STATE OF MAINE OFFSHORE WIND RESEARCH ARRAY

Application for an Outer Continental Shelf Renewable Energy Research Lease

Submitted to BOEM Bureau of Ocean Energy Management

Submitted by Governor's Energy Office

October 2021

Application for an Outer Continental Shelf Renewable Energy Research Lease

Submitted to:

U.S. Department of the Interior
Bureau of Ocean Energy Management
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Sterling, VA 20166

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GOVERNOR'S
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Executive Summary

The State of Maine submits this application to the Bureau of Ocean Energy Management (BOEM) for a research lease in federal waters in the Gulf of Maine (GOM) to allow for a small-scale array of floating offshore wind turbines (the Research Array), with the express purpose of conducting research that will foster better co-existence between floating offshore wind projects and Maine's heritage industries and the marine environment. **Maine has some of the most ambitious statutory requirements in the country to address climate change and utilize renewable energy and offshore wind will become increasingly important to achieving these requirements**. Due to water depths in the GOM, floating platform technology will be required to realize this opportunity.

In 2019, the Governor signed bipartisan legislation to address climate change and require investment in clean energy, including decreasing greenhouse gas emissions by 45 percent by 2030 and 80 percent by 2050, and requiring 80 percent renewable energy by 2030 with the goal of 100 percent by 2050. **Harnessing the unequaled wind resources off the coast of Maine is a critical component of Maine's climate, clean energy, and economic goals**. Further, this effort is of importance in the GOM, where surface temperatures peaked in 2020 and have been warming faster than nearly every other body of water in the world, creating a substantial threat to our traditional fishing industries.

With some of the highest sustained wind speeds in the world, the Outer Continental Shelf (OCS) of the GOM has great potential for generating clean energy and economic opportunity for Maine, as offshore wind investment in the U.S. is estimated to be considerable over the next decade. In Maine's 10-year Economic Development Strategy[1] and a recent Clean Energy Economy report[2] from the Governor's Energy Office, the development of Maine as a hub for offshore wind development was identified as a key opportunity to grow and attract economic development to Maine. This Project is an investment in research and development, a catalyst for achieving those goals, with support solidified by bipartisan legislation passed and the Governor signed legislation supporting this development. **The Research Array is a key component of the State's efforts to set forth a balanced agenda that maximizes economic benefits for Maine people while creating a culture of innovation that creates a foundation for future leadership in this growing industry**. Further, recent actions also highlight the continued interest in future, large-scale development in federal waters, including the GOM, such as the Biden Administration's March 29, 2021 announcement of a federal target of 30 gigawatts of offshore wind by 2030 and a multi-agency plan to advance commercial-scale projects on the East Coast.

In 2021, the State of Maine took several important steps to solidify its commitment to responsible floating offshore wind research and development. The Governor signed LD 336, which passed the legislature with bipartisan support, and directs the Maine Public Utilities Commission to work with the utilities to negotiate a power purchase agreement for up to 144 MW from the Research Array. In response to concerns raised by the fishing industry about potential offshore wind development in state

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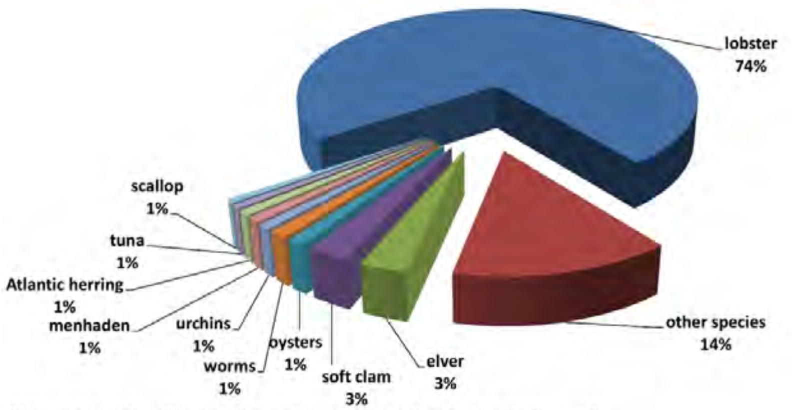
[1] DECD_120919_sm.pdf (maine.gov)

[2] StrengtheningMainesCleanEnergyEconomy_Nov92020.pdf

waters, where up to 75 percent of lobster activity occurs, the Governor introduced legislation to limit new offshore wind projects in state waters, which are three miles from the coast, prioritizing future offshore wind development for federal waters. LD 1619, as enacted, prohibits new full-scale offshore wind projects in state waters and sets a clear path forward for interconnecting federal projects into State of Maine managed waters. The law also establishes a Maine Offshore Wind Research Consortium to strategically manage the research strategy for the Research Array, with engagement from stakeholders, including the fishing industry.

Maine's commercial fishing industry is a cornerstone of Maine's economy, providing approximately $1.5 billion in annual total economic benefit to the state. Driving this economic engine is the Maine commercial fishing industry that made twice as many commercial fishing trips as any other east coast state in 2019 (Figure AA). Maine is also the fishing epicenter for one of the most valuable species in the U.S. – lobster. According to the National Oceanic and Atmospheric Administration (NOAA), Maine landings represented 80 percent of all U.S. lobster landings in 2019 (NOAA Fisheries 2021).

Figure AA
Preliminary 2019 Commercial Maine Landings by Ex-vessel Value
Total: $673,910,558 as of 2/20/2020



*Other species include confidential species and other species that make up less than 1% of total catch.

With only a few floating offshore wind turbines operating in the world, and none currently in the U.S., research and scientific study is needed to understand floating offshore wind technology, its generation of electricity, and its effect on fishing and the marine environment.

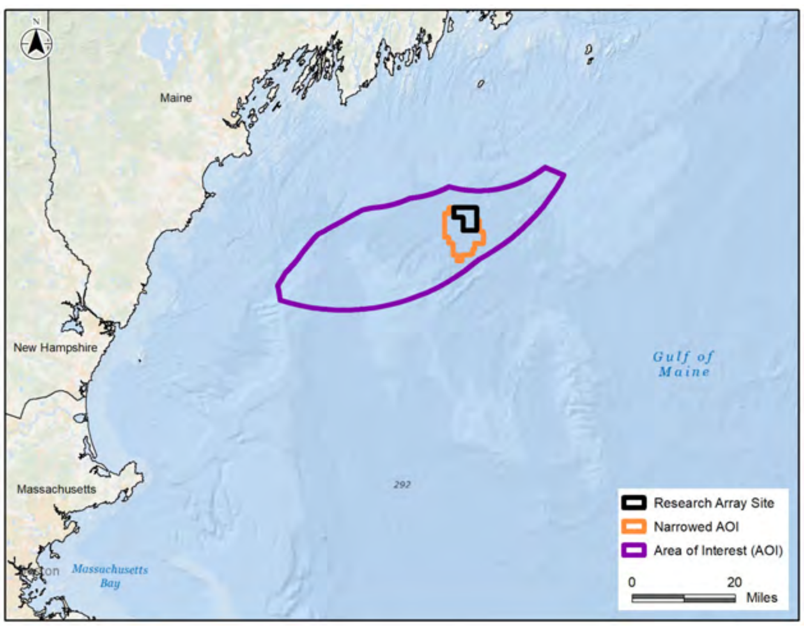
This first of its kind small-scale floating offshore wind research array will provide the state, and the nation, with critical research opportunities, science-based findings and hands-on experience with floating technology. The scale of the Research Array (no more than 12 turbines) is intended to be large enough to demonstrate and evaluate the interactions between offshore wind and traditional marine users and the environment that cannot be observed at a smaller scale. The Research Array will provide the information to make data-driven decisions and create a pathway for future offshore wind projects to maximize compatibility with other ocean users and the marine environment.

The State of Maine is uniquely qualified to hold this research lease. Pursuant to 30 CFR 585.238(a), research leases may only be held by a state or federal agency for renewable energy research activities that support the future production, transportation, or transmission of renewable energy. This research lease application includes information required pursuant to 30 CFR § 585, including a preliminary assessment of the renewable energy resource and environmental conditions in the area requested for lease, anticipated conformance with state energy planning, and documentation of lessee qualifications. This application identifies known existing site conditions, and summarizes, where possible, how anticipated impacts to environmental resources will be considered and evaluated after a research lease area is awarded.

THE RESEARCH ARRAY

The Research Array will be limited to 12 or fewer turbines located within a proposed lease area of approximately 15.2 square miles (9,696.4 acres), in federal waters, off the coast of mid- to southern Maine (Figure AB). The Research Array will be more than 20 miles offshore, consistent with the State of Maine's preference to avoid nearshore waters that are valuable for fishing and recreation and the State's recent decision to impose a moratorium on development of offshore wind in state waters, where up to 75 percent of the lobster catch is landed[3].

Figure AB
Area of Interest & Research Array Site



The Research Array will be one of the first pre-commercial-scale floating offshore wind projects in the world. **The State of Maine intends to utilize the University of Maine's (UMaine) floating platform technology, VolturnUS, for the Research Array to provide an important next phase demonstration of Maine's home-grown technology**. This technology has been supported by the U.S. Department of Energy and compared with other floating technologies now being used globally, the UMaine technology has a high readiness level and is in a good position to create market opportunities around the world.

Given its partnership with UMaine, the State of Maine intends to partner with New England Aqua Ventus – a joint venture of Diamond Offshore Wind, a subsidiary of Mitsubishi Corporation, and

[3] In recognition of concerns raised by Maine's fishing industry during stakeholder conversations on offshore wind, Governor Mills introduced legislation to limit new offshore wind projects located in state waters (LD 1619). The State of Maine believes that this approach strikes a balance between preserving state waters for valuable fishing and recreation, while reaffirming Maine's priority of locating offshore wind projects in federal waters of the Gulf of Maine.

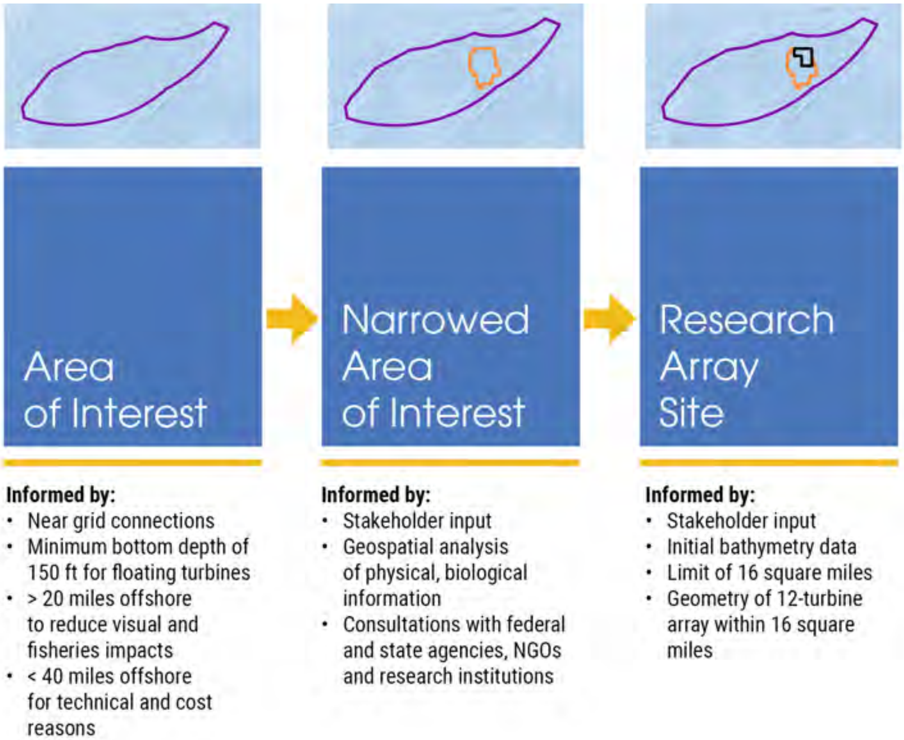
RWE Renewables, some of the world's largest offshore wind companies – to develop and operate the Research Array. To support this project, in June 2021 the legislature passed through a bipartisan vote, and the Governor signed, LD 336, which directs the Maine Public Utilities Commission to enter into contract negotiations for a power purchase agreement for the Research Array.

SITING PROCESS

The proposed Research Array has been shaped and strengthened from extensive stakeholder engagement, which guided siting decisions and associated research priorities for the purposes of this application. The State of Maine engaged hundreds of individuals which resulted in selection of a proposed lease area in a location with limited lobster activity and minimal groundfish activity (DMR 2021).

