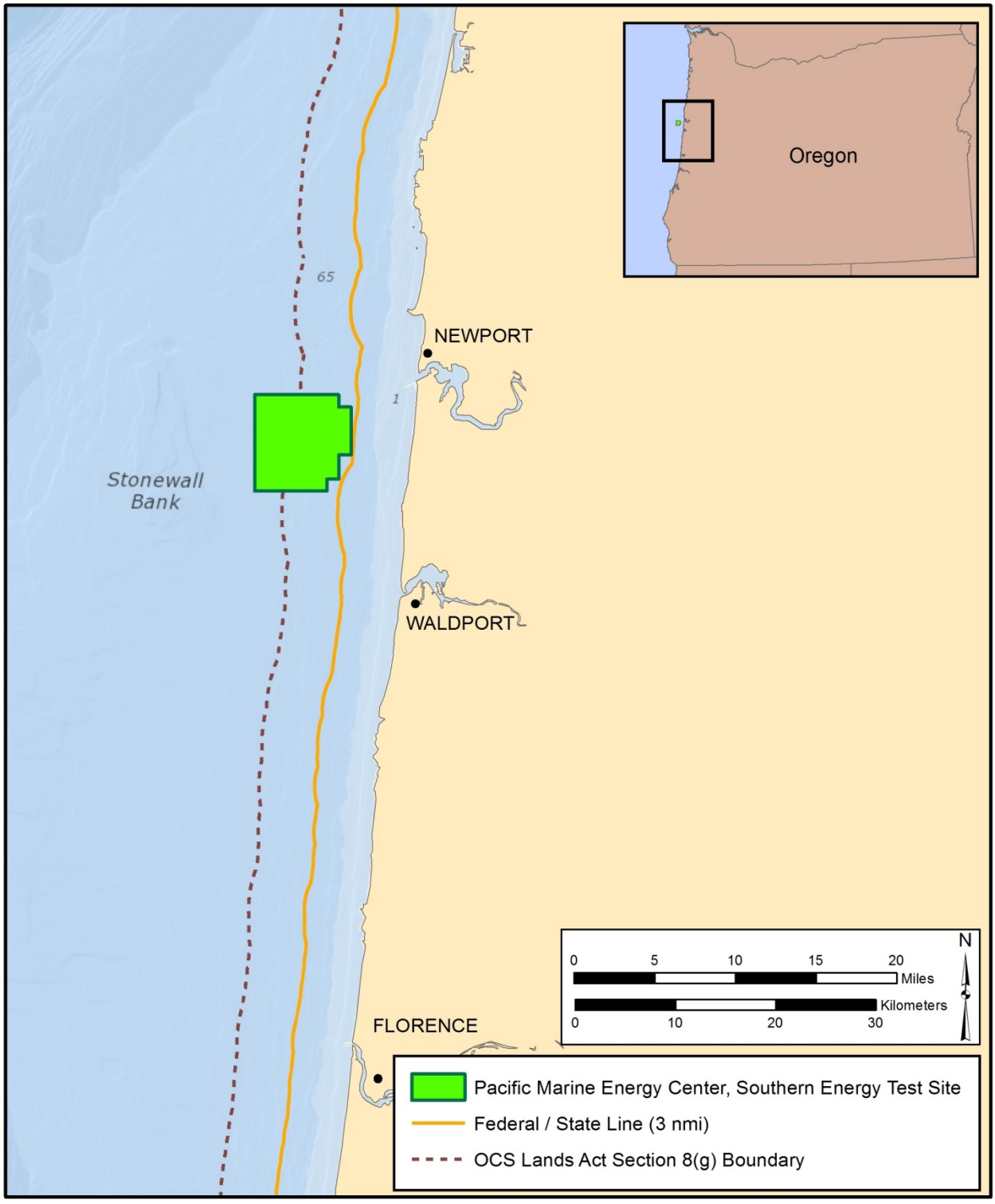

Figure 16. Proposed renewable energy project in the Oregon OCS.

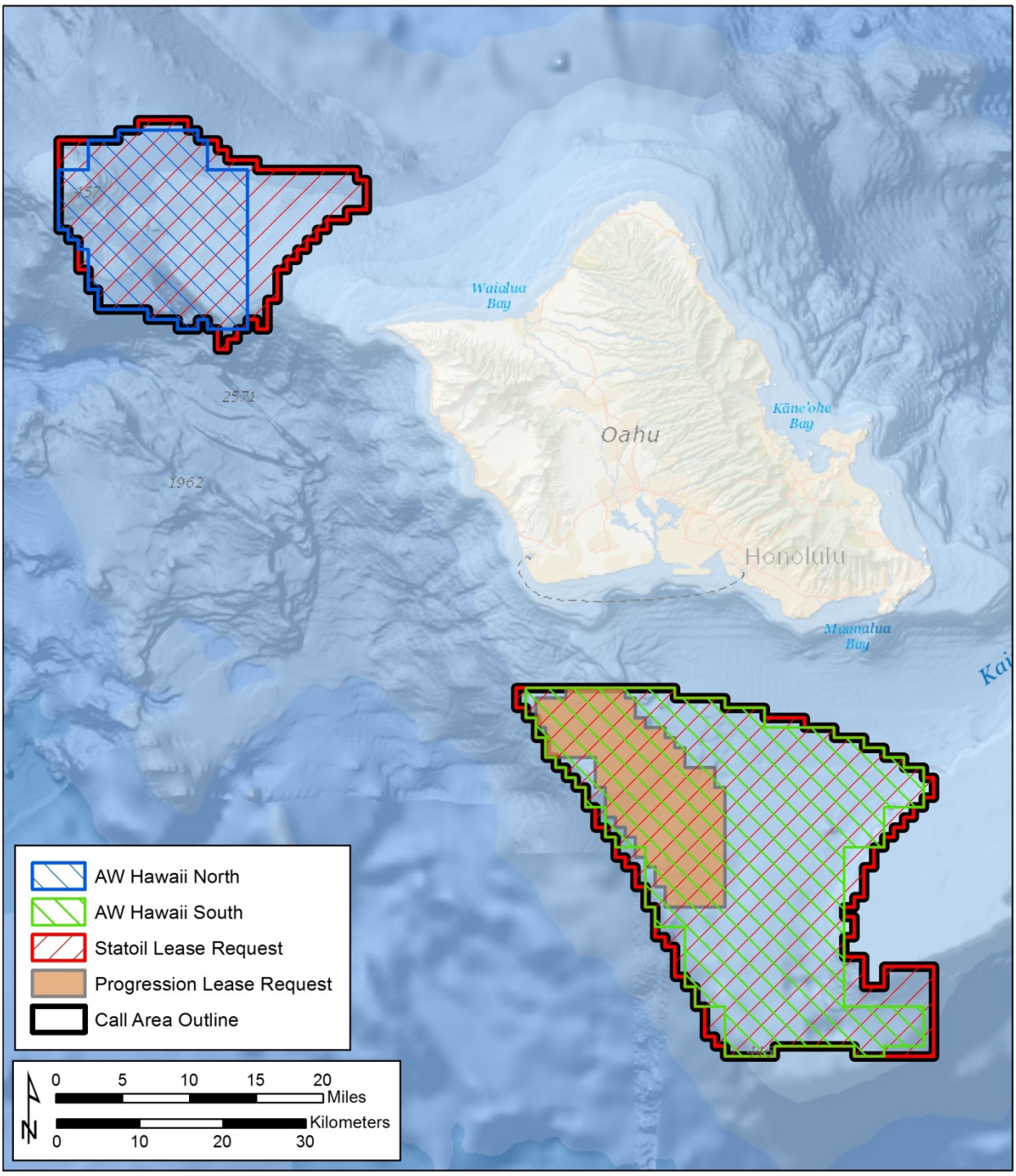

Figure 17. Proposed renewable energy projects in the Hawaii OCS.

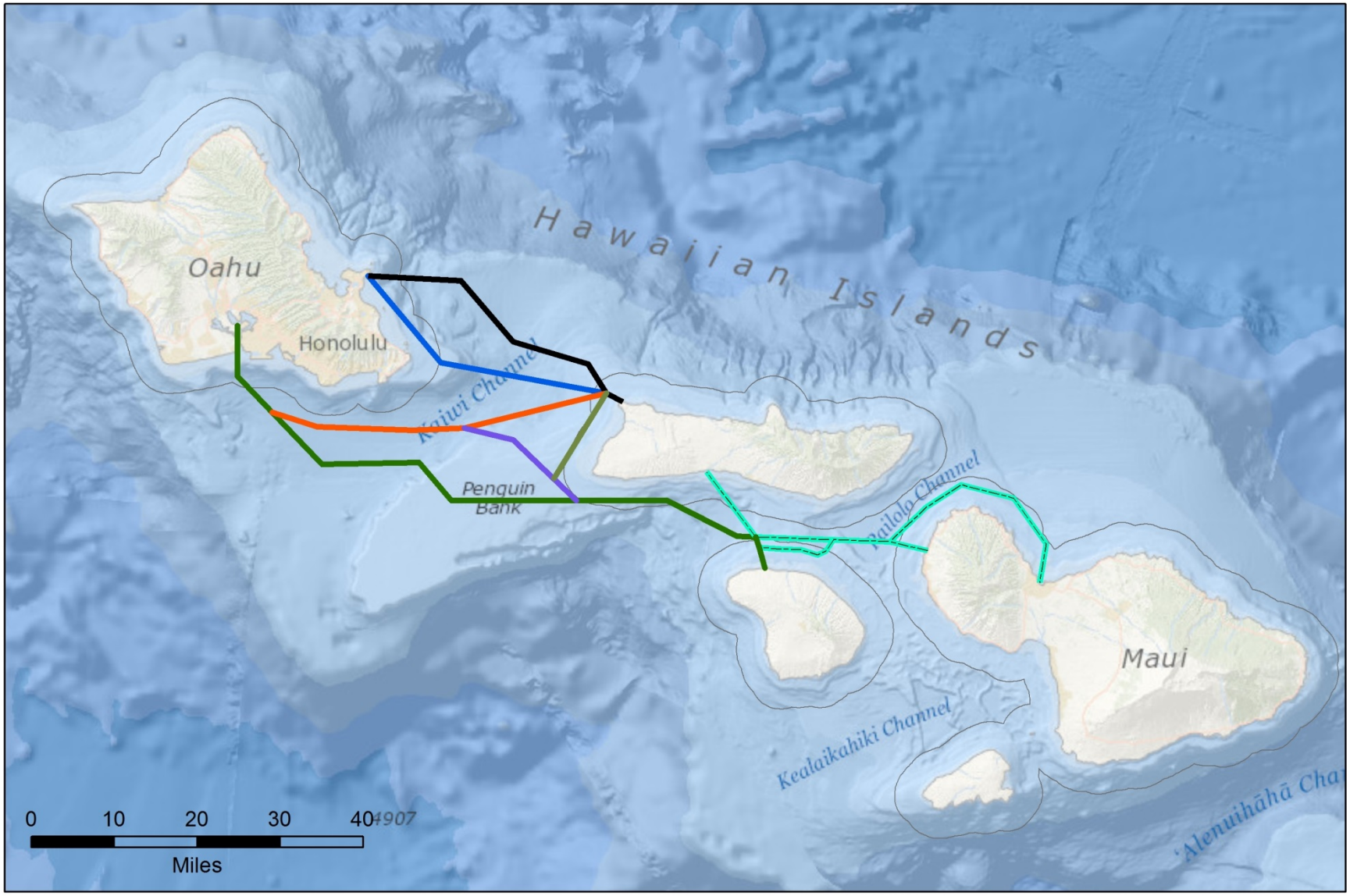

Figure 18. Possible routes for inter-island power transmission cables offshore Hawaii.

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.

Although the MMP is in an early stage of development, the Region proposes two studies that focus on quantifying environmental conditions and biological communities within and adjacent to potential borrow areas offshore California. This information will inform offshore planning efforts and provide baseline survey information needed for impact assessments associated with NEPA reviews.

5.2 Alignment with Strategic Science Questions

Current and forecasted activities in the Pacific Region (please 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 2018, 10 will inform conventional energy, 11 will inform renewable energy, and 2 will inform marine minerals. Of the 14 proposed studies in the portfolio, 7 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 effects (2 studies);
- determining effects of exposure to hydrocarbons (1 study);
- determining effects of habitat or landscape alteration (11 studies);
- determining how future ocean conditions and dynamics may mask effects of OCS activities (2 studies);
- using social science research in impact assessment (7 studies);
- determining impacts of air emissions (2 studies);
- using existing or emerging technology to improve research results (4 studies); and
- determining which resources, measures, and systems are best used for long-term monitoring (3 studies).

Notably, offshore California, several proposed studies address the effect of habitat or landscape alteration from ongoing oil and gas activities, and results from this research can also be used to address renewable energy information needs. In general, proposed studies informing multiple programs and addressing multiple strategic science themes have the highest priority; although other proposed studies have more restricted applications, they are also important because they target critical data gaps specific to foreseeable projects in the Pacific Region.

Tables of proposed studies for the Pacific Region are included in Appendix I. Profiles for these proposed studies are provided in Appendix II.

Table 5. Alignment of proposed Pacific Region studies with BOEM programs and Strategic Science Questions.

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 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 Biological Connectivity Among Offshore Structures and Natural Reefs	✓	✓				✓	✓					
2	California Deepwater Investigations and Groundtruthing (Cal DIG) II	✓	✓				✓		✓			✓	
3	Pacific Seabird Monitoring Program	✓	✓		✓		✓	✓	✓			✓	✓
4	The Ecological Status of Artificial Reefs Offshore California	✓	✓					✓		✓			
5	A Marine Biogeographic Assessment of the California Current Ecosystem	✓	✓	✓	✓							✓	✓
6	Air Emissions Associated with Decommissioning Operations for Pacific Outer Continental Shelf (OCS) Oil and Gas Platforms	✓									✓		
7	Physical Characterization of Outer Continental Shelf (OCS) Shell Mounds Associated with Pacific OCS Platforms	✓						✓					
8	Influence of Visual Characteristics from Offshore Energy Structures on Coastal Property and Recreational Values	✓	✓					✓		✓			
9	Atmospheric Response to Hypothetical Wind Farms Along the Central and Southern California Coast		✓					✓					
10	Creation of Geospatial Datasets for Shoreline Habitats	✓	✓	✓				✓				✓	✓
11	Renewable Energy Facilities Visualization for Offshore South-Central California		✓					✓		✓			
12	Deep Ocean Trails to Hawaii's Second Pearl Harbor		✓					✓		✓			
13	*'Ike Hawai'i*—Understanding Hawaii: Public Awareness and Perceptions of Ocean Energy and Recommendations for Analyses		✓					✓		✓			
14	Evaluation of Pacific Outer Continental Shelf (OCS) Region Platform Materials Processing and Disposal Options and Potential Environmental and Social Impacts	✓								✓	✓		

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5.2.1 Conventional Energy Science Strategy

For new studies proposed for FY 2018, 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 2018, 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 public awareness 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 2018, 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 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)

CHAPTER 6 ATLANTIC STUDIES

6.1 Introduction

The Atlantic OCS extends from Maine to Florida and is divided into four planning areas (Figure 19). The OCS planning areas extend from the State/Federal boundary at 3 nautical miles (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 Ecosystem (LMEs) along the Atlantic as defined by NOAA (see http://www.lme.noaa.gov/). On the Atlantic OCS, the Renewable Energy Program and MMP are actively managing leases, while the Conventional Energy Program is not currently pursuing oil and gas leasing.

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 current five-year program for 2017–2022 OCS oil and gas leasing was approved by the former DOI Secretary in January 2017 and did not include Atlantic lease areas. After a robust public comment process at that time, the Mid- and South Atlantic Program Area lease sale proposed for 2021 was previously removed for a number of reasons, including strong local opposition, conflicts with other ocean users, including the Department of Defense and NASA's Wallops Flight Facility on Wallops Island, Virginia, and market dynamics. Careful consideration was also given to the comments received from governors of affected States. BOEM will now move forward, including building upon past stakeholder outreach activities, in reconsidering potential Atlantic oil and gas leasing as per the new E.O.

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 or in the process of being procured that fill data needs across program areas, including for conventional energy. These studies include:

(1) providing updated baselines of soundscapes in the mid- and south Atlantic through the ongoing Atlantic Deepwater Ecosystem Observatory Network field and modeling program;
(2) synthesizing existing datasets and advanced predictive modeling of deep coral and hardbottom habitats in the southeast Atlantic to guide efficient discovery and protection of sensitive benthic areas, and
(3) 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.

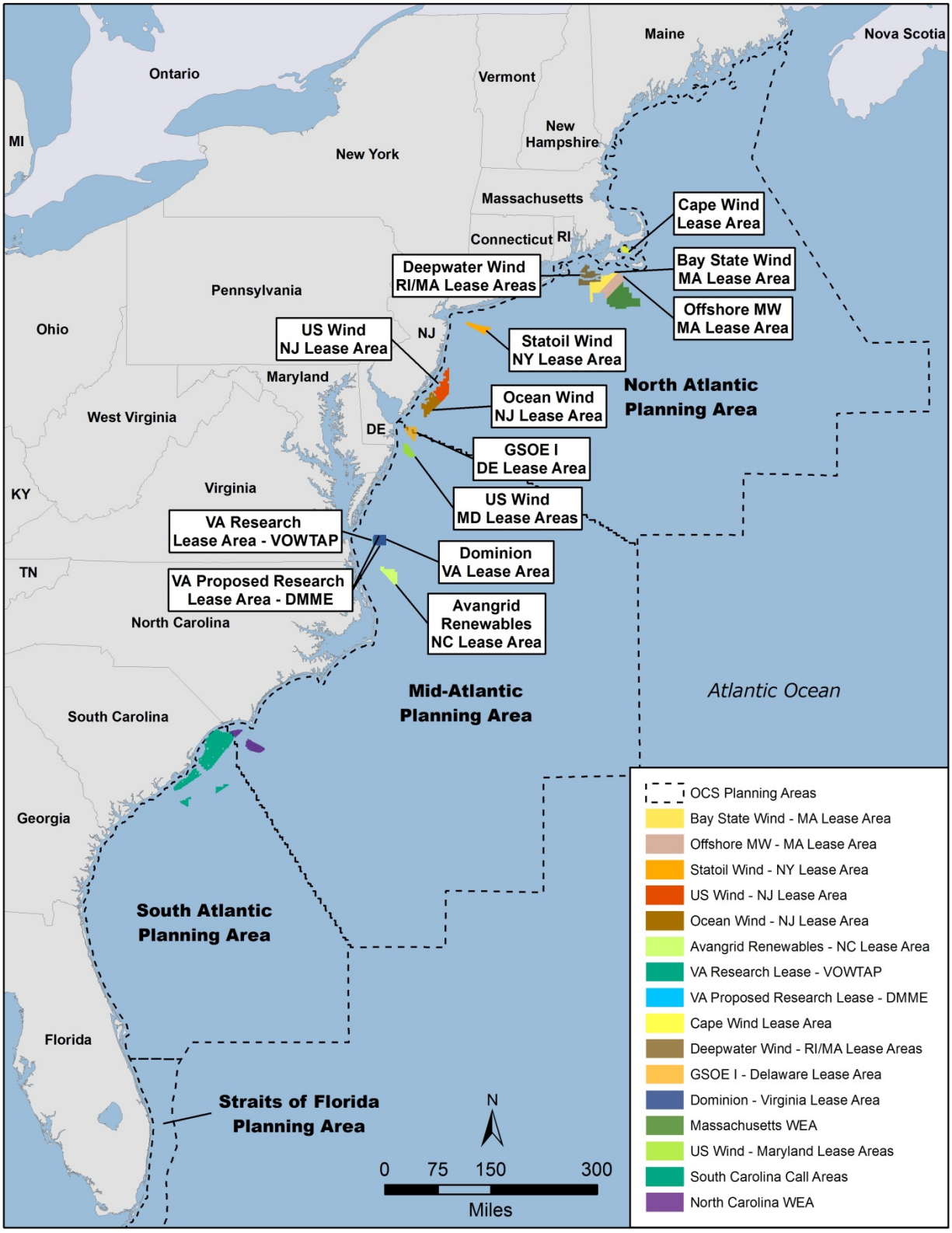

Figure 19. Atlantic OCS Planning Areas for Renewable Energy and Renewable Energy Areas.

6.1.2 Renewable Energy Program

BOEM's Office of Renewable Energy Programs (OREP) is responsible for implementing and managing the Atlantic's offshore renewable energy development, including leasing, leading inter-governmental task forces, State consultations, and post-lease plan approval in Federal waters off the East Coast (Figure 19). The focus of the program is currently for wind and marine hydrokinetic (wave, current) projects.

OREP now has fourteen 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 review of construction and operation plans (COPs) for these lease areas. BOEM anticipates receiving three COPs within the next year. 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

Following the extensive damages caused by Hurricane Sandy (Figure 20) in 2012, 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, including Joaquin and Matthew, 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 20. Before and after Hurricane Sandy storm damages (Seaside Heights, New Jersey).

6.2 Alignment with Strategic Science Questions

Tables of proposed studies for Atlantic Programs are included in Appendix I. Profiles for these proposed studies are provided in Appendix II.

Table 6. Alignment of OREP Studies proposed to start in FY 2018 with BOEM Programs and Strategic Science Questions.

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 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	Science Exchange Forum for Atlantic Studies		✓		✓	✓		✓	✓	✓		✓	✓
2	Support for Regional Ocean Portals		✓		✓			✓		✓			✓
3	Understanding Potential Economic Impacts to Commercial Fishing from Offshore Wind Energy Development		✓		✓					✓			
4	Monitoring Sea Turtle Behavior in the Ecologically Dynamic North Atlantic Foraging Grounds		✓					✓					✓
5	Movement Patterns of Fish on Cox Ledge		✓		✓			✓					
6	Sea Surface and Bottom Layer Hydrodynamic Modelling and Particle Tracking in the U.S. Mid-Atlantic Bight		✓		✓			✓	✓			✓	✓
7	Southern New England Ichthyoplankton and Juvenile Fish Survey		✓		✓			✓					✓
8	Baseline Ecological Study of Wind Turbines at Block Island Wind Farm		✓		✓			✓					✓
9	Detection of Recreational Use of Coastal Areas on the Outer Continental Shelf (OCS)		✓							✓		✓	

Table 7. Alignment of OREP Studies proposed to start in FY 2019 with BOEM Programs and Strategic Science Questions.

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 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	Fish Auditory Thresholds—Part 2 Field Component	✓	✓	✓		✓		✓				✓	
2	Tracking Movements of a Suite of Priority Shorebirds off the U.S. Atlantic Coast to Better Understand Movements in Adverse Weather & Darkness		✓		✓			✓				✓	✓
3	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic		✓	✓	✓			✓					✓
4	Real-Time Offshore Surveys of Marine Protected Species with an Unmanned Aerial System	✓	✓	✓	✓			✓				✓	✓
5	A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot	✓	✓	✓		✓						✓	
6	Advancing the Use of Acoustic and Thermographic Observations of Marine Birds to Support Post-Construction Evaluations of Wind Turbine Interactions	✓	✓					✓				✓	
7	Integrated Analysis of Marine Bird At-Sea Survey and Tracking Data to Inform Spatial Planning		✓		✓			✓					✓
8	Development of Technological Tools to Accommodate Large Scale Acoustic Data Analyses of Existing and Future Datasets for Ocean Noise and Marine Fauna Monitoring	✓	✓	✓		✓						✓	
9	Predicting Future Seabird Distributions on the Atlantic Outer Continental Shelf (OCS)		✓		✓			✓					✓

6.2.1 Renewable Energy Program

Within the OREP, BOEM is proposing in this plan to fund studies to better understand the existing environment and the potential effects from offshore renewable energy on ecological resources including gray seals, sea turtles, ichthyoplankton, and selected fish in the northeast Atlantic. This information will also be used to evaluate cumulative effects and the effects of any habitat alteration by offshore renewable energy development. Of concern to stakeholders is the potential habitat alteration by the presence of wind turbines due to local changes in currents that affect larval transport. BOEM continues to work toward understanding the effects of sound on marine species with an increasing emphasis on marine fish. New computing capabilities are needed to address the complex and voluminous data collected through monitoring. Increased use of telemetry, and now autonomous gliders, to collect data offers new opportunities to collect scientific information about the movements of species in and above the ocean. Evaluation of these methodologies may lead to new monitoring methodologies. The recent use of cameras during aerial surveys has allowed the collection of human activities on the ocean that may be mined to further understand the spatial and temporal extent of these activities.

Specific to the renewable energy program several important resources warrant a more strategic approach. Following are the Atlantic-specific strategies to address these resources.

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, most concerns 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. In addition, information obtained from implementing this strategy will be used to inform BOEM's NEPA process, provide pre-construction baseline data for post-construction impact assessments, and provide information for the design of future studies and guideline development.

BOEM's avian research strategy centers on developing a regional understanding of the distribution and abundance of avian species that are potentially vulnerable to offshore wind energy development on the OCS. BOEM's avian research strategy also includes the identification of the migratory corridors used by vulnerable avian species that may intersect with potential wind energy areas. To better assess the collision risk to birds, BOEM is also interested in the movement patterns of birds around the recently completed Block Island Wind Farm through both a resurvey of the area off of Rhode Island and the use of nanotags to track individual birds s during a variety of weather conditions especially conditions associated with poor visibility.

Implementation:

1. Identify areas where avian species may be vulnerable to renewable energy development:

    a. *The Compendium of Avian Occurrence* (IA with USFWS). A compilation of bird observations dating back to 1907 to document historic distribution patterns of

birds on the Atlantic OCS. This effort is ongoing with new datasets including the data from the New Jersey Ecological Baseline Study, Rhode Island Special Area Management Plan, Atlantic Marine Assessment Program for Protected Species (AMAPPS), and others. We propose to continue this effort for the next three years, including developing a website for data discovery and access.

b. Recent (since 2005) and current avian survey locations on the OCS (BOEM). (http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Mapping_and_Data/ATL_WILDLIFE_SURVEYS.zip) On-going data collection efforts include *Surveying for Marine Birds in the Northwest Atlantic* (IA with USFWS), *AMAPPS* (IA with NOAA), the *Biodiversity Research Institute Baseline Ecological Survey of the Mid-Atlantic* (Department of Energy [DOE] funded study developed with BOEM), plus efforts conducted by different States that are funded in part with cooperative agreements with BOEM. These efforts use a combination of survey methodologies including boat surveys and traditional and high-definition aerial surveys. The surveys were extended into the South Atlantic during FY 2014.

c. *Integrative Statistical Modeling and Predictive Mapping of Seabird Distribution and Abundance on the Atlantic OCS* (IA with NOAA started in 2013). Development of statistical models using data from the Compendium of Avian Occurrence and environmental variables to create continuous maps that predict avian occurrence and abundance on the OCS.

d. *Statistical Analysis to Support Guidelines for Marine Avian Sampling* (IA with NOAA completed in 2012). A general method for estimating the number of avian surveys needed to detect avian hot and cold spots on the Atlantic OCS.

e. *Assess Relative Vulnerability of Migratory Bird Species to Offshore Renewable Energy*. This study compiles species-specific data, calculates vulnerability indices to collision and displacement for some 200 avian species that use the Atlantic OCS.

f. Developing new technologies for surveying on the OCS including high-definition aerial imagery and acoustic/thermographic systems.

2. Identify migratory corridors that may intersect potential wind development sites:

a. *Offshore Use of Diving Marine Birds Using Satellite Telemetry* (partnering with USFWS). Birds that are being studied include northern gannets, surf scoters, and red-throated loons. The study was extended for an additional year of tagging to improve the statistical analysis for the fall migration.

b. *Tracking Offshore Occurrence of Common Terns and American Oystercatchers* (partnering with USFWS). The study completed the first two years with successful results for terns and oystercatchers. The study was expanded in 2015 to include tagging of the endangered roseate tern and the threatened piping plover.

A new study was implemented to track the spring and fall migration patterns of Red Knots during a variety of weather conditions.

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 years and during crucial times during the animal's' life history. It is important to understand this information not only at the project-level but at the level of the species range, and management levels. BOEM has invested resources in understanding high priority fish, high priority locations, and high priority impact producing factors. To date, high priorities have primarily been 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 electromagnetic field [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 have been added.

For example, the study *Fishery Physical Habitat and Epibenthic Invertebrate Baseline Data Collection*, BOEM is collecting baseline information about seafloor habitats and creating maps from these collections in partnership with NOAA. This information will form the basis for understanding the seafloor habitats prior to offshore wind development and may be used for comparison of changes post development. 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.

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. These studies include aerial and vessel-based surveys to determine distribution and abundance as well as the use of passive acoustic monitoring to understand migration and general habitat use. In

addition, OREP is looking to acquire information to evaluate the risk from construction and operation activities, particularly effects from sound and vessel strikes. BOEM has collected, and will continue to collect, empirical sound propagation data during various construction and operation activities through the 'RODEO' (Real-time Opportunity for Development of Environmental Observation) study. In addition, through this study, BOEM is funding research into the plausibility of using fixed and glider-attached mobile hydrophones linked to real-time communication systems for mitigation purposes during construction activities and for monitoring during operational activities. As a potential mitigation measure for sound effects from high resolution seafloor mapping, BOEM is evaluating the use of hydrophone arrays. The accuracy of towed hydrophone arrays for localizing on whale vocalizations is currently unknown and BOEM is funding the development of an algorithm in order to be able to provide this determination.

6.2.2 Marine Minerals Program

While 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.

The proposed study, "Effects of Sand Mining on Nutrient Supply, Biomass, and Production of Benthic Microalgae and Associated Demersal Zooplankton on Sand Bottom Habitats," will address Strategic Science Questions—*viz.* ecological impacts of habitat alteration and *viz.* effective long-term monitoring. There are several approaches to monitoring the impacts of dredging and placing sand on the wide variety of organisms found on the OCS, nearshore, and beach. Most monitoring occurs to track the recovery of organisms and habitat back to their pre-dredge state. However, filling-in data gaps on some of the most important and earliest colonizers, such as benthic microalgae (BMA), and their relationship to offshore sand ridge

features and surrounding habitat (*i.e.*, hard bottom) may help inform more cost-effective and accurate methods of future monitoring. BMA is one of the most important primary producers on the shelf, providing a food resource to higher level predators, as well as surrounding environments. This study aims to characterize BMA in the South Atlantic Bight in several ways: the amount and drivers of production, distribution on and adjacent to sand resource areas, and recovery response to disruption. Historically, BOEM has not invested in BMA research; therefore, this study would fill a significant knowledge gap. This information would contribute to an ecological approach to assessing impacts and monitoring recovery after dredge activities, and would apply to both the Atlantic and GOM regions as well as other program areas.

Table 8. Alignment of Proposed FY 2018 Atlantic MMP Studies with BOEM Programs and Strategic Science Questions. The priority ranking is given with respect to the MMP's other GOMR Studies (Table 4).

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 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	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		✓	✓	✓			✓	✓				✓
3	Sediment Evolution Following Beach Fill Construction: A Literature Review and Technical Workshop			✓	✓			✓				✓	
5	Effects of Sand Mining on Nutrient Supply, Biomass, and Production of Benthic Microalgae and Associated Demersal Zooplankton on Sand Bottom Habitats		✓	✓				✓					✓

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APPENDIX I. TABLES OF PROPOSED STUDIES FOR FY 2018 AND FY 2019

Table 9. National Studies proposed for the FY 2018 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
85	SSE	1	Vulnerability of Communities in Close Proximity to Outer Continental Shelf (OCS) Programs Support Infrastructure and Activity
89	FE	2	Compendium on Oil Spill Science
91	IMO	3	Developing a Roadmap to Maximize Natural Capital and Maintain Natural Infrastructure in Energy and Mineral Planning
93	BIO	4	Catalog of Seabird Colonies
96	AR	5	Archaeological Investigations in Support of Development of Energy and Mineral Resources on the U.S. Outer Continental Shelf (OCS)
99	BIO	6	Mortality Risk for Whale and Basking Sharks During Energy and Mineral Operations
103	IMO	7	Bureau of Ocean Energy Management (BOEM) Graduate Student Award for Applied Scientific Research
105	IMO	8	Enhanced Marine Stewardship with Citizen Science SCUBA Diving
108	SSE	9	Understanding the Socio-cultural Context of Commercial Fishing
Discipline Codes			
AR = Archeological Resource Protection FE = Fates & Effects SSE = Social Science & Economics			BIO = Biology IMO = Information Management & Other

Table 10. Renewable Energy Studies proposed for the FY 2018 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
111	IMO	1	Science Exchange Forum for Atlantic Studies
112	IMO	2	Support for Regional Ocean Portals
114	SSE	3	Understanding Potential Economic Impacts to Commercial Fishing from Offshore Wind Energy Development
117	PS	4	Monitoring Sea Turtle Behavior in the Ecologically Dynamic North Atlantic Foraging Grounds
120	BIO	5	Movement Patterns of Fish on Cox Ledge
122	BIO	6	Sea Surface and Bottom Layer Hydrodynamic Modelling and Particle Tracking in the U.S. Mid-Atlantic Bight
124	BIO	7	Southern New England Ichthyoplankton and Juvenile Fish Survey
125	BIO	8	Baseline Ecological Study of Wind Turbines at Block Island Wind Farm
127	SSE	9	Detection of Recreational Use of Coastal Areas on the Outer Continental Shelf (OCS)
Discipline Codes			
BIO = Biology PS = Marine Mammals & Protected Species			IMO = Information Management & Other SSE = Social Science & Economics

Table 11. Renewable Energy Studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
129	BIO	1	Fish Auditory Thresholds—Part 2 Field Component
131	BIO	2	Tracking Movements of a Suite of Priority Shorebirds off the U.S. Atlantic Coast to Better Understand Movements in Adverse Weather & Darkness
133	PS	3	Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic
135	PS	4	Real-Time Offshore Surveys of Marine Protected Species with an Unmanned Aerial System
138	BIO	5	A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot
140	BIO	6	Advancing the Use of Acoustic and Thermographic Observations of Marine Birds to Support Post-Construction Evaluations of Wind Turbine Interactions
142	BIO	7	Integrated Analysis of Marine Bird At-Sea Survey and Tracking Data to Inform Spatial Planning
144	PS	8	Development of Technological Tools to Accommodate Large Scale Acoustic Data Analyses of Existing and Future Datasets for Ocean Noise and Marine Fauna Monitoring
146	BIO	9	Predicting Future Seabird Distributions on the Atlantic Outer Continental Shelf (OCS)
Discipline Codes			
BIO = Biology			PS = Marine Mammals & Protected Species

Table 12. Marine Minerals Studies proposed for the FY 2018 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
148	FE	1	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
151	PS	2	Fine-Scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico
154	FE	3	Sediment Evolution Following Beach Fill Construction: A Literature Review and Technical Workshop
156	FE	4	Evaluating Changes in Habitat Value and Function in Outer Continental Shelf (OCS) Sand Resource Areas Following Dredging Events
159	FE	5	Effects of Sand Mining on Nutrient Supply, Biomass, and Production of Benthic Microalgae and Associated Demersal Zooplankton on Sand Bottom Habitats
Discipline Codes			
FE = Fates & Effects			PS = Marine Mammals & Protected Species

Table 13. Alaska Studies proposed for the FY 2018 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
162	FE	1	Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbl
164	IMO	2	Environmental Resource Areas: Using Habitat-Based Density Models and Tagging Data for Analysis of Biological Resources
167	PS	3	Range-Wide Distribution of Cook Inlet Beluga Whales (*Delphinapterus leucas*) in the Winter
170	IMO	4	Coastal Marine Institute
172	BIO	5	Impacts of Sedimentation on the Boulder Patch Community, Beaufort Sea
175	FE	6	Oil Spill Occurrence Estimators for Offshore and Onshore Cook Inlet and Onshore Alaska North Slope Spills
178	SSE	7	Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty Final Development and Production Plan
180	PO	8	Circulation Processes and Landfast Ice Dynamics on the Central and Western Beaufort Sea Shelf
183	BIO	9	Benthic Invertebrate Resources and Trophic Ecology of Fishes in the Nearshore Beaufort Sea
185	FE	10	Levels of Polycyclic Aromatic Hydrocarbons (PAHs) and Other Contaminants in Tissues of Animals Collected in Cook Inlet
187	BIO	11	Updating Status and Trends of Seabirds and Forage Fish in Lower Cook Inlet
190	SSE	12	Subsistence Mapping and Identification of Intensity of Use of the Land- and Seascape by Old Believers of Lower Cook Inlet, Alaska
192	PS	13	Generation of Synthetic Audiograms by Applying Finite Element Modeling to Computerized Tomography (CT) Scans for Baleen Whales, Belugas, and Pinnipeds
Discipline Codes			
BIO = Biology			FE = Fates & Effects
IMO = Information Management & Other			PO = Physical Oceanography
PS = Marine Mammals & Protected Species			SSE = Social Science & Economics

Table 14. Alaska Studies proposed for the FY 2019 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
194	PS	1	Walrus Population-Level Response to Underwater Noise
196	BIO	2	Arctic Slope Winter Fish, Invertebrates, and Arctic Cod Spawning Survey
199	PS	3	The View from Above: Expanding Efforts to Use Existing Aerial Photo-Identification Data for Life-History Analyses of Bowhead Whales
201	PS	4	Bowhead Whale Acoustic, Diving, and Movement Behavior Relative to Ambient Noise and Oceanography
203	BIO	5	Synthesis of Bureau of Ocean Energy Management (BOEM) Beaufort Sea Baseline and Monitoring Studies
Discipline Codes			
BIO = Biology			PS = Marine Mammals & Protected Species

Table 15. GOM Studies proposed for the FY 2018 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
206	BIO	1	Long-Term Coral Reef Monitoring at the Flower Garden Banks, Gulf of Mexico: 2019–2022
208	AR	2	Evaluating Potential Mudslide Impacts to Historic Shipwrecks
211	AR	3	Mapping the Late Pleistocene Landscapes of the Gulf of Mexico Through Three-Dimensional (3-D) Seismic Analysis
214	PO	4	Wavelet Analyses of Acoustic Doppler Current Profiler Data from Outer Continental Shelf (OCS) Platforms
216	BIO	5	Synthesis of Potential Wind Turbine Interactions with Wildlife and Their Habitats in the Northern Gulf of Mexico
219	PO	6	Leveraging the National Energy Technology Laboratory's (NETL's) Offshore Integrated Assessment Modeling Tools & Methods for Assessing Oil Spill Risk
222	SSE	7	Socioeconomic Impacts of Outer Continental Shelf (OCS) Infrastructure: Shifts in Recreational Behaviors
225	PO	8	Higher Order Analyses of the Bureau of Ocean Energy Management's (BOEM's) Lagrangian Data
227	SSE	9	Preparing for Disaster: Developing Baseline Data Collection and Action Plans
230	SSE	10	The Visual Impacts of Outer Continental Shelf (OCS) Activities on Horn and Petit Bois Islands
232	PS	11	Assessing Vessel Strike Risk to Sea Turtles at Port Fourchon, Louisiana
236	AR	12	An Analysis of Seafloor Impacts on the Gulf of Mexico Outer Continental Shelf (OCS) for Adaptive Impact Mitigation
238	MAQ	13	Improving Air Quality (AQ) Remote Sensing Products for Managing Applications in the Gulf of Mexico (GOM) Region
241	IMO	14	Wind Resource and Ecological Measurements to Inform Offshore Wind Feasibility in the Gulf of Mexico
243	AR	15	Investigation of an 18th Century Shipwreck as an Analogue for Archaeological Resource Types on the Outer Continental Shelf (OCS)
246	BIO	16	Effect of Oil Contamination on Wetland Loss in Louisiana
249	PO	17	Deepwater Ecosystem Observations at the Stones Project in the Central Gulf of Mexico

Discipline Codes	
AR = Archeological Resource Protection	BIO = Biology
IMO = Information Management & Other	MAQ = Meteorology & Air Quality
PO = Physical Oceanography	PS = Marine Mammals & Protected Species
SSE = Social Science & Economics	

Table 16. GOM Studies proposed for the FY 2019 NSL.

Profile Page #	Discip line	Office Ranking	Study Title
251	PO	1	A Profiling-Buoy Based Survey for the Deep Gulf of Mexico
252	SSE	2	Social and Economic Impacts of Outer Continental Shelf (OCS) Activity on Individuals and Families: Sociocultural Monitoring
254	SSE	3	Houston and New Orleans: Urban Centers, Urbanization, and the Gulf of Mexico Petroleum Industry
Discipline Codes			
PO = Physical Oceanography			SSE = Social Science & Economics

Table 17. Pacific Studies proposed for the FY 2018 NSL.

Profile Page #	Discipline	Office Ranking	Study Title
257	BIO	1	Understanding Biological Connectivity Among Offshore Structures and Natural Reefs
260	BIO	2	California Deepwater Investigations and Groundtruthing (Cal DIG) II
263	PS	3	Pacific Seabird Monitoring Program
266	BIO	4	The Ecological Status of Artificial Reefs Offshore California
269	BIO	5	A Marine Biogeographic Assessment of the California Current Ecosystem
272	MAQ	6	Air Emissions Associated with Decommissioning Operations for Pacific Outer Continental Shelf (OCS) Oil and Gas Platforms
274	FE	7	Physical Characterization of Outer Continental Shelf (OCS) Shell Mounds Associated with Pacific OCS Platforms
276	SSE	8	Influence of Visual Characteristics from Offshore Energy Structures on Coastal Property and Recreational Values
278	MAQ	9	Atmospheric Response to Hypothetical Wind Farms Along the Central and Southern California Coast
280	IMO	10	Creation of Geospatial Datasets for Shoreline Habitats
282	SSE	11	Renewable Energy Facilities Visualization for Offshore South-Central California
284	AR	12	Deep Ocean Trails to Hawaii's Second Pearl Harbor
288	SSE	13	*'Ike Hawai'i*—Understanding Hawaii: Public Awareness and Perceptions of Ocean Energy and Recommendations for Analyses
292	SSE	14	Evaluation of Pacific Outer Continental Shelf (OCS) Region Platform Materials Processing and Disposal Options and Potential Environmental and Social Impacts

Discipline Codes

AR = Archeological Resource Protection
BIO = Biology
FE = Fates & Effects
IMO = Information Management & Other
MAQ = Meteorology & Air Quality
PS = Marine Mammals & Protected Species
SSE = Social Science & Economics

APPENDIX II. FY 2018–FY 2019 STUDY PROFILES ORGANIZIED BY REGION

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): South Atlantic

Administered By: Headquarters

Title: Vulnerability of Communities in Close Proximity to Outer Continental Shelf (OCS) Programs Support Infrastructure and Activity

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management'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:

1) identify baseline conditions used in making policy decisions in federal waters adjacent to coastal communities;
2) analyze and monitor changes in these communities near potential OCS activity, as set forth in Part 525 DM 1 of the Department of the Interior Departmental Manual; and
3) 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*.

Currently, BOEM's environmental justice analyses focus on discrete sub-populations—typically lower income—within a community, without analyzing the relationship between sub-populations in the community. This study proposes an examination of the relationships between sub-populations focusing on how they interact and are situated in relation to shared resources and potential hazards.

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 several strategic concerns (namely, cumulative effects), the effects of OCS activities on the human environment, and potentially, the impacts of air emissions on humans, as well as support for long-term monitoring. The study also provides an opportunity to collaborate with potentially affected communities.

Approx. Cost: (in thousands) $600 **Period of Performance:** FY 2018–2021

Description:
Background: BOEM Headquarters Environmental Justice (EJ) NEPA analyses utilize a county based review of demographics for each of the coastal counties adjacent to current program areas. Data from the poverty threshold and race and ethnic origins of the most recent American Community Survey are used to analyze coastal counties with the

highest percentages of EJ communities. The effects of potential impact producing factors (*e.g.*, lighting, noise, and air quality) from OCS support infrastructure and associated activities on nearby neighborhoods could be better understood with finer resolution data. At the National level, potential impacts to the most concentrated EJ communities are analyzed in BOEM NEPA documents, prior to the approval of a federal action. However, the impact conclusions for these areas are very broad and could be better understood by the agency.

The migrations and shifts experienced by communities over time can be attributed to a number of variables such as changes in federal laws, regional policies, and urban planning and zoning. Analyzing these patterns and movements over a 15 year period allows BOEM a broad understanding of the size, distribution, and behavior of communities in closest proximity to OCS activity. This information affects the significance of cumulative effects when compared to baseline data in NEPA analyses for the human environment. For purposes of disclosing the capacity of vulnerable communities to adjust to and recover from impacts of proposed activities, accidental spills, and natural disasters, it is necessary for BOEM to gain a better understanding of baseline vulnerabilities at the community level for the national program.

Objectives:

1. Garner an enhanced understanding of vulnerabilities affecting environmental justice communities adjacent to OCS planning areas; through an assessment of sub-populations characterized by varied income levels—that examines how they relate, utilize, and are situated near potential hazards (*i.e.*, shipyards, ports, *etc.*). Vulnerabilities could include: income, race, proximity to hazards, preparation for natural disasters, relationship to resources, *etc.*

2. Identify the 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.

3. Gain an understanding of the proximity between the aforementioned populations to industrial zones for offshore support activities and infrastructure; and any cumulative impacts that may result from this relationship.

4. Conduct a geospatial analysis to understand how these populations have moved, changed, or remained the same and shared resources during the past 15 years.

5. Gain understanding on how these variables (relationship to location, history, and existing resources) affect the vulnerability of each community ahead of environmental impacts and disasters.

6. Engage affected communities, particularly on draft final materials.

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 would be useful to 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.

Initial individual ethnographic participant observation and discussion have been used as a way to characterize a sense of place for neighborhoods of study. A secondary approach to ensure accuracy of the data provided is community collaboration and feedback on the information reported.

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

2. Identify high, median, and low income levels and histories in these communities via ethnographic survey.

3. Map their proximity to industrial zones for oil and gas support activities and infrastructure.

4. Define and identify vulnerabilities (*e.g.*, hazards) within the study areas.

5. Use geospatial analysis to illustrate how these populations have moved, changed, or remained the same and shared resources during the past 15 years.

6. Analyze how these variables (relationship to location, history, and existing resources) might affect the ability of each neighborhood to recover from environmental impacts and disasters.

7. Community feedback on draft final materials.

References:

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Revised Date: April 11, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): National

Administered By: Headquarters

Title: Compendium on Oil Spill Science

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management's (BOEM) National Environmental Policy Act (NEPA) analyses and consultations documentation need to be informed by the latest scientific data. Following *Deepwater Horizon* (*DWH*) and other oil spills, such as the Ixtoc I, many agencies and academic institutions have worked to examine acute, chronic, and cumulative impacts to the ocean ecosystem. BOEM needs to synthesize the results from these interrelated and complex studies in order to:

1) continue compliance with environmental regulations;
2) support its responsibility to manage these public resources in an environmentally sound manner;
3) refine our knowledge of long-term, cumulative impacts that are important for making current and future management decisions; and
4) consider any shifts to subject area baselines that may have occurred following oil spill events in program areas.

It is crucial that this large body of scientific research be synthesized to better inform our decision making in a holistic, scientifically accurate manner. The findings from such a synthesis offer insights critical for decision making and effects analysis that no single study alone could identify. The information collected by this study is used to prepare environmental analyses required by NEPA. Consolidation and synthesis of this large volume of work will enable more efficient use of the previously funded studies and identify data gaps that may be filled through future research.

Approx. Cost: (in thousands) $300 **Period of Performance:** FY 2018–2019

Description:
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 associated with OCS and state water spills and remediation efforts.

- Identify critical gaps in science regarding spill and response impacts.

- Provide a thorough literature cited in an Endnote format along with the research papers (when available).

- Host an Information Transfer Meeting (ITM) webinar to share the results with BOEM subject matter experts (SMEs) and encourage discussion on results and data gaps.

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, and for quantitative techniques to be used 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.

Revised Date: April 6, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): National

Administered By: Headquarters

Title: Developing a Roadmap to Maximize Natural Capital and Maintain Natural Infrastructure in Energy and Mineral Planning

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). 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 whole-system, or ecosystem, 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 information to decision-makers as they implement BOEM's responsibilities under the Outer Continental Shelf (OCS) Lands Act. An ecosystem services approach would allow BOEM to engage stakeholders in meaningful ways such as demonstrating impacts to services which they value, effectively synthesize spatial data for alternative development in environmental analysis, and potentially reduce conflict related to uses of the OCS. This study aligns with the BOEM Strategic Science Questions of:

(1) How can BOEM best assess cumulative effects within the framework of environmental assessments?
(2) What are the acute and chronic effects of exposure to hydrocarbons or other chemicals on coastal and marine species and ecosystems?
(3) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
(5) How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?
(6) What affected resources, measures, and systems are best used for long-term monitoring?

Approx. Cost: (in thousands) $410 **Period of Performance:** FY 2018–2020

Description:
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.

Ecosystem services are the services nature provides to humans. These can be divided into producing services (*e.g.*, fish that people harvest), supporting services (*e.g.*, the habitat upon which those fish depend), and cultural services (*e.g.*, places of importance to Native Americans). Because federal guidelines for ocean management are broadly distributed across a portfolio of narrowly-purposed pieces of legislation, the NEPA process provides a mechanism to take into consideration this broad suite of ocean services, as well as the laws and regulations that govern ocean management, ensuring comprehensive assessment of potential impacts. In the NEPA process there is often a lack of clarity in how stakeholder values could be affected beyond broad, qualitative statements. An ecosystem services approach to the analysis would better articulate the benefits and costs to each stakeholder group that could result from the implementation of a proposed action or alternative.

This study will further explore the challenges and information needs identified by the BESTT and move BOEM toward implementing an ecosystem services approach to the analyses that support decision-making. It will provide a roadmap to drive BOEM towards an ecosystem based approach to OCS management.

Objectives: The objectives of this study are:

1) to conduct an analysis of existing BOEM environmental impact documents and what data sources and derived products could be used to implement ecosystem service analysis;
2) to develop a "roadmap" for implementation of ecosystem service approaches to environmental analysis and monitoring across BOEM programs; and
3) to 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 identification of opportunities for incorporating ecosystem services approaches.
2) A roadmap for implementation should include several facilitated meetings to accomplish with BOEM staff and an expert working group
    a. recommended approaches for compatibility analysis (*e.g.*, among alternative uses)

3) Development of education materials to include a narrative video or other collateral that can easily explain ecosystem services at BOEM, via animated wire-framing or similar technique.

Revised Date: May 3, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Atlantic OCS, GOM OCS (Phase I); Pacific OCS (Phase II)

Administered By: Headquarters

Title: Catalog of Seabird Colonies

BOEM Information Need(s) to Be Addressed: A readily accessible geodatabase of seabird colonies sourced from decades' worth of population, phenological, diet, and tracking studies conducted on the Atlantic Coast, Gulf of Mexico, and Pacific Coast. The database will complement BOEM's at-sea monitoring programs, the Avian Compendium (O'Connell *et al.*, 2009), and predictive models of seabird spatial organization on the Outer Continental Shelf (OCS) (Kinlan *et al.*, 2016). Goals and products of the seabird catalog align with: the National Environmental Policy Act (NEPA), in that it will house breeding population and production estimates of endangered seabirds, as well as mapping past and present colony locations; Section 20 of the Outer Continental Shelf Lands Act (OCSLA); and BOEM's Strategic Science Questions (ESP Strategic Framework, Jan. 2017).

Approx. Cost: (in thousands) $300 **Period of Performance:** FY 2018–2020

Description:

Background: Long-term colony-based datasets can help identify population-level baselines, and causal factors that trigger episodic events. Seabird colonies function as ecological indicators of local marine systems, where reproduction, growth, and survival depend on adult foraging success and prey quality. In 2016, seabird colonies in Alaska experienced the largest failure on record. A massive seabird die-off—perhaps 500,000 common murres—starved to death due to low forage fish abundance; an ecosystem-wide event linked to a warm water anomaly known as the Blob (USFWS, 2016; Joling, 2017).

Aerial and ship-based surveys are rarely timed to monitor specific breeding populations, and transects are oftentimes too far offshore to properly capture a colony's spatial footprint on the ocean. This leads to a problem of spatial and temporal mismatch during a period when seabirds are attending colonies during the chick rearing period, and engaged in central place foraging behavior. Despite lip-service paid to the importance of monitoring there are no readily-accessible databases from which regional numbers or trends can be compiled (Nisbet *et al.*, 2013). The U.S. Geological Survey (USGS) currently holds an unedited version of the Colonial Waterbirds Database that dates back to the early 1900's, which contains incomplete population-level data of seabird colonies for the United States. This valuable compilation of seabird populations has not been released to researchers or managers outside the USGS due a critical need for its curation. An updated and accessible database will help address the following baseline data gaps identified by the Waterbird Conservation Plan (Kushlan *et al.*, 2002), Nisbet *et al.* (2013), and the Seabird Colonies and Adjacent Waters Working Group (Waterbird Society Annual Meeting, New Bern, N.C., 2016):

- Geographic locations and phenology of seabird colonies;

- Estimation of local and region-wide population dynamics of protected seabird species;
- Identification of colony-specific foraging areas based on tracking locations, and foraging range estimates based on the literature; and
- Diet trends at colonies as an indicator of changing fish stocks and ecosystem shifts.

Objectives: We propose to use an updated version of the Colonial Waterbirds Database to update breeding colony locations and to answer questions specifically regarding population dynamics, foraging ranges, persistent foraging areas, and diets of seabirds while attending colonies on the outer continental shelf (OCS). Since colonies function as ecological indicators of marine ecosystems, we propose to determine if population perturbations at colonies are a local occurrence or if they point to region-wide synchrony.

Methods: We will collaborate with the USGS, the U.S. Fish & Wildlife Service (USFWS), and the Seabird Colonies and Adjacent Waters Working Group to update the existing Colonial Waterbirds Database and render it accessible to managers and scientists. Regional leads will collect existing datasets from Federal, State, academic, and non-governmental organizations. Leads will also identify non-digitized data sets from reports and publications; however, most of the literature has been identified for some regions (Nisbet *et al.*, 2013). We will expand the database to include colony-specific tracking datasets in order to identify persistent foraging areas important to colony success, and colony-specific diet datasets, *i.e.*, prey fed to chicks. Phase I will focus on the Gulf of Mexico and Atlantic regions. Lessons learned from Phase I will be applied to the Pacific and Alaska regions. The final geospatial database will be served from USGS ScienceBase-Catalog.

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Revised Date: February 15, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): National

Administered By: Headquarters

Title: Archaeological Investigations in Support of Development of Energy and Mineral Resources on the U.S. Outer Continental Shelf (OCS)

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management's (BOEM's) vision of excellence in the management of OCS energy and mineral resources for environmental sustainability, economic development, and national security relies upon responsible stewardship and scientifically-valid, informed decision-making. To effectively minimize impacts to archaeological sites without unnecessarily constraining development, BOEM needs to gather additional information on previously-identified geophysical targets that may potentially represent archaeological sites eligible for listing on the National Register of Historic Places (NRHP). By confirming the presence of these sensitive resources or confidently clearing the area for development, BOEM will be using the best available science in bureau decision making, effectively contributing to the American economy and its energy security, supporting diversification of energy efforts, and increasing access to development of the OCS while reducing risk of environmental impact.

Approx. Cost: (in thousands) $1,500 **Period of Performance:** FY 2018–2022

Description:

Background: BOEM's overarching strategic goal is to achieve expeditious and orderly management of OCS energy and mineral resources, while minimizing impacts on the environment, including impacts to archaeological sites. BOEM is contemplating issuing leases and grants and approving various plans and permits related to conventional and renewable energy and marine minerals sources in each of its regions and programs. BOEM needs data in these areas in order to make sound decisions about how to effectively minimize impacts to archaeological sites without unnecessarily constraining development, and to meet its responsibilities under Sections 110(a)(2)(A), (B), (C), and (E) and 110(b) of the National Historic Preservation Act (NHPA).

At present, BOEM requires developers to avoid all geophysical targets (sidescan sonar contacts and magnetic anomalies) that may potentially represent an archaeological resource. 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. Archaeological ground-truthing of potential targets and determinations of significance and eligibility for listing on the NRHP is necessary both for informed, responsible decision-making, and for compliance with the NHPA. Geophysical targets in areas that cannot easily be avoided by developers through modification or relocation of project elements will be given priority for investigation.

Objectives: The objective is to conduct additional investigations of previously-identified geophysical targets that may potentially represent archaeological resources. These additional investigations will consist of ground-truthing geophysical targets to determine whether they are archaeological in nature, and, if so, determining their significance and eligibility for listing on the NRHP. The methods contemplated are designed to recover data that would (1) confirm which geophysical targets are archaeological sites and (2) produce the site documentation and the recording of diagnostic features and artifacts necessary for completing the process of nomination to the NRHP.

Previously-identified geophysical targets exist in every BOEM region and exceed many thousands in number. The cost of ground-truthing them all would be excessive and not a productive use of BOEM funds. However, by prioritizing those targets in areas where avoidance is not feasible but development imminent—and by creating collaborative partnerships with affected states—BOEM funds can be made to go farther. How many targets can be ground-truthed per year will be a function of their distance from shore and distance from one another, water depth, complexity of targets, ability to quickly relocate targets, and weather. Based on previous projects, it is anticipated that approximately 20 to 25 shallow depth (*i.e.*, approximately 150 ft) targets may be ground truthed per year. Alternatively, approximately 3–5 deep water (*i.e.*, greater than 150 ft) targets may be ground truthed per year. Over the course of five years, across the regions, we could anticipate ground truthing 100–125 shallow targets or 15–25 deep-water targets, or some combination thereof.

Methods: Field operations will involve collecting additional high resolution geophysical data, 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 and high density magnetometer 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 completing NRHP nominations; 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 (*e.g.*, captain(s) and crew to safely and competently operate vessels), and specialized instrumentation necessary to perform archaeological and complementary scientific investigations. It is proposed that Headquarters would establish an indefinite-delivery, indefinite-quantity (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 to create efficiencies and reduce expenditures. 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/or in which CART members already have identified the need for additional investigations to ground truth and obtain documentation of potential archaeological resources 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.

Revised Date: April 17, 2017

Study Area(s): National

Administered By: Headquarters

Title: Mortality Risk for Whale and Basking Sharks During Energy and Mineral Operations

BOEM Information Need(s) to Be Addressed: Similar to marine mammals, lower-trophic-level-feeding, large-bodied sharks 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 Bureau of Ocean Energy Management (BOEM) permitted activities occur. Unlike large whales, which float post-mortem, large sharks such as whale sharks (*Rhincodon typus*) and basking sharks (*Cetorhinus maximus*) 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). Multiple geophysical surveys, offshore energy construction, mineral extraction operations, and associated vessel traffic intersect with known aggregations of these species. Information from this study, focused on whale sharks, 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.

Approx. Cost: (in thousands) $100 **Period of Performance:** FY 2018–2019

Description:

Background: 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 Bureau of Safety and Environmental Enforcement (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 (Ramirez-Macias *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 National Oceanic & Atmospheric Administration (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 Amer*ca*.

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 outer continental shelf (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 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 automatic identification system (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.

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Revised Date: March 10, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): National

Administered By: Headquarters

Title: Bureau of Ocean Energy Management (BOEM) Graduate Student Award for Applied Scientific Research

BOEM Information Need(s) to Be Addressed: BOEM applies the scientific data it receives toward management decisions for the responsible development of the United States' offshore energy and mineral resources. 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 establishment of the BOEM Graduate Student Award for Applied Scientific Research will allow the agency to financially support a graduate student who is performing innovative marine science research and demonstrate to them how their results may be applied to inform Federal management decisions.

Approx. Cost: (in thousands) $25 **Period of Performance:** FY 2018

Description:

Background: BOEM relies on the best available data to inform its decisions, and it encourages the development of innovative yet cost-effective research methodologies to acquire the information it needs. 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). The BOEM Graduate Student Award for Applied Scientific Research 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 Cooperative Ecosystem Studies Unit (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 a crucial 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. 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 also be required to submit their completed thesis or dissertation to BOEM within a mutually-agreed timeframe.

Revised Date: April 18, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Nationwide

Administered By: Headquarters

Title: Enhanced Marine Stewardship with Citizen Science SCUBA Diving

BOEM Information Need(s) to Be Addressed: Resource development and production activities overseen by the Bureau of Ocean Energy Management (BOEM) have the potential to impact areas of marine recreation and tourism, including those within marine protected areas. A number of such areas are frequented by the recreational SCUBA diving community, but there exists no systematic mechanism for BOEM to collect, analyze, respond to, and benefit from these divers' unique *in situ* observations of the waters BOEM is tasked with overseeing. This study will pilot a Citizen Science effort to instrument recreational divers, collect their observations, and analyze these data for changes in the local ecosystem (*e.g.*, unexpected, infrequent, unusual, health-related, *etc.* events) so that, thus informed, BOEM may better respond to observed conditions (*e.g.*, by modifying access or activities permitted at the sites).

Approx. Cost: (in thousands) $25 **Period of Performance:** FY 2018–2020

Description:

Background: BOEM and the National Oceanic and Atmospheric Administration (NOAA) have a longstanding financial partnership to support the Flower Garden Banks National Marine Sanctuary (FGBNMS) and its Long-Term Coral Reef Monitoring Program. The assessments of reef ecosystem health made under this program are used by BOEM and NOAA to design management policies minimizing impacts to coral reefs from offshore oil and gas activities, as well as other factors. This Program includes a Federal diving component as well as pre-existing informal relationships with the recreational dive boat operators that conduct regular charters to the FGBNMS. Further, there are existing academic and non-governmental organizations (NGOs) with express interest in FGBNMS stewardship. This makes the FGBNMS an ideal area to hone a citizen science diving network capable of enhancing marine resource management before expanding to other areas of interest.

The FGBNMS encompasses ~145 km^2 and the extent of SCUBA diving by Federal scientific divers is limited by manpower and budget. Federal diving periodically occurs at a set of mooring locations; and to a lesser extent at other locations throughout the Sanctuary. The limitations of this observing regime were demonstrated when on 7/25/2016 Sanctuary managers were caught unawares by a mass die-off of corals, sponges, sea urchins, brittle stars, clams and other invertebrates at multiple locations within the FGBNMS each bigger than a football field—an incident that was first reported by recreational divers (http://sanctuaries.noaa.gov/news/jul16/noaa-scientists-report-mass-die-off-of-invertebrates-at-east-flower-garden-bank.html). The aforementioned incident highlights how the chance of detecting events and taking corrective action increases with additional observations.

Objectives: The objective of this study is to increase BOEM's situational awareness of the status of the waters within its purview by utilizing recreational SCUBA divers as citizen scientists to provide *in situ* observations. Further, this study aims to develop these observations into intelligence that BOEM can use to improve its stewardship by collaborating with non-governmental and academic organizations for the analysis of the video and other measurements. It is hoped that this study design and the Citizen Science network it grows at the FGBNMS will provide BOEM a platform from which to expand to other areas of the Gulf of Mexico, Atlantic, and Pacific.

Methods: Participation in data collection (*i.e.*, filming) will be solicited from non-Federal groups (*e.g.*, tourism, industry, academic, NGOs, State, *etc.*) that SCUBA dive the FGBNMS. Groups that commit to participating will be provided video/sensor equipment packages commensurate with their number of divers and their dive planning.

The video/sensor equipment packages are planned to be GoPro® or similar video cameras enclosed in a watertight housing that can be mounted to the divers' buoyancy control devices (BCDs), along with clip-on temperature/depth (T/D) loggers such as DiveNav, Inc.'s BlueBuddy and ReefNet, Inc.'s Sensus Ultra. The equipment packages will be designed to impart negligible drag and weight upon the divers, so that their mobility and buoyancy remain unaffected. Further, the equipment packages will be configured so that they require no interaction during the dive to operate—the cameras can simply be turned on prior to the BCD being donned and turned off once the diver removes their BCD at the conclusion of the dive; the T/D sensors will begin logging automatically once submerged and turn themselves off once brought back to the surface. The camera and T/D logger will be configured with sufficient memory capacity to allow recording of multiple dives, enough to record all the dives a diver will make in a day, without the need for downloading data or swapping memory cards between dives. The divers will be asked to fill-out a brief post-dive form reporting on what they observed and identifying the time and coordinates (available from the ship's global positioning system [GPS]) where the dive took place.

For each report we receive from a diver, we will thereby know the time and location of the dive and have available concurrent time-series of water temperature, depth, and video. The data from the report forms, microSD™ memory cards from the associated cameras, and associated T/D loggers can be uploaded (*e.g.*, to Google Drive) or physically mailed back by the group to BOEM and/or its designees at the conclusion of each cruise. The film and other data collected by each citizen scientist will also be made available for their download as a memento and to incentivize participation.

Additional citizen science groups will be retained to assist in the analysis of the collected data for evidence of changes to FGBNMS coral and/or other ecosystem health. BOEM's YouTube® or other video hosting sites will provide the platform for the groups to make the videos easily viewable by their volunteers and crowd-source the image analysis task. Given the frame rate of the GoPro camera *vs.* the relatively leisurely speed with which divers move through the water column, the substantially same area of coral bottom is likely to remain visible on a film for an extended period of time. Thus it will not be necessary for the analyst groups to view every film in its entirety; instead just a reduced set of stills from the films can be analyzed initially, and the originating film flagged for

further review only if indicated by the still analysis. It is hoped that as the process of analysis develops it can benefit from advancements in automated image recognition to allow for increasingly thorough examination of the film record.

The citizen science groups will provide their analyses to BOEM so that our scientists and Federal partners can adapt the management of the FGBNMS better informed by their findings. Further, all data collected will remain available for BOEM's and our partners' own study for continuous improvement of resource management.

Revised Date: February 15, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic

Administered By: Headquarters

Title: Understanding the Socio-cultural Context of Commercial Fishing

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) has issued 13 leases for potential offshore wind energy facilities. In the next few years, BOEM expects to undertake National Environmental Policy Act (NEPA) analyses to inform decisions related to approval of construction and operation plans for at least three leases. In turn, state governments, Congressional representatives, and other stakeholders have expressed the need to understand the potential economic impact to the commercial fishing industry from offshore wind. To more fully answer their question, BOEM needs to better understand how captains of vessels determine fishing locations. This study aims to enhance our understanding of the socio-cultural underpinnings of location-choice decisions made by commercial fishers. This information will enhance the efficacy of BOEM's economic impact model, which requires a simplification of decision-making inputs, by assessing the socio-cultural considerations of fishing communities. This understanding will support NEPA assessments by informing the viability of project alternatives and mitigation options.

Approx. Cost: (in thousands) $375 **Period of Performance:** FY 2018–2020

Description:

Background: Space-use conflicts between offshore wind energy facilities and commercial fishing have been recognized as a significant issue by researchers, fishers, and regulators for some time (Industrial Economics, Inc. 2012; FSF *et al. vs.* Jewel 2016). In 2012, BOEM funded the National Marine Fisheries Service (NMFS) to develop a location-choice model—a tool that analyzed the costs (*e.g.*, fuel consumed) and revenues (*e.g.*, productivity) of fishing a particular location based on historical trip data. NMFS then calculated potential economic impacts of requiring vessels to fish alternative locations under various scenarios (*e.g.*, closure to fishing around the wind turbines during high wind events) (Kirkpatrick *et al.*, 2017). The results indicated minimal economic impact, and for one fishing group, an increase in revenue from not fishing in a lease area.

The location-choice model has roots in economics and psychology and postulates that fishers select fishing grounds with the intent of maximizing utility (*e.g.*, choosing the most direct routes, selecting the most efficient alternative grounds when their first choice is not available). There is no doubt that fishers, as do other harvesters, select fishing locations with an intent to maximize yield and minimize costs; however it is believed that social information—beliefs, values, relationships between and within fishing groups—also influence location-choice decisions. Additionally, the model assumes the fishers have perfect knowledge of the most productive fishing grounds. While the NMFS's location-choice model is useful, BOEM also needs to understand the

context of location selection within the fishers' socio-cultural context, that is, the values, beliefs, norms, practices, and relationships that characterize and structure their operations. It is recognized that fishers of all sorts don't work purely as maximizing individuals, but rather they work within a social arena and make decisions by the rules within these domains (Acheson 1988; Turner *et al.* 2013). This study will provide a pilot study to be followed in other locales (intra- and inter-regional) inhabited by different fisher groups with different customs, beliefs, *etc.*

Objectives:

- Garner an enhanced understanding of the social fabric—values, beliefs, norms, practices, and relationships—of key fisher groups within the Mid-Atlantic and Northeast Atlantic regions.

- Understand the values, beliefs, and norms that structure or influence fishing location choice decisions.

- Understand the dynamics (*i.e.*, process and practice) of location choice decisions by fishers;

    - identify and describe decision activities on the water, including interactions between groups and 'place', and associated common practices, so that context is provided to the outputs of the NMFS location choice model (*i.e.*, fishing an alternative location may not be an option).

- Understand variation in these socio-cultural factors across fisher groups.

- Garner insights on how to incorporate socio-cultural aspects of site selection into NEPA assessments related to the construction and operation of offshore wind energy facilities.

Methods: This research necessitates secondary and primary data to address its objectives. A literature review on the social aspects of commercial fishing can provide context, gauge the level of knowledge on this topic, and garner an initial understanding of significant fisher groups, relevant values, beliefs, norms, practices, and relationships. Primary data collection from fishers and associated individuals can provide specific information on the socio-cultural factors that are prevalent in a select group of fisheries. This effort should be scoped in alignment with the findings from the literature review. The means of primary data collection may be one-on-one, small group discussions, focus groups, and/or direct observations. These techniques are suited to the challenge of understanding the socio-cultural context when fishing groups are comprised of relatively few individuals who hold specialized socio-cultural knowledge. This research will be bound by four case studies centered on select gear/species groups and communities based on those NMFS identified as historically fishing in wind energy leases. This research design will allow for a comparative approach aiding our understanding of socio-cultural variation across fisher groups.

The following research tasks address this study's objectives:

- Identify and describe the values, beliefs and norms that structure or influence location choice decisions.

- Document the dynamics (process; practice and relationships) of location choice decisions by fishers.

- Document variation in these socio-cultural factors across fisher groups;

    - how do different fisher groups vary with regard to values, beliefs, norms, and behaviors.

- Use the socio-cultural findings to provide guidance on how to incorporate these findings into NEPA assessments.

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Revised Date: April 6, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic; South Atlantic

Administered By: Office of Renewable Energy Programs

Title: Science Exchange Forum for Atlantic Studies

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) funds studies along the Atlantic in support of our three program areas: offshore renewable energy, oil and gas, and marine minerals programs. BOEM has the responsibility to share information about these studies with the public and to receive input from the public regarding future studies. Holding a public event is one way to share this information and get input to the studies program. The National Offshore Wind Strategy, prepared jointly by the Department of the Interior (DOI) and the Department of Energy (DOE), commits BOEM to engaging the public through outreach events such as the forum every two years.

Approx. Cost: (in thousands) $100 **Period of Performance:** FY 2018–2019

Description:

Background: In 2016, BOEM hosted the *Atlantic Ocean Energy and Mineral Science Forum* to share ongoing and recently completed studies along the Atlantic and to seek input for future studies; the forum included 25 presentations by researchers and was attended by over 100 people. While all three BOEM programs were represented, the focus of the previous forum was primarily on the renewable energy and marine minerals programs. Following the success of this forum, BOEM should support a similar three-day public meeting in 2018. With the recent decision to reconsider Atlantic oil and gas leasing, studies that inform the oil and gas program will be included. This is also an opportunity for the public to ask questions and gain clarification on the work being conducted and provide suggestions for future studies.

Objectives: Provide the public with the most recent status and results of studies that are ongoing or recently completed in support of BOEM programs along the Atlantic coast and solicit input for future environmental studies.

Methods: BOEM would host a three-day public meeting where results of ongoing and recently-completed studies would be presented. Studies from all disciplines will be included. The public could ask questions and gain clarification on the work being conducted and provide suggestions for future studies. Several studies to support the offshore oil and gas program, including the Atlantic Deepwater Ecosystem Observatory Network and continued studies of deepwater canyons and corals, will be presented. The topics for presentation could be expanded to include work being conducted along the Atlantic in support of offshore energy development by Federal (DOE, National Oceanic & Atmospheric Administration, Navy) or state agencies as well as investigators from other countries. The final product will be a workshop summary with all presentations.

Revised Date: May 4, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic

Administered By: Office of Renewable Energy Programs

Title: Support for Regional Ocean Portals

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) prepares environmental documents in support of the National Environmental Policy Act and other statutes. In these documents, BOEM is required to assess the impacts from activities that result from BOEM leasing decisions on the marine, coastal, and human environment. These documents require a description of the affected environment that is built on knowledge of the natural resources and human activities occurring in the area of interest. Sources for these data may be far reaching, but the use of recently developed data portals will provide efficiencies in finding and using available information. The underlying information need is access to data that are regularly maintained and managed.

Approx. Cost: (in thousands) $1,500 **Period of Performance:** FY 2018–2022

Description:

Background: Through regional ocean partnerships, the Northeast Regional Ocean Council, the Mid-Atlantic Regional Council on the Ocean, and the West Coast Governors Alliance on Ocean Health have established regional ocean portals to provide important spatial data for regional planning. These data portals serve as one-stop locations for data about both natural and human activities in each region. These portals are not exclusively data repositories, but they are central hubs of information that provide both links to a wide variety of data as well as some unique data sources and derived products. The format and display of the data are also most useful for preparers of environmental documents while also having broad applicability to a range of stakeholders. Data can be queried and downloaded as spatial files, ingested as map services, or mapped on-the-fly and meet federal metadata requirements. Lessees of renewable energy leases, as part of their plan preparation and submission required by renewable energy regulations, have utilized the data in the portals.

BOEM currently funds the maintenance of the Marine Cadastre (https://www.marinecadastre.gov/). The Cadastre was established in response to the call for a one-stop location for jurisdictional lines in the Energy Policy Act of 2005, of which BOEM is the authoritative source for some as required by the Submerged Lands Act. BOEM is the authoritative source for leasing boundaries including the state-federal boundary, protraction diagrams, and lease blocks. Over the years, the Cadastre has provided additional information useful for leasing including ship usage and some biological data. However, it is not meant to be the sole location or repository for all marine data. Data from the Cadastre are served to the regional portals through web mapping services allowing for the regional portals to provide the most up-to-date information about BOEM leasing data.

In 2016, both the Northeast and Mid-Atlantic regions released their first regional ocean plans. Much of the data used for the formulation of these plans are provided through the regional data portals. BOEM is committed to supporting and using these plans as part of the leasing process and will benefit from the data provided through the regional portals. Continued support for these portals is in question and it is in the best interest of BOEM to provide some level of support to maintain and update the portals building on the years of work to establish the portals.

Objectives:

- Provide the best available information and data that are timely and complete to preparers of environmental documents which include internal staff, lessees, and contractors.

- Maintain the data portals that disseminate the maps and information used to support the Northeast and Mid-Atlantic Regional Plans, West Coast Regional planning efforts, to refresh data layers, and add additional relevant and timely information.

Methods: BOEM will work with other Federal agencies (National Oceanic & Atmospheric Administration, Navy, Department of Energy) to provide funding and establish a plan for ensuring that the portals are maintained and provide the most recent data and technological updates. Support from BOEM in the amount of $100,000 per year for each data portal will be used to maintain the portals including ensuring that new releases of data are incorporated as well as new technological advances to make the data more accessible. This would include keeping up with current web and web mapping technology and the associated data formats (*e.g.*, GeoJSON [Geographic JavaScript Object Notation]). In addition the data would be packaged and delivered in the most current geographic information system (GIS) compatible formats (*e.g.*, geodatabase, raster). The data provided by the portal will be curated to capture the best available biological, physical, and socio-economic baseline and predictive data for use in describing the affected environment. Continued coordination with local, state, regional, and federal stakeholders will be required to ensure that the data curated are meeting the specific need of users of the regional portal. Specific requirements for updates will be determined annually based on available datasets and improvements in data sharing technology.

Revised Date: April 25, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic

Administered By: Office of Renewable Energy Programs

Title: Understanding Potential Economic Impacts to Commercial Fishing from Offshore Wind Energy Development

BOEM Information Need(s) to Be Addressed: National Oceanic and Atmospheric Administration (NOAA) data indicates that more than $10 million in federally permitted commercial fish revenue may be annually harvested from Bureau of Ocean Energy Management (BOEM) leases off the east coast (Kirkpatrick *et al.*, 2017). As part of National Environmental Policy Act (NEPA) assessments, BOEM must estimate potential economic impacts of offshore wind development to the commercial fishing industry. To date, BOEM has conducted these assessments on leasing activities (*e.g.*, installation of temporary metrological tower). BOEM needs a methodology to determine longer term potential impacts from the construction and operation of an offshore wind energy facility. BOEM's need also includes improved understanding of impact producing factors (*e.g.*, fishing gear compatibility, effectiveness of mitigation options).

Building off NOAA's previous work, BOEM needs a flexible tool that can evaluate a proposed construction and operation plan (COP) and cumulative impacts (*i.e.*, multiple wind projects, fishery management plan closures). Additionally a modeling component needs to evaluate changes in costs and revenue if vessels adjust fishing locations due to construction and operation of offshore wind facilities.

Approx. Cost: (in thousands) $350 **Period of Performance:** FY 2018–2019

Description:

Background: BOEM has issued fourteen offshore wind energy leases in southern New England and the Mid-Atlantic. Conflicts with fishing are 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; RIDEM, 2016; FSF *et al.* v Jewell, 2016). 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. Although there is not total acceptance of the exposure level by the fishing industry, there needs to be more work on modelling the actual potential impacts, while BOEM continues to refine data characterizing the fishing activity. Impact modelling will help to understand which

fisheries, ports, and gear groups might actually be impacted by proposed activities. Anecdotal evidence suggests that highly mobile fishing gear, such as bottom trawls, may not be able to fully utilize the area within a wind facility.

Objectives: Develop a location-choice model to understand potential costs and benefits of vessels adjusting fishing locations. This 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

Vet assumptions and methodology with commercial fishing community.

Methods:

- Assess the spatial data of commercial fishing revenue from NOAA (DePiper, 2014) and recent satellite-based 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.

- Construct a location-choice model pact that would determine how commercial fishermen will behave under various construction scenarios utilizing different mitigations, and with a basic understanding of how the fishery resources may change on a site-specific and coast-wide scale.

- Provide an overview of how other agencies conduct cumulative impact assessments on commercial fishing and provide recommendations for incorporation into BOEM documents.

- Conduct workshops with fishing industry and wind energy developers to both discuss data generation and mitigation options.

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)

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.

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.

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.

Rhode Island (RI) Department of Environmental Management (DEM). 2016. Letter to Mary Boatman from Julia Livermore, Nicole Lengyel, and Jason McNamee. Re: Study Ideas for FY 2018 – Localized Fisheries Exposure Analysis Using VMS Data.

Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic

Administered By: Office of Renewable Energy Programs

Title: Monitoring Sea Turtle Behavior in the Ecologically Dynamic North Atlantic Foraging Grounds

BOEM Information Need(s) to Be Addressed: The North Atlantic region is predicted to undergo rapidly changing ecological baselines (Barton *et al.* 2016). 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. Therefore, it is important for BOEM to understand the movements and behavior of sea turtles to understand the changing baseline conditions predicted to occur in the Greater Atlantic Region. The information will be used for decision-making under the National Environmental Policy Act documents and Endangered Species Act consultations regarding the siting and timing of Bureau of Ocean Energy Management (BOEM) activities. It will provide needed information to assess how future ocean conditions and dynamics are influencing the cumulative effects of BOEM activities in the Atlantic. This information is needed to establish the baseline for sea turtles and evaluate the potential effects of BOEM across all programs in the Atlantic.

Approx. Cost: (in thousands) $1,500 **Period of Performance:** FY 2018–2023

Description:

Background: The Greater Atlantic Region (estuarine and marine waters from Hatteras to Maine, within the U.S. Exclusive Economic Zone [EEZ]) is an area with considerable leasing and development potential for renewable and conventional energy, as well as for marine minerals. The water temperature of the Northeast Shelf in the Greater Atlantic Region is expected to increase far more rapidly than most of the rest of the oceans, and turtles as ectotherms whose behavior and diet changes with temperature and prey distribution are expected to be a species highly vulnerable to environmental conditions. Loggerhead turtles, in particular, are known to have very plastic behavior, which varies greatly depending on environmental influences. Understanding how behavior may change is critical to evaluate the conservation and recovery consequences that may result from any behavioral changes observed in the context of changing baseline conditions and the future effects of BOEM's authorized activities in the Atlantic.

The Atlantic Marine Assessment Program for Protected Species (AMAPPS) primarily supports aerial and shipboard line transect surveys for sea turtles (and marine mammals). The AMAPPS study will continue to support BOEM's priorities for more rigorous distribution and abundance information for sea turtles. This study differs from and complements AMAPPS in that the utility of a separate behavior dataset would be extremely important to evaluating behavioral changes that may result from changing ecosystem conditions, concurrent to trends observed in distribution and abundance,

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.

A successful loggerhead turtle behavioral ecology program has arisen as a result of these AMAPPS resources and other non-AMAPPS funded collaborative efforts, but effort is limited by competing resources for other dedicated surveys for marine mammals. Partners in the 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 program has several successful components including:

1. Many tags have been deployed using consistent techniques. Over 150 tags have been deployed in the Greater Atlantic Region.

2. Tags have been deployed on migrating turtles in such a way that they disperse broadly across the Mid-Atlantic shelf, rather than clumping in narrow geographic areas and limiting the area for which inferences can be made.

3. Tags have had a high retention rate in the Greater Atlantic Region that results in a large amount of information collected per tag.

4. The behavioral data from NEFSC, CFF, and others are downloaded by NEFSC Data Management Staff into a National Marine Fisheries Service (NMFS) maintained Oracle database, thus maintaining the data for future use. Data would also be shared in the National Animal Telemetry Network Data Assembly Center, Ocean Biogeographic Information System - Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP), and regional data portals.

5. The NEFSC-CFF dataset contains > 35,000 oceanographic monitoring records, which can used to improve numerical ocean models.

Objectives: The primary objectives are to continue to examine sea turtle movements and foraging behavior in the Mid and North Atlantic regions. Loggerheads are the most abundant species of sea turtle in the Atlantic and may serve as a sentinel species for environmental changes because they are ectotherms with highly plastic behaviors and feeding both in the water column and the benthos that are sensitive to ecological changes. Robust behavioral data on loggerheads is relatively easy to obtain because tagging techniques are advanced and because loggerheads' hard, inert shell is an ideal foundation for data loggers, resulting in unusually long tag retention rates. A long-term program over 5 years is needed to establish the necessary data set to monitor changes in sea turtles' behavior over time. This would ensure a robust long-term loggerhead behavioral dataset for the dynamically changing baseline in the Greater Atlantic region, including the anticipated increase of renewable energy activities and anticipated activities from BOEM's marine minerals and conventional energy programs.

Methods: Behavioral data collected from tagged animals, coupled with remotely operated vehicle (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, they have a greater return on effort, and they have summer foraging residency, which represents an important component of loggerhead growth and survival. Although loggerheads may serve as a proxy species for other more difficult to study turtle species, other species may be opportunistically tagged and monitored. The utility of the behavior dataset would provide new information on the behavioral ecology of sea turtles. The behavioral data will be maintained in the existing NMFS-maintained Oracle database developed for previous work.

References:

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Smolowitz, R., S. Patel, H. Haas, 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

Revised Date: April 25, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic

Administered By: Office of Renewable Energy Programs

Title: Movement Patterns of Fish on Cox Ledge

BOEM Information Need(s) to Be Addressed: Bureau of Ocean Energy Management (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. Portions of Cox Ledge, including areas overlapping with renewable energy lease areas offshore Rhode Island and Massachusetts have been identified as potential Atlantic cod spawning areas by the New England Fisheries Management Council. Studies of fish movement around Cox Ledge 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. Construction and Operations Plans for portions of Cox Ledge are expected to be submitted to BOEM in Fiscal Year (FY) 2018. This information will aid in monitoring construction impacts.

Approx. Cost: (in thousands) $700 **Period of Performance:** FY 2018–2020

Description:

Background: Cox Ledge off southern New England is an important area for fishing and fish. The New England Fishery Management Council (NEFMC) is currently working on an Omnibus Habitat Amendment 2 to their various fishery management plans in order to update fish habitat and conservation measures to protect important fish habitat. The draft document currently has an option to add two "habitat management areas" on Cox Ledge. These areas were identified, in part, to protect high diversity of fish and winter spawning areas for Atlantic cod (please see NEFMC Draft Omnibus Habitat Amendment 2 at: http://www.nefmc.org/library/omnibus-habitat-amendment-2). The Atlantic cod is of critical importance due to its overfished status and need to rebuild the stock. These proposed habitat management areas overlap with areas leased by BOEM for offshore wind energy development. 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 needs.

Objectives: 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 around Cox Ledge.

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 12-month period would focus AUV activity over areas identified in the first year of surveys to further resolve spatial and temporal use of biologically active areas. 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 third year would be for analyzing and developing a final report.

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.

Revised Date: April 21, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic

Administered By: Office of Renewable Energy Programs

Title: Sea Surface and Bottom Layer Hydrodynamic Modelling and Particle Tracking in the U.S. Mid-Atlantic Bight

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) needs to understand the potential change in sea surface and bottom layer flows in the mid-Atlantic bight between Cape Hatteras and Cape Cod as a result of offshore wind construction projects. Offshore wind construction projects have the potential to alter local and regional physical oceanographic processes that may affect such processes as nutrient, sediment, and larval transport. Understanding these potential impacts will allow BOEM to address stakeholder concerns on altering transport patterns. BOEM will also be able to adequately assess individual and cumulative impacts of offshore wind projects in southern New England and the mid-Atlantic area as part of impact assessments pursuant to the National Environmental Policy Act and the Magnuson-Stevens Fishery Conservation and Management Act.

Approx. Cost: (in thousands) $1,000 **Period of Performance:** FY 2018–2019

Description:

Background: BOEM has issued thirteen offshore commercial wind energy leases in southern New England and the Mid-Atlantic. Although foundation types and the number of turbines are not completely known, BOEM needs to be prepared to accurately assess potential changes in hydrodynamic flows resulting from the build-out of one or several projects. Evidence shows that structures in the water column will change current velocities and flows, as well as change wind velocities and their effect on the water surface. Less understood are the cumulative effects of large and multiple projects on regional circulation. This is especially important in relation to how the changes in flow may impact the transport of juvenile fish and larvae to and from habitat used at different life stages and the transport of nutrients and sediments throughout the region.

Objectives: Assess how the construction of multiple offshore wind facilities in the mid-Atlantic bight will affect local and regional hydrodynamics and nutrient, larval, and sediment transport.

Methods: This study will include a desktop review of existing related studies, particularly those from Europe. A prior BOEM study examined the effect of an offshore wind facility on hydrodynamics during storm conditions. This study will build upon these findings by incorporating typical seasonal conditions and improving upon the particle release and tracking methods. Three models types—wind wake, ocean circulation, and particle tracking—will be needed to address the objective. A wind wake model is needed to estimate the surface wind velocities to be input into a high resolution ocean circulation model capable of resolving small-scale physical processes using

average seasonal conditions throughout the water column. The particle tracking model will be an individual based model used to release and track particles representing nutrients, larvae, and sediment. For instance, each phase of larval development has different characteristics such as size, timing and location of release, duration, and location in the water column once suspended. Careful model selection can allow for these models to be combined into one and nesting of models can allow for finer resolution in areas of interest.