Siting involved a three-step process as outlined in Figure AC, starting with the State of Maine designating an Area of Interest (AOI). This AOI was informed by the technical feasibility of connecting to the electric grid at a high-voltage nearshore location that could accommodate power injection from the Research Array and the economic feasibility of cabling for a project of this smaller size. In addition, the AOI is in a location that will yield data relevant to the development of future larger commercial-scale projects. The AOI was then refined by extensive analytic evaluation of known obstacles and data sets, as well as formal and informal feedback from ocean stakeholders. This resulted in a focused area – the Narrowed Area of Interest. Finally, the Research Array Site (Research Array Site or Site), was identified, after additional input, that could accommodate a variety of turbine array configurations. Siting is further detailed in Section 3.0. The State of Maine's siting process for determining the location of the Research Array Site occurred in advance of, and separate and apart from, a federal review process that will be undertaken by BOEM to determine whether the proposed research lease area will be awarded.

Figure AC
Siting Process Overview



Planned Research

The purpose of the Research Array is to site, design, and operate a multi-turbine array to evaluate the ability of floating offshore wind projects to co-exist with traditional marine users and the marine ecosystem, while advancing floating offshore wind technology. Unlike offshore wind turbines with fixed bottom foundations, there is no world-wide body of knowledge to draw upon to evaluate impacts of floating offshore wind turbines on the ocean environment. The planned research is intended to provide real-world experience to industry, researchers, states, and the fishing industry regarding how to best to co-exist and maximize functionality of floating offshore wind projects. The scale of the Research Array provides an opportunity to evaluate potential interactions with commercial projects, including testing various fishing activity between turbines and in transit lanes. The number of wind turbines needs to be large enough to simulate some aspects of commercial scale projects and their interactions with fisheries, marine mammals, avian species, and the marine environment, all unique to the GOM.

The stakeholder outreach process has generated significant input into the research priorities of the Research Array. The State of Maine has gathered input from local scientists and research institutions, ocean users, federal and state agencies, as well as assessed the global state of relevant offshore wind research, to develop an integrated research framework (Appendix A). This research framework captures the latest state of the industry, highlights the research areas most critical to Maine, identifies data gaps, and outlines an inclusive and thoughtful approach to formalizing the research plan for the Research Array over the various phases of the project. The research framework is further detailed in Section 4.0. In summary, the goal of the research is to optimize the co-existence of floating offshore wind with the human and ecological environment with the following specific objectives:

- Reduce conflicts with existing ocean uses, with emphasis on fisheries;
- Support education, workforce and supply chain development;
- Maintain coastal community culture and heritage while creating socioeconomic opportunities;
- Monitor ecosystem change at the Research Array and inform future projects by providing recommendations for socially and environmentally responsible development; and
- Advance floating wind technology and reduce the levelized cost of offshore wind energy.

The State of Maine will launch and lead a Research Consortium to guide the research process, including to develop research priorities, oversee research activities, provide transparent open-source results, and build on research priorities of other regional and global efforts.

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Abbreviations

AOI	Area of Interest
BOEM	Bureau of Ocean Energy Management
DMR	Maine Department of Marine Resources
DoD	U. S. Department of Defense
DOE	U. S. Department of Energy
EA	Environmental Assessment
ESA	Endangered Species Act
EFH	Essential Fish Habitat
FAA	Federal Aviation Administration
ft	feet
GOM	Gulf of Maine
HMA	Habitat Management Area
IFW	Maine Department of Inland Fisheries and Wildlife
km	kilometers
LiDAR	light imaging, detection, and ranging
MARCO	Mid-Atlantic Ocean Data Portal
MESA	Maine Endangered Species Act
mi	miles
MMPA	Marine Mammal Protection Act
MW	megawatt
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NERACOOS	Northeast Regional Association of Coastal Ocean Observing Systems
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Marine Fisheries Service
NEAV	New England Aqua Ventus, LLC
nm	nautical miles
NREL	National Renewable Energy Laboratory
OBIS-SEAMAP	Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations
OCS	Outer Continental Shelf
OPAREA	Boston Operating Area
SMA	Seasonal Management Area
sq mi	square mile
TSS	Traffic Separation Scheme
USFWS	U.S. Fish and Wildlife Service
UMaine	University of Maine
UME	Unusual Mortality Event
U.S.	United States
USCG	United States Coast Guard
WTG	wind turbine generator

1.0 Introduction

1.1 STATE OF MAINE GOALS

The State of Maine is a national leader in combating climate change and promoting renewable energy to reduce greenhouse gas emissions and take advantage of the significant economic opportunity offered by clean energy and innovation. In 2019 the legislature, with bipartisan support, enacted one of the most ambitious climate change mandates in the country: the State will reduce greenhouse gas emissions 45 percent below 1990 levels by 2030 and 80 percent by 2050. The State of Maine has also enacted a renewable energy portfolio standard requirement of 80 percent by 2030 and a goal of 100 percent by 2050. With 85 percent of statewide emissions coming from residential and transportation sectors – as well as the status of being the most heating oil-dependent state in the nation – achieving these goals will require investment in beneficial electrification in addition to new renewable energy resources.

These ambitious policy actions come even as climate change is affecting all aspects of Maine life, including the Gulf of Maine (GOM), which is warming faster than 99 percent of ocean bodies on earth (Pershing *et al.* 2015). Recognizing the need for action, the legislature, again with bipartisan support, enacted bold climate targets and created the Maine Climate Council to develop Maine's Climate Action Plan. The four-year plan *Maine Won't Wait*[4], released in December 2020, is centered on data-driven outcomes to create new economic opportunities and reach the ambitious emissions reductions goals set out in law. A fundamental component of achieving both of these objectives is pursuing new clean energy resources.

The State of Maine recognizes the tremendous opportunity of offshore wind to help meet the state's climate and clean energy requirements and economic growth opportunities. With some studies indicating the offshore wind industry represents a $1 trillion opportunity worldwide by 2040, the State of Maine is focused on building a floating offshore wind industry here in Maine. Maine is uniquely prepared to create good-paying trades and technology jobs in offshore wind, by advancing innovative floating offshore wind technology, utilizing the state's robust maritime experience, forging public-private partnerships for research and supply chain development and workforce training, and investing in Maine's deep-water ports. This opportunity is supported in the State's 10-Year Economic Development Strategy[5], which highlights the potential for Maine to situate a growing floating offshore wind industry at the intersection of technical services and manufacturing, two thematic areas in which Maine has current strengths and significant opportunities for growth. With the existing port infrastructure, proximity to both European and east coast markets, and the University of Maine's

[4] Maine Won't Wait, A Four-Year Plan for Climate Change, 2020, https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/MaineWontWait_December2020.pdf

[5] Maine Economic Development Strategy 2020-2029, 2019, https://www.maine.gov/decd/sites/maine.gov.decd/files/inline-files/DECD_120919_sm.pdf

(UMaine) history of offshore wind innovation, the State is well positioned to see economic growth from the sector.

The development of floating offshore wind is a key element of Maine's renewable energy strategies. To assess opportunities for reaching renewable energy requirements, in March 2021 the State of Maine released a Renewable Energy Goals Market Assessment[6], which highlights that over the long-term, offshore wind provides a promising opportunity for the state in addition to other renewable energy resources. The GOM has some of the highest sustained wind speeds in the country (Musial and Ram 2010). As an energy source, offshore wind brings unique benefits, including highest wind speeds in the winter, when Maine's energy needs will be the greatest. The vast majority of the GOM is deeper than 60 meters (m; 196.9 ft), which is thought to be too deep for conventional fixed-bottom technology (Musial et al. 2020), making floating technology critical to meeting climate goals.

To further advance the State's opportunities for offshore wind, in October 2020, the U.S. Economic Development Administration awarded a $2.166 million grant to develop a comprehensive offshore wind "Roadmap" as an initiative for growing Maine's overall economy and improving Maine's economic resilience, through targeted development of this global industry. Over the course of the next 18 months the Roadmap will be developed by an expert advisory committee and several working groups, focusing on energy markets, ports and infrastructure, socioeconomic impacts, equity, manufacturing and supply chains, workforce development, and ocean and environmental compatibility. This effort will identify how to support the growing offshore wind sector in a way that embraces the opportunity, while ensuring compatibility with our Maine coastal heritage and minimizing the impacts on fisheries. The Roadmap will outline strategies for how the State can best position itself to advance the offshore wind industry locally, with an emphasis on the unique opportunities around floating technology.

While floating technology is not entirely new and is built off the design elements familiar to the mature deep water offshore oil and gas industry, there are no commercial floating projects in the U.S., and limited experience worldwide with floating projects. As of July 2020, 73 megawatts (MW) of floating offshore wind has been installed in Asia and Europe. Since little is known about floating offshore wind technology and its interactions with ocean users and the environment in North America to inform full-scale development, this Research Array is of moderate scale, consisting of up to 12 floating turbines within an area of approximately 15.2 sq mi.

For centuries Maine's iconic coastline and the productivity of the GOM has been the lifeblood of coastal communities and the economy. Today, the GOM continues to sustain communities with a strong fishing industry, including landing most of the highest value single-species fishery in the U.S. – lobster.

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[6] State of Maine Renewable Energy Goals Market Assessment, 2021, https://www.maine.gov/energy/sites/maine.gov.energy/files/inline-files/GEO_State%20of%20Maine%20Renewable%20Energy%20Goals%20Market%20Assessment_Final_March%202021_1.pdf

The lobster fishery generates roughly half a billion dollars in direct value for Maine annually and supports more than $1.5 billion in indirect economic impact. Other productive fisheries including groundfish, scallops and herring, also rely on the GOM and land their catches through Maine's working waterfronts.

Much of Maine's nearly $10 billion tourism economy is also focused on the state's iconic coastline. Although the industry was heavily impacted by the COVID-19 pandemic in 2020, it is expected to recover to resume its role as one of the state's largest industries – supporting more than one in six jobs statewide as recently as 2019. Many of the more than 37 million visitors to the state, which is commonly known as "Vacationland", in 2019 engaged in recreation, retail, and accommodation activities built around Maine's beaches, lighthouses, island and coastal communities, and state and national parks that provide access to the marine environment and wildlife in the GOM.

It is essential that floating wind be developed in a fashion that respects existing marine users in the GOM. For the long-term success of offshore wind in the GOM, the State of Maine has and continues to embark on a science-driven, phased approach to development. Given the importance of researching floating technology and its compatibility with marine users and the environment, the entirety of the Research Array – from initial outreach, site selection, and research priorities, to the project design, layout, and operations – has been and continues to be centered around research. This research is critical to the State of Maine and its residents and will be designed to answer key questions with the goal of informing construction of large-scale projects in the GOM. Recognizing the need to develop floating offshore wind technology to access wind generation potential in the GOM's deep waters that is compatible with the State's objectives to protect its existing industries and optimize co-existence with traditional marine users and the ecosystem, the Maine Legislature recently passed and the Governor signed LD 336, requiring the Maine Public Utilities Commission to direct the negotiation of a long-term power purchase agreement contract necessary to facilitate development of floating offshore wind research arrays in the GOM.

As part of the Maine Offshore Wind Initiative, this Research Array will be the first of its kind in the U.S. Research will focus on fisheries and marine mammal co-existence both near and within the Research Array, biodiversity and fish stock enhancement, and potential impacts to protected species. Additional research will consider commercial-scale array issues related to siting, constructing, deploying, and operating multiple floating wind turbines while reducing production and energy costs and uncertainty. While the Research Array will produce energy that will be delivered into the Maine grid, this project differs from other commercial projects due to its size[7], which is significantly smaller than the average commercial lease area (which currently range from 43,000 to 187,000 acres); the State of Maine's leadership in designing and overseeing the project; and that open-source research specifically developed for Maine will be fundamental to all aspects of the project conception to operation.