With this information, the study can assess the scale of change of offshore wind development on particles traveling through 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 account for changes in slower air flows in the atmospheric boundary layer from wind facility operations that could influence the vertical mixing of stratified water layers and alter sea surface temperatures. Models should be grounded in empirical evidence from the region(s) assessed, such as acoustic Doppler current profiles and geophysical data including surficial sediment and bathymetry which should be available from existing partners/projects. Finally, models should be representative of actual turbine facility layouts, with realistic spacing and number of turbines.

References:

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.

Ole Henrik Segtnan, Konstantinos Christakos, Effect of Offshore Wind farm Design on the Vertical Motion of the Ocean, Energy Procedia, Volume 80, 2015, 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)

Revised Date: June 30, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic

Administered By: Office of Renewable Energy Programs

Title: Southern New England Ichthyoplankton and Juvenile Fish Survey

BOEM Information Need(s) to Be Addressed: This project would identify planktonic larvae distribution throughout Southern New England/New York Bight (SNE/NYB) that overlap with several Bureau of Ocean Energy Management (BOEM) wind energy lease areas. The SNE/NYB 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. This information will aid BOEM in characterizing biological resources for environmental impact during offshore wind 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.

Approx. Cost: (in thousands) $700 **Period of Performance:** FY 2018–2019

Description:
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: This study would 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 National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center.

Revised Date: April 21, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Atlantic OCS

Administered By: Office of Renewable Energy Programs

Title: Baseline Ecological Study of Wind Turbines at Block Island Wind Farm

BOEM Information Need(s) to Be Addressed: This study provides information to assess the ecological impacts of offshore wind development on the United States Atlantic Outer Continental Shelf (OCS). In alignment with the Environmental Studies Program Strategic Framework the following questions will be addressed:

1) What, if any, are the effects of Block Island Wind Farm turbines on habitats, the landscape and ecological resources?
2) What are the affected resources and what should be measured for long-term monitoring and assessment?
3) How can the Bureau of Ocean Energy Management (BOEM) use what we learn about the ecology of Block Island Wind Farm to model, estimate and assess cumulative impacts with further development of offshore wind energy?

Answers to these questions provide valuable information needed to address federal mandates such as the National Environmental Policy Act (NEPA).

Approx. Cost: (in thousands) $2,000 **Period of Performance:** FY 2018–2022

Description:
Background: The first wind turbine was installed in August 2016 at the Block Island Wind Farm and five turbines have been operational since December 2016. Although located in state waters, their presence is a unique opportunity to conduct ecological research that may be applicable to future wind facility development on the United States OCS.

To date there has been some environmental data collected by the developer, Deepwater Wind (see http://www.inspireenvironmental.com/project/block-island-wind-farm/). This includes benthic, geologic, lobster, fisheries, and recreational boating surveys. In addition, BOEM's Real-time Opportunity for Development of Environmental Observation (RODEO) Study (https://opendata.boem.gov/BOEM-ESP-Ongoing-Study-Profiles-2017-FYQ1/BOEM-ESP-AT-14-01.pdf) has collected extensive physical environmental data and some limited benthic sampling. BOEM is also currently conducting a study on tourism and recreational activities around Block Island Wind Farm (https://www.boem.gov/AT-16-x23/), and is planning a study on the effects of birds response to the turbines (Reference T.B.D., not awarded yet). This study would be the first long-term effort planned by BOEM to examine the artificial reef habitat and associated ecological communities that have been created by the wind turbine foundations. The purpose of this study is to conduct a comprehensive baseline study of

this newly created habitat similarly to how BOEM has a long history of studying the ecology of oil platforms in the Gulf of Mexico and Pacific Ocean.

Objectives: The objectives of this study are to:

1. Review any current ecological work being done at Block Island Wind Farm or similar offshore areas. Identify gaps and opportunities for study and coordination.

2. Determine the seasonal and spatial variation in biomass and size distribution of fish and lower trophic pelagic and benthic organisms associated with the turbine foundations.

3. Examine the productivity and food web structure and community ecology dynamics of the marine community associated with the turbine foundations.

4. Make comparisons among turbine foundations and similar nearby natural habitats.

5. Establish protocols for long-term monitoring of any changes in 1, 2, and 3 above.

6. Model and make predictions about potential cumulative impacts that may occur with the addition of more wind turbine foundations. This includes whether turbine foundations could serve as corridors to facilitate the movement of native and invasive species.

Methods: This study would rely on established methods for sampling populations of marine organisms and understanding populations, trophic and community structure, and food web dynamics that might include:

- Remote sensing methods such as sonar, active, and passive acoustics.
- Fish telemetry including cabled acoustic telemetry receivers.
- Stable isotope analysis, including Carbon and Nitrogen to examine food web dynamics.
- Ecological statistics including sampling designs that allow testable hypotheses and multivariate data analyses.
- Ecological modelling as a tool to gain insights into future conditions as well as the cumulative impacts of the addition of more wind turbines.

In addition, this study will employ citizen science, outreach, and education to engage the public during the study and communicate results.

Revised Date: July 13, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic

Administered By: Office of Renewable Energy Programs

Title: Detection of Recreational Use of Coastal Areas on the Outer Continental Shelf (OCS)

BOEM Information Need(s) to Be Addressed: Coastal and ocean recreation provides significant economic and social benefits. To meet National Environmental Policy Act responsibilities, the Bureau of Ocean Energy Management (BOEM) needs baseline data of recreational use of coastal and outer continental shelf (OCS) areas around wind energy lease areas. There are limited data (Mid Atlantic RPB, 2016), especially beyond near shore areas. For example, 'How far offshore do recreational boaters travel?'; 'What areas do recreational boaters typically use?' As construction and operation plans are proposed for several offshore wind energy facilities, this study provides a unique opportunity to gather observational data before a facility is installed and operational. Such data will be valuable for refining any monitoring and mitigation plans for offshore wind facilities and recreation impacts. This information can also contribute to East Coast marine spatial planning efforts.

Approx. Cost: (in thousands) $100 **Period of Performance:** FY 2018

Description:

Background: BOEM published "Atlantic Region Wind Energy Development: Recreation and Tourism Economic Baseline Development," which relied on secondary data, such as Bureau of Labor statistics for a broad picture of recreation use of a coastal county (ICF, 2012). A conclusion of the report was that further research is necessary to better understand whether anticipated impacts do in fact become actual impacts. Additionally, previous methods to capture recreation use on the OCS include participatory geographic information system (GIS) mapping and after-the-fact surveys (Mid Atlantic RPB, 2016; NOAA, 2015) both of which are fraught with limitations (*e.g.*, informant gaming; reliance on human recall) in providing fine scale spatial data points.

BOEM has funded numerous studies to conduct high resolution aerial surveys to assess the distribution and abundance of marine life in the Atlantic coast's wind energy areas. Reexamination of these existing high resolution data for recreational use may also provide a cost effective method (NOAA, 2006) for enhancing our understanding of how humans use our coasts and oceans.

Objectives: To test the efficacy of using high resolution aerial imagery for mapping human uses of the ocean—via a pilot study.

Methods: Assemble photography databases from previous BOEM projects that have been identified as good candidates for providing information on recreation, based on the recommendations of the previous analysis. The photographic data will be analyzed using statistical procedures, and comparisons of spatial and temporal patterns of

detection. Computer vision (leveraging open source OpenCV [Open Source Computer Vision]) and ground truthing will be used to vet data and to expedite data analysis.

References:

ICF Incorporated, L.L.C. 2012. Atlantic Region Wind Energy Development: Recreation and Tourism Economic Baseline Development. U.S. Dept. of the Interior, BOEM, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2012-085.

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Revised Date: April 25, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic; South Atlantic

Administered By: Office of Renewable Energy Programs

Title: Fish Auditory Thresholds—Part 2 Field Component

BOEM Information Need(s) to Be Addressed: This study will help address questions regarding the impact of noise to commercially important fish and invertebrates such as black sea bass and squid, found in Bureau of Ocean Energy Management (BOEM) offshore renewable energy lease areas all along the Atlantic coast north of Cape Canaveral. BOEM has an obligation to understand how activities that it authorizes may impact commercially and recreationally important fish. In addition to BOEM's regulations under the Outer Continental Shelf Lands Act as amended by the Energy Policy Act of 2005, 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.

Approx. Cost: (in thousands) $1,000 **Period of Performance:** FY 2019–2021

Description:

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 lease areas and are thus not a temporary resident of the 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. Acute and chronic sub-lethal sounds may be generated as a result of offshore wind development. Black sea bass could be vulnerable because they are known to use acoustic and particle motion 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 expected to be 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. These will be funded under two separate awards.

Objectives: The objective of this study is to understand black sea bass, and potentially other species', behavioral and physiological effects when exposed to anthropogenic sounds.

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.

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.

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Revised Date: April 21, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic

Administered By: Office of Renewable Energy Programs

Title: Tracking Movements of a Suite of Priority Shorebirds off the U.S. Atlantic Coast to Better Understand Movements in Adverse Weather & Darkness

BOEM Information Need(s) to Be Addressed: This study would provide new information on movements and flight altitudes of focal shorebird species identified in the Atlantic Flyway Shorebird Initiative (AFSI) on the Atlantic Outer Continental Shelf (OCS). This information will allow scientists to assess the degree to which focal shorebird species use offshore Federal waters during migration, and better understand how migratory movements are affected by adverse weather conditions and time of day. This information is essential for understanding the potential for these species to encounter conflicts with renewable energy development in these areas, for National Environmental Policy Act (NEPA) assessments, and for Endangered Species Act (ESA) consultations with the U.S. Fish and Wildlife Service (USFWS). It will also permit the gathering of information on flight paths and altitude estimates of these birds during periods of inclement weather and limited visibility, when collision risks with structures may be elevated.

Approx. Cost: (in thousands) $1,500 **Period of Performance:** FY 2019–2020

Description:

Background: Since fiscal year (FY) 2013, the Bureau of Ocean Energy Management (BOEM) and USFWS have been collaborating on a project that has verified the effectiveness of using digital very high frequency (VHF) telemetry ("Nanotags") and automated radio telemetry stations to track movements of coastal birds, including American Oystercatchers (*Haematopus palliatus*), Common Terns (*Sterna hirundo*), Federally-endangered Roseate Terns (*Sterna dougallii*), and Federally-threatened Piping Plovers (*Charadrius melodus*) in coastal and Federal (≥3 nm) waters.

For these studies, the movements of tagged birds have been tracked using an array of eight (2013) to 20 (2015) automated radio telemetry stations, distributed from Cape Cod, Massachusetts, to eastern Long Island Sound, New York. To date, millions of detections of tagged terns and shorebirds have been recorded as they move throughout the southern New England shelf during their breeding, post-breeding, and migratory periods (June to September). Design and placement of radio telemetry towers have been optimized for offshore detection range; terns can be tracked to distances of up to 20 km, and shorebirds to distances of up to 80 km. Nanotag technology has proven effective for tracking the offshore movements of birds across regional scales, around-the-clock and during all weather conditions.

The work proposed here aims to collect additional information on the movements of additional species that use the U.S. Atlantic coast during migration, and to expand the

radio telemetry array to include fifteen additional sites configured to monitor movements near major migratory stopover areas in New England and the U.S. mid-Atlantic. We will work with USFWS Division of Refuges in Regions 4 and 5, state biologists throughout Atlantic coast, and non-governmental organizations (NGOs) (*e.g.*, Manomet, The Nature Conservancy) to site and operate telemetry towers in proximity to areas that have been identified as high priority staging and stopover areas, including areas designated by the Western Hemisphere Shorebird Group and Important Bird Areas by Birdlife International.

In addition, this study proposes to employ new techniques (*e.g.*, Global System for Mobile Communications – Global Positioning System [GSM-GPS] tags and/or altimeters/temperature sensors) in combination with nanotags to estimate altitude of tagged birds in flight. This information is essential for determining the extent to which birds passing through wind energy areas are flying within the rotor-swept zone, and thus may be at risk of collision with wind turbines.

Objectives: The objective of the study is to document movements of shorebird species along the Atlantic OCS to determine the occurrence, extent, and altitudes of their flights over Federal waters, particularly during inclement weather and night. This information will better identify potential conflicts to inform ideal placement of alternative energy development projects.

Methods: Each year, during fall migration, a total of 100 shorebirds of 4–6 AFSI focal species representing a cross-section (*e.g.*, Semipalmated Sandpiper, Ruddy Turnstone, Sanderling, Whimbrel) will be captured and fitted with Nanotags at stopover areas within Canada and Massachusetts, in collaboration with partners from Environment Canada and the USFWS Refuge System. Larger-bodied shorebirds such as Whimbrel may be tracked with a new 15 g solar-powered GSM-GPS tag currently in development, which provides locations within 3 m accuracy and determines altitude. These tags log up to 100,000 locations, and then upload them to a database each time the tag is within range of a cellular tower. Solar-powered GSM-GPS tags can provide locations every 1–2 hours, and are anticipated to last for 2–3 years.

Signals from Nanotags will be picked up from automated receiver towers stationed from Cape Cod, Massachusetts to North Carolina. These receivers will be located so that signals can be received simultaneously from a minimum of two towers, allowing '2-dimensional' locations to be obtained. In instances where signals are detected from a minimum of four towers, more precise '3-dimensional' locations of birds will be estimated.

Model movement pathways using models currently being developed at the University of Massachusetts to determine and calibrate altitude using signal strength may be employed. Movement data may be used to estimate movement patterns in offshore waters relative to weather conditions (*e.g.*, wind speed, wind direction, barometric pressure, visibility, precipitation) and time of day (darkness *vs.* daylight).

Revised Date: April 26, 2016

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic

Administered By: Office of Renewable Energy Programs

Title: Mapping Abundance, Distribution, and Foraging Ecology of Gray Seals in the North Atlantic

BOEM Information Need(s) to Be Addressed: Additional information regarding the rapidly increasing gray seal population in northeast U.S. waters will shed light on the role of this species in the marine ecosystem. The installation of foundations for offshore energy structures can create foraging habitat for seals (Russell *et al.* 2014). Increases in the habitat use, distribution, or abundance of animals around foundations can increase the potential for human interactions with offshore wind activities (*e.g.*, construction) and fisheries (*e.g.*, entanglement) in wind energy areas (WEAs). Therefore, it is important for the Bureau of Ocean Energy Management (BOEM) to understand the distribution, abundance, and movements of gray seals on the Outer Continental Shelf (OCS). Additionally, the study would meet the BOEM Environmental Studies Program (ESP) goal to utilize more citizen science by supporting fishers to collect information from the bycatch of seals.

Approx. Cost: (in thousands) $1,260 **Period of Performance:** FY 2019–2023

Description:

Background: The number of gray seals (*Halichoerus grypus*) in the Northeast has risen dramatically in the last 2 decades, with few being observed in the early 1990s to at least 25,000 on a single Massachusetts beach in 2016 (http://www.nefsc.noaa.gov/press_release/pr2016/scispot/ss1609/). Gray seals are now known to use beaches and waters in the northeast to breed, pup, and forage in areas that overlap with BOEM WEAs based on a small satellite tagging study (Puryear *et al.* 2016) as well as National Marine Fisheries Service (NMFS) bycatch estimates from commercial fisheries. Previous surveys to monitor marine mammal distributions in WEAs off Massachusetts and Rhode Island did not survey seals (Krause *et al.* 2016, current Atlantic Marine Assessment Program for Protected Species [AMAPPS] efforts). To better understand the population, ecological, and anthropogenic effects of the rapidly increasing population of gray seals, there is a pressing need to obtain basic demographic and ecological information of this increasing seal population in northeast OCS waters.

Objectives: The objective of this study is to collect baseline information on the distribution, abundance, and movements of gray seals, and support citizen science reporting of human interactions with seals in northeast OCS waters. Survey and tracking data can provide much needed distribution and abundance data on gray seals. Additionally, seal movements from satellite-tagged animals, combined with commercial fishing effort data can be used to predict times and areas of co-occurrence inside of the WEA's. These kinds of seasonal and behavioral patterns form the basis for the implementation of strategies to monitor or reduce adverse interactions between seals and activities occurring within wind energy areas.

Methods: Information collected will determine if the distribution of gray seals in WEAs changes throughout the year depending on the forage base, presence of predators, and other factors. The study will provide information on changes in density over time, given the population appears to be growing rapidly with an uncertain trajectory. A multi-year study is proposed including satellite tagging individual seals to understand their seasonal distributions and movements on the OCS, and aerial surveys of haul out areas combined with radio tagging effort to correct for portion of the population hauled out during survey to estimate total abundance in the region. Additionally, an opportunity for citizen science is available to support commercial fishermen who have expressed interest in working with the scientific and regulatory communities to retrieve carcasses of animals in nets to improve diet information to help inform solutions to reduce interactions between seals and fisheries. An additional fifth year would be dedicated to data synthesis and final reporting with minimal field operations.

The project would be completed over a 4 year period plus an additional year for data analysis and reporting of results. Three years would be devoted to satellite tagging and tracking of individual seals to understand their seasonal distributions in the pelagic environment. One year would be dedicated to aerial surveys of haul-out areas and radio tagging to correct for portion of the population hauled out during the aerial surveys. Haul-out areas will be identified and abundance estimates derived through the aerial survey and radio tagging efforts. A fifth year would be dedicated to synthesis, analysis, and final reporting. In addition to the above work, a citizen science component from fishers would be integrated into the study to support the collection and transport of seals entangled in fishing nets. This dimension of the project will add baseline information on seal bycatch, the diet, and food web interactions in WEA regions. Samples will be transported, stored, information collected on seals, and a diet analysis completed from stomach contents. Data synthesis, analysis, and preparation of a final report would occur in the fifth year of the study.

References:

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Revised Date: May 5, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Nationwide

Administered By: Office of Renewable Energy Programs

Title: Real-Time Offshore Surveys of Marine Protected Species with an Unmanned Aerial System

BOEM Information Need(s) to Be Addressed: The information obtained will meet the Bureau of Ocean Energy Management's (BOEM's) objectives for responsible offshore development of mineral and energy resources across BOEM program areas. Future lease activities on the outer continental shelf (OCS), such as monitoring of pile driving and decommissioning, require readily available aerial monitoring capabilities and will require the application of new technologies that are proven to be effective and practicable to monitor for marine protected species. Innovative strategies with the latest technological advances are needed to be developed and tested in offshore environments. The application of new technologies and methods are critical for BOEM to meet the challenges of safe and effective aerial monitoring in offshore marine environments to meet obligations under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Marine Mammal Protection Act (MMPA).

Approx. Cost: (in thousands) $250 **Period of Performance:** FY 2019–2020

Description:

Background: Visual monitoring is the most common and effective method to survey for sea turtles, marine mammals, seabirds, and other marine fauna and habitat indicators. Activities authorized, permitted, or funded by BOEM programs (*e.g.*, pile driving, drilling, and removal of offshore structures with explosives) are often required to utilize visual observers through lease stipulations and inter-agency consultations. Visual aerial surveys have several advantages over boat-based surveys because they allow for coverage of a large area in a relatively short amount of time, can more easily detect animals below the surface otherwise unavailable to boat-based observers, and are less limited by sea state. When aerial surveys are the preferred monitoring method, boat-based surveys are still more often utilized to monitor for protected species for mitigation reasons due to human safety concerns, scheduling conflicts, and the high cost associated with chartering aircraft. Development of unmanned aerial vehicle (UAV) equipment, methods, and protocols for real-time monitoring will further the knowledge of this technology as an effective, safe, and economically viable method for aerial surveys. UAVs are an integral part of the Department of the Interior's (DOI's) strategy to integrate this new class of aircraft that are better suited than manned aircraft, achieving superior science, safety, and savings to support DOI missions (DOI Unmanned Aircraft Systems [UAS] Integration Strategy [2015–2020]). Currently, the DOI has access to the national airspace system through a Certificate of Authorization (COA) granted by the Federal Aviation Administration (FAA) on a case-by-case basis or by way of a Memorandum of Agreement (MOA) between the FAA and DOI that allows broad access to the national airspace system as long as certain conditions are met.

UAV technology has significantly progressed in recent years to the point that increased flight times, lower costs, and real-time monitoring capabilities make offshore UAV surveys a viable alternative to manned aerial surveys. UAVs have several advantages over manned aerial surveys including the ability to readily change speed, course, and altitude. Additionally, UAVs can be outfitted with cameras for day or night surveys. Protected species surveys with UAVs have been successfully completed with processing of recorded digital images (Hodgson *et al.* 2013; Koski *et al.* 2009; NOAA 2014; AK-15-07 ongoing); however, studies of real-time survey capabilities of marine protected species have only recently been investigated (NOAA 2014; Pomeroy *et al.* 2015).

Objectives: The objective of this study is to test real-time monitoring capabilities of UAVs in an offshore lease area where visual monitoring is currently required over defined areas including:

- Determining the UAV specifications optimal for real-time monitoring of marine mammals and sea turtles such as installation of a meteorological tower, decommissioning of an oil platform, or high-resolution geophysical (HRG) surveys;

- Comparing real-time animal detection capability to identify species or species group, and GPS location under daylight and nighttime conditions;

- Compare UAV survey monitoring to observer visual monitoring and detection;

- Determining optimal survey altitudes for real-time monitoring of various marine fauna including marine mammals and sea turtles;

- Determine optimal survey patterns, flight time, and number of UAVs required to monitor a fixed area around a focal point (*e.g.*, marine pile driving and decommissioning);

- Identifying the logistical, operational, financial, safety, and regulatory constraints of real-time UAV operation in offshore environments; and

- Determining the equipment and software requirements optimal for real-time monitoring in offshore environments.

Methods: Off-the-shelf technologies will be used to design an unmanned aerial monitoring system (UAMS) in offshore environments during pile driving or decommissioning activities. UAMS will be designed and tested to conduct marine species surveys from offshore vessels where a user is capable of analyzing images and video reliably and in real time. BOEM may facilitate coordination in identifying appropriate projects and working with industry. The UAMS system could include all the components necessary to launch, conduct a survey, design survey plans, equipment to conduct real-time monitoring and identification, capture still images of marine species, and recover the UAV. Survey plans using both real-time operation and pre-programmed flight patterns will be tested for effectiveness of detecting marine animals and species identification over a predetermined survey area. The UAMS used for

marine surveys will be field tested in different operational (*e.g.*, speed and altitude) and environmental conditions (*e.g.*, daytime and nighttime) for effectiveness at monitoring and ability to detect and identify marine species in a survey area.

References:

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Revised Date: February 13, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic; South Atlantic

Administered By: Office of Renewable Energy Programs

Title: A Database and Acoustic Reference Catalog of Marine Fish Sounds—Atlantic Pilot

BOEM Information Need(s) to Be Addressed: Passive acoustic monitoring has been demonstrated to be a highly efficient survey method for understanding wildlife occurrence in Bureau of Ocean Energy Management (BOEM) areas of interest. Establishing a library of fish sounds allows for the development of 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) compliance.

Approx. Cost: (in thousands) $300 **Period of Performance:** FY 2019–2020

Description:

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: This study would 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 sounds would be collected 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.

References:

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Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic

Administered By: Office of Renewable Energy Programs

Title: Advancing the Use of Acoustic and Thermographic Observations of Marine Birds to Support Post-Construction Evaluations of Wind Turbine Interactions

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) is considering post-construction monitoring that can address key questions about the interaction between marine and land birds and wind turbines. Of particular interest are movement patterns at night and during inclement weather. The use of acoustic and thermographic techniques may provide insights into these activities and to inform analyses for the National Environmental Policy Act (NEPA) and risk assessments for the Endangered Species Act (ESA).

Approx. Cost: (in thousands) $800 **Period of Performance:** FY 2019–2021

Description:

Background: As construction of the first offshore wind turbines off the coast of the United States nears, the questions being asked about the potential effects are shifting. Careful siting that takes into consideration the distribution of marine birds reduces the risk of birds being killed or displaced by facilities. Now, it is time to prepare for post-construction considerations. Key questions include the behavior of migratory birds at night or in inclement weather. Acoustic/thermographic devices could monitor vocalizations of birds both day and night at all seasons of the year including periods of low visibility that would prevent effective visual monitoring. BOEM funded the study "Acoustic Monitoring of Temporal and Spatial Abundance of Birds Near Structures on the OCS of the Atlantic and Gulf of Mexico" to develop and test the effectiveness of this type of monitoring equipment for offshore use and can it be used to estimate bird flight heights—information which is critical to the assessment of risk to birds from wind turbines. If these instruments are used post-construction, they may be used on the service platforms, meteorological towers, or wind turbine towers. This technique can monitor birds on the outer continental shelf (OCS) during both daytime and night and in both good and poor visibility conditions, but only at point locations where offshore structures are available. Thermographic and conventional cameras will be positioned to obtain stereoscopic images to aid in the identification of species and calculation of flight height and vulnerability.

While each of these systems provides data on only a single point in a large ocean, it can provide data continuously all year. Used in conjunction with high-definition aerial surveys, which provide wide area survey data but only on a single day for each flight, the combination would contribute substantially to our understanding of bird and bat use of the OCS. However, further development of the methodologies based on lessons learned is needed. This study will extend the acoustic study to further refine the methodology with the intent to use the devices during the post-construction phase.

Objectives: Increase our understanding of the movements of marine birds around offshore wind structures.

Methods: The advancements this study will focus on include miniaturization, such that the system can be deployed on more types of structures, including buoys. The limiting factor in size is the solar panels, which must be large enough to produce the power needed; so reducing power demand will be a priority, as well as the ability to switch certain functions off and on remotely, thus further reducing the power needed at any given time. Duty cycles for different pieces of equipment will be determined for optimal data gathering while reducing power usage and data storage needs. There will be an emphasis on the use of cell phone technology to transmit data to shore, either directly or via satellite. This will depend on how far offshore cell phone capability extends; from the previous study, we know it did not extend 29 miles offshore to the Frying Pan Shoals Lighthouse.

In addition, cost reduction for these devices will be pursued. Ideally, 20–30 of these devices would be deployed simultaneously around a wind farm, or on buoys around a proposed wind farm, or just scattered over a broad area along a coast. The cost for this type of deployment needs to be reasonable.

The use of ambient light cameras in addition to thermal cameras will be explored, since bird activity in the pilot study was greater in daytime than at night. Ambient light cameras would increase the ability to obtain accurate species identifications during daytime.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic; South Atlantic

Administered By: Office of Renewable Energy Programs

Title: Integrated Analysis of Marine Bird At-Sea Survey and Tracking Data to Inform Spatial Planning

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) has a responsibility under the Endangered Species Act (ESA) and Migratory Bird Treaty Act (MBTA) to assess the risks of energy development to listed species. BOEM uses information from a combination of sources such as the maps of the relative distribution and abundance seabirds derived from surveys and telemetry studies tracking of seabird movements. This enhancement will strengthen evaluations of the potential impacts of energy development (oil, gas, and renewables) to sensitive seabird species for National Environmental Policy Act (NEPA) analyses and ESA consultations.

Approx. Cost: (in thousands) $400 **Period of Performance:** FY 2019–2020

Description:

Background: Marine birds are wide ranging with a potential to be impacted by offshore energy development. BOEM has recognized this potential and has funded numerous studies in multiple geographic regions to establish baseline information about the distribution of marine birds at sea. 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 survey data cover large geographic areas that can be targeted through survey design, and have been collected for decades. However, survey data provide only instantaneous counts of birds 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 individual birds over time, and can elucidate information about spatial distribution that is difficult to obtain from a limited number of surveys; for example, the identification of areas that are used by birds consistently but only for a short time (*e.g.*, migratory pathways). However, due to costs and logistics, electronic tracking data are often limited to a subset of the population (*e.g.*, subset of individuals or subset of breeding colonies).

At-sea survey data and tracking data have generally been collected and/or analyzed separately through separate BOEM-funded projects, although both types of studies have been conducted simultaneously in multiple geographic areas (*e.g.*, Atlantic and Main Hawaiian Islands). A combined analysis of these (or new) at-sea survey data and tracking data has the potential to more fully characterize the spatial distribution of marine birds and thereby better inform spatial planning. Alone, neither at-sea surveys nor telemetry data do a good job at mapping these dynamic patterns in a comprehensive, unified, statistically robust way across all areas of interest on the Atlantic outer continental shelf (OCS). Merging these types of data in a unified

modeling framework will improve BOEM's description of the affected environment and risk assessments in NEPA analyses on the Atlantic OCS. Depending on the availability of data, the general approach may be expanded to include other BOEM regions.

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

Methods: Ideally, statistical modelling should be used to estimate the spatial distributions of birds using survey and telemetry data simultaneously while properly accounting for the different characteristics of the two data types. Given that these statistical methods are not yet well-developed, it would probably be best initially to focus on a few species with large samples of temporally overlapping at-sea survey and tracking data. A major advantage of these new models is that they would allow incorporation of information regarding movement and habitat usage (inferred from telemetry-derived movement patterns) into static maps of bird distribution, enabling better planning to avoid migratory corridors and foraging areas.

There is no field work planned for this study. The study will merge existing survey data (*e.g.*, Compendium of Avian Information) with existing telemetry data (like the BOEM funded Diving bird telemetry and nanotag studies) through a unified modeling framework. The products will be maps that better represent the distribution of key avian species.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic; South Atlantic

Administered By: Office of Renewable Energy Programs

Title: Development of Technological Tools to Accommodate Large Scale Acoustic Data Analyses of Existing and Future Datasets for Ocean Noise and Marine Fauna Monitoring

BOEM Information Need(s) to Be Addressed: To assess acoustic impacts on protected species from Bureau of Ocean Energy Management (BOEM)-related activities, BOEM has funded studies to collect baseline and empirical passive acoustic data to determine ambient noise levels, as well as describe the biological acoustic environment. Generally these studies result in extremely large datasets that have to be sub-sampled in order to be analyzed, and results are usually only based on these subsets of the larger data. In addition, these data contain information on other acoustical aspects that might not be the focus of the study, but could be informative upon in-depth analysis. One of the main reasons that all the valuable content of the datasets are not analyzed is that, while the acoustic recording technology has improved significantly over the last several years, the development of new analytical tools has not kept up with sound collection hardware and software. In order to make the best use of the data already collected, and future data to be collected, there is a vital need for advanced analytical tools to allow for the analysis of long-term acoustic data sets in a more efficient and cost effective way.

Approx. Cost: (in thousands) $500 **Period of Performance:** FY 2019–2021

Description:

Background: The use of passive acoustics to collect biological data has expanded rapidly over the last few years. However, this type of data collection results in extremely large datasets, usually providing more data than can be analyzed within standard periods of performance for a study. Acoustic recording technology has also advanced over the years, while the development of new cutting-edge analytical tools has lagged behind. In order to make the best use of the data already collected, and future data to be collected, there is a vital need for advanced analytical tools to allow for the analysis of long-term acoustic data sets in a more efficient and cost effective way.

High performance computing (HPC) technologies have been developed, and successfully used, to support big-data analytics on large supercomputers. However, the bioacoustics community does not have the software required to successfully tap into this resource. This kind of effort would be advantageous to all BOEM regions and applicable to other Federal agencies. Funding partners could be approached to assist in moving this initiative forward. In particular, the Department of Energy has computing capability that could be accessed for processing these large datasets.

Objectives: Develop the necessary analytical tools that can make use of, or enhance, existing high performance computing technologies to enable the complete analysis of existing (and future) BOEM-funded long-term acoustic data sets.

Methods: Develop an analytical tool(s) able to interface with, or enhance, existing high performance computing technologies that can process and analyze large long-term acoustic data sets in order to identify and catalog available ecological acoustic elements, including ambient and biological acoustic signatures. This will address different questions than what the data was originally collected for, for example:

- What is the ambient noise level in a given habitat, and how does it change over time, with different weather and oceanographic conditions?
- Which other animals (*e.g.*, fish) are vocalizing in this area? Can that give some indication of habitat quality and/or species diversity?
- How frequent and how loud is boat traffic in the survey area?

This methodology will allow for a better interpretation of the bioacousticly complex data.

Revised Date: April 27, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): North Atlantic; Mid Atlantic; South Atlantic

Administered By: Office of Renewable Energy Programs

Title: Predicting Future Seabird Distributions on the Atlantic Outer Continental Shelf (OCS)

BOEM Information Need(s) to Be Addressed: To assist in the environmental review and evaluation of sites for new offshore energy development projects (including oil, gas, and renewables), the Bureau of Ocean Energy Management (BOEM) uses maps illustrating the seasonal distribution patterns of bird species that are using the Atlantic OCS. Predictions of future shifts in seabird distributions over the coming decades are needed to inform cumulative effects analyses for the National Environmental Policy Act (NEPA) and risk assessments for the Endangered Species Act (ESA).

Approx. Cost: (in thousands) $400 **Period of Performance:** FY 2019–2020

Description:

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). Given that BOEM's leases for offshore energy development can be up to 30 years, 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 seabirds may shift in or out of existing and potential lease areas within the next 30 years.

Methods: The study will use a similar approach as the methods used to create distribution and abundance maps of key avian species along the Atlantic (please see

Kinlan *et al.* 2016). These models use a combination of habitat and oceanographic variables and other information to predict the distribution of almost 50 seabird species on the Atlantic OCS (similar models are being used on the Pacific). Several seabird species will be selected based on the strength of the relationship to oceanographic conditions 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 30–50 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.

Revised Date: April 3, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Mid Atlantic

Administered By: Marine Minerals Program

Title: 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

BOEM Information Need(s) to Be Addressed: Better understanding of demersal and benthic organisms' use of habitats and sand features in the Mid-Atlantic New York Bight (NYB; waters off of New Jersey [NJ] and New York [NY]) is important for the Bureau of Ocean Energy Management's (BOEM's) Marine Minerals Program (MMP) to inform and evaluate the use of potential sand borrow areas in federal waters. BOEM anticipates that in the next 5 years multiple sites may be accessed in federal waters of the NYB, in part to address the Army Corps of Engineers' projected sand deficiency for completing vital federally authorized shore protection projects (USACE 2015). BOEM's current Cooperative Agreements with NY and NJ have gathered data on sand resources and resulted in delineations of potential borrow areas offshore in the NYB. Since dredging on the NYB outer continental shelf (OCS) has been infrequent relative to other regions, research on biological activity, biophysical coupling, geomorphology, and fisheries activity will complement the geophysical and geotechnical data, and strengthen National Environmental Policy Act (NEPA) analyses and other consultations that consider the potential effects of dredging.

Approx. Cost: (in thousands) $1,000 **Period of Performance:** FY 2018–2021

Description:

Background: Sand for NJ beach nourishment projects has mostly come from sources in state waters; however, the need for OCS sand has recently been identified (USACE 2015). Due to the lack of historical activity on the NYB OCS, limited information exists on the ecological function and biological significance of sand waves, ridges, swales, shoals, and other features, especially as they relate to dredge-related disruptions. Dredging activities under BOEM's jurisdiction generally occur 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. Due to seasonal fluctuations, the potential effects and recovery of sand dredging on ecosystem health and the abundance of fish and invertebrate communities may vary spatially and temporally. Many fish and invertebrate species are economically important to commercial, recreational, and charter fishing industries; accordingly, fishermen have voiced concerns about dredge-related impacts to fish and habitat. Because of these potential fisheries impacts, BOEM plans to engage fishing communities in the review process of MMP projects, according to an action item identified in the multi-agency Mid-Atlantic Regional Ocean Action Plan (Mid-Atlantic RPB 2016).

Objectives: Goals include expanding or obtaining new baseline data on the seafloor morphology, substrate type, and the diversity and abundance of demersal and benthic organisms which rely on sand habitats, specifically around sand resources off the NYB, from 3–9 NM offshore. The study should leverage existing knowledge to monitor conditions before, during, and after dredging to document the affected environment, potential impacts, and biological recovery in the NYB OCS areas.

Methods: A plan to gather local shareholder knowledge (*e.g.*, fisheries industry, sport fishing, diving) through appropriate and methodical outreach activities (*e.g.*, meetings, online forums, and fishing activity surveys) will be developed and implemented in accordance with Office of Management and Budget regulatory guidelines during the beginning of this study. The results of this survey effort will then be leveraged prior to activities to highlight issues and further inform study methodology.

Comparative studies on environmental impacts using a before-after-control-impact (BACI) design will be conducted and focused on invertebrates (especially economically important shellfish), both demersal and pelagic fish species, and the presence of basal autotrophs. Existing datasets (*e.g.*, fish and benthic datasets) will be evaluated to identify methods and data gaps unique to the region. Data will be collected on species abundance, size composition, and distribution with a focus on the sea-sediment interface, in order to better understand mesoscale and microscale habitat use, species assemblages, biodiversity, and habitat associations. These data will also be collected through time, so that seasonal changes are observed. The overarching hypotheses are that:

(1) areas with sand features and relief have greater habitat value for benthic invertebrate and fish species than flat areas with limited or no sand features, as determined by species' abundance, distribution, diversity, and assemblages;
(2) the habitat function of various areas displays intra- and inter-annual variability;
(3) dredging results in changes to the biological activity in the short-term, with measurable ecological succession and recovery times; and
(4) dredged areas closer to non-disturbed areas will recover more quickly.

Optimally, monitoring will employ a BACI design, and either verify the continued presence of pre-existing benthic and demersal organisms or identify changes. Surveys will be performed 4–6 times before, during (if practical), and after dredging, covering a timespan of two or three years. A control site with similar features will be monitored proximal to the dredge site, but outside of the expected zone of disruption (*e.g.*, a neighboring ridge-swale complex). Methods could include, at varying frequencies:

- geological sampling via multibeam or sidescan backscatter surveys, and vibracore or grab samples to characterize seafloor morphology and benthic substrate;
- biological sampling via grab samples, clam dredges, trawl surveys, passive acoustic monitoring, and tagging;
- water column profiles of current flow/direction and water chemistry (*e.g.*, temperature, salinity, pH, dissolved oxygen, turbidity, chlorophyll); and
- visual observation using video cameras or remotely operated vehicles.

Opportunities may exist for expanding upon current BOEM funding through new or existing studies. From the NY Department of State and the National Oceanic and Atmospheric Administration's National Center for Coastal Ocean Science's substrate mapping, this may include using an acoustic echosounder during shipboard surveys to quantify fish biomass. From NY Department of Environmental Conservation, Atlantic sturgeon work could be expanded to involve additional fish tagging and systematic receiver gate deployment for broader detection throughout BOEM's area of interest. The results of this study would offer a new level of insight into impacts in the NYB, since it is an area of growing interest, and inform other regional project impacts more accurately than studies conducted in different geographic areas.

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Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Gulf of Mexico OCS / Atlantic OCS

Administered By: Marine Minerals Program

Title: Fine-Scale Dive Profiles and Activity Patterns of Sea Turtles in the Gulf of Mexico

BOEM Information Need(s) to Be Addressed: Fine-scale information on dive profiles and activity patterns is lacking for sea turtles in Gulf of Mexico waters. Such information can provide key data on time spent per individual in various portions of the water column, including surface and bottom times as well as provide support to assumptions about behavior in the Atlantic. Combining fine scale dive information with genetic analyses, population demographics, health, and foraging studies will allow the Bureau of Ocean Energy Management (BOEM) to address information gaps as identified through National Environmental Policy Act (NEPA) and Endangered Species Act (ESA) Section 7 consultations. BOEM needs these fine scale behavior data in support of the oil and gas and marine mineral programs to inform management decisions related to Protected Species monitoring, decommissioning activities and significant sediment resource extraction mitigation operations. This project will link three ongoing BOEM projects: (1) tracking turtles captured in association with mitigation trawlering activities, (2) Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS), and (3) the sea turtle decision support tool/information portal. The results from the proposed research will provide detailed information on dive profiles and behavior of turtles within the water column. This information can also be summarized to calculate availability correction factors (ACFs) for species abundance estimation efforts.

This study will be conducted in collaboration with U.S. Geological Survey (USGS) to fulfill expertise and permitting needs as they possess the expertise and permits required from the National Marine Fisheries Service (NMFS) to collect biological samples and tag specimens.

Approx. Cost: (in thousands) $500 (USGS contributions: $500)

Period of Performance: FY 2018–2020

Description:

Background: Deployment of satellite tags capable of logging dive data on turtles captured in relocation trawling projects is currently underway (BOEM/USGS Inter-Agency Agreement M15PG00032). 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 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 for these imperiled species, especially at the sites of dredging operations and decommissioning efforts which pose risk to sea turtles through entrainment by hopper dredges or during explosive removals.

Despite the impressive body of research available on sea turtle movements, there is still little known about their fine-scale activities and behavior. Acceleration data loggers (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. These high-resolution data can be used to identify and quantify specific behaviors (*e.g.*, various types of swimming behavior based on their flipper-beat frequency and amplitude, stalling/gliding, rolling, resting) using fast-Fourier transforms, wavelet-analysis, and k-means clustering techniques. However, ADLs do not transmit via satellite which means that data is stored to memory and must be recovered from the animal in order to obtain the data. This logistical challenge has meant that most previous ADL work with turtles was focused on short-term deployments where recapture probability was high or deployments on adult females during their inter-nesting period, as tags can be recovered when turtles return to land to nest again. 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.

Objectives: Expand upon ongoing research utilizing hopper dredge relocation trawling operations to opportunistically tag sea turtles to include using an ADL data logger embedded in a float with both a satellite tag and a very high frequency (VHF) transmitter providing fine scale diving profiles to inform management decisions related to trawling and dredge operations. 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 establishing ACF's to support other BOEM information needs.

Methods: The following field methods are proposed utilizing turtles captured through relocation trawling. Once captured, satellite tag and ADL packages will be deployed on sea turtles and set to record tri-axial 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 (SPOT) tags. Innovative techniques are proposed to address the challenge of tag recovery so that data from longer-term deployments associated with this study can be obtained. Specifically, tags will 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 then retrieved by vessel.

A report will be generated by USGS scientists outlining the findings as well as BOEM management suggestions following the collection, processing, and assessment of data gathered. These data and the report will provide fine scale dive analysis allowing investigation of in-water aggregations of sub-adult, juvenile, and adult marine turtles. It is also expected to determine fine scale movement and habitat use within the Northern Gulf of Mexico which will directly inform BOEM on management strategies throughout

its programs and support other on-going BOEM studies as well as provide supportive documentation to behavioral assumptions made in the Atlantic region.

Revised Date: February 15, 2017

Study Area(s): Atlantic OCS / Gulf of Mexico OCS

Administered By: Marine Minerals Program

Title: Sediment Evolution Following Beach Fill Construction: A Literature Review and Technical Workshop

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) needs to better understand the dynamics of Outer Continental Shelf (OCS) sediment placed on beaches to inform future decisions related to non-competitive negotiated agreements and support prudent management of the resource. This information will inform BOEM's environmental compliance responsibilities by helping to discern acute and chronic effects of beach fill sediments on adjacent habitat compared to natural processes. This information is needed to support ongoing Endangered Species Act Section 7 consultations (*e.g.*, protected coral species, green sea turtles, piping plovers) and could 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 resources for coastal infrastructure and habitat restoration projects.

Approx. Cost: (in thousands) $250 **Period of Performance:** FY 2018–2019

Description:

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 140 Million Cubic Yards (MCY) of sediment on Gulf and Atlantic coast beaches; however, its long-term fate is not clear. The placement of sediment on a beach for the purpose of constructing a fill template (*i.e.*, beach nourishment) is an interrelated component of BOEM's non-competitive negotiated agreement decision for dredging of OCS sediment resources. Understanding sediment transport 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). 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 (*i.e.*, geophysical surveys, geochemical tracers, sediment particle tracers, *etc.*) and numerical modeling is required to fill critical data gaps and test the hypothesis: "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 test this hypothesis 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 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: A question to be answered by this study is: How does the addition of new sediment and altered shoreface geometry affect natural sediment dynamics and dispersal processes relative to adjacent habitat?

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 hypothesis will be gathered from current BOEM documents and other ongoing research performed by external stakeholders. Following the literature review, 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 data from the literature review and solicit input from technical stakeholders, (2) select appropriate numerical and statistical models and determine data inputs needed for those models, and (3) develop a concept plan and identify/leverage existing project data where parameters have been or will be measured.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Atlantic OCS; GOM OCS

Administered By: Marine Minerals Program

Title: Evaluating Changes in Habitat Value and Function in Outer Continental Shelf (OCS) Sand Resource Areas Following Dredging Events

BOEM Information Need(s) to Be Addressed: Studies evaluating the efficacy of site specific sand excavation techniques to increase habitat value and function are limited. This additional information will support the Bureau of Ocean Energy Management (BOEM) in the development and management of OCS mineral resources, particularly in regard to National Environmental Policy Act (NEPA) and Essential Fish Habitat (EFH) assessments, to understand the positive and negative impacts of BOEM's actions and in minimizing adverse impacts to the environment. Evaluating the potential benefits of current or modified borrow area design and excavation methodologies to improve or enhance natural sand resource features supports BOEM's adaptive management and environmental stewardship responsibilities.

Approx. Cost: (in thousands) $200 **Period of Performance:** FY 2018–2020

Description:

Background: The Marine Minerals Program (MMP) provides valuable opportunities in collaboration with local, state, and federal partners to provide sand resources that support coastal resiliency initiatives along the Atlantic and Gulf coasts of the United States. A significant literature base exists that evaluates site specific resource impacts associated with the excavation of sand from OCS sediment resource areas (*i.e.*, borrow areas) using hydraulic dredging methodologies. Dredging is a primary impact-producing activity in projects that require offshore sand resources to support coastal resiliency initiatives for improved coastal habitat function and protection of valued resources. Analysis of time-series habitat-relevant data on dredging projects has demonstrated that post-dredging geomorphic features constructed in a manner that retains aspects of pre-dredge morphology in borrow area excavation designs may be conducive to the formation of biological assemblages relative to the pre-dredge conditions. A literature base of post-dredging borrow area monitoring exists, including multiple BOEM investments, documenting the effects and recovery rates of benthic macro-invertebrate communities, biological and biophysical impacts, and habitat associations and long-term effects of dredging on fisheries (BOEM/Navy Interagency Agreement, Ongoing Study #NT-14-x12, Michel *et al.* 2013). Geographically diverse studies suggest that most borrow areas show significant recovery within 1 to 2 years after dredging (Byrnes *et al.*, 2003; Jutte *et al.*, 2002; Blake *et al.*, 1996; Van Dolah *et al.*, 1992) and 5–10 years for recovery of complex biological associations (Newell *et al.*, 1998). However, these studies predominantly focus on the negative effects of dredging activities on biological resources directly impacted by the extraction of the benthic sediment resource, typically documenting methods to avoid or minimize these negative effects to promote quicker recovery to pre-dredge conditions. Little consideration is

given to the potential positive effects of post-dredging environments within the context of increased habitat diversity relative to the surrounding environment. International studies, as well as research on fish assemblages, have suggested that modification of seafloor morphology increases surface area and creates new ecological niches, possibly fostering rapid biotic assemblage recovery. In some cases, this may lead to changes in the biotic community, resulting in different values of species richness and abundance. Dredged sites (*i.e.*, borrow areas) may be sustainable opportunities to increase the ecological value of the seabed but have yet to be fully investigated.

Findings from this study would complement the ongoing borrow area optimization study (NT-15-03) and the Regional Essential Fish Habitat Geospatial Assessment and Framework study (NT-16-09). Potential cooperative support is available by the U.S. Army Corps of Engineers (USACE) Engineering Research and Development Center (ERDC).

Objectives: This study aims to document methodologies with the potential to increase the likelihood of beneficial use through modification of the ecological conditions at dredge extraction sites, based on an analysis of existing data. Specifically, the study objective will be to identify opportunities for improving post-dredging habitat function and value using existing or new excavation techniques while considering dredging feasibility and cost constraints. The study will recommend hypotheses and proposed research methods that test maximization of post-dredging habitat value that can be incorporated in subsequent field-testing study proposals.

Methods: The study entails a review and synthesis of existing literature and data with an analysis that identifies and documents specific factors which support high valued offshore fisheries habit within varying offshore sand resource areas. To achieve the study objectives, the study will identify and collect current available data pertaining to existing and new dredge design templates and methodologies. It should include information about the ecological effects, cost implications, impacts on habitat function, and environmental prerequisites of different design templates. Additionally, it should develop proposed management strategies relevant to the MMP which would further enhance or improve habitat conditions at mining sites in the OCS.

Supporting data will be gathered from current BOEM documents such as the Research Planning, Inc. 2013 report and on-going research on long term ecological recovery in dredged undisturbed furrows. In addition, diverse and thorough literature and data searches will be made to identify, acquire, review, and annotate all scientific and technological literature (*e.g.*, USACE Dredging Operations and Environmental Research [DOER], National Oceanic & Atmospheric Administration Fisheries, European Commission/Directorate-General for Maritime Affairs and Fisheries) used to support the investigation and analysis.

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Revised Date: February 15, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): South Atlantic

Administered By: Marine Minerals Program

Title: Effects of Sand Mining on Nutrient Supply, Biomass, and Production of Benthic Microalgae and Associated Demersal Zooplankton on Sand Bottom Habitats

BOEM Information Need(s) to Be Addressed: Benthic microalgae (BMA) in the nearshore shelf contribute a significant portion of total primary production in these habitats and, being concentrated on the seafloor, they are an important food source for demersal grazers. The Bureau of Ocean Energy Management (BOEM) needs to better understand how BMA are produced, their distribution, and their role in the food web to address data gaps identified in previous National Environmental Policy Act (NEPA) documents. This information will help quantify the impacts of habitat modification from dredging activities associated with Marine Mineral Program lease decisions in the Atlantic, Gulf, and Pacific Regions.

Approx. Cost: (in thousands) $400 **Period of Performance:** FY 2018–2020

Description:

Background: The major primary producers on the continental shelf are phytoplankton and BMA, a group which includes diatoms, cyanobacteria, and dinoflagellates. BMA, which may exceed the extent of phytoplankton biomass by a factor of 4 to 6, is mostly concentrated in a 1–2 mm thick layer of surface sand and represents a nutritious food source for benthic grazers and upper trophic level organisms. Previously published BOEM studies that address BMA lack useful estimates of biomass, production, and recovery and need to be updated with respect to the increased frequency of dredging outer continental shelf (OCS) sand ridge-swale habitats. Recent studies have demonstrated that sub-seafloor saline groundwater seeping upwards likely supplies high concentrations of nutrients supporting BMA growth in the ridge-swale habitats in the South Atlantic Bight (SAB).

As primary producers which are dependent on light for photosynthesis, BMA are likely to inhabit shallower ridge-swale complexes. Potential dredging impacts include resuspension and dispersal of BMA, injury or damage to organisms, an increase of the depth of seafloor, and transport into darker, less suitable habitats (Cahoon, 1999). Furthermore, dredging may disrupt local patterns of nutrient-rich groundwater flow by changing the sediment size distribution of the substrate, which in turn alters the hydraulic conductivity of the substrate. The functional, biological services that are potentially compromised by dredging of sand from ridge-swale habitats and their impacts on BMA and higher trophic levels are unknown.

Objectives: This study aims to complete a comprehensive assessment of BMA biomass, which is necessary to assess the potential impacts of the dredging of SAB sand habitats. Initial investigations would focus on the biomass and production of BMA on sand ridge-

swale resources, as well as quantifying any contribution to adjacent hardbottom communities as trophic support. The importance of groundwater inputs as the supplier of primary nutrient sources supporting BMA production would also be identified. Studies of the response of BMA and changes in groundwater flow (*e.g.*, reduction of flow due to change in hydraulic conductivity, focusing of flow in dredged depressions) following sand removal are essential for monitoring and modeling system recovery.

After the baseline community structure, substrate composition, and groundwater flow regime has been established, the impacts from dredging to BMA and groundwater flow would be investigated. BMA recovery would be measured relative to the pre-dredge conditions by spatial extent and time-series. Surveys may need to occur opportunistically in conjunction with a dredge event, but when practicable, nearby hardbottom sites would also be surveyed to estimate any disruption of BMA nutrient supply to surrounding communities. Repeat surveys of biomass and composition would identify the footprint and severity of dredging impacts, while extending these surveys through time would establish the pattern and temporal spacing of recovery. As needed, impacts of dredging on the flow regime would be assessed, since that may ultimately further affect BMA recovery. With the combined understanding of BMA production and recovery, the impacts of dredging on basal community structure and the remaining ecological network could be modeled and appropriate mitigation measures considered.

Methods: BMA production calculations at various depths to 30 m will be based on the most accurate and feasible technology available. One of the leading techniques quantifies production by measuring the excretion and uptake of isotope-labeled compounds. This enables measurements to be taken underwater, with a higher level of sensitivity. Other methods of estimating BMA productivity include measuring chlorophyll, oxygen flux, or light flux.

Groundwater investigations would include both the sediment and the pore waters (*i.e.*, groundwater). Sediment cores would be taken in a manner that preserves the orientation and internal structure of sediment and pore waters. These cores would be described physically (grain size, mineralogy), chemically (pore water pH, alkalinity, dissolved oxygen [DO]), and biologically (microbial activity, infaunal biota). Additionally, subsurface groundwater flow should be characterized using an appropriate proxy (*e.g.*, radionuclides such as radon or U/Th, electrical resistivity, geochemical tracers.)

Ideally, surveys would be conducted three times before a dredge event: 2–3 months before, 1 week before, and the day before; at three locations at an identified dredge borrow area: within the borrow area, immediately adjacent to the borrow site, and at a point outside of the modeled dredge plume (*i.e.*, control). After the dredge event, these same sites would be surveyed the day after, 1 week after, 2–3 months after, and 1 year after. As previously stated, if hardbottom is nearby, surveys would be included at this additional site. To gain a better understanding of the ecological effects of BMA disturbance, surveys of grazers would be conducted on the dredge site. Using low-impact methods that would not disturb the bottom (*e.g.*, gillnet or video survey), the abundance, composition, and fitness of grazers would be recorded. This study would

not only improve the analysis of impacts on BMA but would also provide insight into effects on higher-trophic level species.

References:

Cahoon, Lawrence B. 1999. The role of benthic microalgae in neritic ecosystems. *Oceanography and Marine Biology: an Annual Review*, 37 (47–86).

Revised Date: February 15, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Chukchi Sea; Beaufort Sea; Cook Inlet

Administered By: Alaska OCS Region

Title: Oil Spill Impact Literature Synthesis: Crude and Refined Spills 1,000–20,000 bbl

BOEM Information Need(s) to Be Addressed: The relationship between Bureau of Ocean Energy Management (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. Information about oil spills, including particular oil types and volumes, and their impacts under specific environmental variables would allow National Environmental Policy Act (NEPA) analysts to make refined evaluations regarding potential impacts from large (≥1,000 bbl) crude and refined oil spills.

Approx. Cost: (in thousands) $200 **Period of Performance:** FY 2018–2020

Description:

Background: 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 use of the older literature, although still valuable, is being lost to the archives.

Objectives:

- Synthesize oil spill effects on biological, social, or economic resources from crude and refined oil spills ranging from 1,000–20,000 bbl in volume.
- Synthesize recovery of biological, social, or economic resources from crude and refined oil spills ranging from 1,000–20,000 bbl in volume.
- Organize information into 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.

Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Alaska OCS

Administered By: Alaska OCS Region

Title: Environmental Resource Areas: Using Habitat-Based Density Models and Tagging Data for Analysis of Biological Resources

BOEM Information Need(s) to Be Addressed: This study would develop tools or methods of analyses to support assessment of potential impacts to marine mammals, cetaceans, and seabirds from outer continental shelf (OCS) oil- and gas-related activities. Refined information of the density distribution and temporal timing will inform better decisions when developing inputs to the Bureau of Ocean Energy Management's (BOEM's) Oil-Spill Risk Analysis (OSRA). Results from this project will help refine Environmental Resource Areas (ERAs) used in OSRA. The tools or analyses will assist BOEM in National Environmental Policy Act (NEPA) analyses for potential future lease sales, for Exploration Plans (EPs), Development and Production Plans (DPPs), Endangered Species Act (ESA) Section 7 consultations, and decision-making in Cook Inlet, the Beaufort Sea, and the Chukchi Sea.

Approx. Cost: (in thousands) $400 **Period of Performance:** FY 2018–2021

Description:

Background: Having a good understanding of the seasonal distribution, relative abundance, and habitat use of marine mammals, birds, and other species in Cook Inlet or the Beaufort and Chukchi Seas is fundamentally important to evaluating the potential environmental impacts associated with oil and gas exploration and development, as well as cumulative impacts related to other activities. Whales, walrus, polar bears, seals, sea lions, and birds have differing temporal and spatial distributions. Moreover, all of these species are used for subsistence and form an important part of the diet and cultural base for people in communities along the Beaufort Sea, Chukchi Sea, and/or Cook Inlet coasts.

BOEM and others have amassed extensive datasets documenting spatial presence and other information for a wide range of species. For example, aerial surveys of the fall migration of the bowheads have been conducted since 1979, initially by the Bureau of Land Management and subsequently by the former Minerals Management Service and now BOEM. This is one of the longest-maintained monitoring programs of a biological phenomenon and has produced an invaluable baseline of the distribution and habitat use of the bowheads.

The distributions of many species are temporally and spatially structured, showing seasonal or interannual changes in response to various mechanisms. These are important factors that affect the vulnerability of a species to contact from a potential oil spill, and BOEM considers them as part of its OSRA. To do this, BOEM identifies ERAs, which are areas of concern relating to social, environmental, or economic resources,

including critical habitat or use areas for different species of concern. Each ERA has a spatial and temporal attribute and its vulnerability may vary according to the time of year. Various methods are used to define the location and geographical extent of ERAs, depending on the availability of data.

Recently, Roberts *et al.* (2016) integrated data from aerial and shipboard cetacean surveys with environmental information from remote sensing and ocean models to develop habitat-based density models for a variety of cetacean species in the U.S. Atlantic and Gulf of Mexico. Using these models, the researchers were able to simulate seasonal movement patterns resembling those suggested in the literature and produce monthly mean density maps for the species considered. A similar methodology would be very useful for refining ERAs used for BOEM's OSRA.

Objectives: The goal of this project is to establish a consistent foundation for developing and refining ERAs used for BOEM's OSRA. Specific objectives include:

- Assess the utility of different modeling techniques or other analyses to evaluate distribution, abundance and temporal timing of marine mammals or birds;
- Identify one or more species/population(s) in Cook Inlet, the Beaufort Sea, or the Chukchi Sea to conduct initial assessment methodologies or metrics;
- Investigate seasonal patterns of movement of the identified species/population(s);
- Evaluate spatial variations in seasonal density of identified species/population(s).

Methods: This study will assimilate available monitoring information about biological resources, habitat, and oceanographic parameters in Cook Inlet or the U.S. Arctic. These data will be derived from a range of sources, including aerial and ship surveys, satellite tags, monitoring buoys, remote sensing, ocean models, *etc.* Researchers will then develop habitat-based models, following Roberts *et al.* (2016), or other analyses of biological resource densities, such as those by Citta *et al.* (2015), for Cook Inlet, the Beaufort Sea, or the Chukchi Sea to help develop a documented method for refining ERAs to support the OSRA process.

References:

Citta, J. J., L. T. Quakenbush, S. R. Okkonen, M. L. Druckenmiller, W. Maslowski, J. Clement-Kinney, J. C. George, H. Brower, R. J. Small, C. J. Ashjian, L. A. Harwood, M. P. Heide-Jørgensen. 2015. Ecological characteristics of core-use areas used by Bering–Chukchi–Beaufort (BCB) bowhead whales, 2006–2012. Progress in Oceanography, 136:201-222. http://dx.doi.org/10.1016/j.pocean.2014.08.012.

Roberts, J. J.; B. D. Best, L. Mannocci, E. Fujioka, E.; P. N. Halpin, D. L. Palka, L. P. Garrison, K. D. Mullin, T. V. N. Cole, C. B. Khan, W. M. McLellan, D. A. Pabst, G.

G. Lockhart. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6: 22615. doi: 10.1038/srep22615.

Revised Date: August 4, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Range-Wide Distribution of Cook Inlet Beluga Whales (*Delphinapterus leucas*) in the Winter

BOEM Information Need(s) to Be Addressed: There is much uncertainty regarding the spatial and temporal distribution of the Cook Inlet Beluga Whale (CIBW) population, which is listed as endangered under the Endangered Species Act (ESA). The Bureau of Ocean Energy Management (BOEM) needs a better understanding of the seasonal distribution and use of critical habitat by CIBW to support evaluation of potential effects on this population from oil and gas exploration and development in Cook Inlet. Results from this study will support National Environmental Policy Act (NEPA) analyses for Cook Inlet Lease Sale 258 (2021), and for future exploration plans (EPs) and development & production plans (DPPs) that may result from Cook Inlet Lease Sales 244 (2017) and 258 (2021). 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.

Approx. Cost: (in thousands) $600 plus Joint Funding **Period of Performance:** FY 2018–2021

Description:

Background: The National Oceanic & Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) designated the CIBW population as depleted under the Marine Mammals Protection Act (MMPA) in 2000, and subsequently listed this population as an endangered species in 2008 under the ESA. In 2016, NMFS identified this population as one of eight endangered "Species in the Spotlight," meaning immediate, targeted efforts are vital for stabilizing their populations and preventing extinctions.

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). Data indicate that underwater noise associated with high energy seismic exploration may cause some cetaceans to avoid areas where seismic exploration is occurring. Other types of activity associated with oil and gas development may disturb and modify the behavior of cetaceans, hamper their ability to communicate, navigate, forage, or avoid predators, or may put them at increased risk of ship strikes. The Marine Mammal Commission (MMC) has recommended incorporation of a broader suite of mitigation and monitoring measures under the MMPA, such as more extensive time-area restrictions, a cessation of sound-producing activities at night or in low visibility conditions, and/or increased numbers of observers to ensure that all CIBW that are within or approaching specified exclusion and disturbance zones would be detected. The MMC also recommended inclusion of a total annual take limit for CIBW,

allocating those takes among all entities holding or seeking an Incidental Harassment Authorization (IHA), which might impact BOEM activities.

The NMFS conducts biennial summer surveys for this species, but the last winter aerial survey for CIBW was flown in 2002 (Rugh *et al.* 2004). The most recent (2014) abundance estimate for CIBW in their summer habitat concluded that only about 340 CIBW remain, down from an historical estimate of 1,300 in 1979. The historic range of CIBW extends south into OCS areas in lower Cook Inlet. There has been a significant 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. In addition to the outdated and limited winter aerial surveys, satellite tagging studies (now prohibited due to concerns over stress of capture to secure tags) on 18 animals (Shelden *et al.* 2015), together with presence/absence passive acoustic monitoring (PAM) (Castellote *et al.* 2016), show CIBW appear to occur within the OCS in the winter. PAMs have limited value in determining wide-scale distribution patterns for CIBW due to strong tidal currents and more limited sound propagation of high frequency sounds. They should be used in small targeted areas to assess presence of belugas that are vocalizing, or in combination with aerial surveys. A wide-ranging aerial survey for CIBW in winter could be augmented with PAM recorders to aid in winter detections of beluga whales, especially in areas of known high use by this species. In the area proposed for Lease Sale 244, ten lease sale blocks are located in CIBW critical habitat and 146 lease blocks are in the vicinity of major anadromous streams which are important foraging areas for CIBW. In addition, CIBW critical habitat is located in regions where stressors may occur from activities supporting OCS-related activities, such as support vessel traffic.

Objectives:

- Identify distribution of CIBW and hot spots for this species throughout their winter range.

- Assess the spatial and temporal extent of use by CIBW in lower Cook Inlet, including OCS areas.

- Make recommendations on precise spatial and temporal mitigation measures for CIBW.

Methods: This project would be coordinated with a project planned by NMFS. BOEM would fund winter aerial surveys in the lower Cook Inlet and NMFS would fund winter surveys in upper Cook Inlet. The BOEM-funded 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. Winter surveys would occur four times a year for three years (n=12), in October, November, February, and March in 2018, 2019, and 2020. 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. A multi-year approach

ensures that variability in CIBW sightings due to environmental factors would be reduced. 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.

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.

Rugh, D.J., B.A. Mahoney, and B.K. Smith. 2004. Aerial surveys of beluga whales in Cook Inlet, Alaska, between June 2001 and June 2002. U.S. Dept. Commer., NOAA Tech Memo. NMFS-AFSC-145, 26p.

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. Marine 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.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Alaska OCS

Administered By: Alaska OCS Region

Title: Coastal Marine Institute

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

Approx. Cost: (in thousands) $5,000 plus Joint Funding **Period of Performance:** FY 2018–2023

Description:

Background: The CMI is a large ongoing program of scientific research into framework issues related to potential future lease sales and other oil and gas-related actions in the Alaska OCS Region. This 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. Beginning in 2016, the CMI instituted a program of Student Research Awards, which provide up to $25,000 in funding for 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.

Objectives: The purpose of the CMI is to support BOEM's commitment to environmental stewardship and generate scientific information for BOEM and the State of Alaska decision-makers that is consistent with the needs outlined by the Framework Issues. The Framework Issues 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.

Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Impacts of Sedimentation on the Boulder Patch Community, Beaufort Sea

BOEM Information Need(s) to Be Addressed: Better information about effects of sedimentation on bottom and sea ice habitats around the Boulder Patch (Beaufort Sea, Alaska) will support direct and cumulative effects analyses and Essential Fish Habitat (EFH) assessments. Impacts to the Boulder Patch from proposed gravel island construction were identified as a concern to local communities during public scoping. This study will conduct monitoring during activities associated with the Liberty Development Project, a proposed gravel island construction in the nearshore Beaufort Sea. These observations will allow Bureau of Ocean Energy Management (BOEM) analysts to attain a better understanding of the potential effects of environmental disturbances, including increased turbidity and sedimentation, on organisms and their habitats. Results from this project will facilitate evaluation of the effectiveness of mitigation measures defined for the Liberty Project. In addition, by understanding more about types of disturbance, recolonization potential, BOEM's future National Environmental Policy Act (NEPA) and EFH analyses for the Beaufort Sea will be enhanced.

Approx. Cost: (in thousands) $325 **Period of Performance:** FY 2018–2021

Description:

Background: The Boulder Patch is a region in the Beaufort Sea outer continental shelf (OCS) that supports diverse Arctic plant, fish, and invertebrate communities, including the large kelp *Laminaria solidungula*. These Boulder Patch communities on the sea bottom are an important component of the nearshore foodweb in the proposed Liberty Island project area. Winter sea ice in and near the Boulder Patch provides a habitat for a wide range of biota that inhabit the surface, interior, and bottom ice layers. The importance of the under-ice community has been described for other parts of the Beaufort Sea, but not for this specialized community. Algal and primary production in the Boulder Patch is heavily reliant on light availability.

Currently, BOEM is writing a NEPA analysis for potential construction of a gravel island (Liberty Island) near the Boulder Patch. Residents of Alaskan communities on the Beaufort Sea expressed significant concern about impact to the Boulder Patch from this project. Turbidity curtains during construction are not feasible in this environment due to ice cover and currents. Increases in turbidity in the winter stemming from proposed construction activities may result in less light penetration, which could have cascading effects on the overall integrity of Boulder Patch community through depressed primary and secondary production, resulting in far reaching impacts to the food web.

BOEM has sponsored several previous studies to understand how vulnerable to disturbance the plants and animals in this specialized community are. These studies have shown that recovery from disturbances is very slow in the Boulder Patch, especially if the plants and animals on the boulders are removed or killed. In some cases, disturbances took a decade or more to resolve. Although not tested in these prior studies, BOEM believes that sediment collecting on the hard-bottom rocky habitat could slow recovery even more through burial and smothering rather than whole organism removal, since the hard-substrate would no longer be available to colonizers. In addition to monitoring impacts to the Boulder Patch from gravel island construction and other activities associated with the Liberty Project, this study will explore potential mitigation measures that may be appropriate in the Beaufort Sea OCS. Field experimental tests of artificial substrates common to offshore island construction (*e.g.*, island armor material) may demonstrate possible replacements for hard-bottom substrate damaged or covered by sedimentation during development activities, ultimately facilitating recovery of affected communities through onsite mitigation measures.

Objectives:

- Measure the effect of sedimentation on the abundance and distribution of Boulder Patch biota in winter and summer conditions.
- Identify and experimentally test potential hard-substrate (*i.e.*, Boulder Patch) impact monitoring approaches for high sediment scenarios.
- Identify and experimentally test potential mitigation methods to minimize lost Boulder patch habitat through replacement or substitute substrates.
- Characterize invertebrate and fish use of under ice habitat of the Boulder Patch.

Methods: This study will conduct field experiments in the Boulder Patch to evaluate the effect of sediments and increased turbidity on Boulder Patch communities in the summer and winter, and any cascading annual impacts on community structure, through observation and quantification of community change. Monitoring efforts to observe the effects of construction, including sedimentation rates and impacts, may include SCUBA observations, local resident observations under ice, and small remotely operated underwater vehicles (ROVs). This research will add to knowledge described in previous BOEM-funded studies (Konar, 2007; Konar, 2013). Researchers will also field test potential artificial substrates in the Boulder Patch during and after construction of the gravel island. This will include testing of common industry materials, such as armor plating, that could be used near constructed gravel islands as artificial substrates to provide mitigation habitats for Boulder Patch species.

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.

Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Chukchi Sea; Beaufort Sea; Cook Inlet

Administered By: Alaska OCS Region

Title: Oil Spill Occurrence Estimators for Offshore and Onshore Cook Inlet and Onshore Alaska North Slope Spills

BOEM Information Need(s) to Be Addressed: The oil spill 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 EISs and exploration plan or geophysical and geological EAs in the Alaska outer continental shelf (OCS) Region. Information from this study will be used by Alaska OCS Region staff to estimate small oil spill occurrence (<1,000 bbl) in preparing National Environmental Policy Act (NEPA) documents for future Cook Inlet, Beaufort Sea, or Chukchi Sea lease sales, as well as for Exploration Plans and Development and Production Plans, and in reviewing oil-spill-contingency plans for OCS and coastal facilities.

Approx. Cost: (in thousands) $225 **Period of Performance:** FY 2018–2020

Description:

Background: In Alaska NEPA documents, the Bureau of Ocean Energy Management (BOEM) uses various datasets and models to estimate the number and likelihood of large (≥1,000 bbl) and small (<1,000 bbl) spills occurring. These estimates are used in the impact producing factors scenario to evaluate the impact of oil spills and derive an impact determination for NEPA analyses of accidental large and small oil spills.

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 (Anderson, Mayes, and Labelle, 2012; ABS Consulting Inc., 2016.). Since 2002, the Alaska OCS Region has incorporated a fault-tree approach to estimate the likelihood of large spills in Arctic regions (*e.g.*, Bercha, 2016). The fault-tree analysis considers 1) differences in oil-spill occurrence factors between the Arctic and Gulf of Mexico/Pacific OCS and 2) Arctic-specific factors. BOEM also analyzes impacts associated with onshore infrastructure. This includes the impacts of potential onshore pipeline spills, as well as the contribution of all potential spills from the proposed action to the cumulative case.

Objectives:

- Update and collate crude and refined oil spills on the Alaska North Slope from industry, U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), U.S. Department of the Interior (DOI), Bureau of Land Management (BLM), BOEM, Bureau of Safety & Environmental Enforcement (BSEE), U.S. Department of Transportation, Pipeline and Hazardous Materials Safety

Administration (USDOT, PHMSA), and Alaska Department of Environmental Conservation (ADEC) data sets through 2019.

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

- Collate crude and refined oil spills onshore and offshore Cook Inlet from industry, USCG, EPA, DOI, BLM, BOEM, BSEE, U.S. Fish & Wildlife Service (FWS), USDOT PHMSA, and ADEC data sets through 2019.

- Develop relative spill occurrence estimator(s) suitable for use for onshore and 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. This will require an understanding 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 collect, examine, and reconcile spill records and cleanup reports for the onshore and offshore Cook Inlet region for spills ≥1 bbl 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.

The investigators will collect, examine and reconcile spill records and cleanup reports and update for the North Slope for spills ≥1 bbl into an electronic database in a standard format. 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.

Deliverables will include comprehensive datasets, as well as user-friendly models and/or algorithms to allow BOEM staff to recalculate the contractor's measures of variability as additional information or data become available.

References:

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Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Monitoring of the Cross Island Subsistence Whale Hunt for Effects from Liberty Final Development and Production Plan

BOEM Information Need(s) to Be Addressed: 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). A Development and Production Plan (DPP) for the Liberty Project is currently under BOEM review. Long-term study efforts to monitor potential effects of such development activities have occurred through the Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) and its continuation cANIMIDA, which occurred between 1999 and 2007. Information obtained from this study will inform National Environmental Policy Act (NEPA) analysis and documentation for NEPA assessments related to potential future lease sales and for Exploration Plans and DPPs that may be submitted for existing leases in the Beaufort Sea.

Approx. Cost: (in thousands) $400 **Period of Performance:** FY 2018–2023

Description:

Background: The Liberty prospect will access OCS oil deposits and will include an offshore gravel island with a pipeline to land. The facility will be constructed to the southeast of Cross Island and subsistence whalers have expressed concern and reservations about potential effects to the bowhead whale hunt, which occurs in the fall as the bowheads are migrating from the east to the west. This study will renew the long-term ethnographic monitoring effort of subsistence whaling activities that occur from the base camp at Cross Island conducted between 2001 and 2012 under the multi-disciplinary ANIMIDA and cANIMIDA projects.

Objectives: This study will gather long-term monitoring data to help BOEM 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. Specific objectives include:

- Evaluation of variation in Cross Island subsistence whaling over time and potential relationship to variations in environmental parameters
- Assessment of whether such variation can be attributed to offshore oil and gas industrial activities

Methods: This study continues the methods established during the ANIMIDA and cANIMIDA projects. It calls for systematic observational and interview data collection from local informants about:

a) number of whales taken;
b) Global Positioning System (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; and
j) weather, wind, and sea states.

The study will also record systematic and observational data collection on

a) non-whaling subsistence activities on and near Cross Island; and
b) observations of local subsistence users.

Potential interdependencies among these factors will be investigated and 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 appended as necessary for clarification of location information.

Revised Date: August 4, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Circulation Processes and Landfast Ice Dynamics on the Central and Western Beaufort Sea Shelf

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) needs information on the seasonal, three-dimensional current structure, hydrographic conditions, and stability of landfast ice on the central and western Beaufort Sea shelf. This knowledge will be valuable for:

(a) improving the quality of information used in the Oil-Spill Risk Analysis conducted by BOEM;
(b) inferring the transport of zooplankton, contaminants, and other quantities in key areas;
(c) providing insight into the flow-related feeding aggregations of bowhead whales near Barrow;
(d) providing important information for the preparation of National Environmental Policy Act (NEPA) documents; and
(e) providing information for ocean modeling efforts (including validation and skill assessment).

Approx. Cost: (in thousands) $4,000 **Period of Performance:** FY 2018–2023

Description:
Background: The central and western portions of the Beaufort Sea represent an important migratory corridor and habitat for birds, fish, and marine mammals. The central Beaufort Sea shelf is substantially influenced by the Colville River outflow, but most of the year-round physical oceanographic measurements in this region have been made offshore of Prudhoe Bay or to the west of Smith Bay. Relevant issues pertain to the patterns and variations in the surface and sub-surface circulation, influence of the Colville River discharge, the winds, and the interaction between the Beaufort circulation (westward on average) and the Chukchi Sea outflow through Barrow Canyon. This interaction is likely to result in complex circulation processes that include fronts and eddies. Sea ice in this area also includes both landfast and pack ice, which result in very different circulation dynamics, which are not fully understood.

The physical oceanographic measurements from this study will be integrated with results from other studies such as the BOEM-funded "Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas." In addition, this study will produce a Landfast Ice Stability Index (LISI) to facilitate evaluation of the stability of an offshore landfast ice platform during potential winter oil and gas exploration or development activities. This study will also help to provide a regional synopsis of the year-round coastal and offshore circulation and landfast ice stability, including the linkages between oceanographic conditions and

the spatial and temporal distribution of marine mammals derived from aerial surveys and passive acoustic moorings data.

Objectives:

- Describe the seasonally varying circulation across the Beaufort Sea shelf and slope from Stefansson Sound west to Smith Bay.

- Describe the surface circulation during the open water season with respect to fronts, eddies, and their variability in response to changing wind conditions.

- Quantify sea-level variability, the causes of this variability, and its relation (if any) to landfast ice breakout events.

- Develop a better understanding of the dynamical processes controlling the circulation in this region, including the process or processes responsible for the anticyclonic eddy that often forms to the west of Smith Bay.

- Develop a firm understanding of the fate of the Colville River plume both beneath the sea ice and after the sea ice has retreated later in the summer.

- Document the landfast ice dynamics for the region and develop a better understanding of how the deformation fields in the landfast ice zone differ from those developed for pack ice.

- Evaluate whether most of the landfast ice melts *in situ* in spring and summer or is advected away from its formation region to improve understanding of the fate of contaminants encapsulated in the ice.

Methods: Researchers will install a system of high-frequency radars (HFRs) to collect surface circulation data between Stefansson Sound and Pt. Barrow. Three to four HFR systems would be needed with each containing their own power supply system. Acoustic Doppler current profiler (ADCP) + conductivity, temperature, and depth (CTD) moorings will be deployed at select locations within the radar mask to capture the three-dimensional circulation and periods of upwelling. Shipboard and possibly glider measurements of water column structure, nutrient concentrations, and marine mammal presence/absence will be collected during mooring maintenance. Drifters will be deployed on a weekly basis during the open water period to capture the finer scale circulation that cannot be addressed by the HFRs. Particular emphasis should be placed on measurements that bridge the transition across the landfast and pack ice zones and measurements of the evolving under-ice river plumes in spring.

During the winter months, the moorings located on the shelf will collect information on currents, hydrography, and ice thickness within the landfast ice and pack ice portions of the shelf and slope. This will help develop a better understanding of the seasonal evolution of under ice topography in this area. In addition, surface moorings and ice drifters will be affixed to the landfast ice to capture under-ice water properties and the extent of under-ice river plumes during the spring freshet. During breakup, the ice

drifters with attached CTD will move with the melting landfast ice. Measurements of the deformation processes and the decorrelation length scales over which these occur should be made in the landfast ice zone. The methodology should include clustered arrays of ice drifters to help determine correlation scales. A LISI and climatology will be developed through the assimilation of ice thickness data from the seabed moorings, results from previous BOEM-funded studies, and available satellite imagery. Deformation structures and noted breakout events from satellite imagery and atmospheric data will be analyzed and synthesized.

This project will be coordinated with recent and ongoing research funded by BOEM, the National Science Foundation, and others to economize effort and minimize duplication.

Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Benthic Invertebrate Resources and Trophic Ecology of Fishes in the Nearshore Beaufort Sea

BOEM Information Need(s) to Be Addressed: Updated information on fish use of nearshore habitats, trophic relationships, and prey availability will prove invaluable in assessing community resiliency in a rapidly changing Arctic. With continued production from the existing Northstar facility, the planned Liberty Development, potential future outer continental shelf (OCS) activities, and anticipated development in state waters, there is a pressing need to better understand trophic processes, nearshore fish habitat use, and document shifting community baselines. This project will provide Bureau of Ocean Energy Management (BOEM) analysts with additional information to support National Environmental Policy Act (NEPA) and Essential Fish Habitat (EFH) assessments related to potential future lease sales and for OCS activity applications that may be submitted for existing leases in the Beaufort Sea.

Approx. Cost: (in thousands) $700 **Period of Performance:** FY 2018–2021 (plus leveraging with USGS offshore funds)

Description:

Background: Nearshore lagoons of the Beaufort Sea coast are important feeding and rearing habitat for diadromous and marine fish species that serve as food resources for fish, marine mammals, seabirds, and people. Yet, the value of nearshore areas as EFH for federally managed fish species is not well understood. Recent sampling in Beaufort Sea lagoons near Kaktovik described a very different fish community compared to sampling in previous decades; this suggests the possibility of major shifts in species distribution, abundance, and community composition. This study addresses information needs on current trophic and community structure in these dynamic nearshore habitats.

This study will provide needed fish community information and augment three ongoing or recent research efforts. The Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) program is an ongoing effort to assess the environmental factors that affect the productivity, biodiversity, and lower trophic dynamics of an arctic kelp bed community. Although the benthic invertebrate assemblages of this community are well known, there has been virtually no effort to assess the fish communities of this unique habitat, which may serve as a refuge for many species. The proposed fish survey will strongly complement the nearly completed U.S.-Canada Transboundary Fish and Lower Trophic Communities study by providing contemporary nearshore survey information for comparison and vastly improving our understanding of habitat use. Such information will facilitate a better understanding of the linkages between nearshore and shelf habitats and address outstanding questions regarding the life history and trophic importance of nearshore habitats that are critical for native subsistence fisheries. The

program will occur during the Kaktovik K–12 Summer Oceanography Program, providing an opportunity for both students and adults to actively participate in the sample collections and the community and research efforts.

Objectives:

- Describe the distribution and abundance of marine and diadromous fish species in nearshore habitats in relation to known hydrographic (*e.g.*, salinity, temperature) and biological (*e.g.*, presence of kelp, epifaunal prey) drivers.

- Compare nearshore and continental shelf fish assemblages to investigate the role of nearshore habitats for marine fish.

- Examine the composition of nearshore fish communities along spatial (central to eastern Beaufort Sea) and temporal (inter-annual) scales.

- Compare the trophic structure of nearshore *vs.* continental shelf fish assemblages

- Engage local Iñupiat residents and students from Kaveolook School through the K–12 Oceanography Program

- Create partnerships with local residents to utilize traditional knowledge (TK) and established TK panels.

Methods: Benthic and water column biota will be collected using small grabs, plankton nets, and 1-m beam trawls in lagoons and adjacent nearshore areas at depths up to 10 m. Samples will be used to assess diversity, biomass, and abundance of infaunal and epibenthic organisms in the lagoons and provide material for stable isotope analyses. Benthic chlorophyll contributions to the marine carbon pool will be analyzed. Fyke nets will collect diadromous fishes and Arctic cod, and stomach contents and tissue samples will be taken for trophic studies. Calculations of trophic spectra for each fish species can be used for comparisons of dietary similarity, establish feeding guilds, and establish the importance of invertebrate prey populations and ultimate carbon sources. To supplement trophic studies, scientists will work with established TK panels and engage the Kaktovik Iñupiat community to collect gut contents and muscle tissue from fish harvested for subsistence. For this project, BOEM will partner with the U.S. Geological Survey to advance the existing program with the Kaveolook School, expand TK integration with the North Slope Borough, and get fish and invertebrate samples from under-ice lagoon sites.

Revised Date: April 21, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Levels of Polycyclic Aromatic Hydrocarbons (PAHs) and Other Contaminants in Tissues of Animals Collected in Cook Inlet

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management's (BOEM's) stakeholders have expressed concern regarding the levels of contaminants that may be found in subsistence species and their prey in Cook Inlet. Additional information is needed about levels of PAHs and other contaminants in the tissues of fish, invertebrate, and marine mammal species in Cook Inlet. This study will provide important baseline information to support National Environmental Policy Act (NEPA) analyses of cumulative effects for Cook Inlet Lease Sale 258 (2021), and for future exploration plans (EPs) and development & production plans (DPPs) that may result from Cook Inlet Lease Sales 244 (2017) and 258 (2021).

Approx. Cost: (in thousands) $500 **Period of Performance:** FY 2018–2020

Description:

Background: Recreational and commercial fisheries, as well as subsistence activities, are important to the economic well-being of the Cook Inlet area. In addition, Cook Inlet contains critical habitat for multiple species listed under the Endangered Species Act (ESA), including endangered populations of beluga whales and Steller sea lions, and the threatened southwest Alaska population of northern sea otters.

In 2015, staff from Seldovia Village Tribe collaborated with the Environmental Protection Agency (EPA) and Alaska Department of Environmental Conservation's (ADEC's) fish tissue monitoring program, to undertake contaminant testing of a total of 36 sockeye salmon and 40 Dolly Varden trout, collected from around Seldovia, Port Graham, Nanwalek, and Tyonek. Further work is needed to examine contaminant levels in salmon at different life stages, as well as a broader range of resident fish species. In addition, the Cook Inlet Regional Citizens Advisory Council (CIRCAC) has maintained a program for more than two decades to monitor the biological and chemical environment in and around Cook Inlet to detect impacts of oil industry operations.

This study will build upon results from these programs to further examine contaminant levels in the tissues of important marine mammal, fish, and invertebrate species in Cook Inlet to provide additional information for evaluation of potential impacts from oil and gas exploration and development and production activities on the outer continental Shelf (OCS) in Cook Inlet. Particular attention will be given to species that are harvested through commercial, recreational, and subsistence activities, including: sea lions, harbor seals, sea otters, salmon and other fish species, and bivalves.

Objectives:

- Document levels of PAHs, trace metals, and other contaminants in the tissues of marine mammals, fish, and invertebrates collected in Cook Inlet, including different life stages of an array of species.

- If feasible, test archived tissue samples collected over time to evaluate the variability of contaminant levels in populations.

- Collate and synthesize existing PAH and other contaminant data collected by CIRCAC, Alaska Department of Fish and Game (ADF&G), Seldovia Village Tribe, and others.

Methods: Researchers will review existing literature to identify the most appropriate species of focus for this project. Resources consulted should include: *Assessment of Cook Inlet Tribes Subsistence Consumption* (Merrill and Opheim, 2013) and *Survey of chemical contaminants in fish, invertebrates and plants collected in the vicinity of Tyonek, Seldovia, Port Graham and Nanwalek—Cook Inlet, AK* (USEPA, 2003). Researchers will then work with ADF&G, the Alaska Native Harbor Seal Commission, the Alaska Sea Otter and Steller Sea Lion Commission, the National Oceanic & Atmospheric Administration (NOAA), fishing organizations, native communities and tribal organizations, and tissue archives to obtain samples for the marine mammal, fish, and invertebrate species. Laboratory analyses will be conducted to establish contaminant levels in the specimens obtained. Samples available from frozen tissue archives will also be evaluated to determine if appropriate samples are available in sufficient quantities to provide information about the variability of the contaminants over time.

References:

Merrill, T. and Opheim, M. 2013. Assessment of Cook Inlet Tribes Subsistence Consumption. Prepared for Seldovia Village Tribe Council. Published on September 30, 2013.

USEPA. 2003. Survey of chemical contaminants in fish, invertebrates, and plants collected in the vicinity of Tyonek, Seldovia, Port Graham, and Nanwalek-Cook Inlet, AK. Prepared by the U.S. Environmental Protection Agency, Region 10, Seattle (WA). EPA 910-R-01-003.