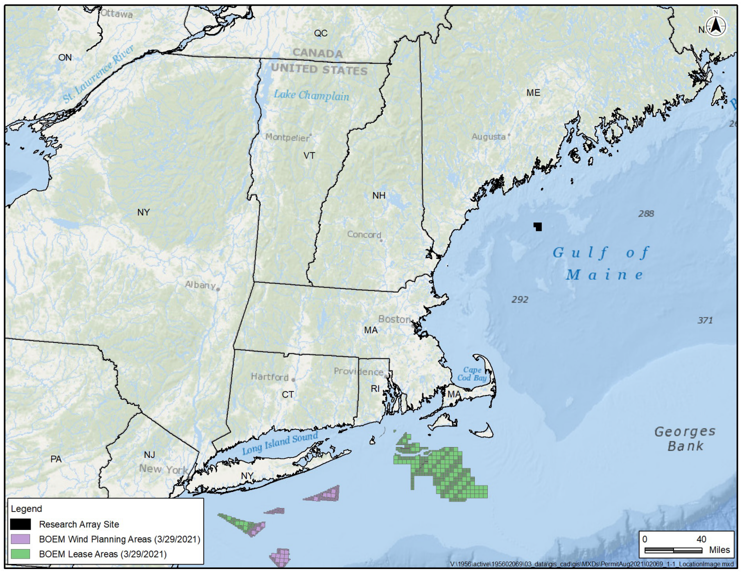
[7] The most recent awards for offshore wind projects are for projects ranging in size from 1.148 to 1,510 MW.

1.2 OBJECTIVES OF RESEARCH ARRAY

The objective of the Research Array is to arrive at a set of informed best practices and standards for commercial-scale floating offshore wind projects in the GOM to utilize in planning, permitting and constructing commercial-scale projects in a fashion that optimizes co-existence with traditional marine users and the ecosystem.

There currently are no commercial or research lease areas in the GOM. The proposed Research Array is relatively small, but also large enough to simulate how a full commercial-scale project will function in the ocean environment. The nominated Research Array Site (Research Array Site or Site) which comprises 15.2 square mi (sq mi; 9,728 acres), is small compared to BOEM commercial-scale leases which range from 43,000 to 187,000 acres (Figure 1-1). This relative scale is most evident where the planned Research Array Site is shown in relation to the existing Massachusetts lease areas. This 15.2 sq mi site amounts to 0.04 percent of the 36,000[8] sq mi in the GOM.

Figure 1-1. BOEM Lease Areas and Proposed Lease Area



The objectives of the Research Array are to:

- Prudently advance offshore wind off the coast of Maine in a manner that fully considers the state's coastal communities and heritage industries while proactively taking steps to seek new opportunities to support clean energy innovation;

- Provide real-world experience with a multi-turbine array to investigate science-based avenues to maximize co-existence with the fishing industry;

8 https://gulfofmaine.org/public/gulf-of-maine-council-on-the-marine-environment/about-the-gulf-of-maine/

- Advance technical and commercial considerations related to floating offshore wind development that will result in more efficient, cost effective, energy production that can be integrated into full-scale deployment;
- Evaluate interactions and seek to minimize potential impacts of the floating turbine array on marine environment and protected wildlife species;
- Undertake a data-driven, science-based, inclusive and transparent approach that will produce learnings and research that will benefit the state, federal agencies, researchers, and offshore wind developers; and
- Create a set of real-world tested best practices and standards that can foster more prudent development of commercial-scale projects in the future.

Given that the goal of the Research Array is to inform future commercial projects, if the lease is issued, the State of Maine will work expeditiously to plan and responsibly develop the Research Array so that it can inform future commercial scale projects before construction and operations. The process for site identification is separate from BOEM's wider offering of commercial leases for offshore wind development in the GOM. The State of Maine serves on BOEM's Interagency Regional Gulf of Maine Task Force and will continue to work with BOEM, Massachusetts and New Hampshire on the information needed to support future federal commercial leasing decisions in the GOM that recognize the importance of the Research Array to the State of Maine and the needs of other states to meet critical climate objectives.

It is understood that BOEM regulations require that it determine, before it enters into a lease, there is no competitive interest in leasing the same location that is requested in this application "for substantially similar wind energy activities" building on the precedent set in the Virginia Request for Competitive Interest[9] [10]. The "wind energy activities" proposed herein are (i) small scale (no more than 12 wind turbines); (ii) State-sponsored; and (iii) focused on research intended to support future renewable energy production in a fashion goes well beyond what's possible at commercial projects and that also protects the State's vital interests in its natural resources (see fishing activity summary in Section 5.6), including its significant role in the commercial fishing activities in the GOM. Wind energy activities proposed herein are purposely limited to no more than 12 wind turbines within a lease area that is a small fraction the size of BOEM's past commercial leases.

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[9] *See,* BOEM, *Research Lease on the Outer Continental Shelf (OCS) Offshore Virginia, Request for Competitive Interest,* 146 Fed. Reg. 45,965 (July 30, 2013) (the "CVOW RFCI").
[10] CVOW RFCI, 78 Fed. Reg. at 45,956, 45,967 (expressions of interest must be "for substantially similar wind energy activities" and involve the "installation of no more than two [wind turbine generators]" as proposed by DMME).

2.0 Description of Project

2.1 PROJECT DESCRIPTION

2.1.1 Overview

The Research Array is intended to be a small-scale array of wind turbines that is large enough to evaluate and resolve many of the issues associated with commercial-scale floating turbine arrays built and operated in the GOM. The Research Array is anticipated to consist of 12 or fewer wind turbines, producing no more than 144 MWs, and is more than 20 miles (mi) from shore at a location that is reasonably indicative of future commercial-scale project locations. Maine law requires that commercial-scale projects may only be sited in federal waters and as such the contemplated Research Array has to be sited in federal waters to provide appropriate data to inform future commercial-scale development.

2.1.2 Research Array Design

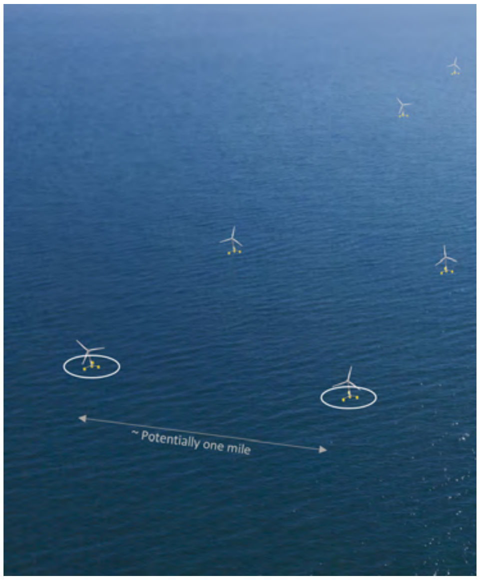
The turbines in the Research Array will be mounted on floating foundations that use a design patented by UMaine as depicted in Figure 2-1. This foundation design supports one of the State of Maine's key goals for offshore wind in the GOM: maximize local job creation. The planned floating foundation utilizes prefabricated concrete, rather than solely steel, allowing it to be manufactured locally and create local jobs.

Figure 2-1. Indicative Floating Foundation

UMaine has an extensive body of work, including over 40 floating turbine patents, created over more than 10 years, funded partly by the U.S. Department of Energy (DOE), the State of Maine and New England Aqua Ventus, LLC, that documents how fabrication of this type of foundation is designed so that it can be manufactured in Maine. Regardless of the State of Maine's interest in job creation associated with this specific foundation design, this foundation is also indicative of the footprint required by other floating foundation designs and can function as a reasonable proxy for any floating foundation in the GOM.

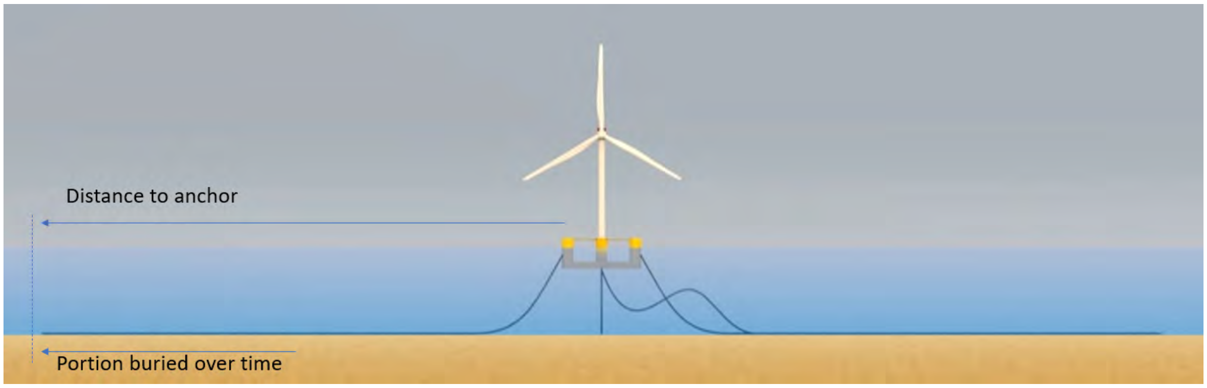
The fishing industry, and others, have many questions regarding the basic architecture and behavior of offshore wind projects, including their footprint, the ability to optimize (reduce) the footprint to allow proximate fishing, the burial of cables, how they behave in storms, whether or not developers, insurers or the United States Coast Guard (USCG) will create exclusion zones, and whether vibration or electromagnetic fields impact the behavior of important marine species such as lobster or right whales. One of the central design and behavioral issue questions that will be incorporated into the Research Array is depicted in Figure 2-2 and Figure 2-3 – the spacing between turbines and the distance to the anchor, whether or not this can be optimized through design or use of alternative materials and what portion of this mooring line becomes buried over time, enabling greater potential for fishing activity in the wind farm.

Figure 2-2. Indicative Turbine Spacing



The Research Array will utilize state of the art turbines, likely of the largest then-available size, that will be most indicative of future turbines that will be utilized in commercial-scale projects. Specifications indicative of the smallest and largest turbine models are summarized in Table 2-1. Each turbine will be deployed on a floating concrete semi-submersible hull held in position by no less than three marine mooring lines in the water column securely anchored to the seabed. Turbines will be connected by interconnection alternate current cables, which will be connected to an onshore transition point by a cable.

Figure 2-3. Indicative Distance to Anchor



It is anticipated that the final turbine model selection will take place during the design process and be informed by (i) then-available turbine models, (ii) site-specific metocean data and geological surveys, and (iii) the configuration of the array (as discussed further below), and potentially (iv) other considerations that arise from the research planning process.

Table 2-1. Range in Size of Potential Turbines

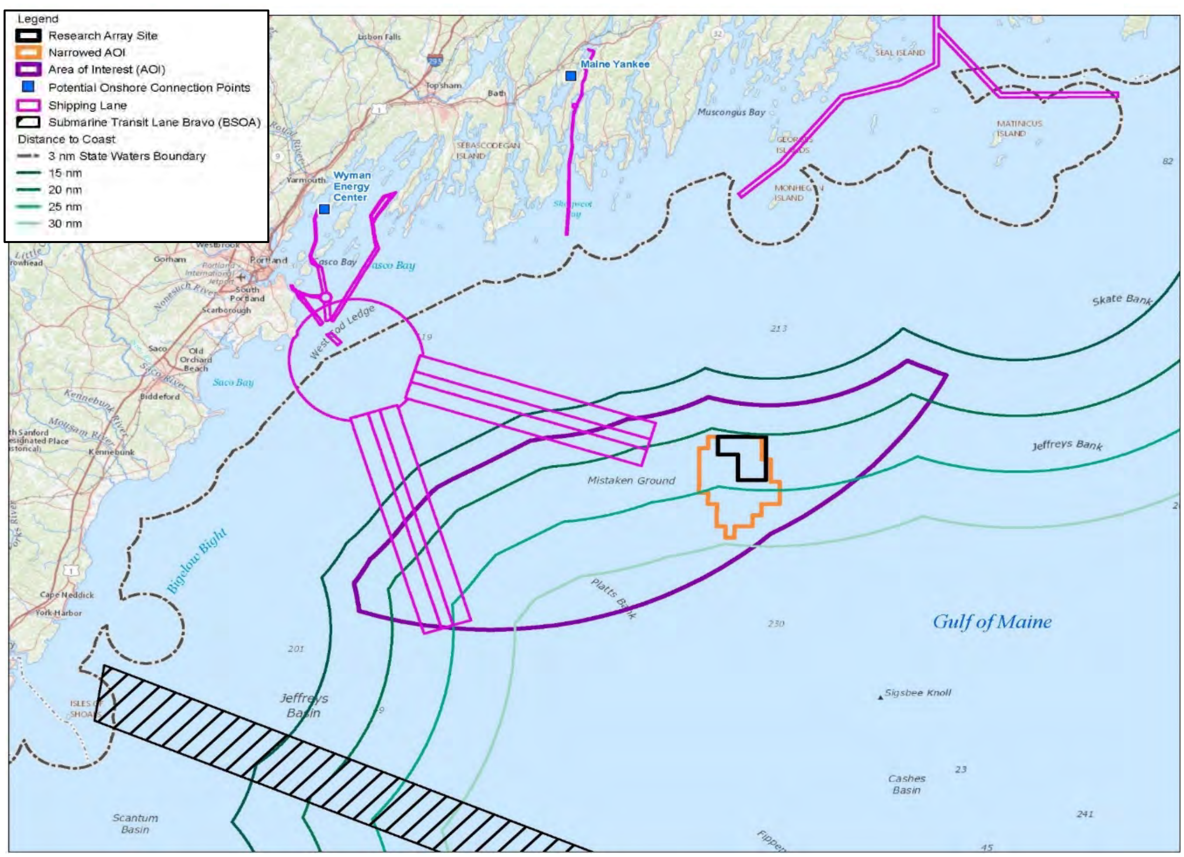
Turbine	Indicative "Smaller" WTG SGRE 11MW-200m	Indicative "Larger" WTG National Renewable Energy Laboratory Reference Turbine 15MW-242m
Hub Height (m)	123	156
Tip Elevation (m)	223	267
Clearance from Water (m)	23	25.5
Swept Area (m^2)	31,415	45,966

The planned Research Array Site was determined as detailed in Section 3. In essence, the Site (i) avoids known prohibited areas, such as shipping lanes, (i) is more than 20 mi from shore, (ii) is proximate to grid connection, (iii) is in deep water (greater than 150 feet [ft]; 46 m deep), (iv) avoids sea-floor features with a goal of de-conflicting, to the extent possible, with fisheries and altogether is indicative of areas that could accommodate commercial-scale projects.

2.1.3 Grid Connection

The Research Array Site, shown in Figure 2-4, will include the designation of two high voltage substations that are the potential grid connection locations. No subsea substations are planned for this project. Both substations are connected to 345-kilovolt lines and have more than enough potential to accommodate the capacity of a Research Array. The final grid connection location will be determined later in the development process and will be informed by grid studies that will determine costs of interconnecting, cable landing logistics, permitting, real estate considerations, local community engagement, and cable route geophysical and geotechnical investigations. The route of eventual cables, inter array and export, will be determined after cable route surveys are completed. Similar to other cable projects in Maine waters, this cable route survey will be conducted in coordination with and with adequate notice to stakeholders, with the intention of finding a route where the cable can be buried to a depth of 6 ft (1.8 m) to minimize impacts. The eventual substation on land will include a transformer that will increase the voltage of incoming power to match that of the grid.

Figure 2-4. State of Maine Research Array Area of Interest and Site



2.1.4 Other Spatial Considerations

A core purpose of the Research Array is to install a sufficient number of turbines in a configuration that is indicative of how commercial-scale projects might be arranged. This small array is intended to allow in situ observations of how traditional marine users and marine species interact with an array. The designated Research Array lease boundaries are intended to allow flexibility in determining exactly what array configuration will be most appropriate from a technical standpoint and useful as a basis for research. Three potential array configurations are depicted in Figure 2-5. These figures show the potential to optimize turbine spacing and the potential to allow built-in array transit zones that could be 2 mi in width. This transit zone concept is potentially indicative of what could be incorporated between wind farms, to allow ocean users, including the fishing industry, to interact with the Research Array and provide feedback that could inform future wind farm layouts. Given the small footprint, the layout of the Research Array itself is not anticipated to obstruct future commercial-scale wind turbine arrays in the GOM.

The requested lease area is 15.2 square miles (9,696.4 acres; 11.4 square nm; 3,924.0 hectares); while small compared to commercial leases, it is larger than BOEM's prior research leases because of three factors:

1. As noted above and as depicted in Figure 2-5, the lease area is sufficient to allow evaluation of multiple possible array layouts that will only result in a final turbine layout after extensive stakeholder interaction and technical and financial evaluation (research in its own right);

2. The intended inclusion of transit lanes that can be empirically evaluated by fishermen and larger vessels; and

3. A substantial conservative allowance for mooring lines to fit within the lease area, allowing a robust evaluation of different mooring and anchor line technology[11].

As such, it is clear that a small array of wind turbines using fixed bottom foundations in a pre-designated grid, without transit lanes or mooring line allowanced would be much smaller. In the event BOEM desires, the State would be amenable to working with BOEM to relinquish eventual undeveloped area in order to reduce the overall lease size.

It is anticipated that the final turbine configuration will be influenced not only by technical and public evaluation of potential configurations but also based on detailed site investigations, turbine selection,

[11] In a small floating turbine array, where almost all turbines are on the outer edge of the lease, the edge effects associated with mooring lines amplifies the apparent need for more lease area to accommodate the planned small number of turbines relative to projects using fixed bottom foundations. The net effect is that this allowance makes the requested lease area appear disproportionately large.

mooring designs and feedback from researchers, fishermen, and other ocean stakeholders, as well as BOEM's review process under the National Environmental Policy Act.

Figure 2-5. State of Maine Research Array Area – Potential Array Configurations

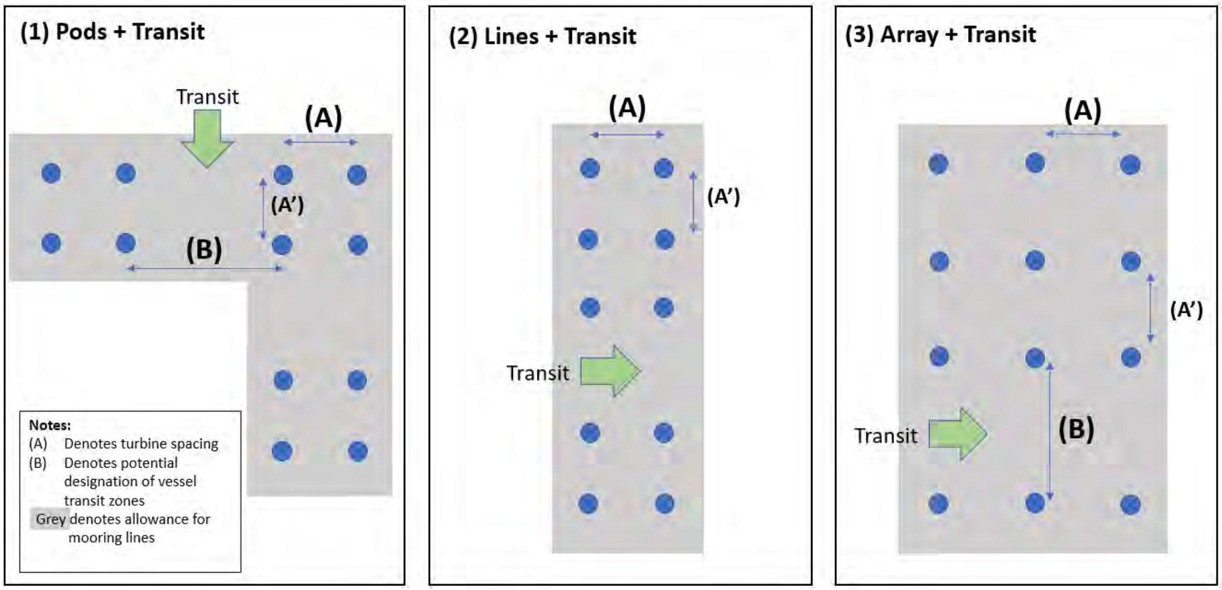
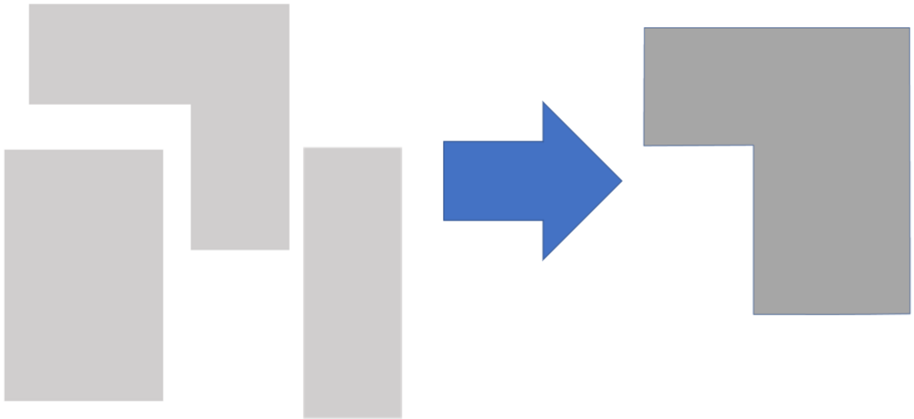


Figure 2-6. Lease Area that Accommodates Multiple Array Configurations

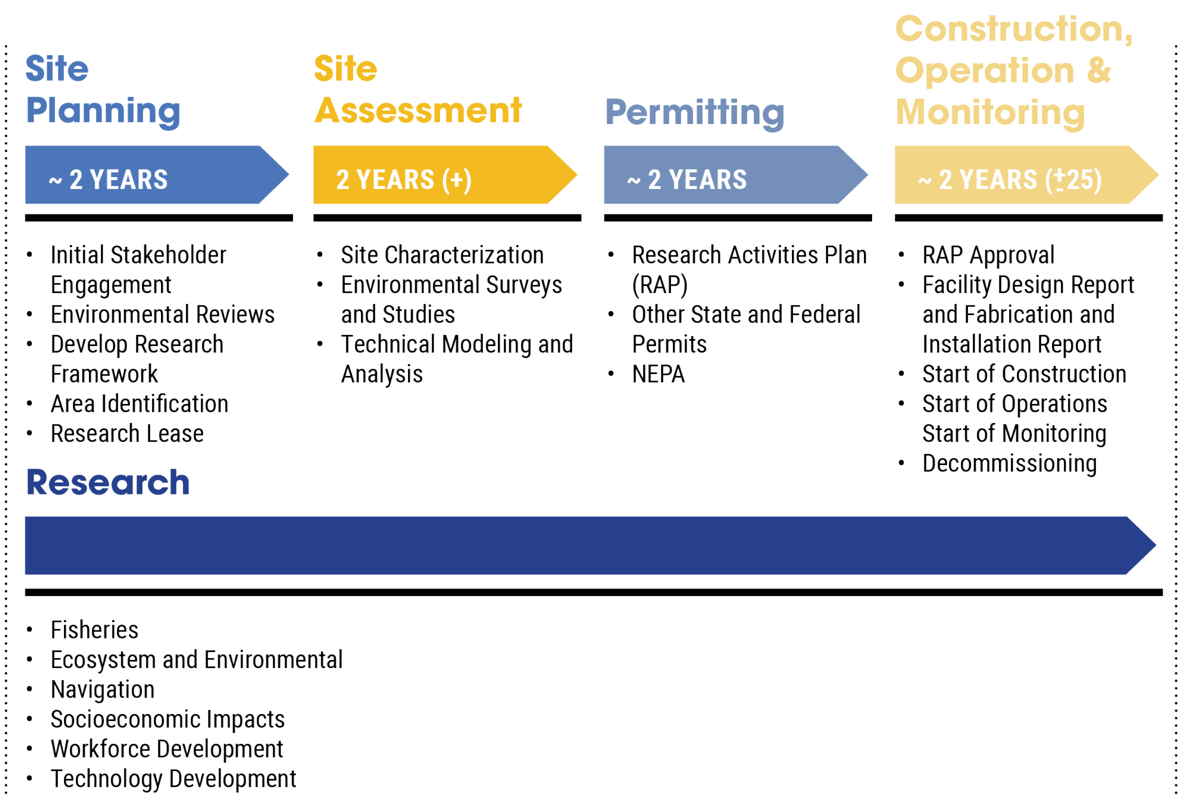


2.2 GENERAL SCHEDULE

The Research Array is intended to eventually inform commercial-scale development in the GOM. As such, the proposed general schedule aims to move as expeditiously as possible to develop meaningful research findings that can be used to inform future projects without potential delays.

The Research Array schedule is based on a multi-year development phase (Figure 2-7.). The development phase will include surveys of the physical environment in and proximal to the Research Array Site, the compilation of robust baseline data expected to include multiple years of biological resource studies; an analysis of impacts including an Environmental Impact Statement that is prepared in compliance with the National Environmental Policy Act; and activities to satisfy state and federal permitting requirements. In addition, research will span the multi-year development phase and continue into the operational phase which also will include monitoring. See Section 4.0 for additional information regarding research and monitoring.