Revised Date: April 24, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Updating Status and Trends of Seabirds and Forage Fish in Lower Cook Inlet

BOEM Information Need(s) to Be Addressed: This study will monitor seabird populations and forage fish stocks to assess potential impacts from oil and gas development, while updating scientific knowledge on forage fish and seabird populations in Lower Cook Inlet (LCI). The study will also contribute to cumulative effects analyses by adding to the understanding of the massive die-off of seabirds during the winter of 2015–2016, as well as how forage fish stocks have been affected by recent ocean temperature anomalies in the Gulf of Alaska. The information collected in this study will support National Environmental Policy Act (NEPA) analyses for Cook Inlet Lease Sale 258 (2021), and for future Exploration Permits and Development and Production Permits that may result from the Cook Inlet Lease Sales 244 (2017) and 258 (2021).

Approx. Cost: (in thousands) $1,300 **Period of Performance:** FY 2018–2022 (includes leveraging with USGS offshore funds)

Description:

Background: From 1995 to 2000, the U.S. Geological Survey (USGS) led seabird and forage fish studies in LCI to assess the recovery of seabird populations following the 1989 *Exxon Valdez* Oil Spill (EVOS). The project measured foraging and population responses of six seabird species to fluctuating forage fish densities around three seabird colonies (Barren, Chisik, and Gull Islands) in LCI. The study included at-sea forage fish surveys, measured seabird breeding biology (egg and chick production, chick growth, population status and trends), and foraging behavior (diets, feeding rates, foraging time) at the three colonies. Detailed data were collected on common murres (*Uria aalge*) and black-legged kittiwakes (*Rissa tridactyla*) because of their high densities. Study results showed that breeding biology and the population trend of seabirds differed markedly between colonies relative to persistent geographic differences in forage fish abundance, which were in turn related to persistent oceanographic structuring of habitat in the LCI.

Since this original study, little comparable work has been completed in the past seventeen years. In 2016, the Bureau of Ocean Energy Management (BOEM) and USGS initiated a project that leveraged USGS outer continental shelf (OCS) funds and was prioritized by BOEM to conduct limited surveys at Chisik and Gull Islands with the understanding research would be expanded to include the Barren Islands with a four-year follow-up study from 2017 to 2020. The expanded research will capture longer time series data to improve seabird population estimates. Preliminary data from the 2016 survey suggest substantial changes in the LCI ecosystem have occurred since the 1995–2000 study. These changes include large fluctuations in ocean temperature,

possibly influencing the timing of breeding and reproductive success of seabirds on Gull and Chisik Islands. Whether these changes have resulted in the overall population trends observed in the 1990s remains unknown. During the winter of 2015/2016 a massive die-off of common murres occurred in waters in and around the Gulf of Alaska; preliminary evidence has been attributed to starvation. Murre die-offs have occurred in the past, but not to the extent seen in 2016.

Objectives:

- Assess the current abundance, distribution and species composition of forage fish near the three main seabird colonies in lower Cook Inlet over four years.
- Assess foraging behavior (diets, feeding rates, foraging time) at the three colonies
- Census current breeding populations of murres and kittiwakes at their colonies in LCI and assess average levels of annual production over four years.
- Compare findings for fish and seabirds with data collected in 1995–1999, and identify long-term environmental changes in ocean climate.

Methods: This study will gather new data on seabird demography and forage fish abundance around the three colonies. The project will assist in establishing the range of natural variability in population parameters in relation to environmental factors, and provide information on current ecosystem conditions in advance of the new oil and gas lease sales and assess potential impacts from oil and gas development.

To facilitate comparisons with data from the prior studies, similar protocols for measuring food availability and seabird population biology will be employed, with some refinements. Forage fish abundance will be assessed using mid-water trawls (measured as catch per unit effort and catch composition) and acoustic surveys (measured as metric ton per square kilometer of biomass) around each colony. Densities of seabirds and marine mammals, and sea surface temperature/salinity will also be recorded continuously on transects. A conductivity, temperature and depth (CTD) profiler will measure temperature, salinity, chlorophyll, and turbidity at depth on selected stations. USGS researchers will coordinate and collaborate with the National Oceanic & Atmospheric Administration (NOAA) Kasitsna Bay Laboratory in collection of oceanographic data, and provide all data to the NOAA Kachemak Bay National Estuarine Research Reserve data archives.

At each colony, researchers will census kittiwakes and murres on established monitoring plots, measure reproductive success of adult birds, and collect data on diet composition of adults and chicks. If USGS researchers obtain supplementary funding from other sources (*e.g.*, *Exxon Valdez* Oil Spill Trustee Council [EVOSTC]; North Pacific Research Board [NPRB]) the work may be expanded to monitor foraging time budgets at colonies, and resume banding studies to measure annual adult survival rates of murres and kittiwakes. Researchers will coordinate and collaborate with the U.S. Fish & Wildlife Service (USFWS) Alaska Maritime National Wildlife Refuge on studies of seabirds at

Chisik and Barrens islands, and with the Seldovia Native Corporation for studies on Gull Island.

The data analyses will center on contrasting the functional responses of seabirds to prey fluctuations within and between decades of study, and relating trends in birds and fish to directly measured local changes in the environment (*e.g.*, temperature, salinity) and to larger scale indices of climate change (*e.g.*, El Niño Southern Oscillation [ENSO], Pacific Decadal Oscillation, Global Warming Trend). It will be important to quantify these sources of natural variability to evaluate future trends under different climate scenarios, and distinguish these from potential direct human impacts of OCS oil and gas exploration and development or oil spills in Cook Inlet.

Revised Date: April 20, 2017

Study Area(s): Cook Inlet

Administered By: Alaska OCS Region

Title: Subsistence Mapping and Identification of Intensity of Use of the Land- and Seascape by Old Believers of Lower Cook Inlet, Alaska

BOEM Information Need(s) to Be Addressed: This study will provide baseline subsistence mapping data to monitor community impacts at the Old Believer communities in the vicinity of the Cook Inlet Lease Sale area. Systematic mapping of subsistence harvest over the last decade and identification of areas of high, moderate, and low importance both on and offshore in the vicinity of the communities of Nikolaevsk, Vosnesenka, Razdolna, and Kachemak Selo will provide much needed information on subsistence practices, Local Knowledge, and subsistence harvests of keystone species that provide sustenance for the Old Believers. A distinct socio-cultural group, the Old Believers have made this area home since 1969 and have legal rural subsistence preference, yet little is known about their subsistence practices or patterns. Study results will serve as community baselines to monitor and mitigate future changes in subsistence activities over time and identify potential conflicts with oil and gas exploration and development activities in lower Cook Inlet. The study could help the Bureau of Ocean Energy Management (BOEM) determine if the Old Believer communities should be included in future Environmental Justice analyses. Results from this study will support National Environmental Policy Act (NEPA) analyses for Cook Inlet Lease Sale 258 (2021), and for future exploration plans (EPs) and development & production plans (DPPs) that may result from Cook Inlet Lease Sales 244 (2017) and 258 (2021).

Approx. Cost: (in thousands) $550 **Period of Performance:** FY 2018–2022

Description:

Background: This study would provide key subsistence baseline data for Lower Cook Inlet. There is an acute need for information in the vicinity of Old Believer communities Nikolaevsk, Vosnesenka, Razdolna, and Kachemak Selo of Lower Cook Inlet. These religious communities were established in 1969 by Russian immigrants seeking to protect their traditional culture; and the people speak Russian as their primary language. BOEM would benefit from an updated geospatial baseline in the Old Believer communities, as well as identification of key harvest areas, trails, camps, and intensive use areas. There has not been a comprehensive subsistence survey conducted by a Federal or State agency at these communities, although the Alaska Department of Fish & Game (ADF&G) has collected limited data at Nikoleavsk during reviews of subsistence as practiced on the Kenai Peninsula. This study will enable a more precise assessment of impacts and contribute to cumulative effects analyses for all four communities that may be affected by Cook Inlet oil and gas exploration and development.

Objectives:

- Characterization of contemporary harvest patterns for the communities of Nikolaevsk, Vosnesenka, Razdolna, and Kachemak Selo; including species identification, spatial distribution of harvest, seasonality of harvest, quantity through consultation with subsistence harvesters—what was harvested and from where.

- Gain a spatial understanding of Harvest Patterns (potentially revealing change over time) for the last ten years through delineation of use over the past decade and the past year on map overlays.

- Gain an enhanced understanding of the relationship between subsistence and commercial fishing through identifying if subsistence fishing occurs using commercial boats as platforms of opportunity.

- Identification and/or development of methods used to mitigate problems with respondent recall and accuracy through delineation of use over the past decade and the past year on map overlays.

- Gain an enhanced understanding of the interplay between access to land, and environmental and socioeconomic factors in influencing subsistence use patterns.

- Define and geospatially identify the intensity of use per species harvested over a 10-year period and in the last year, as well as overlapping use areas.

Methods: This project will draw upon local knowledge and best available science as sources of information. Early procedures will involve organizations such as the Kenai Peninsula Borough, local government at each Old Believer community, and other appropriate entities. Researchers will conduct a literature review and assess the quality of existing geospatial data, converting it to geographic information system (GIS) format where possible. The study will gather primary source data regarding current subsistence effort, and use of resources from knowledgeable residents of Nikolaevsk, Vosnesenka, Razdolna, and Kachemak Selo. Researchers will obtain information from subsistence harvesters about areas used 10 years ago in relation to areas used in the past year and identify rationale for variation. The data collection effort will coordinate with other relevant BOEM studies and researchers will engage with local residents through community workshops, integrate workshop feedback into the final analysis, and disseminate final products of study to the communities. All final spatial information on subsistence activity will be provided in GIS or GIS-compatible format for use by BOEM NEPA analysts. The final product will include a descriptive report. BOEM will seek to establish partnerships in this work with other organizations and agencies, including ADF&G. This study will be of benefit to the ADF&G and the Kenai Peninsula Borough.

Revised Date: April 20, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): National

Administered By: Alaska OCS Region

Title: Generation of Synthetic Audiograms by Applying Finite Element Modeling to Computerized Tomography (CT) Scans for Baleen Whales, Belugas, and Pinnipeds

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) requires information on the effect of anthropogenic ocean noise on marine mammal behaviors and demographics to identify and mitigate potential environmental impacts from oil and gas activities under the National Environmental Policy Act (NEPA). Other agencies also need such information in their decision-making processes when issuing incidental take regulations under the Marine Mammal Protection Act (MMPA) and making a final determination of the status of marine mammals under the Endangered Species Act (ESA). As the Arctic ice pack continues to diminish, the potential for increased vessel and other anthropogenic activities remains high, and with it the potential for effects of noise associated with these activities becomes increasingly important. Despite research into this topic, information is needed related to the hearing abilities of baleen whales, many of which are endangered, and information on pinnipeds is also limited. Results and refined procedures developed through this study will facilitate the use of the methodology for additional species and geographic areas.

Approx. Cost: (in thousands) $2,000 plus Joint Funding **Period of Performance:** FY 2018–2021

Description:

Background: The overlap in acoustic bandwidths of the anthropogenic sound with the frequency ranges of a particular marine mammal can be analyzed to evaluate potential effects of sound on marine mammals. Frequency ranges can be: quantified through inference that the animal can hear the sounds they generate, based on the morphology of the hearing apparatus, or focused on behavioral reactions to sounds. Given the size, behavior, and distribution of marine mammals, there are challenges with all three approaches. 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 species (*i.e.*, large whales) which are otherwise impossible to measure in a tank or in the field. For certain species, this method has shown that the skull itself acts as a pathway for transmitting low-frequency sounds from the environment into the ear.

This approach will not only provide much needed audiograms for multiple species of marine mammals for which a skull with the associated auditory features are present, but

it will also allow calculation of the pathways through which a marine mammal can be exposed to a sound. Instead of assuming that an animal is exposed to a sound when it is in the calculated zone of influence of the sound, we might be able to better calculate what direction the sound must be made from in order to actually be heard by a whale. In doing so, estimation of the number of incidental takes during anthropogenic activities that produce sound may be more accurately assessed and monitored.

Objectives: The objective of this study is to derive hearing sensitivity and sound reception mechanisms in walrus, seals, belugas, and baleen whales, by analyzing CT scans with a finite element model to visualize what occurs when sound interacts with the anatomy of a skull.

Methods: Skulls or complete heads, if available, of walrus, ice seals, belugas, and baleen whales (Bowhead, Right Whale, or Humpback) will be obtained opportunistically from agencies involved in stranding and/or subsistence activities, as per appropriate permits. In some cases, it may be possible to work with a museum specimen if the skull has been properly preserved. The specimens will be shipped to a CT scanner which is large enough to fit them, and will be scanned using state-of-the-art techniques. An appropriate modeling toolkit will be used to simulate a vibration that is conducted through bones and/or soft tissue to the hearing apparatus. The auditory sensitivity from various angles will also be calculated to gain a better understanding of potential exposure levels to sound coming from various angles. The end result is a derived audiogram that represents the frequencies of best hearing for each species.

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.

Revised Date: August 4, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Chukchi Sea

Administered By: Alaska OCS Region

Title: Walrus Population-Level Response to Underwater Noise

BOEM Information Need(s) to Be Addressed: The cumulative effects of underwater noise on the Pacific walrus population are unclear. Reduced summer sea ice has led to increased vessel activities in the Chukchi Sea. To assess potential impacts of vessel traffic and industrial activities on the walrus population, as required under the National Environmental Policy Act (NEPA), the Bureau of Ocean Energy Management (BOEM) needs information on the effects of anthropogenic ocean noise and vessel presence on walrus behaviors, which can be obtained by combining marine traffic data from the Automatic Identification System (AIS) with the animal movements based on tag data. Results from this study will inform NEPA analyses for potential future lease sales in the Chukchi Sea, as well as cumulative impact analyses related to vessel transits of the Chukchi Sea in relation to potential future lease sales, exploration plans (EPs), and development & production plans (DPPs) in the Beaufort Sea. This information will also support the U.S. Fish & Wildlife Service (USFWS) in issuing incidental take regulations for oil and gas activities under the Marine Mammal Protection Act and addressing policies related to the Endangered Species Act, and may lead to refined mitigation measures.

Approx. Cost: (in thousands) $1,400 **Period of Performance:** FY 2019–2024

Description:

Background: There has been a pronounced decline in the extent of Arctic sea ice over the last three decades. Summer sea ice decline in the Chukchi Sea is projected to continue and lead to increased vessel activities and sound production. Ocean noise associated with these activities could potentially affect walrus movement patterns and ultimately population vital rates. The limited information that is available on the influence of underwater noise on walrus behaviors in the wild comes mostly from anecdotal observations, and population-level responses to these behaviors are unknown.

The U.S. Geological Survey (USGS) has collected satellite-linked radio telemetry data from 392 individual walrus in the Chukchi Sea from 2007–2015. These data have been used in various studies related to walrus habitat associations and population studies. Currently, USGS is compiling AIS vessel tracking data collected from satellite and ground receiving stations during 2010–2015 and is working with BOEM to facilitate acquisition of data related to oil and gas exploration during years coincident with walrus tagging data.

Objectives:

- Obtain a better understanding of the hearing range of walrus and their responses to noise through development of audiograms from captive animals.

- Assess walrus behavioral response to the presence of, or noise from, ship transits and industry activities (*e.g.*, drilling and seismic surveys) to determine the behavioral response of walrus to these activities.

- Estimate walrus energetic consequences from the identified behavioral responses using existing walrus bioenergetics models.

- Evaluate the cumulative impact of various vessel and industrial related disturbances on population vital rates.

Methods: Audiograms will be developed for one or more walrus in captivity to supplement the work of Kastelein *et al.* (2002) and improve understanding of walrus hearing and inform assumptions about walrus responses to sound. Once the hearing range has been better defined, researchers will conduct retrospective analyses of existing walrus tracking and behavioral data coincident with existing data on ship tracking and oil and gas exploration activities in the Chukchi Sea. Events when tagged walrus interacted with ship transits and seismic and drilling activities will be further analyzed together with audiogram results to refine theorized reactions of the walrus. Estimates of walrus activity levels relative to the occurrence of an interaction will be used in an existing walrus bioenergetics model to estimate the interaction's effect on walrus energetic demands and subsequent influence on population vital rates.

The retrospective analyses will also help guide identification of additional information needed to more comprehensively address the cumulative impact of various vessel and industrial related disturbances on population vital rates. Researchers will then conduct a two-year field campaign and produce a report detailing the estimated cumulative impacts of these anthropogenic activities on walrus. Opportunities for partnerships with USGS and USFWS and other agencies will be explored.

References:

Kastelein, R.A.; Mosterd, P.; van Santen, B.; Hagedoorn, M.; de Haan, D. 2002. Underwater audiogram of a Pacific walrus (*Odobenus rosmarus divergens*) measured with narrow-band frequency-modulated signals. Journal of the Acoustical Society of Amer*ica*. 112(5):2173-2182.

Revised Date: April 26, 2017

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Arctic Slope Winter Fish, Invertebrates, and Arctic Cod Spawning Survey

BOEM Information Need(s) to Be Addressed: Complete spatial and seasonal fish community information in the Chukchi and Beaufort Seas is limited, particularly along the continental slope and under ice-covered conditions. Arctic cod are a keystone species in the Arctic food web, and occur in Chukchi and Beaufort Planning Areas. Existing reports of spawning condition Arctic cod are limited to ice-covered locations, and were documented in the 1980s; current spawning stock estimates are based on very limited information. Exposure to oil for eggs and larvae is known to have detrimental effects on growth, and possible impacts to future reproductive health. A greater understanding of Arctic cod vulnerability—especially the location of the sensitive spawning, egg, and larval development life stages—and its ecological role as a keystone species linking lower trophic organisms to upper level mammals and seabirds is needed to support analyses of potential effects of oil spills and oil and gas exploration, development, and production in Arctic marine ecosystems. The under-studied winter season and the currently uncertain location of suspected Arctic cod spawning, egg, and larval habitat is of increasing public concern and this information is especially important for Essential Fish Habitat (EFH) and National Environmental Policy Act (NEPA) analyses, including analysis of the potential effects of spilled oil trapped and held for many months under ice.

Approx. Cost: (in thousands) $650 **Period of Performance:** FY 2019–2023

Description:

Background: 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. Recent Bureau of Ocean Energy Management (BOEM) studies are elucidating possible nearshore and offshore genetic stock differentiation for Arctic cod. Additionally, open-water surveys in the U.S. and Canadian Beaufort Seas, as well as the Chukchi Sea, 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.

Thick ice cover during three-fourths of the year restricts access for scientific studies and limits our understanding of Arctic cod ecology. However, 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 the NPRB's Arctic Integrated Ecosystem Research Program (Arctic IERP) to add an under ice net gear testing to fulfill

BOEM needs through additional ship days (and without additional ship transit days). This effort would be a first in the U.S. Arctic, and would expand knowledge about winter habitat and spawning location.

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. Information about habitat use and sensitive life stages during the long ice-covered season will support BOEM's environmental analyses. To assess direct and cascading effects from potential oil and gas development and production on Arctic cod and cumulative effects from climate change, it is important to understand whether this ecologically dominant species is ice-obligate in one or more of its life stages and therefore susceptible to significant effects as the ice recedes.

Objectives:

- Validate survey methods adapted for use in ice-covered areas.
- Document 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. The project will engage local coastal residents through established Traditional Knowledge panels to obtain information about winter fish ecology.

Planned operations of the ice strengthened R/V *Sikuliaq* in the northern Bering Sea, Chukchi Sea, and western Beaufort Sea during spring 2018 or 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.

References:

van Franeker, J. A., H. Flores, and M. Van Dorssen. 2009. The Surface and Under Ice Trawl (SUIT). In H. Flores, editor. Frozen Desert Alive—The Role of Sea Ice for

Pelagic Macrofauna and its Predators, PhD thesis, University of Groningen. pp. 181–188.

Revised Date: April 21, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Chukchi Sea; Beaufort Sea

Administered By: Alaska OCS Region

Title: The View from Above: Expanding Efforts to Use Existing Aerial Photo-Identification Data for Life-History Analyses of Bowhead Whales

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) needs information regarding important life history parameters of bowhead whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort Seas (BCBS) stock. Results from this study will provide information for estimating population abundance and support evaluations of the potential effects of oil and gas exploration, development and production activities on marine mammals as required under the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Marine Mammal Protection Act (MMPA). Data from this project will inform NEPA assessments for potential future lease sales and for future exploration plans (EPs) and development & production plans (DPPs) that may be submitted in association with leases in the Beaufort Sea.

Approx. Cost: (in thousands) $200 **Period of Performance:** FY 2019–2021

Description:

Background: The bowhead BCBS population is one of the most important subsistence animals for many Native communities in northern and western Alaska. The harvest is managed by the International Whaling Commission (IWC) and basic biological data are essential for setting safe harvest levels. After being severely depleted by commercial whaling in the 1800s, research indicates that this population is recovering well; however, cumulative effects of arctic shipping, commercial fishing, climate change, and oil and gas exploration could slow population recovery. Since the mid-1970s, monitoring of the BCBS population has been primarily through ice-based surveys conducted near Barrow, Alaska. A future on-ice census may be attempted, but due to deteriorating ice conditions (related to climate warming and sea ice loss), it may be necessary to transition to aerial surveys and photo-identification mark-recapture studies for monitoring the BCBS stock. The proposed project offers a unique opportunity to match more than 30 years of aerial photos in the master catalog. This information will be valuable for (a) estimating population size and trends via capture-recapture modeling; (b) estimating survival rates far more accurately and precisely; (c) determining calving intervals; and (d) evaluating changes in fishing-gear entanglements and ship strikes.

The bowhead photo-id program, which is currently managed by the National Oceanic & Atmospheric Administration's (NOAA's) Marine Mammal Laboratory (NOAA-MML), the North Slope Borough (NSB), and LGL Ltd. - Canada, was started by NOAA-MML, Cascadia Research, and LGL in the early 1980s to begin addressing questions about bowhead life history, of which very little was known. The urgency was in part from the

IWC moratorium on the subsistence hunt of bowhead whales by Alaska Natives. The program grew in sophistication and was conducted intensively through the 1980s and early 1990s to investigate important life history questions, in particular calf production rates, as well as questions regarding the effects of oil and gas activities on bowhead whales. While few surveys were done from 1992 to 2002, two remarkably successful aerial photogrammetric surveys were conducted in 2003 and 2004, funded by NSB with logistical support by LGL. In 2011, aerial photographic surveys for bowhead whales were conducted near Point Barrow, and a mark-recapture analysis is underway using the 2011 data. Further, photographs are still being collected during NOAA National Marine Fisheries Service (NMFS) aerial surveys, so the database spans from 1982–2015.

The collection includes at least 21,000 images of more than 13,000 individuals. However, the photo matching effort is sporadic and incomplete; although each additional inter-year re-identification provides essential information for the basic biology, conservation, and management of bowhead whales. Between the collections maintained at NOAA-MML in Seattle, Washington and at LGL in King City, Ontario, there are about 5500 (naturally) marked bowhead whales in the photographically captured population (1985–2011), representing roughly 30% of the individuals in this stock.

Objectives: The goal of this study is to assist with continuation of the NSB/NOAA-MML/LGL bowhead whale photo-identification program to:

- Evaluate the population size and trend of the BCBS bowhead whale stock.
- Refine existing estimates of individual growth rates, survival rates, calving intervals, scar accumulation, and estimated ages.
- Analyze injuries to bowhead whales from fisheries gear entanglement and other anthropogenic activities, as well as killer whale (scarring) injuries
- Test working hypotheses about bowhead life history parameters using photo-id, including: high individual survival rates, extremely high longevity, delayed age at maturity (*ca.* 25 years), and 3–4 year calving intervals.

Methods: Standard protocols established by NOAA-MML will be used to complete inter-year matching of aerial photographs of bowhead whales primarily taken during their spring migration past Point Barrow for the years 1985 to 2011. These aerial photographs will be used to identify individual whales. Proven scientific methods will be used for analyses such as mark-recapture abundance estimation, estimation of survival rates, calving intervals, human-caused injuries, and measurement of individual growth rates.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Chukchi Sea; Beaufort Sea

Administered By: Alaska OCS Region

Title: Bowhead Whale Acoustic, Diving, and Movement Behavior Relative to Ambient Noise and Oceanography

BOEM Information Need(s) to Be Addressed: Obtaining a better understanding of how vocalization rates relate to ambient noise levels would greatly improve the ability to interpret passive acoustic data and provide a better understanding of how bowhead whales react to noise, facilitating development of better mitigation measures. Results from this study will support National Environmental Policy Act (NEPA) analyses for potential future lease sales and for exploration plans (EPs) and development & production plans (DPPs) for existing leases in the Beaufort Sea. The information will also inform oil spill risk analyses, development of mitigation measures, and Endangered Species Act (ESA) Section 7 consultations.

Approx. Cost: (in thousands) $2,500 **Period of Performance:** FY 2019–2023

Description:

Background: The use of passive acoustics to monitor the presence of vocalizing marine mammals has become a standard method in the Arctic; however, its usefulness is limited by the lack of information regarding the acoustic behavior of the species being studied. The overall number of bowhead whale vocalizations is known to decrease during high noise-level seismic operations; this could be due to whales leaving the area or because whales simply stop vocalizing in a noisy environment. Furthermore, we do not know how likely it is that whales vocalize in the vicinity of passive acoustic buoys, and are just beginning to evaluate how counts of whale vocalizations from acoustic buoys relate to the abundance of whales in some locations.

Bowhead whales are tightly connected to physical oceanography and wind conditions that concentrate their weakly-swimming prey. Bowhead whales consume zooplankton, which is concentrated by oceanographic features such as fronts or stratified layers. Pairing oceanographic model data with conductivity, temperature, and depth (CTD) data collected from tags on whales and whale locations has proven useful for explaining the timing and location of bowhead whale movements including arrival, departure, and residence time. However, refined oceanographic models, in combination with the CTD data collected by the tags, are necessary for generating up-to-date predictions for when and why bowhead whales move. By refining existing oceanographic models and linking these models with bowhead movement data, we can better explain why and when bowhead whales move, including through shipping lanes and industrial zones. Incorporating particle-tracking with the oceanographic models will also be explored.

Acoustic tags developed during the Bureau of Ocean Energy Management (BOEM)-funded study "Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring" (AK-12-02) can be deployed to ascertain bowhead whale

acoustic behavior relative to ambient noise throughout their range. Oceanographic data will also be collected via instrumentation associated with the acoustic tags. By working with subsistence whalers, more than 60 satellite transmitters have been successfully deployed on bowhead whales, greatly expanding upon our knowledge regarding bowhead whales since 2006. Integrating information gleaned from the satellite tags with ocean modeling results can provide additional insight into bowhead behavior. The Regional Arctic System Model was successfully used to describe the ecological characteristics of bowhead whale core-use areas from 2006–2009 using data collected during the above-mentioned study. This model also was used to explain bowhead movements in the Chukchi Sea from 2006–2009. Oceanographic output from this model only extends through 2009 and updated models are needed to help fully explain bowhead movements and timing of movements throughout their range (including movements within the Bering and Beaufort Seas), especially as ecological characteristics change with the climate.

Objectives:

- Document bowhead whale movements and vocalization behavior relative to ambient noise.

- Evaluate whether ambient noise levels have any effect on this prey availability-whale distribution relationship, *i.e.* to assess whether prey availability is the driver for bowhead whale distribution and movements regardless of the soundscape.

Methods: Researchers will work with subsistence whalers to deploy acoustic tags on bowhead whales. Acoustic data from tags on bowhead whales will be paired with acoustic data from buoy arrays. Both acoustic tags and previously deployed acoustic buoys record whale calls with time-stamps. Acoustic tags on whales will also yield satellite locations, allowing for estimation of how often whales vocalize as they pass through an acoustic array and if these vocalizations were detected by recorders on acoustic buoys. Most acoustic tags will also have instrumentation to collect oceanographic data (temperature, depth, and salinity).

Researchers will integrate acoustic and oceanographic data with results from the BOEM-funded study "Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas." Bowhead location data will be paired with oceanographic features selected by bowheads and compared with oceanographic features that were available (*i.e.*, resource selection modeling) to evaluate what oceanographic features determine the timing and direction of bowhead movements. Analyzing existing bowhead depth-temperature data with oceanographic model output will also provide insight into model performance and the location of oceanographic features (*i.e.*, stratified layers and fronts) that may aggregate zooplankton throughout the range of bowhead whales and within industrial zones.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Beaufort Sea

Administered By: Alaska OCS Region

Title: Synthesis of Bureau of Ocean Energy Management (BOEM) Beaufort Sea Baseline and Monitoring Studies

BOEM Information Need(s) to Be Addressed: The changing physical environment of the U.S. Arctic outer continental shelf (OCS) is hypothesized to drive a rapid tempo of change in the distribution and behavior of marine organisms that inhabit those waters. The same species may be affected by oil and gas activities within BOEM Planning Areas, with strong potential for deleterious interactions between natural and human induced phenomena. Under the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), BOEM is required to evaluate whether and how Federal actions associated with oil and gas development may affect protected populations, including analysis of cumulative effects. Information on ocean circulation and hydrography is useful for those evaluations as well as for input into various models used to forecast the outcome of oil spills and other physical phenomena. Given recent high investment in interdisciplinary biological and oceanographic research by BOEM in the Arctic, a synthesis of results from completed and ongoing Beaufort Sea studies would be useful to inform management and decision-makers about trends and vulnerabilities of the resources under changing environmental conditions and potential cascading ecological effects. Results from this study also will provide useful guidance for future research activities.

Approx. Cost: (in thousands) $1,000 **Period of Performance:** FY 2019–2023

Description:

Background: The western Arctic appears to be undergoing rapid physical and biological changes. The rapidity of the observed physical changes was unexpected, as the consensus of the climate research community just a few years ago was that such changes would not be seen for another 30 years, as expected from the CO_2 anthropogenic contribution alone. In addition, climate-related range expansion of many marine species is occurring and likely will continue in future years, given the continuing retreat of sea ice. For example, beluga whales in the Beaufort Sea have been observed in recent years to increasingly feed on capelin rather than their traditional Arctic cod prey. Other changes in behavior and habitat also may accelerate as ice continues to degrade and water temperatures rise.

This study proposes a synthesis of research in the Beaufort Sea Region over the last half century. Extensive historic data are currently available for multiple research programs, including the Outer Continental Shelf Environmental Assessment Program (OCSEAP), which extended from the 1970s to the early 1990s, as well as the Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) and its continuation cANIMIDA, which occurred between 1999 and 2007. Since 2008, BOEM has invested more than

$10,000,000 in fish and lower trophic research and related oceanographic studies in the Beaufort Sea. The primary ongoing studies include:

- ANIMIDA III: Contaminants, Sources, and Bioaccumulation
- U.S.-Canada Transboundary Fish and Lower Trophic Communities
- Beaufort Sea Marine Fish Monitoring Survey in the Central Beaufort Sea
- Aerial Surveys of Arctic Mammals (ASAMM)

Other recent and ongoing studies that will contribute include:

- Marine Arctic Region Ecosystem Study (MARES)
- Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort and Chukchi Seas
- Wading Shorebird Habitats, Food Resources, Associated Infauna, Sediment Characteristics, and Bioremediation Potential of Resident Microbiota of Deltaic Mudflats
- Genomics of Arctic Cod: A Sentinel Species in a Changing Environment
- Development of a Very High-resolution Regional Circulation Model of Beaufort Sea Nearshore Areas

A synthesis of these data would increase our body of knowledge regarding ecological interactions about the region considerably, including the complicated current environmental changes.

Objectives:

- Evaluate the inter- and intra-relationships of oceanographic conditions and lower trophic prey species including fish in the Beaufort Sea Planning Area, and adjacent waters to increase understanding of observed trends.

- Examine of the inter- and intra-relationships of lower trophic prey species and higher trophic birds, marine mammals, and humans to assess the vulnerability of these resources and their interactions to recent and projected changes in environmental conditions.

- Enhance capability to estimate future changes in oceanographic features such as currents, upwellings, and ice leads and associated changes in the Beaufort Sea.

Methods: Using a synthesis approach, Principal Investigators (PIs) will analyze data available from studies funded by BOEM and others in the Beaufort Sea Planning Area and adjacent waters. Available statistical and other models will be used to identify and test hypotheses that cross scientific disciplines. This study will be guided by an oversight committee consisting of senior scientists and accomplished through annual, or more frequent, meetings. In the first meeting participants will inventory available data and deem its sufficiency for use to address specific hypotheses and questions identified by the participants in facilitated sessions. Recommendations for further analyses and publication development will be provided in a report to BOEM summarizing that

meeting. After BOEM review and approval, subgroups of interdisciplinary scientists will work together to prepare data for integration, digitizing older dataset as needed, and conduct appropriate statistical analyses or modeling to identify interdisciplinary relationships and/or test hypotheses previously identified. If useful, PIs may integrate data into new ecosystem models to enhance their predictive capability. After analyses are completed, sub-groups will prepare manuscripts for publication in appropriate peer-reviewed literature. Topics for synthesis include, but are not limited to: inter- and intra-relationships of oceanographic circulation, sea ice, hydrography, lower-trophic abundance and distribution, and marine mammal distributions and behavior. Deliverables from this study will include interim meeting reports identifying summary recommendations and a final synthesis report, as well as multiple peer-reviewed journal publications.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM

Administered By: GOM OCS Region

Title: Long-Term Coral Reef Monitoring at the Flower Garden Banks, Gulf of Mexico: 2019–2022

BOEM Information Need(s) to Be Addressed: The National Oceanic & Atmospheric Administration (NOAA) and the Bureau of Ocean Energy Management (BOEM) will continue the ongoing collaborative partnership to support the Long-Term Coral Reef Monitoring Program within the Flower Garden Banks National Marine Sanctuary (FGBNMS). The monitoring protocol shall be generally consistent with the most recent agreement (BOEM Interagency Agreement #M16PG00018) for monitoring the coral reefs of the East and West Flower Garden Banks (FGB). The primary objective of this study is to continue to assess the health of the coral reefs, expand baseline understanding of the adjacent deeper habitats, and provide an analysis of the status of coral reefs in comparison with historical data, within the context of outer continental shelf (OCS) oil and gas exploration, development, and production. This information will be utilized by BOEM and NOAA to inform management policies that minimize impacts to coral reefs from offshore oil and gas activities, as well as other factors. This program will be conducted through an interagency agreement.

Approx. Cost: (in thousands) $100 **Period of Performance:** FY 2018–2023

Description:

Background: The coral reefs of the East and West FGB are well documented to be among the healthiest in the western Atlantic and Caribbean region. While many coral reefs have experienced significant declines in coral cover, the reefs of the FGB remain in relatively stable condition. Coral reefs are focal points for marine biodiversity, provide critical habitat for a variety of fish and invertebrate species of commercial and recreational importance, supply valuable public recreational opportunities, and contribute to local and regional economies. The health of coral reefs may be threatened by a number of potential sources, including direct and indirect impacts from human activities. Due to concern about potential impacts of offshore oil and gas development, the Department of the Interior (through the Minerals Management Service—now BOEM) started regularly monitoring the East and West FGB in 1988 to assess the health of the coral reefs to establish baseline data and determine if these reefs were impacted by nearby OCS exploration and production activities. Since 2009, the FGBNMS staff has managed long-term monitoring under this program. The Sanctuary has contributed scientific divers, a research vessel, and the necessary supplies, equipment, and expertise to carry out long-term monitoring.

This study is designed to continue monitoring environmental conditions of the coral reefs at the East and West FGB located within the FGBNMS (or Sanctuary). The biological health of the coral reef community shall be monitored to detect any significant effects from natural and/or human-induced activities that could potentially endanger

the coral community integrity. Surveys at both the East and West FGB shall be performed over a four-year period. Annual data collecting cruises on each bank shall be conducted during summer or early fall (generally August or September) each year of the agreement. Annual technical reports shall be provided to report observations, and a synthesis report with full analysis will be prepared following the fourth year of monitoring.

Objectives: The objectives for this long-term monitoring effort are to collect data that will enable NOAA and BOEM to assess the long-term health of the coral reefs, detect short-term disturbance, and, in the event of a disturbance, evaluate contributing factors, impacts, and significance. This program is of significant interest to both NOAA and BOEM, who share responsibility to protect and monitor these important marine resources.

Methods: Data collection will be achieved through the evaluation of changes in living coral and other benthic community cover, coral growth rates, reef fish population dynamics, water quality, and other indices of reef vitality. Observations shall be made to evaluate coral reef diversity, growth rates, and long-term changes in individual coral colonies, accretionary growth, and general coral reef community health during years 2019–2022. In general, survey techniques are listed and described in detail in monitoring reports from previous reporting periods. However, completion of a recent program review has resulted in implementation of several changes to methods and analyses, and the addition of deep monitoring stations. The partners will continue to reevaluate methods and review new techniques and technologies for opportunities to better achieve shared BOEM and NOAA objectives.

Revised Date: April 18, 2017

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: Evaluating Potential Mudslide Impacts to Historic Shipwrecks

BOEM Information Need(s) to Be Addressed: Since the late 1970s, multiple studies sponsored by the Bureau of Ocean Energy Management (BOEM) and industry have identified an actively leased area of the Mississippi River Delta Front (MRDF) on the Outer Continental Shelf (OCS) that is subject to a highly dynamic environment affecting sediment deposition, stability, mass-wasting, and other transport processes. This area contains several shipwrecks of potential historical significance, and recent industry surveys and BOEM studies have exhibited evidence that these sites are being impacted by the same environmental processes, which are suspected to occur on an annual or sub-annual timescale. As part of its responsibilities under the National Historic Preservation Act (NHPA) BOEM requires avoidances of these shipwrecks during permitted activities; however, there is often a delay of years or decades between when industry surveys locate these sites and when permitted seafloor-disturbing activities take place. During this interval, sediment transport processes may displace these sites beyond the boundaries of the initial avoidance requirement, placing both the archaeological sites and industry infrastructure at risk. This study proposes a multi-disciplinary investigation of selected known and potential shipwreck sites to identify previous and predicted future impacts from mass-wasting and other sediment transport processes. This information is needed to better understand archaeological site formation in the MRDF, and to develop appropriate mitigation strategies for industry avoidance of these sites, which in turn will inform BOEM's NHPA and National Environmental Policy Act (NEPA) analyses of potentially significant historic properties on the OCS.

Approx. Cost: (in thousands) $750 **Period of Performance:** FY 2018–2022

Description:

Background: In the late 1970s, BOEM sponsored a study that examined sediment transport in the MRDF and identified large areas of instabilities and mudslide activity (Coleman *et al.* 1980). More recent studies, including one currently being conducted through BOEM's study program with Louisiana State University's (LSU's) Coastal Marine Institute (CMI), have further examined the site-specific observed and predicted frequency and effects of this activity (Nodine *et al.* 2006, Bentley *et al.* 2016). Additionally, industry has sponsored surveys to identify impacts to oil and gas infrastructure in these areas following major storm events. These surveys documented, among other impacts, an 18-inch oil pipeline that was displaced 3,000 feet over a 14 mile length during Hurricane Ivan. While these processes may be exacerbated during major storm events, evidence suggests that they are also present during routine annual winter conditions (Bentley *et al.* 2016). The resulting impacts to bottom-founded structures have not been limited to industry infrastructure. Industry surveys have

recorded evidence of a historically significant World War II shipwreck, the 500-ft long, 10,700 gross-ton tanker *Virginia*, being displaced at least 1,800 feet since 2004. No additional surveys have been done at this site since 2006, though the above referenced BOEM CMI study will be returning to the site in 2017.

The mudslide activity area identified in Coleman *et al.* (1980) includes all or portions of 123 OCS lease blocks. To date approximately 23% of this area has been subject to lease block surveys that included an archaeological analysis. Including *Virginia*, 11 suspected shipwrecks have been identified during these surveys, and another 10 sonar targets indicative of potential shipwrecks have received avoidance mitigations in association with BOEM permit reviews. Evidence suggests one of the shipwrecks is potentially another World War II casualty, *Rawleigh Warner*, though no archaeological investigation has been conducted to verify its identity or historical significance. Multiple surveys of this site between 2003 and 2011, however, indicate that the shipwreck has moved approximately 800 feet during that time. Additionally, a historic wreck from 1918 has reported coordinates in a South Pass lease block within this mudflow area that has never been subject to industry survey. A modern shipwreck, also in South Pass, was confirmed during site clearance operations in 2003, but was not located during a subsequent survey in 2010 and the area appeared to be covered by a mudflow gully. Uncertainty about the effects of these sediment transport processes on shipwrecks calls into question BOEM's mitigation strategies in this area. When a 500-ft long shipwreck such as *Virginia* can move 1,800 feet during a single storm event, then an avoidance mitigation of 1,000 ft (as is typical for avoidances placed on known shipwrecks) may be insufficient, and the shipwreck could pose a hazard to nearby pipelines or other oil and gas infrastructure or be adversely impacted if colliding with infrastructure.

Additionally, both *Virginia* and *Rawleigh Warner* have been identified as potential environmental hazards because it is suspected that they each contain heavy bunker fuel (NOAA 2013a, 2013b). The potential threat of a worst-case release of this oil due to a hull breach could be significantly increased during a mudslide event. Better knowledge of this hazard potential would allow BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) to better assist federal response efforts, should a sudden oil spill appear in these areas.

Objectives: In order to comply with BOEM's preservation mandates for historic properties on the OCS and inform our knowledge of the environmental processes affecting them, this study aims to:

1) Build upon previous studies to identify the type (*e.g.*, lateral displacement, vertical displacement/burial, rolling, structural collapse, and dispersion, *etc.*) and range of potential impacts to shipwrecks due to mudslide or other extreme sediment transport events;

2) Conduct a site assessment of the wreck suspected to be *Rawleigh Warner*, including an assessment of National Register eligibility and environmental threat potential;

3) Investigate other potentially significant shipwrecks within the mudslide area; and

4) Recommend mitigation and monitoring strategies for potentially significant shipwrecks in this area.

Methods:

1) Remotely Operated Underwater Vehicle (ROV) investigation of the suspected *Rawleigh Warner*, and creation of a site map;

2) Remote-sensing survey of a select number (<10) of previously located shipwrecks to identify potential subsequent effects from extreme sediment transport events;

3) Remote-sensing survey of selected areas that have never been surveyed but which existing archival research indicates may contain reported shipwrecks; and

4) Geotechnical data collection at selected study sites to identify sediment characteristics, stability, and behavior, and inform the analysis supporting the above objectives.

References:

Bentley, Samuel J., Xu, K., Georgiou, I., and Maloney, J. 2016. *Mass Wasting Processes and Products of the Mississippi Delta Front: Data Synthesis and Observation*. CA M13AC00013 Project Year 3 Annual Report.

Coleman, J.M., Prior, D.B., and Garrison, L. 1980. *Minerals Management Service Open File Report 80-02*.

NOAA. 2013 a. *Screening Level Risk Assessment Package,* Rawleigh Warner. Office of National Marine Sanctuaries, Office of Response and Restoration.

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Nodine, Mary C., Wright, Stephen G., and Gilbert, Robert B. 2006. *Mudslides during Hurricane Ivan and an Assessment of the Potential for Future Mudslides in the Gulf of Mexico*. MMS Project Number 552.

Revised Date: April 30, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: Mapping the Late Pleistocene Landscapes of the Gulf of Mexico Through Three-Dimensional (3-D) Seismic Analysis

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) is tasked, under Section 110 of the National Historic Preservation Act (NHPA) and Section 101(b)4 of the National Environmental Policy Act (NEPA), with identifying and preserving potential submerged, buried prehistoric archaeological sites on the outer continental shelf (OCS). Currently, areas for avoidance are determined through the analysis of widely-spaced sub-bottom sonar data collected in individual block and rights-of-way (ROW) surveys. A 2004 BOEM-funded study offshore Western Louisiana, "Preservation of Paleolandscapes and Identification of Sand Resources for Coastal Restoration," has evaluated these block survey analyses at a regional level and has determined several issues with this approach. For example, many of the paleovalleys and channels marked for archaeological avoidance are too old to contain Paleoindian sites; gas in estuarine deposits may mask features of potential archaeological interest below them; and because of block size and the extents of typical survey, an interpreter may not realize that a survey is within a larger feature of potential archaeological interest. Additionally, entire paleovalleys may be missed with current line spacing requirements. BOEM needs a 3-D regional model of buried paleolandforms in which to situate and interpret block and site-specific high-resolution geophysical surveys in order to accurately mitigate and apply avoidance criteria to best protect potential submerged, buried prehistoric archaeological sites from potential impacts from the oil and gas and marine minerals industries. Additionally, methodology for regional modeling and analysis should be in place before surveys begin in advance of oil and gas activity in the Gulf of Mexico (GOM) Eastern and Atlantic Planning Areas.