Figure 2-7. Indicative Project Schedule



3.0 Siting Process

Site selection for the Research Array was an extensive, multi-party, coordinated effort, that can be broadly characterized as a three-step process, which is described in the subsections below and further elaborated on in Section 3.2. First, the AOI was identified within the GOM based on a set of preliminary siting criteria (Section 3.1) that was specific to a project of this scale. A period of outreach and engagement was then undertaken to narrow the AOI based on stakeholder feedback and integration of more refined technical criteria (Section 3.2). Finally, layout and alignment considerations were taken into account and the final site of the Research Array was selected (Section 3.3). The State of Maine's siting process for determining the location of the Research Array Site occurred in advance of, and separate and apart from, the federal review process undertaken by BOEM to determine whether the proposed research lease area will be awarded.

3.1 IDENTIFYING THE AREA OF INTEREST (AOI)

The initial step of the siting process was to evaluate potential locations for an AOI, with a goal of identifying the most advantageous area within the GOM to support a Research Array aimed to be low impact, low reasonable cost, energy efficient, and accessible. To achieve this, identification of the original AOI was based on the following preliminary siting criteria and constraints:

1. The proposed area will be in proximity to potential onshore high-voltage electric grid connection sites.

2. The array will be in an environment with a minimum bottom depth of 150 ft (46 m) to allow for use of floating technology.

3. The substrate will include mud or gravel bottom to accommodate anchoring.

4. The array will be no less than 20 statute mi (17.4 nautical miles [nm]) offshore. This consideration was to reduce potential impacts on inshore fisheries and visual resources and drives the nearshore boundary of the AOI.

5. The array will be no more than 40 statute mi (34.8 nm) offshore. This consideration was for technical and cost reasons and drives the offshore boundary of the AOI.

6. The selected location will factor in and minimize conflict with known fishing grounds, exclusion areas, and highly trafficked areas.

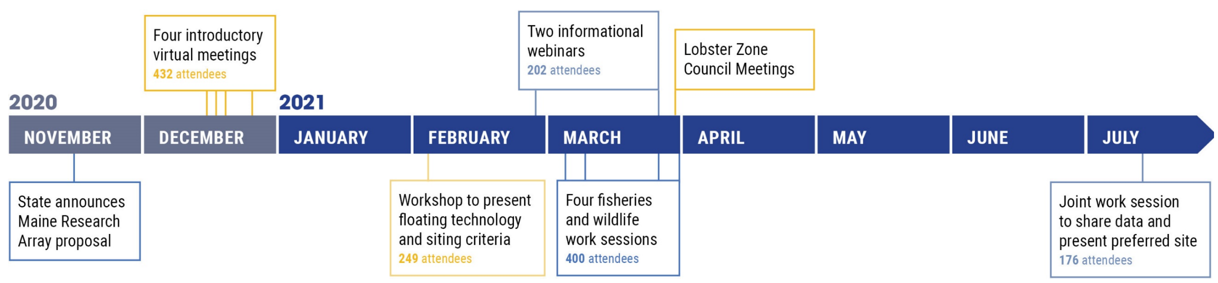
Ultimately, through review of publicly available data and in consideration of the parameters described above, the State of Maine, with support from the Maine Department of Marine Resources (DMR), identified the AOI of approximately 770 sq mi. The Research Array itself will occupy a very small portion of the AOI. The process of narrowing down the AOI was driven by stakeholder engagement, discussed in Section 3.2.

3.2 REFINING THE AREA OF INTEREST – STAKEHOLDER ENGAGEMENT

In December of 2020, the State of Maine began to refine the baseline criteria described above based on stakeholder input to introduce specific coordinates for the ultimate lease boundaries of the Site.

The Governor's Energy Office, in coordination with DMR, and Department of Inland Fisheries and Wildlife (IFW), held a series of informational meetings focused on the fishing industry during the winter of 2020/2021 to share information and solicit feedback (Figure 3-1). Between February and May of 2021, the Governor's Energy Office held a series of virtual webinars to share information, describe the components of the Research Array, and receive stakeholder feedback. The Governor's Energy Office held four virtual work sessions throughout the month of March 2021 which focused specifically on recent and historic fisheries and wildlife research in the AOI. Each interactive work session included

Figure 3-1. Stakeholder Engagement



presentations by agency staff or other subject matter experts where appropriate, opportunities for viewer questions and feedback, and resources. Sessions were followed by targeted meetings to review materials, receive additional stakeholder feedback, and identify and discuss specific topics of interest or concern. The Governor's Energy Office coordinated with DMR who conducted a geospatial analysis of physical and biological information (characterization/mapping) for the AOI (See Section 5.6 for additional information). The DMR compiled data for the Governor's Energy Office on fishing industry concerns regarding the Research Array and more broadly, offshore wind. In April 2021, additional one-on-one interviews were held as part of the data collection effort to refine the location of the Site. DMR engaged directly with fishing industry members to understand their activity and solicit input to inform the siting process, as well as to address questions, outside of public meetings and webinars. DMR also conducted an additional seven public meetings with the Lobster Zone Councils and a group of groundfishermen. Information on intensity of use, value to the community, seasonality, diversity of fisheries for site selection and input into the research framework were received and considered.

By Spring 2021, the Governor's Energy Office had identified the most prominent concerns of the fishing industry and those with concerns regarding wildlife. For the fishing industry, concerns included the displacement of fishing access within the array depending on gear type and target species. Fishermen are also concerned about ecosystem changes that could affect fisheries resources, economic costs outweighing the benefits, protected species entanglement, and species relocation due to electromagnetic fields deterring fish from areas where the transmission cable will be. As an initial step in characterizing the potential collision risk the Research Array would pose to marine birds, IFW coordinated with Biodiversity Research Institute (BRI) who conducted a desktop analysis using Marine-life Data and Analysis Team models developed by the NOAA National Centers for Coastal Ocean Science (Curtice et al. 2019) and a Maine-specific vulnerability analysis to prepare a series of maps depicting spatial avian risk for 36 avian species likely to be present within the AOI. The maps indicated the spatial location of avian risk across three categories including population vulnerability, collision vulnerability, and displacement vulnerability (Goodale et al. 2021, included as Appendix C) to identify the areas within the AOI of greatest relative potential risk to marine birds (See Section 5.7 and Appendix C for additional details). The Governor's Energy Office conducted further consultations with other state and federal agencies, NGOs and research institutions. Discussions with IFW and partners and DMR informed sections 5.5, 5.6, and 5.7, with the Department of Defense (DoD) informed Section 5.8, and with the Maine Historic Preservation Commission informed Section 5.11.

Ultimately, through input from the fishing industry and other stakeholders, as well as federal agencies, the State of Maine identified the Narrowed AOI of 54 sq mi (34,596 acres; 41 nm^2;); the Narrowed AOI is approximately 28.1 mi (24.3 nm) measured from the nearest boundary to the mainland.

3.3 IDENTIFYING THE SITE

The Governor's Energy Office, in coordination with DMR and IFW, held a virtual webinar in July to share information and solicit feedback from the fishing industry and other stakeholders. Prior to the webinar, the Governor's Energy Office released their *Pre-application Siting and Stakeholder Summary, December 2020 to July 2021* (Stakeholder Summary)[12], which summarized the stakeholder input that had been considered during the preceding months. The Stakeholder Summary and webinar called for additional information and public feedback on the Governor's Energy Office's proposed location for the preferred Research Array Site within the Narrowed AOI.

Between the July webinar and August of 2021, the Governor's Energy Office received written comments and other input from the fishing industry, other stakeholders and federal agencies. Feedback was minimal and included opposition as well as general support that based on available data and initial analysis of the Site's physical attributes, the preferred Research Array Site avoids known, significant physical features (*e.g.*, Platts Bank), thereby aiming to reduce potential impacts to wildlife, and also expressed that potential impacts to fishing activity is uncertain. Further, the Research Array Site balances the needs and safety of all waterway users, and consultation with federal agencies concluded

[12] GEO Stakeholder Summary [July 2021] (maine.gov)

that based on initial assessments (*e.g.*, navigational assessments), anticipated potential impacts to navigation and defense can be mitigated (see Sections 5.8 and 5.9).

The Site is approximately 23.4 mi (20.3 nm; 37.7 km) measured from the nearest boundary to the nearest point of land on Monhegan Island, 28.8 miles (25.0 nm; 46.3 km) to the nearest point on the mainland at Cape Small, and 44.8 mi (38.9 nm; 72.0 km) to Portland. The Site encompasses 15.2 mi^2 (9,696.4 acres; 11.4 square nm; 3,924.0 hectares). Additional information regarding the physical attributes of the Site is in Section 5.0.

4.0 Research Framework

4.1 GOAL

The research that will be conducted at the Research Array will fill existing data gaps, thereby reducing uncertainty around impacts from floating offshore wind projects on existing ocean users and the ecological environment and inform the responsible development of future wind projects in the GOM to support co-existence with these important considerations. Studies conducted at the Research Array will augment existing research, monitoring, and impact assessment guidance for offshore wind, in particular work being conducted by existing regional research consortia, such as the New York State Energy Research and Development Authority (NYSERDA)'s E-TWG (Environmental Technical Working Group), ROSA (Responsible Offshore Science Alliance), and the RWSE (Regional Wildlife Science Entity)[13], with specific focus on floating technologies and priority needs for the GOM.

4.2 INFORMING THE RESEARCH

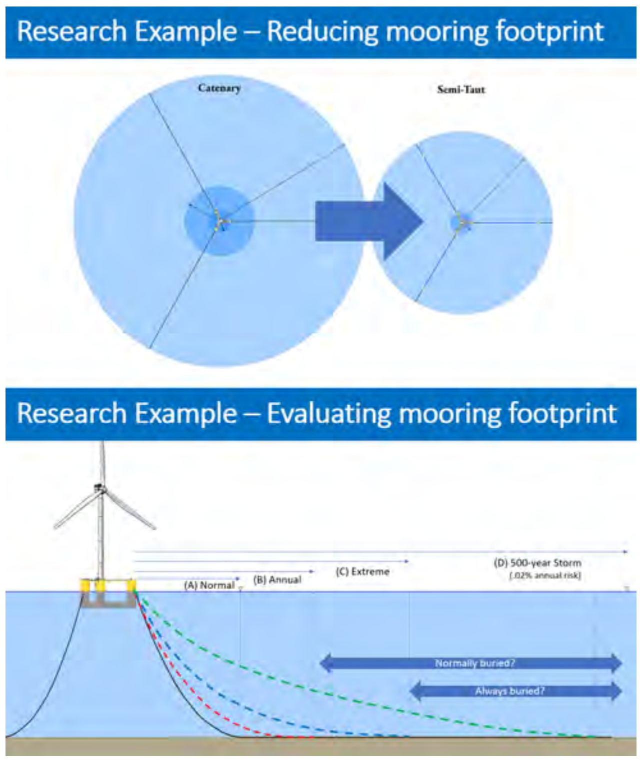
As previously described, the formation of the research framework, summarized herein and provided as Appendix A, was developed through input from subject matter experts, state agencies, and the results of public outreach efforts. As described in Section 3.0, the Governor's Energy Office hosted a series of subject-based workshops to inform the siting process. During these workshops, stakeholders also were asked to identify research questions that the Governor's Energy Office incorporated into the research framework. The research framework outlines an interdisciplinary approach to answer fundamental questions about floating offshore wind. Desktop studies, including modeling efforts, have and will be performed to summarize the biological and socioeconomic information known about the Research Array Site. These studies and modeling efforts have informed initial predictions and hypotheses regarding potential impacts to some resources and existing uses as a result of the Research Array. These hypotheses will guide the research in the field. Predictive modeling performed to date has analyzed use by mariners and effects on navigation, bird use, and cetacean use. Collectively, modeling efforts,

[13] https://www.nyetwg.com/; https://www.rosascience.org/; https://www.nyetwg.com/regional-wildlife-science-entity

along with a formal analysis to refine what is currently unknown and worthy of analysis, will help further refine research questions.

As a result of information collected during the efforts described above, three core research themes were identified: human dimensions, ecological interactions, and technology development. The three core research themes will require individual study, yet findings will be considered among the themes, resulting in an interdisciplinary understanding. Subcategories were identified as follows:

Figure 4-1.
Potential Mooring and Anchor Footprints



__**Fisheries.**__ Impacts to fish are expected to differ among species and therefore, fisheries. Components of the Research Array, (*i.e.*, the catenary anchoring chains) may affect the presence or distribution of marine species, as well as the feasibility of using certain types of fishing gear. Research methodologies to further investigate potential fisheries issues may include acoustic tracking of species within and in proximity to the array, evaluation of habitat changes, vessel tracking before and after construction and active experimental fishing under controlled conditions in proximity to the anchor chains. For example, the impacts of mooring line configuration and materials on fish behavior and fishing activity could be evaluated (Figure 4-1) and informed by surveys as well as with stakeholder interviews.