Approx. Cost: (in thousands) $500 **Period of Performance:** FY 2018–2020

Description:

Background: It is prohibitively expensive to conduct a standard Phase I archaeological survey for the identification of potential submerged, buried prehistoric sites on the OCS to meet BOEM's obligation under NHPA Section 110; therefore, BOEM prefers to avoid and protect any buried paleolandform (interpreted from sub-bottom profiler data) that potentially dates to the Late Pleistocene/Early Holocene. We need better models for paleovalley infilling and preservation because, in most cases on the GOM and mid to south Atlantic shelves, these are the only possible locations where former landscapes that humans might have occupied would be preserved on the shelf. To date, no buried prehistoric sites have been confirmed on the OCS in the Western and Central GOM. In 2005, geologists and geophysicists at the University of Birmingham, United Kingdom developed a methodology to investigate sub-seafloor stratigraphy representing paleolandscapes exposed during the Late Pleistocene/Early Holocene and created a

regional paleolandscape model by employing preexisting 3-D seismic survey data collected by the oil and gas industry (Gaffney *et al.*, 2007). This methodology was successfully applied to a region in the southern North Sea known as Doggerland, an area in which trawlers regularly recover Mesolithic artifacts. Similar 3-D seismic data are available for the Western and Central GOM, but geomorphic response to sea level rise in the northern GOM was quite different than the southern North Sea because of open shelf *versus* confined fluvial valley settings, respectively. However, select areas of the northern GOM where major stream systems (*e.g.*, the Mississippi) cut large valleys on the exposed shelf during the Last Glacial Maximum would be candidates for similar modes of paleolandscape preservation as those observed in the southern North Sea.

Objectives: The primary objective of this study is to build upon the work of the Doggerland 3-D seismic analysis project (Fitch *et al.*, 2005) on the GOM shelf within the Late Quaternary Mississippi River incised valley using existing industry-produced 3-D seismic datasets coupled with higher resolution geophysical data and geologic core data to create a regional paleolandscape model. Project goals include:

- To employ 3-D seismic data and other available resources to interpret Late Wisconsinan to recent incised valley fill character and the erosional/depositional response to sea level rise (sequence stratigraphy) within the Mississippi River incised valley on the GOM shelf;

- To ground-truth and verify Late Pleistocene/Early Holocene stratigraphic interpretations with subsurface geologic (core) data;

- To create a process-response model that predicts preservation potential for subaerially exposed landforms and prehistoric archaeological sites within the incised valley;

- To provide paleocoastline data which may be used to develop and calibrate sea level and paleolandscape models; and

- Based on the conceptual model above, develop a tool that can inform BOEM decisions on how to better identify and avoid potential prehistoric cultural resources on the shelf.

Methods: BOEM is provided processed 3-D seismic data from commercial seismic survey companies that receive permits to survey from BOEM in the GOM. As with the Doggerland project, it is likely that the survey companies would be amenable to donating 3-D seismic data to BOEM for scientific, non-commercial purposes. The first two years of the study will involve evaluation and selection of the seismic data (~40–60 blocks), post-processing to better resolve the shallow sections of interest, analysis, and modeling. The third year of the study, to expand the spatial area of study, may be exercised if the initial analysis proves successful. The methodology of this study will follow that of the Doggerland project incorporating modifications suggested as part of the outcome of that project. The approach includes:

1. Identify a 3-D seismic data set with which the area of interest may be resolved;

2. Map regionally significant reflectors using the regional 3-D seismic dataset;

3. Interpret these surfaces using artificial illumination and horizon attributes such as amplitude and dip to identify morphological features and developmental chronology;

4. Generate seismic attributes for the regional 3-D seismic dataset;

5. Sequentially time-slice these attribute volumes (*e.g.*, amplitude, coherence, root-mean-square [RMS] amplitude) and employ opacity rendering techniques to identify morphological features and the developmental chronology;

6. Integrate the above to interpret stratigraphic architecture and develop a sequence stratigraphic model that will ultimately be employed to produce a process-response conceptual geomorphic model to predict paleolandscape preservation potential within the valley;

7. Use existing high-resolution two-dimensional seismic data and borehole data to refine the stratigraphic model, provide material suitable for age-dating, resolve interpretational and chronological ambiguities, and provide paleoenvironmental data;

8. Generate digital spatial models that can be imported into a geographic information system (GIS) for map production and spatial analysis; and

9. Develop data type, collection, management plan, and analysis recommendations for the improvement, enhancement, and expansion of this research.

References:

Fitch, Simon, Ken Thompson, and Vince Gaffney. 2005, Late Pleistocene and Holocene depositional systems and the paleogeography of Dogger Bank, North Sea: Quaternary Research, v. 64, p. 185–196.

Gaffney, Vincent, Kenneth Thomson, and Simon Fitch (Eds.). 2007. Mapping Doggerland: The Mesolithic Landscapes of the Southern North Sea. Archaeopress, Oxford, England.

Revised Date: April 27, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM

Administered By: GOM OCS Region

Title: Wavelet Analyses of Acoustic Doppler Current Profiler Data from Outer Continental Shelf (OCS) Platforms

BOEM Information Need(s) to Be Addressed: Environmental assessments of biological processes by OCS activities in the marine biotope are required by existing Federal regulations. These assessments need to consider ocean currents and their variability. This study will provide information about currents and their variability from inertial to intra-annual temporal scales from OCS platforms in deep waters. The information generated will help improve assessments of oil spills and other pollution events from OCS activities in the marine environment for National Environmental Policy Act (NEPA) related documents.

Approx. Cost: (in thousands) $175 **Period of Performance:** FY 2018–2021

Description:

Background: Understanding of the circulation over the northern Gulf of Mexico (GOM) including long-term variability is critically important for oil and gas exploration, development, and production in deep water. Acoustic Doppler Current Profilers (ADCPs) have been required by the Bureau of Safety & Environmental Enforcement (BSEE)/Bureau of Ocean Energy Management (BOEM) on production platforms in the northern GOM. These platforms are located in water depths less than 1000 m to the east of the Mississippi River Delta (*e.g.*, Viosca Knoll), to 1424 meters deep west of the Mississippi River Delta (*e.g.*, Garden Banks), providing a diversity of areas for investigation. These areas are impacted by cold front passages, Loop Current intrusions, Loop Current Eddies, Loop Current Frontal Eddies, and interactions with the continental shelf. The currents in these areas change quickly over time due to passing eddies, rapidly changing wind fields, and interaction with the shelf. Hence, the current patterns are very difficult to predict. Fortunately, some individual records from these platforms are continuous (fewer than 10 days break) over a period as long as two years and the ensemble of records span over a decade. Analyses of such long time series of currents in the GOM have never been attempted.

Objectives: The objective of this study is to describe the current variability over a range of time scales including inertial-tidal, intra-seasonal, seasonal, intra-annual, annual, and inter-annual scales across the northern GOM and to relate the current variability to existing oceanographic and atmospheric conditions and knowledge.

Methods: As stated above, these currents are not stationary and conventional Fourier spectrum analysis presumes stationary data. This study will use wavelet analysis which is appropriate to describe non-stationary currents and provide an effective way for obtaining their time-frequency information (Teague *et al.*, 2014).

Binary files from five (5) selected platforms have been extracted and investigated for quality and revealed that the objective of this study can be successfully achieved. A report will present the results of these analyses.

References:

Teague, W.J., H.W. Wijesekera, E. Jarosz, A. Lugo-Fernandez, and Z.R. Hallock. 2014. Wavelet analysis of near-inertial currents at the East Flower Garden Bank, Cont. Shelf Res., 88: 47–60.

Revised Date: April 11, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: Synthesis of Potential Wind Turbine Interactions with Wildlife and Their Habitats in the Northern Gulf of Mexico

BOEM Information Need(s) to Be Addressed: Offshore wind energy development is within the Bureau of Ocean Energy Management's (BOEM's) purview under the Energy Policy Act of 2005 (EPAct). Understanding the potential for biologically-significant impacts to wildlife informs the siting of offshore wind facilities and the design of appropriate mitigations to minimize harm to environmental resources. As BOEM assesses wind energy feasibility in the Gulf of Mexico (GOM), it is important to understand potential interactions with wildlife and their habitats and where information needs lie in existing datasets. This study will compile existing information on birds, bats, marine mammals, fish, and other sensitive species and their habitats to analyze potential turbine interactions in the GOM. The resulting analyses will inform BOEM's regional strategic planning and possible future environmental documents related to offshore renewable energy in the region, including National Environmental Policy Act (NEPA) environmental impact statements (EIS) and environmental assessments (EA), Essential Fish Habitat (EFH), Marine Mammal Protection Act, Migratory Bird Treaty Act, and Endangered Species Act (ESA) compliance, and for Coastal Zone Management Act (CZMA) purposes with Gulf states.

Approx. Cost: (in thousands) $350 **Period of Performance:** FY 2018–2019

Description:

Background: Supporting effective stewardship is a strategic theme identified in the Department of Energy (DOE)/Department of the Interior (DOI) National Offshore Wind Strategy (2016) and involves managing key environmental concerns as an action area. A positive benefit from offshore wind development is reduced greenhouse gas emissions with implications for sea level rise and fragile Gulf coast ecosystems. Responsible stewardship and proper management are required to minimize the direct impacts of large-scale offshore wind developments on wildlife, sensitive habitat, and existing uses. Wind-wildlife interaction studies have been performed in other regions, such as the Mid-Atlantic (*e.g.*, Williams *et al.*, 2015), and have helped identify species that are likely to be exposed to development, assessed key migratory corridors, and provided data and analysis towards future EIS.

This study will help inform the GOM Region's developing Renewable Energy Strategic Framework. As part of this framework, the Gulf is currently conducting the "Offshore Renewable Energy Feasibility Study Across Technology Types for the U.S. Gulf of Mexico" with the National Renewable Energy Laboratory (NREL). With relevance to wind-wildlife interactions, the GOM has a diverse offshore biome of seabirds, marine mammals, sea turtles, sessile benthics, and other living marine resources, including threatened and endangered species. The Central and Mississippi migratory bird flyways

of North America are special considerations for offshore wind development in the GOM, involving both circum-Gulf and trans-Gulf migrants. A recent report identified the confluence of the Mississippi River and the Gulf as one of the particularly significant migratory blueways (Brenner *et al.*, 2016).

Objectives: The purpose of this study is to provide an analysis of potential offshore wind turbine interactions with wildlife and habitat in the northern GOM. The questions to be answered by this study are:

(1) What are the best data layers that can be developed for offshore wildlife in the region of interest?

(2) What species are most likely to be impacted and during which times of year?

(3) What are the priority data needs that exist related to wind-wildlife interactions to inform potential future fieldwork?

Methods: The region of interest for this study will be informed by the existing NREL wind resource assessment and the underway GOM feasibility study. The initial step in this synthesis will be to develop an inventory of the existing wildlife and habitat datasets in the GOM that are pertinent to potential offshore wind interactions in OCS waters. Taxonomic groups of interest include fish, marine mammals, sea turtles, birds, and bats, with focus on species that are highly regulated or otherwise singularly important such as surrogate species. Data types to be inventoried include boat surveys, aerial surveys, high-resolution digital video, satellite telemetry, acoustic datasets, and nocturnal migration monitoring. Weather surveillance radar (Next-Generation Radar [NEXRAD]) will also be analyzed to detect offshore bird migratory activity in the atmosphere on a broad scale. This study will coordinate with ongoing studies to gather new datasets, including the "Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS)" and "Baseline Monitoring of Avian and Bat Activity and Offshore Platform Interactions."

Several different approaches and analytical methods will be used to synthesize the data gathered from the inventory. Simple mapping of raw survey data can be informative when there are insufficient observations to support alternative approaches. More involved analyses will be applied where appropriate, to correct for variation in effort and detection bias, resulting in products such as persistent hotspot, seasonal predicted abundance, and utilization distribution (telemetry) maps. Geographic and temporal patterns in species abundance and distribution will be analyzed to determine implications for potential offshore wind development. Major gaps in existing datasets will also be identified to inform potential areas of future research. This study will be a first step towards synthesizing wildlife datasets to understand the implications of potential offshore wind energy development in the GOM. The geographic information system (GIS) layers of all data collected will be delivered to BOEM for mapping purposes to be used in overlaying wind areas with wildlife and habitat to inform the best placement/operation of wind projects in terms of least impacts to sensitive species and provide information for the writing of future environmental documents.

References:

Brenner, J., C. Voight, and D. Mehlman. 2016. Migratory Species in the Gulf of Mexico Large Marine Ecosystem: Executive Summary. The Nature Conservancy, Arlington, 20 pp.

Williams, K. A., I. J. Stenhouse, E. E. Connelly, S. M. Johnson. 2015. Mid-Atlantic Wildlife Studies: Distribution and Abundance of Wildlife along the Eastern Seaboard 2012–2014. Biodiversity Research Institute. Portland, ME (US). http://www.briloon.org/uploads/BRI_Documents/Wildlife_and_Renewable_Energy/FINAL%20DOE%20booklet%20092515.pdf.

Revised Date: May 16, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: Leveraging the National Energy Technology Laboratory's (NETL's) Offshore Integrated Assessment Modeling Tools & Methods for Assessing Oil Spill Risk

BOEM Information Need(s) to Be Addressed: Activities associated with offshore oil exploration, development, production, and transportation have the potential for oil spills to occur. Stakeholders continue to have concerns about oil spills and the threat they pose to the environment. Pre-lease and post-lease National Environmental Policy Act (NEPA) analyses evaluate the potential impacts from oil spills to offshore and onshore environmental and socio-economic resources. Results from this study will assess the risks associated with oil spills from exploration through decommissioning and help strengthen the Bureau of Ocean Energy Management's (BOEM's) oil spill risk assessment program by providing much-needed information concerning spill impacts to outer continental shelf (OCS) resources. This information is also useful for oil spill prevention, preparedness, and response planning.

Approx. Cost: (in thousands) $300 **Period of Performance:** FY 2018–2019

Description:
Background: The Department of Energy's (DOE) National Energy Technology Laboratory's (NETL) Research Innovation Center (RIC) has long conducted research associated with offshore domestic hydrocarbon systems. Since 2010, NETL RIC's offshore research (https://edx.netl.doe.gov/offshore) has aligned predominantly to supporting development of knowledge, technologies, and tools to support offshore spill prevention. The majority of this research also aligns with BOEM's information needs regarding oil spill risk and impact analysis. The RIC's projects target three core areas:

- Evaluating performance and integrity of key offshore materials for which data are limited;
- Developing critical data for predicting *in situ* conditions required for assessing risk associated with loss of well control conditions; and
- Developing a coordinated database and modeling system for risk assessment to allow for independent, rapid-response and science-based predictions in support of oil spill prevention, preparedness, and response.

Objectives: This research builds on DOE's core competencies to simulate and predict behaviors of engineered-natural systems. The proposed research will apply a combination of laboratory-based experimental and characterization studies, integration and interpretation of field-based datasets, and development & application of analytical methods & models. Ultimately, these efforts will result in new data and an integrated

assessment modeling (IAM) (Rose *et al.* 2014) platform to allow for independent, rapid, science-based prediction of offshore hydrocarbon production risks and potential environmental impacts.

The development of the Offshore IAM will include:

(1) experimental studies to improve understanding of key parameters that contribute to loss of control events in offshore settings, such as delineation of materials performance and properties used for barriers and controls in these systems;
(2) building a comprehensive, subsurface, offshore to onshore, open, spatial dataset that describes key elements of the engineered-natural system that affect risk;
(3) predicting *in situ* conditions required for assessing risk, borehole/drilling design, and loss of control conditions;
(4) increasing knowledge of wellbore integrity, both near-term and long-term in offshore settings;
(5) improving safety through rapid detection and *in situ* characterization; and
(6) developing novel tools and techniques to monitor and quickly detect potential hazards associated with offshore hydrocarbon systems and operations.

The Offshore IAM will be utilized to understand spatial and temporal trends and identify potential risks associated with offshore activities in the Gulf of Mexico (GOM). Some of these analyses include development of a refined assessment of subsurface pressure and over-pressure trends, identification of separate regions with distinct transport characteristics using 12 years of data-assimilative ocean-model solutions, a spatio-temporal evaluation of spill-impact trends, and a spatially explicit gap-analysis of response readiness capabilities.

Methods: Adapting, enhancing and applying NETL's IAM tools for BOEM's environmental analysis and resource management needs would include:

- Variable Grid Method (VGM)
    - NETL's VGM is a novel approach that leverages geographic information system (GIS) capabilities to simultaneously visualize and quantify spatial data trends and underlying data uncertainty. The flexible VGM approach utilizes a range of spatial datasets and uncertainty quantifications, which can be calculated using data related to sample density, sample variance, interpolation error, multiple simulations, *etc.*, to create an integrated visualization of data and uncertainty. The intuitive manner of the VGM helps communicate the relationship between uncertainty and spatial data to effectively guide research, support advanced computation analyses, and help inform management and policy decisions.
- Cumulative Spatial Impact Layers (CSIL) tool
    - NETL's CSIL is a GIS-driven spatio-temporal additive model that allows the user to quantify how many variables or economic costs coincide with a given grid cell or area of interest. CSIL's will be used to identify potential

impacts to various socio-economic and environmental resources within a region related to offshore exploration and development. When integrated with NETL's Blowout Spill Occurrence Model (BLOSOM) (Sim *et al.* 2015) or other oil spill model simulations (*e.g.*, Oil Spill Risk Analysis [OSRA]), the CSIL layers provide a qualitative and quantitative representation of various receptors' spatial extent or economic value to help evaluate potential impacts and risks associated with various uncontrolled hydrocarbon release scenarios to better inform environmental analysis and spill prevention efforts.

- Spatially Weighted Impact Model (SWIM) tool
    - SWIM builds off of the CSIL approach, so that it not only evaluates potential impacts to key socio-economic and environmental resources in an area, but also allows users to rank and compare. SWIM applies user-defined weights to impacts to evaluate scenario outcomes and utilizes spatial and temporal analyses used to more accurately evaluate interactions and assess potential impacts.

References:

Rose, K.; Aminzadeh, F.; Sim, L.; Ghanem, R. G.; Disenhof, C.; Bauer, J.; Mark-Moser, M.; Thimmisetty, C.; Jabbari, N.; Khodabakhshnejad, A. 2014. Risks and impact assessment for deepwater and ultra-deepwater Gulf of Mexico resources. Offshore Technology Conference. doi:10.4043/25364-MS https://www.netl.doe.gov/File%20Library/Events/2016/fy16%20cs%20rd/Tues/CSsubter-8-2016-Rose-OffshoreIAM.pdf

Sim, L.; Graham, J.; Rose, K.; Duran, R.; Nelson, J.; Umhoefer, J.; Vielma, J. 2015. Developing a Comprehensive Deepwater Blowout and Spill Model; NETLTRS-9-2015; EPAct Technical Report Series; U.S. Department of Energy, National Energy Technology Laboratory: Albany, OR, p 44. http://www.netl.doe.gov/research/on-site-research/publications/featured-technical-reports

Revised Date: January 27, 2017

Study Area(s): Western GOM; Central GOM

Administered By: GOM OCS Region

Title: Socioeconomic Impacts of Outer Continental Shelf (OCS) Infrastructure: Shifts in Recreational Behaviors

BOEM Information Need(s) to Be Addressed: 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 outer continental shelf (OCS) infrastructure. In addition, technological advances, socioeconomic changes, and regulatory changes have likely changed patterns of recreational behavior since a prior Bureau of Ocean Energy Management (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 National Environmental Policy Act (NEPA) analyses. For example, this study will allow BOEM to more accurately estimate the distances from shore that BOEM activities and recreational activities interact in various locations. In addition, this study will clarify the onshore economic impacts of these recreational activities. 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 will likely soon develop a programmatic environmental impact statement (PEIS) regarding decommissioning activities, and this study would provide important information to that PEIS. Finally, this study will inform decisions regarding which structures should be maintained through Rigs-to-Reefs programs; Fikes (2013) provides additional information regarding these programs.

Approx. Cost: (in thousands) $200 **Period of Performance:** FY 2018–2021

Description:

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 some information regarding the overall levels of fishing and diving near oil and gas platforms; it also estimated the economic impacts arising from expenditures by these fishermen and divers. However, that study was based on 1999 data and is therefore becoming less applicable as the recreational landscape changes. In addition, that study did not examine certain subcategories of these activities, such as the scales of recreational fishing and diving that occurred in state *versus* federal waters. Hiett and Milon (2002) also did not examine 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 (*e.g.*, Global Positioning System [GPS]) have allowed the OCS to become increasingly accessible to recreators. Public awareness of the oceans, environmental impacts, and climate change may have changed 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 various ways in recent years. It is unclear how these various factors have impacted recreational activity in the Gulf of Mexico (GOM).

Recreational activities have been associated with nearshore infrastructure for decades. However, the number of platforms in the GOM has decreased from a peak of just over 4,000 in 2001 to approximately 2,100 in 2017 (BSEE, 2017). Therefore, recreational fishermen and divers have had to adapt to this changed landscape. This may have entailed performing recreational activities farther offshore, in different nearshore locations, or curtailment of activities. The addition of artificial substrate to areas suitable for fish habitat and conducive to recreational fishing and diving may encourage participants to continue pursuing activities locally. Fishermen, divers, government agencies, and industry participants would benefit from information regarding the changed landscape so that they can plan and adjust their behavior.

Objectives:

1. Assess recreational demand for OCS infrastructure and Rigs-to-Reefs sites.
2. Identify key factors for structures particularly suitable for recreational activities.
3. Identify behavioral shifts resulting from removal of obsolete OCS infrastructure.
4. Aggregate existing information sources into a coherent framework.

Methods: Due to an emerging pressing information need (the decommissioning PEIS), this study will entail methods that can yield results quickly, while laying the groundwork for a potential larger-scale study in the future. First, this study will entail a limited number of interviews with recreation industry participants and government (federal, state, and local) officials. The interviews will be targeted to leverage existing information regarding Objectives 1–4 to the maximum extent possible. For example, the interviews will explore whether information regarding the recreational uses of platforms could be built into existing data gathering efforts. This study will also entail a literature review, and compilation of 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, and this study will explore the potential insights of these new data. This study will also develop visual representations of how platforms and other artificial reefs correlate with socioeconomic indicators relevant to recreational fishing. In addition, this study will examine the appropriateness of a larger-scale, Office of Management and Budget (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 study would take, and would develop potential survey questions.

References:

BSEE. 2017. Offshore statistics by water depth. Website: https://www.data.bsee.gov/Leasing/OffshoreStatsbyWD/Default.aspx

Fikes, R. 2013. Artificial reefs in the Gulf of Mexico: A review of Gulf state programs and key considerations. National Wildlife Federation staff report.

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 Service, Gulf of Mexico OCS Region, New Orleans, LA. 98 pp.

Revised Date: May 1, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: Higher Order Analyses of the Bureau of Ocean Energy Management's (BOEM's) Lagrangian Data

BOEM Information Need(s) to Be Addressed: BOEM needs to have better current fields to estimate oil spill risks, verify circulation models, and estimate dispersion of biological particles and oil spills. Furthermore such information could be used for National Environmental Policy Act (NEPA) related documents and biogeographic studies of the deep Gulf fauna.

Approx. Cost: (in thousands) $350 **Period of Performance:** FY 2018–2022

Description:

Background: BOEM has sponsored physical oceanographic research in the Gulf's deep waters for almost two decades. Yet, because of their costs and sampling technology, many of these studies have focused on specific areas and short periods. To increase geographical and temporal coverage BOEM decided to conduct a basin-wide study using drifting and profiling buoys under the study "A Lagrangian Approach to Study the Gulf of Mexico's Deep Circulation." The 152 drifters and 6 profiling buoys or Lagrangian particles released over the entire Gulf were tracked for nearly three (3) years and sampled every eight (8) hours at two depths: 1,500 and 2,500 m. The resulting database consists of about 194-float years and 489 vertical profiles of temperature, salinity, and bio-optical properties covering most of the basin. These extremely important and revealing data were subjected to basic analyses during the initial contract and documented in the report entitled "Deep Circulation in the Gulf of Mexico: a Lagrangian Study." Yet, the rich information contained in these data has not been completely extracted and many second-order analyses still need to be performed to maximize its usefulness. This proposed study is for conducting higher order analyses and extracting as much information as possible from these data.

Objectives: The purpose of this study is to characterize the Gulf of Mexico (GOM) deep circulation and defining spatio-temporal scales, as well as its potential relationship to the circulation in upper levels and other known aspects of the Gulf's oceanography.

Methods: The proposed study will perform higher order data analyses to fulfill the objectives:

- extract second-order statistics of deep water circulation such as Eulerian metrics, circulation patterns, censuses of eddies, and seasonal variations;
- examine circulation processes such as the cyclonic boundary currents, Rossby waves, and vertical coupling of surface to deep currents

- calculate and analyze particle dispersion statistics; and
- examine variations of the water masses and hydrography of the Gulf.

The raw data have been collected and basic analyses completed under the initial contract. For this proposed study the methods consist of higher order statistical analyses (*e.g.*, two particle dispersion), a combination of graphical displays of various dynamical quantities such as vorticity, horizontal and vertical coherence, satellite altimetry, and complex and regular empirical orthogonal function (EOF) analyses to examine the variations of the computed quantities.

Revised Date: April 11, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: Preparing for Disaster: Developing Baseline Data Collection and Action Plans

BOEM Information Need(s) to Be Addressed: Federal agency research programs are not organized to respond quickly to catastrophic oil spills such as *Exxon Valdez* and *Deepwater Horizon*. As a result, despite public interest and concern, how catastrophic oil spills affect various communities is poorly understood. This lack of understanding hinders the Bureau of Ocean Energy Management's (BOEM's) ability to include analyses of catastrophic spill impacts in its National Environmental Policy Act (NEPA) documentation, as recommended by the Council on Environmental Quality (2010). Long-term monitoring on the human environment is mandated in the Outer Continental Shelf Lands Act (OCSLA) and would contribute to NEPA analysis of the cumulative effects of outer continental shelf (OCS) activity. The background data collected in such a program would also provide a baseline for understanding the impacts of a catastrophic spill. BOEM does not have: 1) a protocol for socioeconomic research in case of a catastrophic oil spill, or 2) a socioeconomic monitoring program. Gulf of Mexico Region (GOMR) staff are working to improve BOEM's NEPA assessments and future Environmental Studies Program (ESP)-supported research on cumulative impacts and catastrophic oil spills by developing a monitoring program and a catastrophic spill research protocol. This study will support that effort.

Approx. Cost: (in thousands) $220 **Period of Performance:** FY 2018–2020

Description:

Background: Catastrophic oil spills, while rare, can have significant and complex socioeconomic impacts. The low rate of occurrence of catastrophic spills combined with the immediacy of their impacts mean that research efforts are difficult to plan in advance. Additionally, these research efforts must rely on existing baseline data if they are to illustrate changes resulting from a spill. Such research is difficult to incorporate into existing agency and university studies models that require months or years of planning, preparation, and contracting before a study can begin. For these reasons, much of the existing research on oil spills took place after the fact and the opportunity to gather baseline data pertinent to understanding oil spill impacts or data on what occurs during the early days, weeks, months, or years was lost. For example, during the *Deepwater Horizon* spill in 2010 only one federal agency was able to respond with a study of the socioeconomic impacts as they were occurring (Austin *et al.* 2014). This was not planned in advance. BOEM was lucky enough to have a seasoned team of contractors conducting fieldwork in the area at the time and could quickly redirect the research. In years following the spill, considerable resources were devoted to understanding the disaster's impacts (NAS 2017), but none of the later research could make up for their lack of baseline knowledge and early, sustained data collection.

Rapid-response research protocols exist for disaster research (*i.e.*, NHC 2017, NIEHS 2017). These protocols are not suited to BOEM's needs because they cover many kinds of disasters and are therefore assured a steady stream of research opportunities. BOEM's interest is focused on catastrophic oil spills occurring on the OCS. The rarity of this combination presents challenges to program and study development and funding not addressed by existing rapid-response protocols.

While BOEM's geographic focus presents challenges, it also offers an opportunity: socioeconomic monitoring of affected areas would provide baseline information that much disaster 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 catastrophic oil spill research plan. This study will provide expert and technical support by identifying best practices in disaster research applicable to understanding the socioeconomic impacts of catastrophic oil spills. The objectives for this study are:

1) To identify key background data to support research effort on catastrophic oil spills in the GOM that should be collected as part of a long-term monitoring plan and best practices for collecting that data; and

2) To describe and assess protocols for socioeconomic disaster research and suggest adaptations to meet ESP's requirements as specified by the GOMR.

Methods: This study will provide a series of deliverables reviewing and analyzing existing socioeconomic disaster 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 disaster research. Deliverables will consist of, but will not be limited to, workshops with BOEM staff and experts, reports resulting from those workshops, an annotated bibliography, and a series of white papers including: best practices in disaster research relevant to socioeconomic impacts of oil spills, details of baseline data necessary for a holistic understanding of these impacts, and technical analyses of existing rapid-response research protocols.

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Revised Date: April 10, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: The Visual Impacts of Outer Continental Shelf (OCS) Activities on Horn and Petit Bois Islands

BOEM Information Need(s) to Be Addressed: This study will evaluate the visual impacts that could result from OCS oil and gas activities near Horn and Petit Bois Islands, which are part of the Mississippi District of the Gulf Islands National Seashore (GUIS). The visibility of platforms (during day and night) and OCS vessel traffic could potentially affect the wilderness character and visitor experience of the national seashore. This information would be used in future Environmental Impact Statements (EISs) to meet requirements of the National Environmental Policy Act (NEPA), particularly in light of recent participation by the National Park Service (NPS) in Bureau of Ocean Energy Management (BOEM) EISs.

Approx. Cost: (in thousands) $300 **Period of Performance:** FY 2018–2020

Description:

Background: The GUIS consists of two mainland portions and four barrier island portions in the northwest Florida panhandle, and a mainland section and six barrier islands in Mississippi. In 1978, Horn and Petit Bois Islands in the Mississippi District of the GUIS were designated by the U.S. Congress as having Wilderness status. This status reflects the pristine and undeveloped nature of these islands that are important to island visitors. OCS structures have existed close to these islands. Most of these have been removed; a few structures remain 7–10 miles away. The NPS, while participating as a Cooperating Agency for recent Lease Sale EISs, has raised concerns regarding the potential visual impacts from OCS activities on Horn and Petit Bois Islands. For example, NPS is concerned about the impacts of platform lighting on the visual experiences of these islands at night. No prior studies have analyzed the impacts of the historical OCS structures near Horn and Petit Bois Islands on visitor experiences. BOEM has done some work regarding the potential visual impacts of renewable energy facilities in the Atlantic Ocean. For example, BOEM procured the Visual Impact Evaluation System for Offshore Renewable Energy (VIESORE), which is a computer tool that creates spatially accurate visualizations of offshore renewable energy facilities from multiple viewpoints in order to perform visual impact assessments.

Objectives: The objectives of the study are to:

- Determine the visual impacts arising from existing OCS activities near GUIS. This includes impacts from platforms, lighting, and vessel traffic.
- Determine the visual impacts that could arise from future OCS leases.

- Identify cumulative visual impacts to GUIS. For example, there is a high amount of non-OCS vessel traffic near GUIS.

- Identify possible measures to mitigate impacts.

Methods: There are various potential methods to address the objectives of this study. The ultimate methods chosen will depend on budget constraints, the availability of the required information, and the trade-offs these methods offer. Some potential techniques to estimate the visual impacts to GUIS from OCS and non-OCS sources are:

- Photographic and video analysis of platforms in the vicinity of GUIS.

- Background research and simulation analysis of the impacts of potential future OCS structures.

- Interview GUIS visitors regarding the visual impacts of current and potential future OCS structures.

- Analyze existing data on vessel traffic. For example, Portvision® is a data package that provides data on historical movements of OCS and non-OCS vessel traffic. These data could provide baseline information on the visual disturbances near Horn and Petit Bois Islands. These data could also be used to forecast the visual impacts from vessel traffic that could arise from future OCS lease sales.

- Collect night sky measurements to compare anthropogenic *vs.* natural light conditions near GUIS.

- Assemble a panel of experts to assess cumulative visual impacts, as well as potential mitigation measures.

The results from these methodologies will be synthesized into a report that puts the visual impacts from current and potential future OCS activities in context, and identifies potential mitigation measures for BOEM's consideration.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: Assessing Vessel Strike Risk to Sea Turtles at Port Fourchon, Louisiana

BOEM Information Need(s) to Be Addressed: Port Fourchon is an active port facility providing support for almost all of the deepwater outer continental shelf (OCS) activities in the Gulf of Mexico (GOM). Of the 53,000–119,000 annual vessel trips that support the OCS program in the GOM, half of these are coming out of Port Fourchon (Kaiser 2015). The risk of vessel strikes to marine protected species has been considered by National Marine Fisheries Service (NMFS) in previous Endangered Species Act (ESA) consultations for OCS activities. The 2007 Biological Opinion (BO) (NMFS 2007) recognized the risk to all 5 species of sea turtles in the GOM and authorized both lethal and non-lethal take associated with vessel strikes for OCS activities. The high concentrations of seemingly resident sea turtles found at the Fourchon jetty are similar to aggregations noted for other sea turtle studies conducted in Texas, which reported that jetty habitat received a disproportionately high amount of use (Shaver *et al.* 2013). Due to the large concentrations of resident juvenile green turtles found in such a small area, these jetties may represent important year-round developmental habitat for green turtles. As such, a study calculating the risk of OCS vessel strikes in this heavily trafficked area to resident sea turtles is warranted. Data from this study would be used for ESA consultations as well as National Environmental Policy Act (NEPA) documents which have already received public comments asking for data regarding risk of OCS vessel strikes on protected species (BOEM GOM Multisale 2017–2022).

Approx. Cost: (in thousands) $224 **Period of Performance:** FY 2018–2020

Description:

Background: In 2014, the U.S. Geological Survey (USGS) initiated a long-term capture-mark-recapture study of juvenile and sub-adult marine turtles at Belle Pass, a heavily trafficked channel that leads into Port Fourchon, on the Louisiana coast. To date, loggerhead and green sea turtles, both federally listed under the ESA, have been observed in this area in the GOM. Many anthropogenic factors threaten turtle survival and long-term assessments are necessary to evaluate the impacts of anthropogenic activities on turtles, especially in the northern Gulf (Hart *et al.* 2014, Coleman *et al.* 2016). Stranding data indicates that coastal bays in the Gulf are important habitat for juvenile marine turtles, but there is still a lack of knowledge of juvenile habitat utilization patterns (NMFS and USFWS 1991, NMFS *et al.* 2011, Lamont *et al.* 2015). Considering that the aforementioned USGS study is still ongoing, along with the high OCS traffic use of Port Fourchon, a collaborative effort with USGS to analyze the risk of vessel strike to sea turtles occupying this area is needed.

Objectives: This study addresses the following questions:

- What is ship traffic volume by time of day, day of year, and how does this correspond to sea turtle movement in the area?

- What are the residency rates of tagged individuals within the area and do they fluctuate over time?

- What proportion of turtles captured has visible injuries and what are the potential causes such as recreational boat strikes, interaction with commercial boats, or entanglement/ingestion of fishing gear?

- What are the movement rates of turtles across the canal, between jetties, and up the Bayou Lafourche?

- What is the health/status of the sampled turtles?

Methods: From the ongoing study, USGS used dip nets at the bow of a 25' motorboat to capture turtles along a pair of 0.64 km rock jetties (Figure 1); the sampling periods occur bi-annually in May and December. To date, 89 turtles have been captured.

Figure 1. Sea turtle capture locations.

Of these 89 capture events, all captures had not been previously tagged elsewhere, 78 were first-time captures and 11 were recaptures from the ongoing study's previous tagging efforts (12% recapture rate). Each captured turtle receives a standard assessment which includes recording morphometric measurements, documenting injuries, applying individual identification tags, and taking blood and tissue samples for genetics, health, and stable isotope analyses. The current study will continue capture-mark-recapture efforts (twice annually) and continue sampling turtles to address condition of individuals (Figure 2).

Figure 2. Juvenile Loggerhead with injury.

Additionally, the proposed Interagency Agreement would:

- tag captured turtles with acoustic tags (V13s) (recaptures would be highest priority);
- design, deploy, and test an acoustic telemetry array to detect movement patterns and occupancy rates of tagged turtles across the study site (at both east and west jetties, offshore of jetties, and further inland up the Bayou Lafourche); and
- utilize a web-based automatic identification system (AIS) to determine ship traffic volume by time of day and day of year, vessel speeds, vessel types (commercial, recreational, *etc.*), and amount of oil and gas related traffic across the study site to assess the risk of vessel interactions with tagged sea turtles (www.marinetraffic.com).

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Revised Date: April 10, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: An Analysis of Seafloor Impacts on the Gulf of Mexico Outer Continental Shelf (OCS) for Adaptive Impact Mitigation

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) manages a complex range of activities across the spectrum of oil and gas infrastructure 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. 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. A guide that provided a scale and context to industry activities under Agency review would 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 mitigation strategies for preserving natural and cultural resources when doing NEPA and National Historic Preservation Act (NHPA) assessments.

Approx. Cost: (in thousands) $150 **Period of Performance:** FY 2018–2021

Description:

Background: BOEM's comprehensive site-specific review process for compliance with NEPA and NHPA requires a great deal of practical understanding of general oil- and gas-related industry practices for the completion of the work. Many of the SMEs rely on the experience of others or are required to make "Requests for Information" to the operators which can often slow the permitting process. 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.

Objectives: The study's objective is to create a guide explaining how common industry activities impact the seafloor. 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. For example, it was only learned by accident some years ago that pipeline installers could install mid-line buoys to eliminate contact with the seafloor from anchor chains.

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:

- 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? Are alternative methods available that could reduce these impacts?
- 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?
- Descriptions of various rigs and the bottom impacts from each.
    - Example: How big is a 4 ton anchor? Would an alternative anchor type, such as a suction pile anchor, provide equivalent control with a smaller impact area?
- 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?
- 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?

Revised Date: April 20, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM

Administered By: GOM OCS Region

Title: Improving Air Quality (AQ) Remote Sensing Products for Managing Applications in the Gulf of Mexico (GOM) Region

BOEM Information Need(s) to Be Addressed: During an AQ Remote Sensing Training in Atlanta, Georgia in September 2015, the Bureau of Ocean Energy Management (BOEM) presented ideas of collaboration to the National Aeronautics & Space Administration (NASA) to explore the applicability of satellite data for AQ applications in the GOM and a proposal was submitted to the NASA Digital Earth Virtual Environment and Learning Outreach Project (DEVELOP) National Program. Using NASA Earth observing satellites, this preliminary project would create a methodology for BOEM to monitor atmospheric pollutants in the GOM. BOEM alone does not have the technology or the monitor network to address interconnected air quality concerns and remote sensing information. As satellite data provides coverage and a long-term (15+ years) record of metrics related to air quality in the region, BOEM is especially interested in utilizing NASA satellite imagery and data processing techniques that are relevant to BOEM's needs of monitoring AQ in the offshore environment of the GOM. These data will help answer questions pertaining to the impact of emissions from outer continental shelf (OCS) oil and/or gas producing activities *vs.* terrestrial sources, and the impacts of these emissions at least on onshore ozone and particulate matter concentrations. The outcome from this project suggested that Terra Moderate Resolution Imaging Spectroradiometer (MODIS) and Aura Ozone Monitoring Instrument (OMI) satellite data have significant potential for AQ applications; however, there is a gap in offshore observational data, specifically atmospheric profiles to calibrate AQ satellite products, to make them useful for managing applications.

This study proposes combining unmanned aircraft system (UAS) and miniature AQ sensors to fill the gap of atmospheric profiles as the BOEM-NASA project has suggested. UAS provides a novel and cost effective approach for monitoring uses, avoiding expensive cost of maintenance and operations, and reducing human risks at remote areas or harsh conditions. Deploying AQ instruments in UAS, and flying these aircraft simultaneously when the NASA satellites cross the GOM, allows a practical alternative to gathering AQ information of the atmospheric column to be used in correcting remote sensing data to support BOEM's mission.

Approx. Cost: (in thousands) $900 **Period of Performance:** FY 2018–2020

Description:

Background: UAS technologies are evolving rapidly and have been increasingly used in multisectorial fields. In environmental management, pollution monitoring, and AQ merging UAS and sensors confront some issues—like payload, hover capabilities,

operating altitude, battery life and endurance, sensor limits, post-processing imagery, improving algorithms for end products, and ultimately tolerance to environmental conditions (winds and temperature)—of operation. Because of these issues, two phases are considered to carry out this project. First, a period (two months) for testing UAS systems and AQ sensors to assess comprehensive limits of operation for UAS and AQ sensors, levels of accuracy, and determine possible adjustments in the operational system. Then, field measurements during several days depending on weather conditions during two seasons. AQ sensors in the range of visible and infrared frequencies have been tested to achieve concentration measurements and monitoring transport of aerosols pollutants, and they are currently supporting management operations (CAPPS 2008; Ramanathan *et al.*, 2007). The U.S. Environmental Protection Agency (EPA) already has sampling platforms to deploy on UAS with the capability to measure pollutants regulated by BOEM including CO, fine particulate matter ($PM_{2.5}$), and Volatile Organic Compounds and is currently developing lightweight sensors for aerial measurements. An interagency collaboration along with possible contracting is envisioned to carry out this project.

Objectives: There are key interrogations to address at the beginning of this study, including:

1. What is the state-of-the-art technology that can be transported by UAS to obtain useful information to perform AQ missions of BOEM in the GOM?

2. What is the accuracy and limits of applicability of miniature AQ sensors to measure pollutants?

3. Is the range of UAS technology operation capable of sampling the coastal boundary layer height (about 1 miles vertically) in Louisiana to survey local short-term variability?

Methods: There is a high density of emission sources and production activities within 25 miles (40 kilometers) from shore in the Central Planning Area of the GOM, making this area ideal for testing and executing this project. Overland travels in transects toward coastal emission sources are planned for the test (to evaluate limits and accuracy of sensors) and field sampling phases. Sampling the area will be achieved in short periods (hour or less) while satellites are crossing over the GOM. Simultaneously, this project provides an unprecedented approach to evaluate variability of air pollution transport and their range of properties (type, size, concentrations, and estimate of volumetric distribution). This project is proposing a combination of mobile lab and UAS for testing and assessing performance of UAS in a very initial test; the performance evaluation of UAS's air quality sensors; and for the first time proposing algorithms to calibrate sensor's readings with actual measurements. Once the initial phase is accomplished, flying UAS-AQ sensor system simultaneously to satellites crossing the GOM will be achieved, aiming to obtain a correction methodology to improve NASA AQ satellite products in the GOMR.

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Revised Date: April 7, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: Wind Resource and Ecological Measurements to Inform Offshore Wind Feasibility in the Gulf of Mexico

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) is in the process of assessing wind energy feasibility in the Gulf of Mexico (GOM) to inform potential development activities within the Bureau's purview under the Energy Policy Act of 2005 (EPAct). These regulations provide a framework for issuing leases, easements, and rights-of-way for outer continental shelf (OCS) activities that support production and transmission of energy from sources other than oil and natural gas. This study will help inform BOEM's strategic long-term planning related to the potential for OCS alternative-leasing activities in the GOM by providing measurements of hub-height winds and ecological data in areas of highest wind energy feasibility. The data will help provide validation of modeled hub-height wind fields recently provided by the National Renewable Energy Laboratory (NREL). The study would support National Environmental Policy Act (NEPA) impact assessment and consultation and coordination activities.

Approx. Cost: (in thousands) $1,000 **Period of Performance:** FY 2018–2021

Description:

Background: The Department of Energy (DOE)/Department of the Interior (DOI) National Offshore Wind Strategy (2016) identified approaches for facilitating the development of the offshore wind industry in the United States. Two of the key challenges identified included the need for offshore wind power resource characterization and collecting environmental data for sensitive biological resources to support effective stewardship. Wind measurements at heights relevant to wind turbines ("hub height") are non-existent in the GOM beyond a single metocean tower off Galveston. More cost-effective technologies for collecting hub-height wind measurements have been developed, including various forms of Light Detection and Ranging (LiDAR) (Terray *et al.*, 2014), and have been effectively utilized for data collection in the Atlantic. Additional environmental sensors have also been co-located with metocean sensors to collect data on the presence of potentially sensitive biological resources and to ultimately inform appropriate mitigations for minimizing impacts of offshore wind installations on wildlife.

Objectives: The purpose of this study is to inform offshore wind feasibility and related wildlife mitigations in the GOM through collection of offshore wind resource and ecological data. The questions to be answered by this study are:

(1) What are the observed characteristics of hub-height winds in the northern GOM?

(2) How do actual wind resource measurements compare to current estimates for the region?

(3) What is the observed occurrence of potentially-sensitive biological resources in the area?

(4) How do these ecological measurements inform potential mitigations to minimize impacts of turbines on wildlife?

Methods: Partnerships will be explored with DOE, including their LiDAR Buoy Loan Program, given mutual interest in ground-truthing NREL's wind resource model results. Study locations for co-located wind resource and ecological measurements will be chosen based on the best available understanding of offshore wind feasibility in the GOM, including results from ongoing BOEM studies, such as the "Offshore Renewable Energy Feasibility Study Across Technology Types for the U.S. Gulf of Mexico". Sampling design will seek to maximize areal coverage, whether through use of multiple fixed point measurements or volumetric scanning technologies using LiDAR, and may include a combination of OCS and State waters. Cost-effective and innovative solutions will be developed based on encouraging partnerships, leveraging existing oil and gas platforms, and broadly assessing available technologies. For example, offshore wind resource measurements can be made from fixed sensors on offshore structures, integrated floating buoy systems, and volumetric scanning technologies from shore. It is anticipated that a continuous time series of ~1–2 years' worth of measurements will be collected as part of this study. Data will be analyzed to understand characteristics of hub-height winds, including average speed/direction, variability, and extremes due to storm events. Data will be used to validate current wind model estimates.

Study design will also include ecological measurements for key biological species that could be impacted by potential offshore wind development (*e.g.*, birds, bats, marine mammals, sea turtles, or other wildlife). Again, cost-effective and innovative solutions for integrating metocean and ecological measurements will be considered, such as using co-located biological sensors on the same platform or remote observation technologies (*e.g.*, radar, thermal, or aerial imaging). The time series of biological data will provide presence/absence and possibly species-specific information and will be used to inform recommendations for wind-wildlife mitigations including timing of operations.

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Revised Date: April 5, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: Investigation of an 18th Century Shipwreck as an Analogue for Archaeological Resource Types on the Outer Continental Shelf (OCS)

BOEM Information Need(s) to Be Addressed: Bureau of Ocean Energy Management (BOEM) meets its requirements under Section 106 of the National Historic Preservation Act (NHPA) and Section 1340(g)(3) of the OCS Lands Act in part by requiring industry and/or Marine Minerals Program (MMP) lease applicants to conduct remote-sensing surveys to identify potential historic shipwrecks in a project's Area of Potential Effect. While these surveys are considered effective at identifying shipwrecks that have features exposed above the seabed and detectable with sonar, there is much less confidence in their ability to accurately identify buried wooden shipwrecks or associated vessel remains that are detectable only with a magnetometer. In spite of over 40 years of industry surveys in the shallow waters (<100 m) of the Gulf of Mexico (GOM) OCS, and a projected ratio of historic wooden-hulled shipwrecks to metal-hulled wrecks estimated to be as high as 13:1 (Gearhart 2011), no wooden-hulled shipwreck has ever been confirmed to date based solely on the data from an industry magnetometer survey. Using a targeted survey that exceeded industry survey requirements, a current BOEM study has located a suspected 18th Century buried shipwreck. This site is illustrative of the type of historic shipwrecks likely to be encountered throughout the GOM OCS, particularly in shallow-water areas that may be targeted for future Marine Minerals leasing. An intensive remote-sensing survey and archaeological excavation of this site will provide BOEM, and the Gulf states, with information on historic resource and site preservation potential in the Gulf, and what survey parameters are required to locate similar OCS resources. This information will further inform BOEM's survey guidance, National Environmental Policy Act (NEPA) analyses, mitigation effectiveness, MMP project planning, and NHPA consultations.

Approx. Cost: (in thousands) $350 **Period of Performance:** FY 2018–2020

Description:

Background: Numerous studies, including several sponsored by BOEM, have attempted to determine the optimal methods for collecting and analyzing magnetometer data to identify buried shipwrecks. These methods are typically targeted to identify potential wooden-hulled sailing vessels which, relative to metal-hulled vessels or wooden-hulled steam vessels, have the lowest mass of ferromagnetic components and are, therefore, the most difficult to detect in a remote-sensing survey. Though the federal, state, academic, and private archaeological community at-large has steadily improved the accuracy and reliability of survey data collection and analytical methods, BOEM's survey and reporting requirements have not kept pace. As a result, BOEM's practices effectively minimize the chances of confidently identifying a buried, historically-significant wooden-hulled shipwreck, while also maximizing the occurrence of false positives. This

is evident in the fact that no buried wooden-hulled sailing vessel has ever been confirmed as a result of industry surveys, which have covered hundreds of lease blocks in areas where shipwrecks were common, despite this being the only type of vessel in use during almost the entirety of the 400 years of GOM maritime history between European discovery and the turn of the 20th Century. Conversely, numerous diver investigations of magnetic anomalies as a result of BOEM mitigation requirements have consistently resulted in identifying modern debris or nothing at all. Resultantly, BOEM has no examples of wooden-hulled shipwreck discoveries that can be used to test, confirm, or refine either its own current survey requirements or the more rigorous standards of the scientific community.

In 2016, however, such an example was located on the Gulf side of the Chandeleur Islands, in Louisiana state waters. Even though the site is not on the OCS, it is a useful analogue for shipwrecks sites that are expected to be present in BOEM's oil and gas and MMP lease areas, and has the additional benefit of being easily accessible for further study. The site was previously discovered by local fisherman, and was the subject of a 1989 BOEM study. That study did not identify any wooden remains and, therefore, concluded the site was not a shipwreck but rather a collection of ship's ballast that had been dumped from a late-18th Century vessel. Detailed location information for the site was not recorded, and multiple BOEM attempts to return to the site since 1989 had been unsuccessful. In 2016, the site, which is now buried under three feet of sand, was rediscovered after intensive survey during a BOEM study to analyze the potential impacts to cultural resources at significant sand extraction areas. Diver investigations documented evidence that portions of the wooden hull do in fact remain preserved and buried under the sand and ballast pile, casting doubt on the 1989 study's conclusions. Comparison of artifacts recovered from the site in 1989 to those from other known shipwreck sites has also moved the potential date of the wreck to the early 18th Century, possibly contemporaneous with or pre-dating the founding of New Orleans. The site is expected to be eligible for nomination to the National Register of Historic Places (NRHP).

Objectives:

1) Assess the age, nationality, type, function, historic context and NRHP eligibility of the shipwreck.

2) Quantify the amount of ferromagnetic material within the site to correlate with the magnetometer survey data, and to establish baseline assumptions about archaeological site characteristics and preservation potential likely to be found elsewhere on the OCS.

3) Test and examine the effectiveness of BOEM's magnetometer survey requirements to identify this shipwreck, or others similar to it, were its location not already known.

4) Recommend improved survey and data analysis guidance, as necessary, for both oil and gas and marine minerals projects.

Methods: First, a systematic remote-sensing survey of the site at variable line spacing and orientation to compare the potential results of a blind survey. Second, an archaeological excavation will be conducted to remove the sediment overburden and ballast, followed by the creation of a detailed site map and *in situ* catalog of extant artifacts and ferromagnetic materials. Selected diagnostic artifacts may be recovered and conserved for further analysis and public education if appropriate curation agreements with the State of Louisiana can be arranged in advance. The final report will document the results of the remote-sensing and diver investigations, provide an archaeological and historical analysis of the site, and recommend survey data collection and analysis methods for identifying similar shipwrecks likely to be buried elsewhere on the OCS. A project webpage and other public outreach materials will also be required. Finally, eligibility to the NRHP will be determined; if the site is deemed an historic property, it will be formally nominated in collaboration with the appropriate State Historic Preservation Office.

References:

Gearhart, Robert L. 2011. Wooden Shipwrecks of the Central and Western Gulf of Mexico. Offshore Technology Conference, Houston, Texas, May 2011.

Revised Date: April 30, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: Effect of Oil Contamination on Wetland Loss in Louisiana

BOEM Information Need(s) to Be Addressed: The *Deepwater Horizon* (*DWH*) oil spill was the largest in the history of the U.S. In Bureau of Ocean Energy Management (BOEM) National Environmental Policy Act (NEPA) cumulative impact analyses BOEM evaluates the incremental contribution of the proposed action to all other activities impacting coastal wetlands, and essentially permanent loss of wetlands due to the *DWH* spill must be part of that analysis. Further information is needed to understand how oil spills from BOEM-regulated activities impact rates of wetland loss in comparison to other factors such as rising sea levels, pipelines, and other physical disturbances. There is significant evidence that wetland loss is an ongoing impact related to *DWH*. BOEM needs to understand the chronic and cumulative impact from offshore activities for our NEPA analyses. Therefore, a better understanding of the specific impact of the *DWH* oil spill on wetland loss is needed. This study will examine patterns of shoreline recession, using photography of the most highly impacted areas of the coast over time, to differentiate wetland loss caused by oil contamination from other sources. BOEM will use the information to support the Outer Continental Shelf Lands Act (OCSLA) and NEPA process when preparing Environmental Impact Statements.

Decision-making during spill response, particularly the use of dispersants, greatly affects the resulting impacts to wetlands. BOEM's contribution to this study could provide vital information that could influence future response actions (by the Coast Guard). The information would also be helpful in responding to public comments and cooperative agency comments on NEPA documents.

Approx. Cost: (in thousands) $378 **Period of Performance:** FY 2018–2019

Description:

Background: Coastal habitats, including wetlands, are important resources in the Gulf of Mexico (GOM) region, providing habitat to an immense number of species of plants and animals. A U.S. Geological Survey (USGS)-National Aeronautics & Space Administration (NASA) study applied Polarimetric Synthetic Aperture Radar (PolSAR) images collected in 2009 (pre-oil spill), 2010 (oil spill and clean-up), 2011 (oil spill clean-up), and 2012 (Hurricane Isaac) covering the heavy oil impact in Barataria Bay. That study documented for the first time that shoreline erosion dramatically increased during the clean-up period and that the intense shoreline recession caused by Hurricane Isaac distinctly differed in pattern from recession associated with the oil spill clean-up (Rangoonwala *et al.* 2016). That study used limited photography for validation and covered only one of the severely oiled coastlines. A complementary study is needed now that extends the PolSAR mapping spatially to more of the Delta and to the present day, in conjunction with photographic shoreline mapping. USGS and NASA would conduct this study with funding from BOEM's Environmental Studies Program.

Objectives: This study will extend the previous successful PolSAR and photographic shoreline mapping, both spatially and temporally.

- The combined PolSAR and photographic shoreline mapping will allow cross-validation of results and further substantiate a new mapping technology while providing photographic-based maps conforming to historic mapping. While this methodology is relatively new, the earlier study was based on a smaller area and fewer years of data. This effort would cover much of the most highly contaminated area in Louisiana's coastal marsh, providing an estimate of the damage caused by the spill.

- Extend the shoreline mapping from 2009 to 2015 (data now available) to selected deltaic coasts with known oiling and non-observed oiling. The proposed work area would cover the western half of Barataria Bay to the Louisiana-Mississippi border. Those maps and their analysis would improve the holistic assessment of the oil spill impacts and their long-term consequences to coastal wetland resilience.

Methods: PolSAR mapping is based on a calibrated and georeferenced 2-m NASA-Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)* data product (Fore *et al.*, 2015), web-available image processing, and the USGS Digital Shoreline Analysis System based on common geographic information system (GIS) procedures (Rangoonwala *et al.* 2016). Photographic collections in 2008, 2010, and 2011 to 2015 of the Mississippi River Delta are available. Those photographic sets will be interpreted to provide shoreline positions and combined with PolSAR-based shorelines to calculate shoreline change.

Many of the published studies of land-loss related to shoreline oiling from the *DWH* spill were ground-based studies focused on particular areas (Turner *et al.*, 2016; McClenachan *et al.*, 2013). This study will use pre-spill, post-spill, and post-hurricane photography to examine how the patterns of shoreline recession, rather than the shoreline recession at particular locations, are directly relatable to different causes.

*please see https://uavsar.jpl.nasa.gov/education/what-is-uavsar.html

References:

Fore, A. G., B. D. Chapman, B. P. Hawkins, S. Hensley, C. E. Jones, T. R. Michel, and R. J. Muellerschoen (2015), UAVSAR polarimetric calibration, IEEE Trans. Geosci. Remote Sens., 53(6), 3481–3491, doi:10.1109/TGRS.2014.2377637

McClenachan, G., Turner, R.E., Tweel, A.W. 2013. Effects of oil on the rate and trajectory of Louisiana marsh shoreline erosion. Environ. Res. Lett. 8, 044030.

Rangoonwala, A., C. E. Jones, and E. Ramsey III. 2016. Wetland shoreline recession in the Mississippi River Delta from petroleum oiling and cyclonic storms, Geophys. Res. Lett., 43, doi: 10.1002/2016GL070624

Turner, R.E., *et al.* 2016. Islands in the oil: Quantifying saltmarsh shoreline erosion after the *Deepwater Horizon* oiling, Marine Pollution Bulletin http://dx.doi.org/10.1016/j.marpolbul.2016.06.046

Revised Date: April 6, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Central GOM

Administered By: GOM OCS Region

Title: Deepwater Ecosystem Observations at the Stones Project in the Central Gulf of Mexico

BOEM Information Need(s) to Be Addressed: As stated in the Outer Continental Shelf Lands Act (OCSLA), the Bureau of Ocean Energy Management (BOEM) requires environmental monitoring data designed to provide time-series information for the purpose of identifying any significant changes in the quality and productivity of marine environments potentially impacted by oil and gas (O&G) activities over the multi-decadal time scale of leases. This study will help establish a new time-series of biological, water quality, and oceanographic measurements in central Gulf of Mexico (GOM) ultra-deep waters (>5,000 ft). These data will allow BOEM to better assess changes in environmental quality and productivity potentially due to deepwater O&G activities, and will inform BOEM's environmental documents in compliance with the National Environmental Policy Act (NEPA).

Approx. Cost: (in thousands) $750 (+ partnering funds/assets) **Period of Performance:** FY 2018–2022

Description:

Background: In the GOM, a vast majority (~82%) of oil production comes from wells drilled in 1,000 feet of water or greater. However, long-term environmental monitoring measurements are rare in deep waters (>1,000 ft) largely due to expense and access. A new deepwater monitoring asset has recently become available in the GOM that offers a promising beginning platform for initiating long-term environmental monitoring. Royal Dutch Shell plc's (Shell's) new Stones field is the world's deepest oil and gas project, operating in around 2,900 meters (9,500 feet) of water in an ultra-deep area of the U.S. GOM (Walker Ridge Block 508). The project started production in September 2016 from a floating production, storage, and offloading (FPSO) facility. A new, independent metocean mooring is near the FPSO facility and currently measures the speed, direction, and temperature of water currents for monitoring potential Loop Current impacts. Shell plans to share parts of the metocean mooring with universities and research institutions, making extra space available to study the ocean's various zones, circulation in deep ocean environments, and the numerous organisms that inhabit this unique ecosystem. Expanded monitoring at the Stones Project offers the potential for obtaining long-term deep-ocean time series data during the life of the project—up to two decades and potentially longer through Gulf partners.

Oceanographic properties at the Stones Project location are characteristic of ultra-deep waters in the central GOM. This area is routinely impacted by Loop Current features and eddies, which are associated with high speed currents, changes in nutrient levels, and markedly different biological communities (*e.g.*, chlorophyll, primary production, and zooplankton) compared to ambient waters. These deep waters also provide habitat

for highly migratory species such as bluefin tuna, blue marlin, and whale sharks (Brenner *et al.*, 2016), in addition to marine mammals, sea turtles, and seabirds that may migrate through this region. The abundance and distribution of these living marine resources (*e.g.*, prey distributions and soundscape) are critically important to BOEM.

Objectives: The purpose of the study is to expand environmental monitoring in the ultra-deep Gulf around the Stones Project, to initially include 3 years of baseline measurements of biological, biogeochemical, and physical variables. Questions to be answered by this study include:

(1) Which Essential Ocean Variables (EOVs) can best be sustained at this deepwater location to provide long-term measures of ecosystem health and productivity?
(2) What sample design in and around the Stones site most robustly resolves ecosystem processes?
(3) Following initial measurements obtained through this study, what is the observed biological and biogeochemical baseline against which to assess future trends?

Methods: This study will be accomplished in partnership with Shell and other interested parties to establish a study design and a baseline environmental dataset, with a view towards collecting long-term observations. An initial assessment will be performed with existing environmental data to determine the best experimental design. This design will consider utilizing the existing metocean mooring line, potential to collect measurements using autonomous underwater vehicles (AUVs) around the site, and close proximity to Mexican waters where an additional mooring or measurements could potentially be established. The location of the Stones project relatively near the boundary of the U.S. Exclusive Economic Zone may provide a unique opportunity for U.S. and Mexican scientists to work together on deep water data collection. The focus will be to incorporate new technologies that can collect biological information across trophic levels and water quality datasets, such as for dissolved oxygen, pH, nutrients, and chlorophyll. Consideration will be given to use of bio-optical instrumentation, passive acoustic monitoring, active acoustics for plankton and fish, acoustic receivers for tagged animals, and camera/video systems. It is anticipated that a broad range of observing platforms will be applicable to this study, including moorings, AUVs, satellites, and ship-based measurements. All measurements will be made actively available to a broad user community through publicly-available archives, including the Gulf of Mexico Coastal Ocean Observing System (GCOOS) web portal. The products of this study will include a baseline time-series dataset at the Stones location, time-series analysis describing variability, quarterly status reports, progress presentations, a final report, and a plan for long-term monitoring.

References:

http://www.shell.com/inside-energy/scientists-gain-new-line-to-the-deep-ocean.html

Brenner, J., C. Voight, and D. Mehlman. 2016. Migratory Species in the Gulf of Mexico Large Marine Ecosystem: Executive Summary. The Nature Conservancy, Arlington, 20 pp.

Revised Date: May 1, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: A Profiling-Buoy Based Survey for the Deep Gulf of Mexico

BOEM Information Need(s) to Be Addressed: The observations from these buoys will extend the climatology of temperature, salinity, bio-optical properties, and dissolved oxygen in the Gulf of Mexico's (GOM's) deep waters. This information will support analyses under the National Environmental Policy Act (NEPA). Specifically, the information collected could be used to assess oxygen changes due to deepwater oil spills, and how Loop Current eddies affect the particle distribution which in turn affects marine mammals.

Approx. Cost: (in thousands) $2,000 **Period of Performance:** FY 2019–2024

Description:
Background: The post-Macondo oceanographic community of the GOM has expanded its interest in near real-time observing systems. The idea behind the change is the belief that availability of oceanic observations will make response to oil spill events more effective while increasing our understanding of oceanographic processes. The Bureau of Ocean Energy Management's (BOEM's) Environmental Studies Program responded to this expanded view by emphasizing monitoring-centric studies and coordination with Federal and state agencies. Because of the areal extent, bathymetric range, and the diversity of information needs along with geographic concerns, creating a single unified observing system for the basin with available resources seems out of reach. However, BOEM studies and experiences with different observing platforms suggest that a reasonable and affordable observing system of deep waters could be made by using profiling buoys equipped with conductivity, temperature, and depth (CTD) systems and bio-optical and oxygen sensors reporting in near real time. Such data benefits BOEM, Federal and State Governments, academic scientists, and other stakeholders.

Objectives: To expand the CTD, bio-optic, and oxygen climatology of the upper 1,500 m of the GOM's deep waters and statistically summarize these observations. Additionally, these observations will be contrasted to existing databases and used to help detect changes if present.

Methods: This study will be conducted using 14 drifting profiling buoys collecting continuous profiles of the upper 1,500 m (7 CTD/bio-optic & 7 CTD/oxygen) released in the deep waters (U.S. and Mexican territories) of the GOM for four (4) years. Observations will be distributed and archived in near real-time through an existing data distribution center (*e.g.*, National Data Buoy Center). The amassed database will be subject to quality assurance/quality control (QA/QC) procedures and analyzed using simple statistical techniques.

Revised Date: January 27, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM; Eastern GOM

Administered By: GOM OCS Region

Title: Social and Economic Impacts of Outer Continental Shelf (OCS) Activity on Individuals and Families: Sociocultural Monitoring

BOEM Information Need(s) to Be Addressed: One of the top priorities for the Bureau of Ocean Energy Management (BOEM) is to strengthen its monitoring of the OCS program under the National Environmental Policy Act (NEPA), and BOEM has yet to establish a socioeconomic monitoring system. This study will update the BOEM study "Social and Economic Impacts of Outer Continental Shelf Activity on Individuals and Families" (Austin *et al.* 2002) and develop it into the basis for a socioeconomic monitoring system. The original Austin *et al.* 2002 study has served as the primary source for BOEM analyses of local-level socioeconomic conditions and effects for the last 14 years and has been consistently cited by every Gulf Environmental Assessment ever since its publication. Monitoring sociocultural and socioeconomic impacts is recognized by BOEM as an undertaking that must be pursued. This study will address this urgent need to establish a methodology and system for continued monitoring. Because this monitoring system will provide rich, systematic, and comparable information over time through repeated studies it will, like the original Austin *et al.* 2002, continue to provide significant support for social and economic impact analyses in all NEPA-related documents.

Approx. Cost: (in thousands) $675 **Period of Performance:** FY 2019–2023

Description:

Background: The coastal Gulf, its communities, and the OCS industry have gone through many changes and witnessed great shocks during the last several years and, as a result, Austin *et al.* (2002)—the basic source for community-level socioeconomic baseline and analysis—needs to be updated. As an extension of the original BOEM study (Austin *et al.* 2002), this effort represents an important first step toward establishing a strong socioeconomic monitoring system in the Gulf of Mexico Region (GOMR). If the past is any measure, one cannot anticipate all the significant factors that will be driving Gulf oil or shaping Gulf families and life 10 or 20 years hence. However, the basic areas of BOEM local-level socioeconomic concerns are more stable than are these drivers. For example, Austin *et al.* (2002) indicates that many oil industry effects on family community life relate to changing labor demands or conditions of work, what the industry needs, how schools, family, and individuals respond, *etc.* BOEM seeks a monitoring system that compares and contrasts family life effects among communities to assess salient conditions and factors, and compares and contrasts these with earlier ones to monitor changes in industry effects on family life. This study will establish the methodology for sociocultural monitoring and will begin to address wider Gulf socioeconomic monitoring questions.

Objectives: The main objective of this study is to better understand the issues, approaches, and methodologies relevant to Gulf socioeconomic monitoring. A secondary objective is to improve socioeconomic assessments and knowledge of the social and economic impacts of OCS activity on individuals and families in three communities.

Methods: The analytical approach will involve comparing and contrasting community effects across time. This backward-facing approach reflects the richness of the available information as well as the unpredictability of its future, and it reflects the NEPA direction to monitor as "taking a second look." The problem is to identify approaches, methods, and systems that are sufficiently stable to support comparisons through time and sufficiently flexible to be applicable decades hence.

The study will update the original "Social and Economic Impacts of Outer Continental Shelf Activity on Individuals and Families" (Austin *et al.* 2002) study and will use similar research methods such as literature review, field-based ethnography, and community partnering. The study will include the 2 original and 1 additional study communities. Interim products are designed to facilitate early use of information to support the development of a socioeconomic monitoring program and to support environmental assessment. This study will provide BOEM with meeting reports, literature syntheses, oral transcripts, and a final report. Future updates will benefit from detailed research notes from this effort. Thus, while not normally a deliverable, to the extent practicable a record of such notes will be delivered that is stripped of personally identifiable information and other inappropriate materials. These materials would provide BOEM with the basic blueprint for follow-up monitoring studies that will be repeated approximately once a decade.

References:

Austin, D., K. Coelho, A. Gardner, R. Higgins, and T. McGuire. 2002. Social and Economic Impacts of Outer Continental Shelf Activities on Individuals and Families. Volume I: Final Report. Prepared by the University of Arizona, Bureau of Applied Research in Anthropology, Tucson. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico Region, New Orleans, LA. OCS Study MMS 2002-022. 298 pp.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Western GOM; Central GOM

Administered By: GOM OCS Region

Title: Houston and New Orleans: Urban Centers, Urbanization, and the Gulf of Mexico Petroleum Industry

BOEM Information Need(s) to Be Addressed: This study addresses two informational needs: one stemming from National Environmental Policy Act (NEPA) guidance and socioeconomic assessment, the other from the Bureau of Ocean Energy Management's (BOEM's) economic modeling. First, this study advances the Gulf of Mexico Region's (GOMR's) ongoing and challenging effort to strengthen local-level socioeconomic assessments. This study will provide local-level socioeconomic assessments for the two urban areas where the majority of past outer continental shelf (OCS) effects have occurred and many future ones will occur. In doing so, this effort will also provide tools to support additional local-level assessments of Gulf of Mexico (GOM) urban areas. Second, the GOM offshore petroleum industry has been undergoing continuous reorganization since the mid-1980s and one significant outcome has been the concentration of more industry in Texas, particularly in Houston, at the expense of New Orleans; a transformation encountered in Model of Alaska & Gulf using Impact Analysis for Planning (MAGPLAN) modeling as a "data problem." This study will provide information on the changing Houston/New Orleans situation that should refine BOEM modeling and industry assessments.

Approx. Cost: (in thousands) $415 **Period of Performance:** FY 2019–2023

Description:

Background: Beginning with a 2005 planning conference, reviews by the National Research Council, the Gulf States, and other stakeholders all directed the GOMR to develop more local-level socioeconomic assessments (NRC, 1992; Luton and Cluck, 2004; McKay and Nides, 2005). The GOMR's two-decades-long effort to do this has made great progress but has also faced great difficulties for the following reasons:

- the magnitude, geographic reach, and variability of onshore OCS-related activities;
- the many types of oil-related activities and their 100-year-long integration into their social surroundings and;
- the variety of surroundings found within the GOMR.

A major topic in the findings of the Minerals Management Service (MMS)-sponsored 2004 workshop (McKay and Nides, 2005) on socioeconomic issues for the GOMR was the lack of information on the socioeconomic effects of offshore oil and gas activities on urban communities. Economic and social effects of OCS activities primarily occur in urban areas. Much of the related employment is concentrated in large metropolitan areas. Yet, MMS/BOEM studies have basically ignored such areas, having assumed that

large city populations diffuse any socioeconomic effects so they are not as significant as those in small, rural communities.

The GOM offshore petroleum industry has been undergoing almost continuous reorganization since the oil price bust of the mid-1980s through such processes as mergers, acquisitions, joint ventures, downsizing, outsourcing, new bookkeeping and cost control procedures, and technological efficiencies. The industry move into the deepwater GOM and its continuing globalization seem to reinforce its reorganizational trends. In the GOM, one significant outcome of these changes has been the concentration of more of the industry in Texas, particularly in the Houston area, at the expense of New Orleans and such smaller centers as Lafayette, Louisiana. The analysis of the changes to industry sectors that were causes and adjustments to these shifts will further an understanding of the Houston and New Orleans impact areas, and also those of overall industry dynamics. These changes are also clearly related to other socioeconomic impacts, such as long-term low income growth in New Orleans or the recent spike in unemployment in Houston.

Objectives: BOEM seeks to understand the socioeconomic effects of the oil and gas industry on the two largest and most industry-involved urban centers in the GOMR, and also to gain insight into how the evolving oil and gas industry and its continual reorganization may or may not relate to socioeconomic trends in these two large metropolitan areas.

Methods: This project is historical and comparative. The project will use comparative approaches to illustrate similarities and differences between the development of Houston and New Orleans including their suburbs, their respective roles in the surrounding environment, and the place of the petroleum in that development. While the study will look at earlier periods (such as the 1980s when oil prices boomed and collapsed), the emphasis will be on 2000 and later, and particularly after 2007 and on current conditions and the potential consequences for the future. In doing this, the analysis will address several "standard" socioeconomic impact categories particularly relevant in examining urban effects such as community identity, shifts in the tax base, real estate markets, transportation and infrastructure, changes in residential and local business patterns, and schools and education. This effort will include the collection and analysis of standard economic data that was used by BOEM in its MAGPLAN economic modeling.

This effort should not "reinvent the wheel." Much excellent secondary literature (*e.g.*, books, monographs, government reports) exists that addresses the topics at hand and a primary method will be to identify, assimilate, and synthesize existing work along with other standard forms of literature synthesis (*e.g.*, grey literature, newspaper, magazine, and trade journal articles) and standard data sources.

However, while principally based on the collection and analysis of existing primary and secondary literature and data, other methods such as discussions with key industry and community experts and representatives will be appropriate when addressing particular research questions. For example, the analysis might address the question of Houston's locational advantages compared to New Orleans (and oil centers elsewhere in the world)

using the literature review, existing data, and discussions with knowledgeable individuals. It could then use these materials to identify the specific factors (*e.g.*, transportation, available services) that encouraged decisions to locate in the Houston area and analyze the role that changes in the industry had in creating or emphasizing these factors. Study deliverables will include a literature review, bibliography, quarterly reports, field reports, journal publications, and a final report.

References:

Luton, H. and R. Cluck. 2004. Social impact assessment and offshore oil and gas in the Gulf of Mexico. In Proceedings of the 24th Annual Conference of the International Association of Impact Assessment, Vancouver Canada- 2004. Fargo, ND: International Association of Impact Assessment. CD-ROM or published at www.iaia.org.

McKay, M., and J. Nides. 2005. Workshop on socioeconomic research issues for the Gulf of Mexico OCS Region. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region: New Orleans, LA. MMS 2005-016.

National Research Council. 1992. Assessment of the U.S. Outer Continental Shelf Environmental Studies Program: III. Social and Economic Studies (Washington D.C.: National Academies Press), app. C, 111. http://www.eoearth.org/view/article/165542/.

Revised Date: April 26, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: Understanding Biological Connectivity Among Offshore Structures and Natural Reefs

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (BOEM) needs to continue to advance its knowledge of the biological connectivity of natural reefs and anthropogenic structures in southern California, as well as understand the possible contribution of each platform to mainland and island marine communities. This information is needed to elucidate the role that offshore artificial structures may have in supplying propagules that can influence the composition and function of biological communities. This will enable BOEM to comply with the duties of federal agencies that are outlined in Section 2 of Executive Order 13112 (Invasive Species). BOEM will use study results for environmental reviews concerning existing operations and decommissioning alternatives of offshore platforms and potential marine renewable energy facilities. This study is aligned with two BOEM Strategic Science Questions:

1) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
2) How will future ocean conditions and dynamics amplify or mask effects of BOEM regulated OCS activities?

Approx. Cost: (in thousands) $800 **Period of Performance:** FY 2018–2021

Description:

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. Particular taxa of interest include the non-indigenous species (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. 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.

Objectives: The overall objective of this study is to understand biological connectivity among artificial and natural habitats using genetic markers. The following questions will be examined by this study:

- Is invertebrate species dispersal greater in the offshore than in the nearshore environment?
- Are there distinct genetic structures on groups of offshore platforms, harbors, shipwrecks, and natural reefs for native and non-native species?
- Is gene flow between populations more restricted for species with spatially limited planktonic dispersal?
- Do the genetic structures lead to confirming specific pathways for non-native species introductions?
- What are the effects of location and spacing of artificial structures on natural biological communities?

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.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Central California; Southern California

Administered By: Pacific OCS Region

Title: California Deepwater Investigations and Groundtruthing (Cal DIG) II

BOEM Information Need(s) to Be Addressed: The offshore area of south-central California has proven to be a region of competitive interest for the development of energy on the outer continental shelf (OCS). The Bureau of Ocean Energy Management (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. This area has been targeted because an obsolete power plant, located at Morro Bay, retains an operational connection to the California electrical grid and the Central Valley electrical backbone. In addition, this area has ongoing oil and gas production from OCS leases, and the infrastructure on the leases will eventually be decommissioned.

Information garnered from this study of seafloor habitats and sensitive shelf and slope features will be utilized to 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. This area, which is larger than the State of Connecticut, has potential to contain unique or sensitive areas that BOEM should consider in its decisions regarding potential leasing. Results from this study will provide a regional understanding of biological communities. That context is needed to evaluate future applicant's site-specific surveys. This study addresses three BOEM Strategic Science Questions:

1) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
2) How does BOEM ensure the integrated use of its social sciences in assessing the impacts of OCS activities on the human environment?
3) How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?

Approx. Cost: (in thousands) $1,250 **Period of Performance:** FY 2018–2021

Description:

Background: No seafloor habitat characterizations or visual surveys are available for this area, which extends on the outer slope south of Monterey Canyon south to Point Conception. The Long Term Ecological Research project has supported and supplemented the longstanding 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. Adjacent to this region in the south, Huff *et al.* 2013 found that benthic fish and invertebrate species associated with these slope reefs and canyons are statistically distinct and more diverse

than on surrounding continental slope habitats. To the north of this area, adjacent seafloor (south of Monterey Canyon) was surveyed in 1998 primarily by Monterey Bay Aquarium Research Institute. The surveys in the general bathymetric range of 300–1000 m documented diverse and sensitive habitat types including statistically significant populations of high-relief hard bottom substrates, hard and soft deep-water corals (Greene *et al.* 2003), and canyon-wall areas with a high diversity of associated sessile benthic communities 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.

Starting in FY 2017, BOEM and the U.S. Geological Survey will initiate geophysical surveys in the area of interest (Cal DIG I area, 20–35 mi offshore, 500–1200 m water depth). That effort will collect sub-bottom and multibeam sonar to assess regional hazards and generate regional bathymetry (10 m resolution) and reflectivity of the seabed. Cal DIG I geophysical data are necessary and will be used to direct subsequent biological and habitat surveys for this study. An assessment of benthic biological communities at a regional scale will identify sensitive areas and species that are sensitive to disturbance, which are factors that inform future offshore floating wind leasing and/or oil and gas decommissioning.

Objectives: The goal of this study is to provide BOEM with a regional-level characterization of seafloor (benthic) habitats and fish and invertebrate communities that exist in anticipation of commercial energy installations. The objectives of surveys offshore south-central California are to quantify benthic fish and invertebrate communities, as well as identify benthic habitats including sensitive seafloor features, such as deep-water coral communities, fish refugia, chemosynthetic areas, and historic properties (shipwrecks).

Methods: Biological and limited physical sampling is planned at multiple selected areas through two cruises and over two years. This project will primarily utilize manned submersibles or remotely operated vehicles (ROVs) capable of performing high-definition visual surveys of roughly 14 days at sea and sampling at depths of 500–1200 m. Contractor and BOEM staff will prioritize multiple target areas for habitat characterization from Cal DIG I. Depending on platform capabilities, additional high resolution bathymetry and backscatter will be collected on complement surveys conducted during Cal DIG I.

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 using high-definition video and still photo imagery capability at a variety of scales. The ROV or submersible will also collect limited samples of coral and sponge species for taxonomic identification 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 if any historic shipwrecks are encountered during the Cal DIG I surveys. The possibility of shipwrecks exists in this region 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 & Marine Ecological Classification Standard (CMECS) Biota mapping classifications and existing habitat suitability models to create geospatial maps that have the potential sensitivity to disturbance. 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.

BOEM will partner with the National Oceanic & Atmospheric Administration's (NOAA's) deep sea coral and sponge field effort in the Pacific Region during this study. BOEM is actively working to align other potentially complementary field efforts to maximize the return on federal dollars and support for multiple agency priorities.

References:

Greene, H.G., J.J. Bizzarro, D.M. Erdey, H. Lopez, L. Murai, S. Watt, and J. Tilden. 2003. Essential fish habitat characterization and mapping of California continental margin. Moss Landing Marine Laboratories Technical Publication Series No. 2003–01, 29 p., 2 +CDs.

Hixon, M.A., B.N. Tissot, and W.G. Pearcy. 1991. Fish assemblages of rocky banks of the Pacific northwest, Heceta, Coquille, and Daisy Banks. U.S. Department of the Interior, Minerals Management Service. OCS Study MMS 91-0052. 410 p.

Huff, D.D., M.M. Yoklavich, M.S. Love, D.L. Watters, F. Chai, and S.T. Lindley. 2013. Environmental factors that influence the distribution, size, and biotic relationships of the Christmas tree coral *Antipathes dendrochristos* in the Southern California Bight. Marine Ecology Progress Series, Vol. 494: 159–177.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): National

Administered By: Pacific OCS Region

Title: Pacific Seabird Monitoring Program

BOEM Information Need(s) to Be Addressed: 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 well known threats to seabird survival, and offshore wind turbines are a potential new source of avian mortality. Proper mitigation through oil spill response planning, infrastructure positioning, and lighting schemes can reduce potential effects. The effectiveness of these mitigation strategies needs to be confirmed via a cost-effective monitoring program that will elucidate regional population trends of vulnerable species. The purpose of this study is to develop a monitoring program using acoustic methods, high resolution satellite imagery, or other appropriate technology for ongoing or prospective offshore energy projects within the entire Pacific Region (California, Hawaii, Oregon, and Washington) of the Bureau of Ocean Energy Management (BOEM). This study will satisfy requirements for Endangered Species Act consultations, National Environmental Policy Act impact analyses, and Migratory Bird Treaty Act obligations. The study addresses six BOEM Strategic Science Questions:

(1) How can BOEM best assess cumulative effects within the framework of environmental assessments?
(2) What are the acute and chronic effects of exposure to hydrocarbons or other chemicals on coastal and marine species and ecosystems?
(3) What is the effect of habitat or landscape alteration (*e.g.*, lighting) from BOEM regulated activities on ecological and cultural resources?
(4) How will future ocean conditions and dynamics amplify or mask effects of BOEM regulated outer continental shelf (OCS) activities?
(5) How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?
(6) What affected resources, measures, and systems are best used for long-term monitoring?

Approx. Cost: (in thousands) $1,750 **Period of Performance:** FY 2018–2022

Description:
Background: Seabirds play an important role in marine ecosystems and have been identified as a wildlife resource that can be heavily impacted by offshore energy development. 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 ongoing 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, and Synopsis of Research Programs That Can Provide Baseline and Monitoring Information for Offshore Energy Activities in the Pacific Region*.

Objectives: The objective of this study is to coordinate and support a monitoring program of vulnerable seabird species that encompasses ongoing and prospective offshore energy projects in the Pacific Region. These objectives will be met by conducting the following tasks:

1. Using the *Vulnerability Index* and other sources of information, 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*, review ongoing monitoring efforts (including those that feature citizen science), to determine which programs would be useful to coordinate over larger scales and perhaps supplement with acoustic sensor devices, high resolution satellite imagery, or other support in order to meet objectives for a draft monitoring program.

3. Via a series of small workshops, draft a monitoring program that aims to distinguish population trend modifications resulting from offshore energy projects compared to other factors such as dynamic oceanographic conditions, degraded ocean productivity, or fisheries bycatch.

4. For selected seabird species identified as good monitoring candidates, conduct a 3-year regional monitoring and research effort that will enhance baseline information, improve site-specific estimates of species diversity, refine acoustic signal-density relationships, and groundtruth high resolution satellite imagery techniques that estimate seabird abundance.

5. Write final report, which will include acoustic and satellite imagery databases.

Methods: Most tasks will use standard approaches to accomplish objectives (*e.g.*, statistical power analyses). Two comparatively new monitoring methodologies proposed by this study include acoustic technology and high resolution satellite imagery. Acoustic sensors can be an effective tool for monitoring the presence, distribution, and relative abundance of rare and elusive seabirds (Borker *et al.*, 2014). The application of acoustic sensors could enable consistency and exceptional cost efficiency for long-term monitoring programs across the entire Pacific Region. High resolution satellite imagery has recently been shown to be an effective tool to estimate albatross abundance on remote islands (Fretwell, *et al.*, 2017), and shows great promise in monitoring larger species that roost or nest in areas difficult to access.

References:

Borker, A.L., M.W. McKown, J.T. Ackerman, C.A. Eagles-Smith, B.R. Tershy, and D.A. Croll. 2014. Vocal activity as a low cost and scalable index of seabird colony size. Conservation Biology 28:1100–1108.

Croxall, J.P., S.H.M. Butchart, B. Lascelles, A.J. Stattersfield, B. Sullivan, A. Symes, and P. Taylor. 2012. Seabird conservation status, threats and priority actions: a global assessment. Bird Conservation International 22:1–34.

Fretwell, P.T., P. Scofield, R.A. Phillips. 2017. Using super-high resolution satellite imagery to census threatened albatrosses. Ibis 159:481–490.

Revised Date: June 30, 2017

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: The Ecological Status of Artificial Reefs Offshore California

BOEM Information Need(s) to Be Addressed: 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. 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. Additionally, information on shipwrecks, a subset of artificial reefs, will be used in consultations required by the National Historic Preservation Act. This study addresses two Bureau of Ocean Energy Management (BOEM) Strategic Science Questions:

(1) What is the effect of habitat or landscape alteration (*e.g.*, marine infrastructure) from BOEM regulated activities on ecological and cultural resources?
(2) How does BOEM ensure the integrated use of its social sciences in assessing the impacts of outer continental shelf (OCS) activities on the human environment?

Approx. Cost: (in thousands) $1,250 **Period of Performance:** FY 2018–2021

Description:

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. Although the State of California enacted legislation in 2010 to enable

consideration of a rigs-to-reefs alternative for decommissioned platforms, the California Artificial Reef Program (CARP) has been dormant for a number of decades. Before any artificial reef proposals, including rigs-to-reefs applications, can be properly evaluated, the CARP must be updated to ensure it complies with the most recent NARP (NOAA, 2007) and best available science.

Previous studies of offshore energy structures have demonstrated that they can be productive habitats (*e.g.*, Schroeder and Love, 2004). In southern California, it remains undetermined to what extent this habitat and other similar manmade 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 manmade habitat available and variation in the quality of these habitats across the Southern California Bight (SCB). 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 status of artificial reef habitat in the SCB. These data will provide guidance for management of future artificial reef proposals, especially those related to rigs-to-reefs.

Methods: To meet the overall objective the following tasks will be performed:

1. Determine the physical, biological, and sociological status of artificial reefs in California and assess whether or not these reefs are functioning as intended.

    a. 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, and by collecting new data via directed discussions with stakeholders. Similar data on selected nearby natural habitats will also be collected to provide a basis for comparison.