__**Ecosystem and Environment.**__ How the ecosystem responds to fixed bottom offshore wind turbines has been well studied in Europe; however, while European research provides a solid base of understanding of how the ecosystem will respond to offshore wind, the studies have been focused on fixed bottom technology and substantial questions remain on how the ecosystem will be affected by floating turbines. Some species may collide with turbines and/or be attracted to them, while others may avoid them completely. For species opting to avoid the turbines, a potential shift in distributions and migrations could occur. Simultaneously, the new hard substrate may change the habitat causing a 'reef effect' where species are attracted to the turbines and resident populations may shift. Marine life may also respond to electromagnetic fields and operational noises. While European research provides some of these predictions, studies have been focused on fixed bottom technology which tend to be in shallower waters (less than 100 m; 328 ft). Additional research is therefore needed to understand how floating technology in deeper waters (150–400 m [492 ft–1,312 ft]) may impact the ecosystem and environment. Research to further investigate this issue will include improving understanding of the following: (1) the occurrence of species around the Research Array and how these change through phases of development; (2) the potential stressors of floating offshore turbines and methods to assess and minimize those stressors; and (3) how to optimize the co-existence of fisheries and wildlife with floating offshore wind in the GOM.

Navigation. Although the Research Array was macro-sited to allow for minimized conflicts with marine navigation, merchant shipping, and DoD areas, the research question on navigation remains on how the micro-siting and layout of the Research Array can be optimized to minimize impact on the navigation of existing tug-tow, passenger, cargo, tanker, and other vessels. Additional questions were also raised on how vessels might navigate around the Research Array service vessels that will be transiting to and from the Research Array. The inclusion of transit zones within the Research Array will allow the fishing industry to interact with the Research Array and provide feedback that could inform future wind farm layouts. Research to further investigate these issues will include a variety of methods such as interviews, polls, AIS (automatic identification system) tracking, surveys, and simulated search and rescue scenarios.

Socioeconomic Impacts on Coastal Communities. Research is needed to provide insight into positives and negatives of offshore wind development for GOM coastal communities. Additional studies will be conducted to investigate the potential impact of lost fishing opportunities on shoreside fishing infrastructure, job loss/creation, local tax structure and community resilience to change. New economic opportunities are anticipated, such as turbine tourism; however, there may be an expectation of change(s) that may or may not be actualized. Research to further investigate this issue will include interviews, polls, and economic analyses to study how offshore wind may impact coastal communities.

Workforce Development. Offshore wind is expected to offer job opportunities, some requiring workforce education, training, or specialized skills. Workforce education and training will be needed to support creation and retention of jobs for siting and permitting, construction, manufacturing, community and fisheries relations, maintenance, and monitoring jobs for Maine workers. Training opportunities will also be available at multiple levels. Research to further investigate this issue will include determining which work sectors will have the most opportunities, and what workforce development innovations and/or new worker attractions might be needed.

Technology Development. Deployment of floating offshore wind turbines will provide an opportunity to identify technological challenges and to identify key areas necessary to reduce costs for larger arrays in the future. Offshore wind technology to be optimized may include moorings, hulls, control systems, turbines, turbine blades, etc., and how to best decrease the cost of energy. Research to further understand these key concepts will include monitoring and data gathering technology and studying climate and metocean conditions. Furthermore, commercial co-existence and navigation improvements can be further refined during passive and active tracking of activities around and through the Research Array.

Research Consortium. A key component of the Research Array is developing and executing a research strategy to answer the most critical questions about interactions with floating offshore wind in the GOM. As outlined in LD 1619, the State of Maine will establish a consortium to manage the research for the array, including the development of a full research strategy and management of research priorities and projects for the Research Array. The research consortium will be designed to take an integrated approach to research in an open, transparent, and inclusive manner that is informed by the work of regional and national scientific entities and work to fulfill the mission of the Research Array, with input from Maine stakeholders, including the fishing industry, state and federal agencies, and external scientific experts. Collectively, research at the array will substantially move forward groundbreaking research in floating offshore wind by identifying opportunities and challenges to the human environment, developing methods to avoid and minimize impacts to the ecosystem, and lowering the cost of floating offshore wind energy.

5.0 Site Renewable Energy Resource and Environmental Conditions

The following sections describe the site characteristics, or affected environment, within and surrounding the Site and/or the AOI, as appropriate. Renewable energy resources and physical resources discussed include wind energy resources, meteorological conditions, as well as bathymetry and geology. Natural resources discussed include marine fish and wildlife, as well as avian and bat species. Additional resources considered include proximity to military use areas, vessel and aviation traffic, existing telecommunication cables, and visual and cultural resources. These resources were identified based on a wide variety of available information including, but not limited to, the following:

- The Mid-Atlantic Regional Council on the Ocean (MARCO), Northeast Ocean Data Portal, MarineCadastre, National Oceanic Atmospheric Administration (NOAA) National Centers for Environmental Information, and other applicable online data portals;
- The GOM Council on the Marine Environment reports titled *GOM in Context, State of the GOM Report* and *Commercial Fisheries State of the GOM Report*;
- The Wave Hindcast Database focusing on the Atlantic North West and Oceanweather's hindcast model output, *Global Reanalysis of Ocean Waves United States East Coast*;
- Ongoing UMaine and NOAA buoy data within the GOM associated with the Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS);
- The Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) sightings data available within the GOM which ranges from 2012 to 2020 (OBIS-SEAMAP 2020);

- The U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation Web Tool and IFW's Maine Endangered and Threatened species list;

- North Atlantic right whale (*Eubalaena glacialis*) Seasonal Management Area (SMA) data, established Dynamic Management Areas, WhaleMap web portal data (Johnson 2018), and the Right Whale Sighting Advisory System;

- National Marine Fisheries Service (NOAA Fisheries) Southeast Fisheries Science Center Sea Turtle Stranding and Salvage Network Reports;

- OBIS-SEAMAP Dataset on aerial surveys conducted for upper trophic level predators on Platts Bank, GOM;

- Publicly available resources provided on webpages from the following entities: the NOAA Fisheries, USFWS, U.S. Geological Survey, Turtle Expert Working Group, IFW, DMR, Center for Coastal Studies; and

- Peer-reviewed, published scientific literature.

5.1 WIND ENERGY RESOURCE

The GOM is a semi-enclosed body of water, surrounded by Maine, New Hampshire, Massachusetts, Nova Scotia, and New Brunswick. Wind resources within the GOM are abundant. Preliminary data indicate that wind resources within the GOM are comparable to other developed offshore wind project locations around the world (Viselli et al. 2015; NERACOOS 2021). The GOM was identified by the DOE's National Renewable Energy Laboratory as having Classes 6 and 7 winds with an estimated 157 gigawatts of wind power available within a 59 mi (95 kilometer [km]) radius (Musial and Ram 2010).

During wave development, momentum from the air is transported to the ocean and in turn, the waves themselves also influence wind fields (Kalvig et al. 2014). Ongoing data collection occurs via multiple buoys in the GOM (Figure 5-1) which focus on wave height and wind speeds. These buoys are utilized by UMaine, NOAA, and NERACOOS. The nearest buoy to the Research Array Site is NOAA buoy (44005) in Cashes Ledge at 13.7 mi (11.9 nm; 22.0 km) measured from the closest boundary of the Research Array Site; data from this buoy likely provides the most representative wind and wave conditions for the Research Array Site. Table 5-1 provides average wave height, wind speed, and wind direction data from the NOAA buoy collected from 2015 through 2020 (NERACOOS 2021).

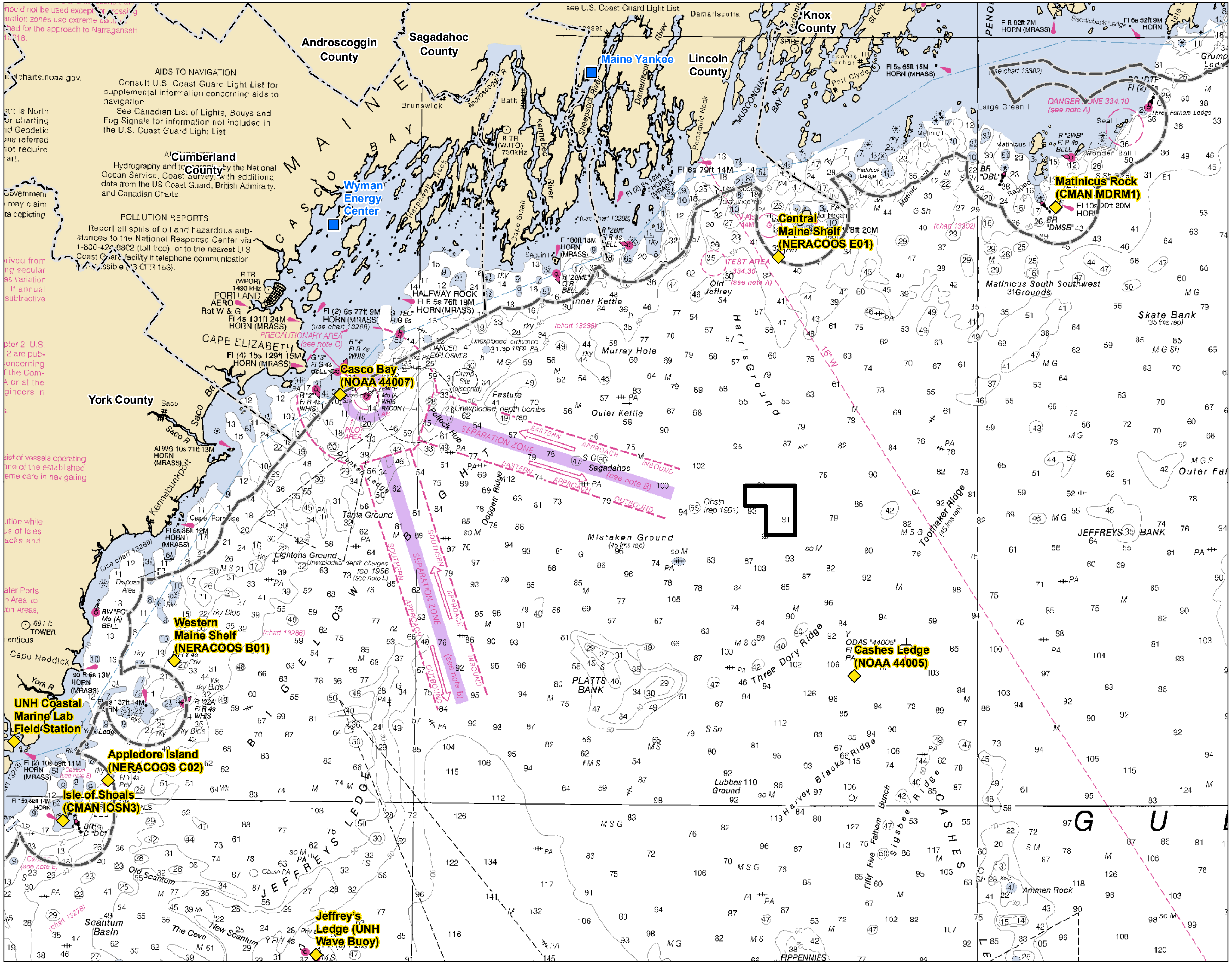


Figure No.

5-1

Title

Ocean Observing Buoys

Client/Project 195602069

Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend

- Research Array Site
- Potential Onshore Connection Points
- Active Observing Buoy
- County Boundary
- 3-nm State Waters Boundary

N

0 — 9 Miles

(At original document size of 11x17)
1:570,240

Notes

1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: MEGIS, NOAA
3. Background: NOAA Chart 13006 West Quoddy Head to New York.