2. Determine which physical, biological, or geographical features are important in determining the ecological status of these reefs.

    a. The data collected in (1) 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.

3. Develop evaluation criteria for current and proposed artificial reefs.

    a. To guide management decisions, evaluation criteria and best management practices will be developed based on artificial reef characteristics and geographic location that maximize productivity and resilience. All

surveyed shipwrecks will be assessed to determine eligibility for listing on the National Register of Historic Places. A report will be prepared that synthesizes the detailed life history data available on federally managed fish species, the comparative ecological quality of artificial *versus* natural habitats offshore California, and the criteria outlined in the Magnuson-Stevens Fishery Conservation and Management Act, to determine if any surveyed habitats could be nominated as essential fish habitat.

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 pp.

National Oceanic and Atmospheric Administration (NOAA). 1997. National Artificial Reef Plan (as Amended): Guidelines for Siting, Construction, Development, and Assessment of Artificial Reefs. 60 pp. 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.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Washington/Oregon; Northern California; Central California; Southern California

Administered By: Pacific OCS Region

Title: A Marine Biogeographic Assessment of the California Current Ecosystem

BOEM Information Need(s) to Be Addressed: In 2016, the Bureau of Ocean Energy Management (BOEM) determined that at least two parties, Trident Winds and Statoil Wind U.S., are 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. All of these potential renewable energy lease areas are located in one contiguous ecosystem known as the California Current. A comprehensive marine biogeographic assessment of the California Current ecosystem 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 this ecosystem. This study is aligned with three BOEM Strategic Science Questions:

1) How can BOEM best assess cumulative effects within the framework of environmental assessments?
2) How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?
3) What affected resources, measures, and systems are best used for long-term monitoring?

Approx. Cost: (in thousands) $1,050 **Period of Performance:** FY 2018–2021

Description:

Background: In 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 the National Oceanic & Atmospheric Administration (NOAA) to compile information and conduct preliminary analyses in the form of a biogeographic assessment. Like Hawaii, defining biogeographic patterns in the California Current ecosystem (waters within 100 miles of the Pacific Coast from Washington to California) 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 Geographic Information System (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 renewable energy siting and development 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 geo-referenced data for environmental reviews of offshore energy projects along the Pacific coast.

Questions to be addressed in this study include:

- How are trophic groups, families and species distributed spatially & temporally in the California Current ecosystem?
- Where can offshore renewable energy projects be located to maximize energy production and minimize potential impacts to the marine environment?
- What significant gaps exist in our knowledge about of the physical, biological, and ecological characteristics of the California Current ecosystem?

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 allow, 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 bio-physical 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.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: Air Emissions Associated with Decommissioning Operations for Pacific Outer Continental Shelf (OCS) Oil and Gas Platforms

BOEM Information Need(s) to Be Addressed: One of the most significant potential environmental impacts from offshore oil and gas decommissioning activities will be from air emissions resulting from the use of heavy equipment and the effects of those operations on regional air quality. Local air quality regulations require projects exceeding air quality standards to mitigate project emissions below emission thresholds and to assure a net air quality benefit from the project. Future oil and gas platform decommissioning projects will be required to estimate the equipment and emissions from those operations and will be subject to the rules and regulations of the air pollution control agencies. As such, the potential to emit emissions and the ability to demonstrate net air quality benefits from these operations are largely unknown and will be required of the Bureau of Ocean Energy Management (BOEM) to support environmental evaluations and analyses under the National Environmental Policy Act (NEPA). Information from this study will help define the BOEM Strategic Science Question: What are the BOEM regulated industry impacts of air emissions to the human, coastal, and marine environment?

Approx. Cost: (in thousands) $200 **Period of Performance:** FY 2018–2019

Description:

Background: Since 1958, offshore oil and gas production platforms have been present off the Southern California coast. At the present time, there are 23 offshore platforms located in Federal waters, installed between 1968 and 1989 and operating in water depths ranging between approximately 29 and 365 m (96 to 1,197 ft.). These platforms have finite economic lifespans and at the end of their productive life will eventually be decommissioned and removed. Current regulations in place require the complete removal of platform structures and associated debris and site clearance following decommissioning of the offshore oil and gas facilities. Due to the large platform sizes and water depths (~30% are in water depths exceeding any decommissioning projects in the world), air emissions from those operations are expected to be a potential significant impact to local and regional air quality and will need to be controlled and mitigated to assure a net air quality benefit from those operations. Recent changes to laws and regulations now allow for alternative decommissioning options such as partial removal to 85 feet below the ocean surface in lieu of complete removal options.

Objectives: Due to the operation of heavy equipment supporting all phases of decommissioning, estimations of air pollutants (criteria, toxic, greenhouse gases [GHG]) are needed for the two potential decommissioning options (complete removal and

partial removal) for all Pacific OCS Region oil and gas facilities. Emission estimates will be required for individual platforms for the following decommissioning phases:

- Pre-Abandonment (well-plugging & abandonment, platform preparation, marine growth removal, removal of conductors)
- Topside Removal
- Jacket Removal
- Debris Removal
- Pipeline/Power Cable Removal
- Processing/Disposal (transfer components to shore [tugs/cargo barges], processing, recycling, shipment, disposal of materials onshore)

Emission estimates will be based on applicable emission factors and include the types and numbers of equipment utilized, fuel types and volumes, engine size, fuel use, operating specifications and vessel usage, and other applicable means of estimating emissions.

Methods: Based on available funding, describe and detail the equipment expected to be utilized during the individual decommissioning phases that would be required for projects due to water depths (deepwater/shallow), platform sizes, and weights for the complete removal and partial removal to 85 feet below the ocean surface options. Equipment assumptions shall also include applicable emission factors, fuel consumption estimates, operating specifications, and emission profiles. Provide emissions estimates for both offshore (platform, vicinity, transiting) and onshore (likely ports, offloading in port, salvage, disposal, *etc.*) for each Pacific OCS oil and gas facility. In addition, provide a review of air regulations that would be required of decommissioning projects and how those regulations would be applied to comply with projects within specific air quality agency jurisdictions including requirements to achieve a net air quality benefit. Previous decommissioning studies offshore California should be consulted, such as previous efforts conducted by the California Ocean Science Trust (*Evaluating Alternatives for Decommissioning California's Offshore Oil and Gas Platforms: A Technical Analysis to Inform State Policy. Bernstein et al., 2010*) and other applicable information sources should be utilized to develop project assumptions and estimations.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: Physical Characterization of Outer Continental Shelf (OCS) Shell Mounds Associated with Pacific OCS Platforms

BOEM Information Need(s) to Be Addressed: The focus of this study is to conduct field surveys of representative Pacific OCS Region platforms using multi-beam sonar or other appropriate hydrographic survey methodology to provide measurements of the physical size and shape of the shell mounds located under Pacific OCS Region oil and gas facilities. Technological advances in the methodologies previously utilized to survey the shell mounds would provide better imaging and more current estimations of shell mound volumes. As the Pacific Region facilities get closer to their end-of-life economic viability and with the enacting of California Rigs to Reef legislation, the Bureau of Ocean Energy Management (BOEM) will need better estimations of shell mound sizes and volumes to more accurately gauge the fates and future disposition of these shell mounds. Information from this study will help to address the BOEM Strategic Science Question: What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?

Approx. Cost: (in thousands) $350 **Period of Performance:** FY 2018–2020

Description:

Background: Current regulations require the complete removal of platform structures and associated debris and site clearance following decommissioning of offshore oil and gas facilities. Over the life of the platform, drilling muds and cuttings discharges interlayered with shells and marine organisms have resulted in topographic features referred to as shell mounds. The physical characterization of these shell mounds was previously assessed beneath 16 OCS Platforms in 2002 along with an analysis of the factors contributing to shell mound formation. All the platforms in the Santa Barbara Channel and Santa Maria Basin were surveyed with the exceptions of Platforms Harmony, Heritage, and Harvest and the Beta Unit located offshore Los Angeles County. Due to the depth and relatively newer age of Platforms Harmony and Heritage, there is a low probability of significant shell mound formation and those platforms were not proposed for the survey. The results of the previous surveys indicated that shell mound formation was most conducive to depth (< 350 ft) and slope (< 1%), with those platforms in deeper waters with greater slopes dispersing the organic material and muds over broader areas.

Objectives: Design and conduct multi-beam or other appropriate hydrographic surveys and utilize data processing techniques to generate detailed maps of bathymetry in planar view and cross section depicting the OCS mounds. Include the physical proximity of the mounds to the platform, mound size and dimensions, and any correlations between water depth, platform orientation, platform installation, and muds and cuttings on debris distribution. Surveys shall be conducted and consistent with

Class 1 methods and accuracies outlined in the Army Corps of Engineers Hydrographic Surveying Manual (EM 1110-2-1003, November 2013). Deposition rates of shell mound formation should additionally be determined, as possible, based on previous shell mound volumes and heights and comparability to other Pacific Region data sets such as the University of California, Santa Barbara (UCSB)/U.S. Geological Survey (USGS) Dr. Milton Love fish studies. Technological advances and better imaging techniques in the methodologies previously utilized to survey the shell mounds would provide better imaging and more current estimations of shell mound volumes to more accurately gauge the fates and future disposition of these shell mounds during National Environmental Policy Act (NEPA) analyses.

Methods: Based on available funding, conduct hydrographic surveys of shell mounds under 20 OCS oil platforms in the Santa Barbara Channel, Santa Maria Basin, and offshore Los Angeles County, California. The survey shall be designed to correlate the presence and physical characterization of potential shell mounds located under the platforms and, at a minimum, the representative platforms to be surveyed shall be consistent in hydrographic survey methodology and data processing techniques employed with OCS platforms surveyed as part of the previous Minerals Management Service Environmental Mitigation Monitoring Study (*An Assessment and Physical Characterization of Shell Mounds Associated with Outer Continental Shelf Platforms Located in the Santa Barbara Channel and Santa Maria Basin, California.* MEC, Sea Surveyor, February 2oo3) and considerations from previous surveys of OCS shell mounds conducted by UCSB/USGS Milton Love fish studies.

The 20 OCS oil platforms proposed for the survey include: Eureka, Edith, Elly, Gail, Gina, Grace, Gilda, Hogan, Habitat, Hillhouse, Houchin, Henry, A, B, C, Honda, Hermosa, Hidalgo, Harvest, and Irene. Platforms Harmony and Heritage are excluded from the survey due to their low probability of shell mound formation.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: Influence of Visual Characteristics from Offshore Energy Structures on Coastal Property and Recreational Values

BOEM Information Need(s) to Be Addressed: Visual impacts are among the most common stakeholder concerns about wind energy development projects. Given that there are no offshore wind farms currently operating in the Pacific Region, it remains a challenge to provide reliable estimates regarding the nature and probability of any potential effects on coastal property and recreation values from a visible offshore wind farm. Within the Southern California Planning Area, offshore oil and gas infrastructure has been a feature of the coastal seascape for a number of decades and, given the variable distribution and abundance of offshore facilities, the intensity of visual disamenities from offshore energy varies considerably among locales within the region. By comparing trends of coastal property values and recreational activities (*e.g.*, beach visitation rates) among areas that display a gradient of visual impacts from offshore energy, the direction and intensity of potential effects of development to local economies may be estimated. Understanding the effects from existing offshore oil and gas infrastructure will provide insight into potential effects from offshore wind farms. Further, results from this study will also aid in understanding potential consequences of the decommissioning phase of ongoing oil and gas projects. Study products will be used to inform National Environmental Policy Act documents, National Historic Preservation Act consultations, marine spatial planning efforts, and to provide needed information to the California Renewable Energy Task Force, the Interagency Decommissioning Working Group, and interested stakeholders. This study addresses two Bureau of Ocean Energy Management (BOEM) Strategic Science Questions:

(1) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
(2) How does BOEM ensure the integrated use of its social sciences in assessing the impacts of outer continental shelf (OCS) activities on the human environment?

Approx. Cost: (in thousands) $400 **Period of Performance:** FY 2018–2020

Description:

Background: Renewable energy technology provides potential global environmental benefits in terms of reducing CO_2 emissions and slower depletion of natural energy resources. However, like most power generation and transmission infrastructure, there may be effects on the visual character of the region where renewable electricity generation occurs. During outreach meetings stakeholders frequently express concern regarding the potential consequences of offshore wind energy development on a region's property values and recreational sectors (*e.g.*, beach activities, wildlife watching, boating, *etc.*).

While BOEM has seen significant interest in offshore wind energy development, the absence of any operating offshore wind farm in the Pacific Region has made it difficult to identify and analyze the potential impacts of development on coastal property values and recreation activities. This lack of information makes planning and decision-making challenging for BOEM and other stakeholders including state governments.

Objectives: This study will evaluate the impacts of existing offshore oil and gas infrastructure on coastal property and recreational values in Southern California, and use the results as a proxy to consider qualitatively the potential effects of offshore wind energy development in the same area.

This study will address the following questions:

1. What is the distribution and intensity of coastal visual disamenities from offshore oil and gas structures in Southern California?

2. Have these visual disamenities contributed to measurable impacts on (a) property values, (b) tourism, or (c) beach visitation rates in Southern California?

3. Are there any differences in public perception between offshore oil and gas and renewable energy infrastructure?

Methods: Methods used to answer questions will use existing datasets of property values and recreational beach use. Visual impacts characterization could be conducted using trained observers and following a method established in a previous BOEM Pacific Region study (*Visual Impact Evaluation System for Offshore Renewable Energy*). Guided discussions will be used to determine differences in public perception among energy development types.

The primary statistical method used to estimate the effects of offshore energy infrastructure to visual disamenities will be hedonic regression, which is a commonly used technique in economic studies related to real estate appraisal. Hedonic regression breaks down the item being researched into it constituent characteristics, and obtains estimates of the contributory value of each characteristic.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: Atmospheric Response to Hypothetical Wind Farms Along the Central and Southern California Coast

BOEM Information Need(s) to Be Addressed: Commercial wind facilities may result in localized and regional changes to meteorology. These changes could result in environmental consequences. The frequency of fog along the central and southern California coast may increase the likelihood of turbine-fog/cloud interaction. Local effects on meteorology may have impacts on commercial and recreational activities and navigation in the area of the wind the farm. The Federal Aviation Administration has raised concerns about visibility of offshore wind turbines if a significant fog/meteorological event were to occur around wind facilities. Understanding potential impacts from wind energy facilities on local and regional meteorology will assist the Bureau of Ocean Energy Management (BOEM) in analyses under the National Environmental Policy Act (NEPA). This study is aligned with the BOEM Strategic Science Question: What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?

Approx. Cost: (in thousands) $300 **Period of Performance:** FY 2018–2019

Description:

Background: California formally legislated through SB 350 (the Clean Energy and Pollution Reduction Act of 2015) the requirement that 50% of all electricity generated and sold come from renewable energy sources by December 31, 2030. The California Energy Commission (CEC) is now looking toward offshore wind as one part of California's renewable energy portfolio with a planning effort focused on central/southern California. A 2015 CEC report (Huang and Hall 2015) published preliminary data off of northern California showing local and possible regional changes to the microclimate (more clouds, colder temperature, increased moisture) from a hypothetical wind farm. This modeling effort was conducted from 1 year (2009) of wind data. These findings are consistent with wind energy facility studies from Europe.

This study would expand on the initial CEC effort and examine hypothetical wind farms off of central and southern California over a 10 year period. An ongoing Pacific Region Study (PC-14-01) generated a 10 year hindcast (2004–2013) of winds at a 6 km resolution for central and southern California. This data set will be utilized in modeling wind farm configurations.

Objectives:

- Model hypothetical wind farms in central and southern California using the existing 10 year hindcast wind data.

- Assess local and regional effects from various wind farm configurations in multiple locations in the area of interest (central/southern California).

Methods: Atmospheric modeling will occur with and without wind farms over the 10 year hindcast period (2004–2013) using a regional atmospheric model and the results compared. The hypothetical wind farms will be modeled using different build out scenarios and current floating wind technology specifications. A wind farm parameterization tool will be used to model the turbine-induced wake expansion. The atmospheric model will be validated using point-scale observations from National Oceanic & Atmospheric Administration (NOAA) buoys and satellite records of sea surface wind speed and direction. The end products will be:

1) visualizations of wind farm configurations under different build out scenarios in the area of interest;
2) summary of potential environmental effects for the scenarios;
3) identification of conditions that may lead to local and regional environmental effects;
4) model outputs and raw data that will be publicly available; and
5) information that will be in a format compatible with other BOEM analysis requirements (*e.g.*, Marine Cadastre and Environmental Studies Program Information System).

References:

Huang, Hsin-Yuan and A. Hall. 2015. Preliminary assessment of offshore wind development impacts on marine atmospheric environment. California Energy Commission Report. http://www.energy.ca.gov/2016publications/CEC-500-2016-023/CEC-500-2016-023.pdf

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: Creation of Geospatial Datasets for Shoreline Habitats

BOEM Information Need(s) to Be Addressed: Sandy and rock habitats along the shoreline are particularly vulnerable to oil spills. These habitats are also directly impacted by sand replenishment projects. Environmental documents related to oil spill risk and mineral leasing address the potential disturbance to these habitats and the effects on threatened and endangered species such as black abalone and snowy plover. There are also other vulnerable bird species including oystercatchers and turnstones that feed in these habitats. The Bureau of Ocean Energy Management (BOEM) needs highly accurate geospatial elevation and substrates data to create a baseline and track changes to the intertidal/shoreline habitats these species rely upon. This study is aligned with three BOEM Strategic Science Questions:

1) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
2) How can BOEM better use existing or emerging technology to achieve more effective or efficient scientific results?
3) What affected resources, measures, and systems are best used for use in long-term monitoring?

Approx. Cost: (in thousands) $250 **Period of Performance:** FY 2018–2020

Description:

Background: In Alaska, BOEM and other agencies have coordinated the collection of shoreline data through the ShoreZone program. While in southern California, oil spill drills and response activities maps are based on low resolution aerial images, hand-drawn maps, and observer knowledge to monitor intertidal habitats. BOEM has been monitoring biological communities on rocky intertidal habitats as part of the Multi-Agency Rocky Intertidal Network (MARINe) for many years. However, there is no way to correlate biological changes to changes in substrate or elevation of the surrounding habitat. In the last few years, researchers have developed methods for using high resolution photographic data to create geospatial products including Digital Orthophotos, Digital Elevation Models (DEMs), and Substrate Classification layers. Our goal is to create a partnership with a university for developing geospatial methods to document the current state and monitor changes in intertidal areas.

Objectives:

- Provide detailed Orthomosaics, DEMs, and Habitat Type Maps for locating study areas and providing aesthetically pleasing educational materials.

- Monitoring changes to study areas at multiple scales.

- Develop methodology to monitor natural variability over time and by location based on elevation and aspect as well as other variables that can be derived from DEMs and Habitat Maps.

- Assess the cost effectiveness of novel methodology to apply to different types of BOEM information needs in the future.

Methods: With the present state of technology, the creation of these geospatial products will involve the collection of fine-scale aerial photos and LiDAR (Light Detection and Ranging) data using drones and other techniques. Field collection techniques may vary by site or over time as methods are refined. These data will be analyzed using photogrammetric software to produce orthomosaics, DEMs and three-dimensional models, and photo interpretation software to create habitat type polygons. These geographic information system (GIS) products will be a useful tool in evaluating the vulnerability of listed species as well as other species of interest such as birds. We will also develop techniques to manage, archive, and display these data intensive files for future analyses. Additionally, we will look into novel use of these analysis techniques, such as using photos from remotely operated vehicles (ROVs) to create models of benthic habitats.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: Renewable Energy Facilities Visualization for Offshore South-Central California

BOEM Information Need(s) to Be Addressed: With recent interest from the renewable energy industry in leasing areas for wind energy developments offshore central and southern California, the Bureau of Ocean Energy Management (BOEM) will need viewshed information to analyze potential visual impacts of proposed renewable energy projects under the National Environmental Policy Act and the National Historic Preservation Act. This study is aligned with two BOEM Strategic Science Questions:

1) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
2) How does BOEM ensure the integrated use of its social sciences in assessing the impacts of outer continental shelf (OCS) activities on the human environment?

Approx. Cost: (in thousands) $325 **Period of Performance:** FY 2018–2019

Description:

Background: In 2012, in response to stakeholder interest regarding visual impacts from potential future renewable energy development offshore North Carolina, BOEM developed visual simulations of hypothetical wind facilities on the OCS. BOEM has since done similar visualizations for hypothetical wind facilities offshore the Rhode Island-Massachusetts and New York Call Areas. Initial stakeholder outreach efforts, led by the California Energy Commission, revealed concerns by tribal governments and environmental non-governmental organization (NGOs) on visual impacts related to renewable energy projects off the California coastline. BOEM and the State of California have begun planning for the identification of wind energy areas offshore California, with emphasis on the south-central coast (the area this study would address).

Objectives: The purpose of this study is to characterize the potential visibility of offshore wind turbines from locations along the south-central coast of California under different seasons, times of day, elevations, distances, and weather conditions. The area of study would extend from approximately the southern limit of the Monterey Bay National Marine Sanctuary south-southwest to the Santa Rosa Flats area.

The goals of the study are:

- To provide photo realistic simulations and video montages of hypothetical wind energy facilities at 12, 20, 25, and 35 miles offshore from various locations along the south-central coast.

- To simulate anticipated visual impacts from existing historical and cultural sites (*e.g.*, Hearst Castle, Piedras Blancas Lighthouse, the beach by Morro Rock, Santa Rosa and Santa Cruz Islands within the Channel Islands National Park, *etc.*).

- To develop, produce, and provide video simulation of visual impacts (including night time lighting) of a hypothetical wind energy facility over the course of a simulated 24-hour day, simulating changes in lighting, oceanic, and meteorological conditions (utilizing of the locations in the bullet above).

- To fully characterize and synthesize the information into reports and video for BOEM.

- To provide photographic and/or videographic materials throughout the project for outreach, analysis, or social media purposes.

Methods: Most tasks will use standard approaches to accomplish objectives. This study will require the use of photographic and video equipment capable of high resolution imagery as well as the use of existing professional software programs (*e.g.*, WinPRO 2.8, Adobe Photoshop, Arcview GIS, *etc.*). Photographic resolution would be the highest resolution necessary to accurately represent offshore conditions up to a distance of 35 miles. Site investigation will utilize standardized field work protocols for every viewpoint location, and will include the use of Global Positioning System (GPS) units, aerial imagery, and maps, as needed. The study would involve the following:

- Compute view for existing and prototype designs at various distances from coastal sea level and various elevations.

- Compute diurnal and night views of existing and prototype designs under varying atmospheric conditions and for seasonal time periods characteristic of the south-central California coast.

References:

Lavalle, T. 2012. Visualization Study for Offshore North Carolina, Task 6: Document and Analyze Meteorological Conditions. U.S.D.O.I. Bureau of Safety and Environmental Enforcement and Bureau of Ocean Energy Management, Herndon, VA.

Sullivan, R., L.B. Kirchler, J. Cothren, and S.L. Winters. 2013. Offshore Wind Turbine Visibility and Visual Impact Threshold Distances. Argonne National Laboratory, Argonne, IL.

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Hawaii

Administered By: Pacific OCS Region

Title: Deep Ocean Trails to Hawaii's Second Pearl Harbor

BOEM Information Need(s) to Be Addressed: The Bureau of Ocean Energy Management (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 the Bureau of Safety & Environmental Enforcement (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 subject to be affected by agency actions. In addition, this effort will help BOEM scientists to understand how historic properties on the deep seafloor are 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 supporting benthic community development, evolution, and sustainability. This study will address two BOEM Strategic Science Questions:

1) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
2) How does BOEM ensure the integrated use of its social sciences in assessing the impacts of outer continental shelf (OCS) activities on the human environment?

Approx. Cost: (in thousands) $925 **Period of Performance:** FY 2018–2020

Description:

Background: In 2013, BOEM undertook an inter-agency baseline study to identify known and potential underwater cultural heritage sites around the eight main Hawaiian Islands (Maritime Cultural Resources Site Assessment in the Main Hawaiian Islands), and completion of this effort is expected in May 2017. In 2016, BOEM received unsolicited applications for development of offshore wind energy facilities off the southern end of the island of Oʻahu (Oʻahu South), where a number of known and reported historic shipwrecks are located. The Oʻahu 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 21 May 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 four of the larger Landing Craft Tanks (LCTs 961, 963, 983, and 984) and four Landing Ship Tanks (LSTs 43, 69, 179 and 353) 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 laid on in the NHPA, NEPA, and OCS 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 Oʻahu South call area will provide valuable archaeological and historical information on this little known World War II (WWII) event, which is only now being more fully understood in its broader context, and contribute data for their potential nomination to the National Register of Historic Places (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 Oʻahu South area. BOEM has supported similar deepwater shipwreck reef projects in the Gulf of Mexico (2004–2007, *The Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico*) and Atlantic (2010-2015, *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 Oʻahu coastline. This survey sought to bound, characterize, and assess the historic deep-water munitions sea-disposal site to determine the potential impact of the munitions on the ocean environment and vice versa (Edwards *et al.* 2016: 4), but only collected data from a portion of the Oʻahu South area.

This project builds upon an existing collaboration between BOEM and the National Oceanic & Atmospheric Administration (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, assessing their historic/archaeological nature and their biological impact to the marine environment. Such collaboration provides cost efficiencies in equipment and survey platforms.

Objectives: The Deep Ocean Trails project seeks to survey and characterize known and reported wreck locations associated with the historic WWII West Loch explosion, fill baseline data gaps by locating previously unknown wreck sites within the call area, and study associated benthic ecological communities. NOAA's Office of National Marine Sanctuaries and the Maritime Heritage Program have expressed interest in this effort and estimate they will be able to provide at least a $100K match to the proposed research; there may also be an opportunity for an additional match through in-kind vessel support. The information obtained through this effort will directly support BOEM's responsibilities under NEPA and NHPA. The known sites suggest a generalized 1940–1950 vessel deposition zone. The proposed survey area will also fill a gap in sidescan survey coverage for the Japanese submarine I-23, lost during combat operations in WWII, fill an unmapped gap in the HUMMA, and provide important seafloor characterization data within the northwest portion of the Oʻahu South call area.

Methods: The project proposes to survey a partial seafloor survey area associated with a number of known and possible significant vessel losses, and defines project objectives based on three related disciplines:

1) Archaeological component

    a. 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.
    b. 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.
    c. Assess any environmental impacts caused by the wreck, and make observations relating to its rate of deterioration.
    d. Analyze imagery along with historical documentation to determine potential eligibility to the NRHP.
    e. For vessels determined to be potentially eligible, prepare subsequent NRHP nomination forms.

2) Biological component

    a. Characterize the environment at each site (*e.g.*, water depth, bottom sediment type, currents, *etc.*).
    b. Determine the biological effects of wreck artificial reefs at the selected sites, including detailed imagery of marine species at a variety of scales.
    c. 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.
    d. Conduct limited sampling of fauna attached to hard substrate for taxonomic and other potential analyses such as isotope studies.
    e. Analyze imagery and sample collection to address spatial heterogeneity of any fouling community and motile fish and invertebrate association with wrecks.

3) Unexploded Ordinance (UXO) component

    a. Identify spatial extent and distribution of munitions in the survey area in order to define western boundary of disposal zones.
    b. Identify type of munition and corrosion status of munition, casing, *etc.*
    c. Document munition interaction with biological environment, marine species.
    d. Data sharing with University of Hawaii (Applied Research Lab, School of Ocean and Earth Science and Technology [SOEST], *etc.*).

References:

Edwards, M.H., S.M. Shjegstad, R. Wilkens, J.C. King, G. Carton, D. Bala, B. Bingham, M. Bissonnette, C. Briggs, N.S. Bruso, R. Camilli, M. Cremer, R.B. Davis, E.H. DeCarlo, C. DuVal, D.J. Fornari, I. Kaneakua-Pia, C.D. Kelley, S. Koide, C.L. Mah, T. Kerby, G.J. Kurras, M.R. Rognstad, L. Sheild, J. Silva, Jeff, *et al.* 2016. The Hawaii Undersea Military Munitions Assessment. Deep Sea Research Part II: Topical Studies in Oceanography, 128: 4-13. doi:10.1016/j.dsr2.2016.04.011

Revised Date: May 2, 2017

Environmental Studies Program: Studies Development Plan FY 2018–2020

Study Area(s): Hawaii

Administered By: Pacific OCS Region

Title: *'Ike Hawai'i*—Understanding Hawaii: Public Awareness and Perceptions of Ocean Energy and Recommendations for Analyses

BOEM Information Need(s) to Be Addressed: Hawaii has the most aggressive renewable energy goal in the nation—100% by 2045. Ocean energy may play an important role in meeting this goal. The Bureau of Ocean Energy Management (BOEM) would have regulatory authority over energy projects on the Outer Continental Shelf (OCS), such as offshore wind development, wave energy projects, and cabling to transmit energy between islands. Although some information about public awareness and perceptions of ocean energy is available from previous research and public meetings, information representative of the full spectrum of Hawaii stakeholders is lacking. This study will provide needed information on public awareness and perspectives before large-scale installations occur. This study will also provide needed information on how BOEM should consider Hawaii's unique resources and sociocultural systems in its analyses of direct and indirect effects from ocean energy development. This study aligns with two BOEM Strategic Science Questions:

1) What is the effect of habitat or landscape alteration from BOEM regulated activities on ecological and cultural resources?
2) How does BOEM ensure the integrated use of its social sciences in assessing the impacts of OCS activities on the human environment?

This information will support BOEM decision-making for leasing under the OCS Lands Act as amended by the Energy Policy Act and for analyses under the National Environmental Policy Act (NEPA)—the study results will improve BOEM's consideration of other uses of the sea or seabed; inform the potential identification of areas for leasing; provide information on baseline conditions for ecological, socioeconomic, and cultural impact assessment; and inform the development of project alternatives and mitigation measures. This information will also be used to improve the effectiveness and efficiency of BOEM's public engagement and inform future research efforts on issues about which the public has concerns.

Approx. Cost: (in thousands) $600 **Period of Performance:** FY 2018–2021

Description:

Background: A diverse mix of renewable energy sources is needed to meet Hawaii's 100% renewable energy goal, and stakeholders' awareness and perceptions of those sources' impacts and benefits play a role in determining that energy mix. Currently, ocean energy is being considered to meet Hawaii's needs as evident in Hawaii's Power Supply Improvement Plan (HECO, 2016). Three developers expressed formal interest to BOEM in leases for floating wind projects offshore O'ahu in 2016. Grid-connected wave energy devices are being tested in Kaneohe Bay. Additionally, there has been

discussion and debate in recent years about an inter-island cable to transmit renewable energy generated onshore between islands.

Public understanding and acceptance of the rationale, process, and results associated with new ocean energy infrastructure are crucial for a successful BOEM leasing process—which may or may not result in a lease and/or plan approval. BOEM and other organizations have engaged the public in efforts to enhance their understanding of novel ocean energy technologies and their potential effects. This study will show in what areas—geographically and topically—engagement must continue and improve, and the particular issues the public is concerned about and/or for which they desire more information. For example, BOEM has already received comments from some stakeholders whose concerns include adequate stakeholder engagement and impacts on cultural resources, fish and fishing, birds, and marine mammals. At least one previous project in Hawaii revealed that the public can mobilize opposition when a new technology is not explained and when it appears that the public has been excluded from the decision-making process (de Figueiredo *et al.*, 2003). Furthermore, BOEM has been advised to find a way to listen to all stakeholder perspectives and concerns, not just a vocal minority.

This study will improve BOEM's understanding of the uniqueness and importance of Hawaii's marine environment and stakeholders, thereby improving BOEM's cultural awareness and public processes in Hawaii. BOEM's engagement with Hawaii stakeholders thus far has revealed that there are inextricable links among ocean resources, use, traditional and customary practices, and sociocultural systems in Hawaii. To appropriately consider ocean energy development effects on these unique systems, BOEM seeks recommendations for how to analyze direct and indirect effects within its established leasing process and the NEPA framework. For example, the cultural tradition of sharing ocean harvest among family and community is not reflected in typical economic assessments but should be included in NEPA analysis.

BOEM will consider input from State and local contacts regarding additional information needs to inform Hawaii's renewable energy portfolio.

Objectives: This study will collect and synthesize information from a representative sample among a broad spectrum of Hawaii stakeholders on:

1. The level of public awareness of potential ocean energy development, including emerging energy conversion technologies.

2. Public perceptions of the potential risks and benefits from ocean energy on human, marine, and coastal environments.

3. Perceived information gaps for future study and public engagement efforts.

4. With consideration of the inextricable links between resources, use, and sociocultural systems in Hawaii, recommended approaches for BOEM to:

a. consider Hawaii's unique resources, ocean uses, and sociocultural systems in its siting and leasing decisions (*e.g.*, Area Identification); and

b. appropriately analyze the potential direct and indirect effects of ocean energy infrastructure on Hawaii's unique sociocultural resources and systems in its NEPA analyses.

Methods: Suggested methods to address the study objectives are included here, but BOEM will expect the potential conducting organizations to submit research designs that they deem best meet the objectives. The research methods will be determined through consultation with scientific experts (*i.e.*, government scientists, academia) and State and local contacts.

The information described in the four objectives above may be collected from a representative sample of the Hawaii public by conducting a stakeholder analysis, then one or more social scientific surveys in-person, by phone, by mail, or online. The survey(s) would likely require approval under the Paperwork Reduction Act by the U.S. Office of Management and Budget (OMB). Focus groups are recommended prior to any surveys, or may be employed as the primary information collection method. Facilitation services by a local facilitator that understands and appreciates both native Hawaiian and local culture are recommended for any focus groups, workshops, or group interviews. The research results and products will be shared with the communities in culturally appropriate ways.

The OMB-approved surveys for ongoing studies on public attitudes and spatially-explicit social values in the Atlantic Region serve as models of BOEM-funded surveys to inform decision-making for ocean renewable energy (BOEM 2017a, BOEM 2017b). A recent survey conducted by the University of Hawaii can serve as a model of a Hawaii-specific survey effort related to energy (Lilley *et al.*, 2015).

References:

BOEM, 2017a. Atlantic Offshore Wind Energy Development: Public Attitudes, Values, and Implications for Recreation and Tourism. Cooperative Agreement with University of Delaware. Accessed at https://www.boem.gov/AT-12-04/.

BOEM, 2017b. Quantitative Assessment of Spatially Explicit Social Values. Interagency Agreement with National Oceanic and Atmospheric Administration, National Ocean Service, National Centers for Coastal Ocean Science. Accessed at https://www.boem.gov/Quantitative-Assessment-of-Spatially-Explicit-Social-Values/.

de Figueiredo, M.A., D.M. Reiner, and H.J. Herzog, 2003. "Ocean Carbon Sequestration: A Case Study in Public and Institutional Perceptions," *Proceedings of 6th International Conference on Greenhouse Gas Control Technologies (GHGT-6)*, Volume I, J. Gale and Y. Kaya (Eds.), Elsevier, pp. 799–804.

HECO, 2016. Power Supply Improvement Plans (PSIP): Book 3. Accessed at https://www.hawaiianelectric.com/Documents/about_us/our_vision/dkt_2014_0183_20161223_companies_PSIP_update_report_3_of_4.pdf.

Lilley, J., D.E. Konan, and D.T. Lerner, 2011. "Cool as a (sea) cucumber? Exploring Public Attitudes Toward Seawater Air Conditioning in Hawaii," Energy Research & Social Science 8, pp. 173–183.

Revised Date: May 2, 2017

Study Area(s): Washington/Oregon; Northern California; Central California; Southern California

Administered By: Pacific OCS Region

Title: Evaluation of Pacific Outer Continental Shelf (OCS) Region Platform Materials Processing and Disposal Options and Potential Environmental and Social Impacts

BOEM Information Need(s) to Be Addressed: There are 23 oil and gas platforms located on the federal Outer Continental Shelf (OCS) offshore California. Some of the platforms are nearing the end of their economic life and are likely to be decommissioned within the next 5–10 years. Due to the lack of decommissioning activity that has occurred in the Pacific Region (to date, only seven small platforms have been removed in State waters, all prior to 1997), very little information exists describing the current capabilities ports and onshore facilities have to receive and process the large volumes of steel and other materials that will be generated by future OCS decommissioning projects. There is also a lack of information on transportation and disposal options, materials processing and disposal costs, and the environmental and social impacts associated with these activities. This type of information is required by Bureau of Safety & Environmental Enforcement (BSEE)/Bureau of Ocean Energy Management (BOEM) to evaluate decommissioning applications submitted by OCS operators and conduct environmental reviews required to comply with the requirements of the National Environmental Policy Act (NEPA) and other environmental laws and regulations. This study aligns with two BOEM Strategic Science Questions:

1) How does BOEM ensure the integrated use of its social sciences in assessing the impacts of OCS activities on the human environment?
2) What are the BOEM regulated industry impacts of air emissions to the human, coastal, and marine environment?

Approx. Cost: (in thousands) $200 **Period of Performance:** FY 2018–2019

Description:

Background: The 23 OCS platforms located offshore California are situated in water depths ranging from approximately 150 feet to 1,200 feet, and have combined deck and jacket weights ranging from 1,002 tons to 70,000 tons. In total, the 23 platforms contain approximately 400,000 tons of steel, nonferrous metals, and other materials; not counting pipelines, power cables, and other related equipment. Federal regulations require that OCS oil and gas leases be cleared of all structures within one year after production on the leases ceases. OCS platform removal projects will generate large volumes of materials (steel, nonferrous metals, cement, wood, plastics, hazardous waste, marine growth, *etc.*) that will need to be transported to port and onshore scrapyards where the materials will be cut up into manageable pieces for eventual transport to smelting, recycling, or other waste handling and disposal facilities. Potential destinations include ports and processing facilities located in southern California, or

alternatively the materials could be transported to northern California, Oregon, Washington, Mexico, and Southeast Asia.

There have been a few Minerals Management Service (MMS)-sponsored workshops and technical reports describing past and anticipated future decommissioning projects, most recently in 2003. Though some previous work has included some cost estimates, none has included a comprehensive capability assessment.

Objectives: The overall objective of this study is to estimate the volume of materials and waste streams generated by future OCS platform decommissioning projects and identify options for processing and disposal. Specific study objectives are:

- Estimate the volume of wastes and materials that will be generated during future OCS platform decommissioning projects.
- Assess the capabilities that ports, scrapyards, and onshore facilities have to offload and process the materials.
- Estimate cost to break-up platform topsides and jackets into manageable pieces at onshore scrapyards.
- Evaluate the market for scrap steel and nonferrous metals.
- Review and summarize the environmental and social impacts of transportation, materials processing, and disposal operations.

Methods: The study will compile and synthesize information on materials and waste streams generated and processed during previous offshore oil and gas decommissioning projects by reviewing journal articles, technical reports, and environmental documents prepared for previous decommissioning projects.

The volumes of materials and waste streams generated during future OCS platform removal projects will be estimated for each of the six projected decommissioning projects described in the "Decommissioning Cost Update for Pacific OCS Region Facilities, October 2016 Report" prepared by TSB Inc. for BSEE. These estimates will be used to evaluate the capabilities ports, scrapyards, and disposal facilities have to handle the volume of materials and wastes generated during each project.

Information on the capabilities and costs to break-up platform components will be compiled by contacting onshore facilities in the Gulf of Mexico and California that dismantle platforms into small pieces for transport to smelters and other facilities. The study will assess the methodology used by Schnitzer Steel Products Company (see TSB Inc. cost report referenced above) to estimate breakup costs and develop updated cost estimates for processing platform and jacket components using Schnitzer's methodology or other methodology as appropriate.

The study will review the environmental impact analysis documentation for previous decommissioning projects (*e.g.*, Chevron 4-H and Belmont Island projects) and provide

a summary of the environmental and social impacts associated with the projects, and any mitigation measures adopted to minimize those impacts. The study will also evaluate any new or different foreseeable impacts from future OCS decommissioning projects based on differing conditions, and suggest mitigation measures.

Revised Date: May 2, 2017

APPENDIX III. ABBREVIATIONS AND ACRONYMS

3-D	three-dimensional
4-D	four-dimensional
ACF	availability correction factor
ADCP	acoustic Doppler current profiler
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADL	acceleration data logger
AFSI	Atlantic Flyway Shorebird Initiative
AIS	automatic identification system
AMAPPS	Atlantic Marine Assessment Program for Protected Species
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
AQ	Air Quality
ARIS	Adaptive Resolution Imaging Sonar
ASAMM	Aerial Surveys of Marine Mammals
AUV	autonomous underwater vehicle
AWI	Alfred Wegener Institute
BACI	Before-After-Control-Impact
bbl	barrels
BCBS	Bering-Chukchi-Beaufort Seas
BCD	buoyancy control device
Bcf	billion cubic feet
BESTT	Bureau of Ocean Energy Management Ecosystem Services Task Team
BLM	Bureau of Land Management
BLOSOM	Blowout Spill Occurrence Model
BMA	benthic microalgae
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
ca.	*circa* (English: "approximately")
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
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
CSIL	Cumulative Spatial Impact Layers
CT	computerized tomography
CTD	conductivity, temperature, and depth
CZM	coastal zone management
CZMA	Coastal Zone Management Act
de facto	(English: "in fact")
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
DWH	Deepwater Horizon
e.g.	*exempli gratia* (English: "for example")
E.O.	Executive Order
EA	Environmental Assessment
Eds.	editors
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
EOV	Essential Ocean Variable
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
et al.	*et alia* (English: "and others")
et seq.	*et sequens* (English: "and the following")
etc.	*et cetera* (English: "and so forth")
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
FGB	Flower Garden Banks
FGBNMS	Flower Garden Banks National Marine Sanctuary
FPSO	floating production, storage, and offloading
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
GOM	Gulf of Mexico
GoMMAPPS	Gulf of Mexico Marine Assessment Program for Protected Species
GOMR	Gulf of Mexico Region
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
i.e.	*id est* (English: "that is")
IA	interagency agreement

IAM	integrated assessment modeling
IDIQ	indefinite-delivery, indefinite-quantity
IERP	Integrated Ecosystem Research Program
IHA	Incidental Harassment Authorization
in situ	(English: "on site")
Inc.	incorporated
ITM	information transfer meeting
IUCN	International Union for the Conservation of Nature
IWC	International Whaling Commission
LCI	Lower Cook Inlet
LCT	Landing Craft Tank
LiDAR	Light Detection and Ranging
LISI	Landfast Ice Stability Index
LLC	limited liability company
LME	large marine ecosystem
LST	Landing Ship Tank
LSU	Louisiana State University
MAGPLAN	Model of Alaska and Gulf using Impact Analysis for Planning
MARINe	Multi-Agency Rocky Intertidal 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
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory

NEXRAD	Next-Generation Radar
NFEA	National Fishing Enhancement Act of 1984
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
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
NY	New York
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
OpenCV	Open Source Computer Vision
OREP	Office of Renewable Energy Programs
OSRA	oil spill risk analysis
P.L.	Public Law
PAM	passive acoustic monitoring
PEIS	programmatic environmental impact statement
PHMSA	Pipeline and Hazardous Materials Safety Administration
PI	Principal Investigator
plc	public limited company

PLD	planktonic larval duration
PM2.5	fine particulate matter
PolSAR	polarimetric synthetic aperture radar
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 of 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
SPOT	Smart Position and Temperature
SUIT	Surface and Under-Ice Trawl
SWIM	Spatially Weighted Impact Model
T/D	temperature/depth
TK	traditional knowledge
TO	task order
U.S.	United States
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
viz.	*videlicet* (English: "namely")
vs.	*versus* (English: "in contrast to")
WEA	Wind Energy Area
WWII	World War II