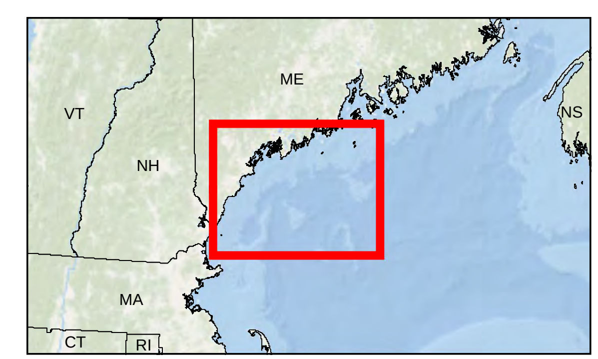


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Table 5-1. Average Wind and Wave Data (2015 to 2020) from NOAA Buoy 440051

Parameter	2015	2016	2017	2018	2019	2020
Wind Speed (m/s)	8.3 (4.0)	7.1 (3.6)	9.0 (3.8)	NA2	6.2 (3.7)	8.4 (3.8)
Wind Direction (degrees)	205.8 (103.8)	206.5 (94.8)	217.7 (85.1)	NA2	201.4 (97.5)	221.3 (98.1)
Wave Height (m)	1.4 (0.9)	1.4 (0.9)	2.0 (1.1)	1.4 (0.9)	1.4 (1.0)	1.7 (1.0)

Source: NERACOOS 2021

Notes:

1/ The NOAA Buoy 44005 collects data once per hour. Data gaps are evident for various timeframes in the raw data which was likely due to weather impacts and/or technical difficulties.

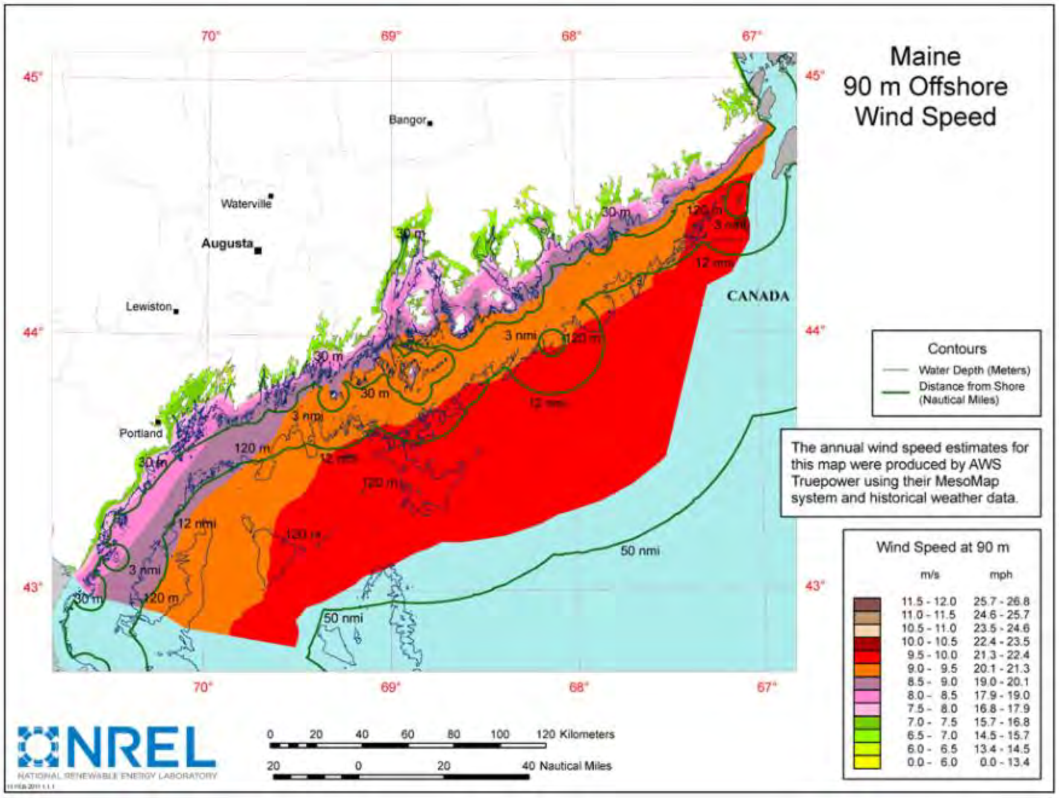
2/ Data were not collected for wind speed or wind direction in 2018 for unknown reasons

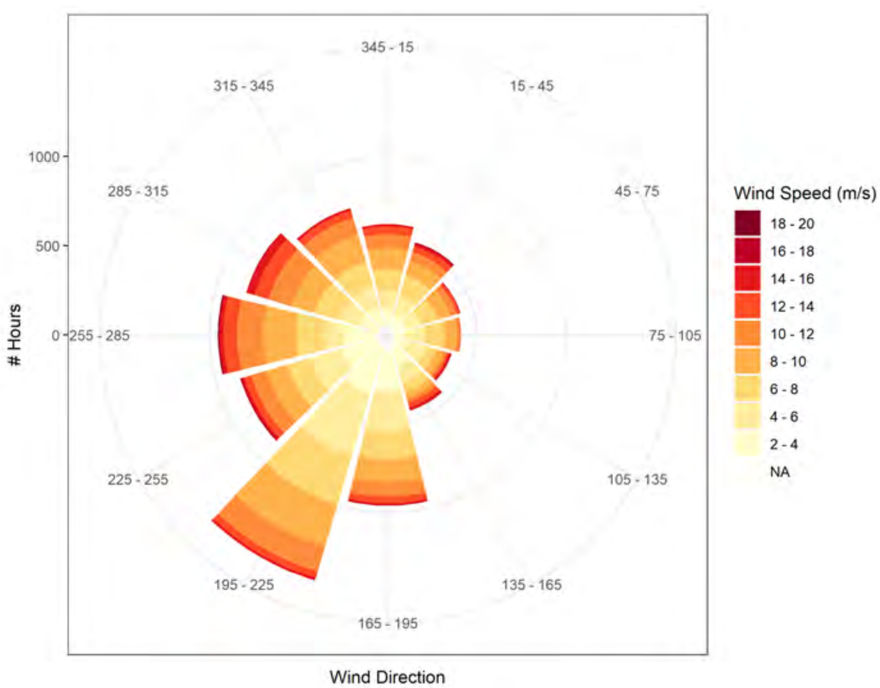
Key:

m = meters
m/s = meters per second
NOAA = National Oceanographic Atmospheric Administration

Figure 5-2 provides the annual offshore wind speed estimates at 90 m (295 ft) and wind velocity as produced by NREL (top) and a wind rose depicting wind speed and wind direction based on data collected from NOAA buoy 44005 in Cashes Ledge for 2016, the most recent year with the largest dataset (NERACOOS 2021) (bottom).

Figure 5-2. Wind Regime





5.2 METOCEAN

Large-scale circulation within the GOM originates from the Labrador Sea, north of the Province of Newfoundland, and south to Cape Hatteras. Specifically, Scotian Shelf water enters the GOM in the Northeast Channel and flows around Nova Scotia and into the Bay of Fundy where it moves southwestward forming the GOM Gyre, then forms a secondary, clockwise-spinning gyre with water leaving the GOM through the Great South Channel and over the Georges Bank eastern edge (GOM Council on the Marine Environment 2010). The IOWAGA-ATNW database was reviewed at the nearest grid point for oceanographic and meteorological conditions, including current velocities. The nearest buoy to the Research Array Site that has collected data on current velocities is UMaine's E01 (located approximately 20.5 mi [17.8 nm; 33.0 km] from the Research Array Site) located where water depth is approximately 328 ft (100 m). Currents were measured 6.6 ft (2 m) below the surface with a current meter and from 33 to 295 ft (10 to 90 m) with a current profiler, collecting measurements every 13 ft (4 m). Data collection occurred on an hourly basis from July 9, 2001 to December 7, 2016. Results are included in Table 5-2 and show that surface current velocities were below 0.4 m/s 97 percent of the time (NAVAL Energies 2016).

Table 5-2. Representative Current Velocities (m/s) Collected at Buoy E01[a]

Water Depth (rounded to nearest m)	Mean Value	Standard Deviation	90th Percentile	99th Percentile	99.9th Percentile	99.99th Percentile	Max Value
2	0.17	0.11	0.31	0.49	0.66	0.99	1.15
10	0.15	0.09	0.27	0.43	0.59	0.81	0.92
14	0.14	0.08	0.25	0.40	0.56	0.69	0.77
18	0.13	0.07	0.22	0.36	0.51	0.62	0.69
22	0.13	0.07	0.22	0.36	0.52	0.63	0.75
26	0.12	0.07	0.21	0.35	0.50	0.60	0.73
30	0.12	0.07	0.20	0.33	0.48	0.59	0.70
34	0.11	0.07	0.20	0.32	0.47	0.56	0.67
38	0.11	0.06	0.19	0.31	0.45	0.55	0.61
42	0.11	0.06	0.19	0.30	0.44	0.53	0.59
46	0.10	0.06	0.18	0.29	0.43	0.52	0.59
50	0.10	0.06	0.18	0.28	0.42	0.51	0.59
54	0.10	0.06	0.17	0.28	0.41	0.51	0.59
58	0.10	0.06	0.17	0.27	0.41	0.51	0.59
62	0.10	0.05	0.17	0.27	0.40	0.52	1.33

Water Depth (rounded to nearest m)	Mean Value	Standard Deviation	90th Percentile	99th Percentile	99.9th Percentile	99.99th Percentile	Max Value
66	0.10	0.05	0.16	0.26	0.40	0.52	0.69
70	0.09	0.05	0.16	0.26	0.39	0.51	1.48
74	0.09	0.05	0.16	0.26	0.39	0.51	0.92
78	0.09	0.06	0.16	0.26	0.42	0.64	2.99
82	0.09	0.06	0.16	0.27	0.47	0.76	2.00
86	0.09	0.06	0.16	0.29	0.53	1.27	2.60
90	0.08	0.07	0.16	0.32	0.61	1.42	3.65

Source: NAVAL Energies 2016

Notes:

[a] *Italicized text* represents measurements that, due to the distance from the sensor, show "regularly suspicious values" and are therefore not realistic and should not be considered for design purposes.

Key:

m = meters

5.3 BATHYMETRY AND GEOLOGY

The GOM consists of numerous deep basins and shallow banks which are likely the result of complex sequences of marine deposition, and subsequent river-based deposition and erosion thought to have been altered by glacial deposition and erosion (GOM Council on the Marine Environment 2010). The underlying geology of the GOM is linked to large-scale, deep channel habitats, including the Northeast and Great South Channels which serve as the primary means of inflow and outflow of water to the Gulf (GOM Council on the Marine Environment 2010).

Water depths within the Research Array Site range from approximately 518 to 620 ft (158 to 189 m), as illustrated in Figure 5-3. This depth range is compatible with the use of the previously described floating turbine design and technology. Additional site-specific analysis will need to be conducted to determine a definitive bathymetry distribution for the exact locations of the Research Array components. As illustrated in Figure 5-4, within the Research Array Site the predominant sediment type is composed of silts.

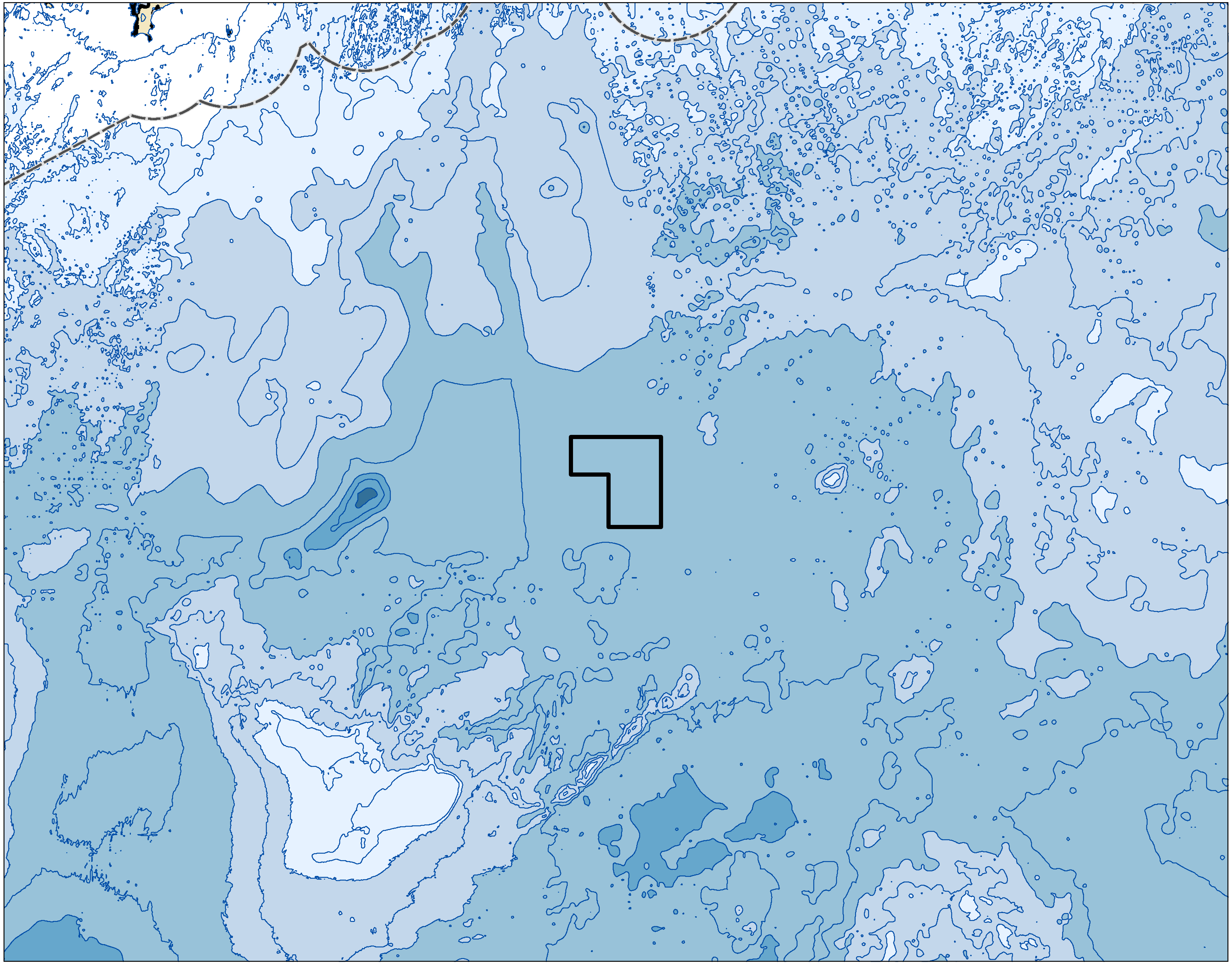


Figure No.
5-3

Title
Bathymetry

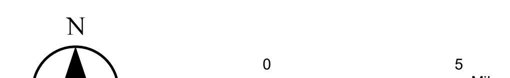
Client/Project 195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend
- Research Array Site
- 3-nm State Waters Boundary
- 25-m Depth Contour

Depth (meters)
- 0 – -50
- -51 – -99
- -100 – -149
- -150 – -199
- -200 – -249
- -250 – -299



(At original document size of 11x17)
1:316,800

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: USGS bathymetry 3 arc second digital elevation model of the Gulf of Maine

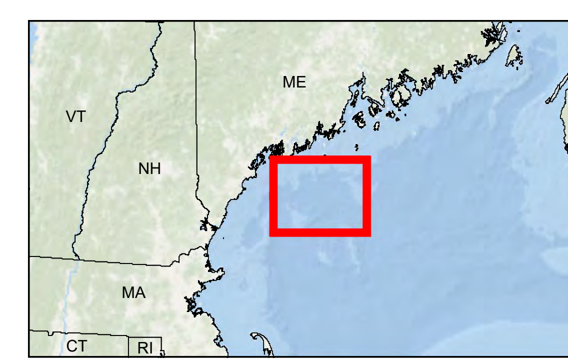


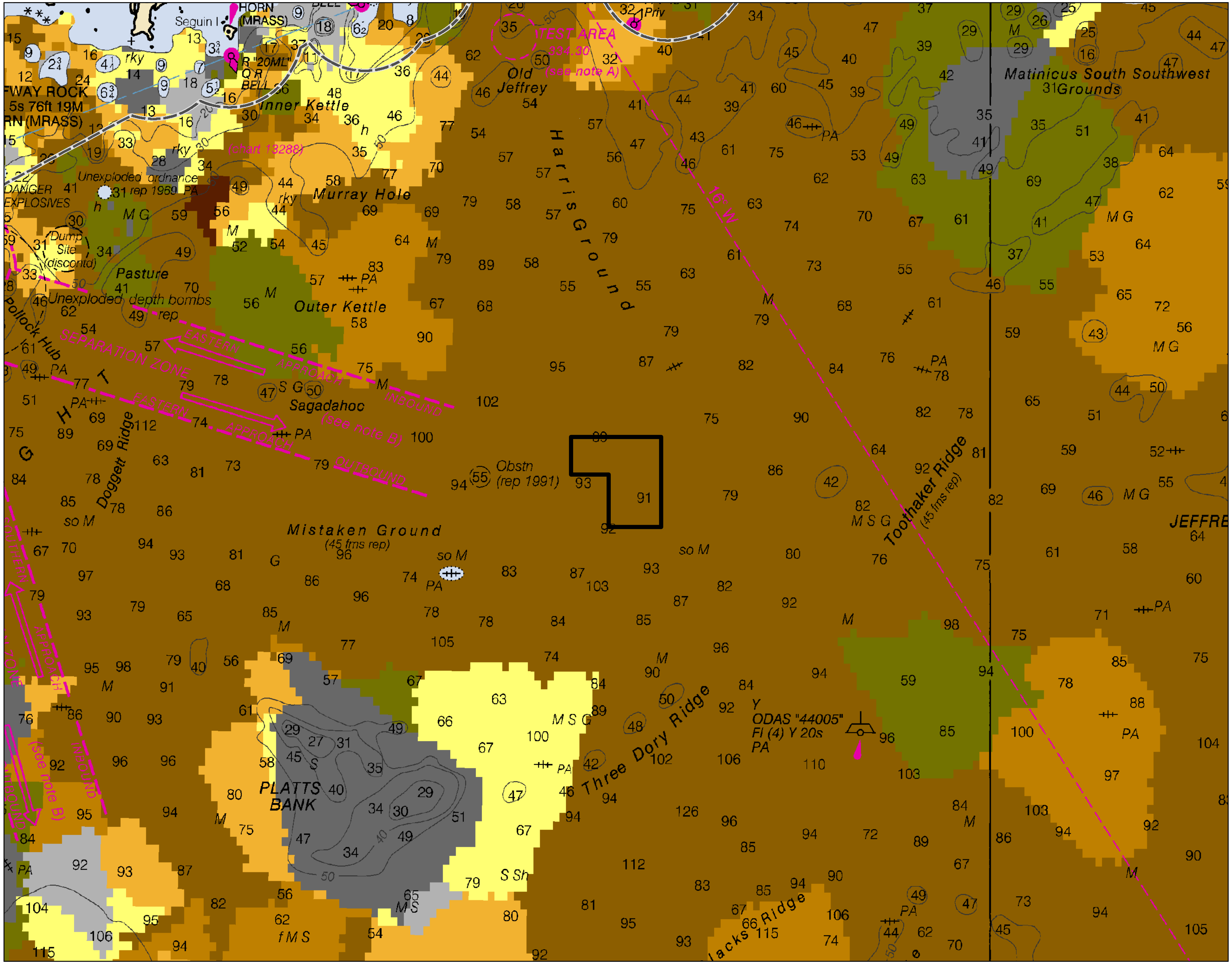
Figure No.
5-4

Title
Sediment Types

Client/Project 195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24



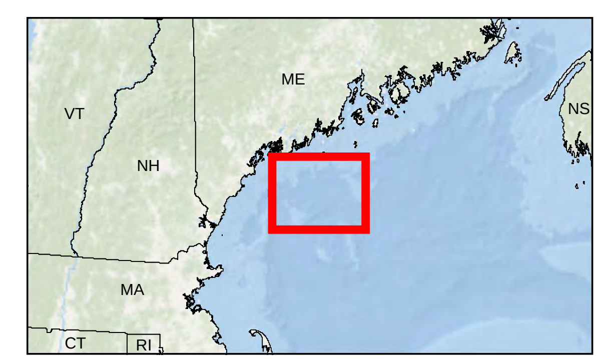
Legend
- Research Array Site
- 3-nm State Waters Boundary

Soft sediments (by grain size in millimeters)
- Clay (< 0.002)
- Silt (0.002 - 0.06)
- Very Fine Sand (0.06 - 0.125)
- Fine Sand (0.125 - 0.25)
- Medium Sand (0.25 - 0.5)
- Coarse Sand (0.5 - 1)
- Very Coarse Sand (1 - 2)
- Gravel/Granule (> 2)

N

0 5 Miles
(At original document size of 11x17)
1:316,800

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: Northeast Ocean Data Website, Soft sediments by grain size (in mm) Northwest Atlantic United States, March 2016, The Nature Conservancy,
3. Background: NOAA Chart 13009 Gulf of Maine and Georges Bank.



5.4 ENVIRONMENTAL IMPACT

The evaluation of potential environmental impact associated with leasing, development, operation and decommissioning of the Research Array will be a multi-year process of research and engagement at the federal and state levels. In 2009, BOEM released its Renewable Energy Program Regulations (30 CFR Part 585), which set out the statutory framework within which the offshore renewables industry will be regulated. BOEM has subsequently released rules and guidelines for many aspects of the development, and construction and operations of offshore renewable energy projects. If BOEM approves the research lease area, the State of Maine will prepare a Research Activities Plan (RAP), as required under federal regulations. BOEM will prepare NEPA document to analyze project impacts as described in the RAP and pursuant to NEPA requirements. State evaluation and permitting will be required for nearshore activity and onshore transmission.

5.5 MARINE MAMMALS AND SEA TURTLES

All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act (MMPA; 16 USC §§ 1361 et seq.) and some are listed under the Endangered Species Act (ESA). Additionally, all sea turtle species found in U.S. waters are ESA-listed. The MMPA and ESA were enacted to protect marine mammals, and endangered and threatened species, including within the U.S. Exclusive Economic Zone waters.

The MMPA is implemented by three entities: NOAA Fisheries, USFWS, and the Marine Mammal Commission. The MMPA prohibits the "take" of marine mammals, which is defined as the harassment, hunting, capturing, or killing of marine mammals, or any attempt thereof. Harassment can include any act of pursuit, torment, or annoyance that has the potential to injure or disturb a marine mammal or marine mammal stock in the wild; or, which has the potential to cause disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. For the purposes of offshore wind development, activities (including any that may produce disruptive noise) must be assessed for potential "take" of marine mammals, and that assessment must be provided to NOAA Fisheries for approval. Similarly, the ESA (Section 7) requires that federal agencies ensure their actions do not jeopardize the continued existence of any threatened or endangered species listed under the ESA or result in the destruction or modification of identified critical habitat. To comply with this obligation, BOEM must consult with NOAA Fisheries and/or the USFWS for actions that could affect protected marine species under NOAA Fisheries or USFWS jurisdictions (*e.g.*, marine mammals, sea turtles, and fish).

There are 39 marine mammal species and four sea turtle species with the potential to occur in the Western North Atlantic Outer Continental Shelf (OCS) Region and the GOM, which includes the

Narrowed AOI[14]. Appendix B provides a list of these species, their associated stocks (for marine mammals), the current federal and state listing status, and most recent estimated population sizes. Of the 39 marine mammals listed in Appendix B for the western Atlantic Ocean, 14 are expected to have a common or regular occurrence within the AOI, and sighting records reported to OBIS-SEAMAP between 2004 and 2020 document the occurrence of 4 species in the Narrowed AOI: fin whale (*Balaenoptera physalus*), North Atlantic right whale, harbor porpoise (*Phocoena phocoena*), and Atlantic white-sided dolphin (*Lagenorhynchus acutus*) (OBIS-SEAMAP 2020). OBIS-SEAMAP sighting records for these and other marine mammals documented are illustrated in Figure 5-5 (baleen whales), Figure 5-6 (toothed whales), and Figure 5-7 (seals). These species also could occur in the Site; however, based on the available data, no species have been documented in the Site. Many species of marine mammals are migratory, most have large home ranges and can travel great distances in a single day, and sighting records are largely opportunistic and not effort corrected. Lack of sightings therefore should not be interpreted to imply lack of potential for occurrence.

As illustrated in Figure 5-8, no sea turtle sightings have been documented and reported within the Narrowed AOI or Research Array Site, based on sightings recorded in OBIS-SEAMAP from 2013 to 2020; however, based on their habitat requirements and movement patterns, sea turtles could still occur in Research Array Site. The most likely species, those most frequently observed in the GOM, are the leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*). Appendix B includes additional information on general sea turtle presence within the GOM.

[14] Potential for marine mammal presence was determined through review of the following resources: OBIS-SEAMAP data, USFWS Information for Planning and Consultation Web Tool, IFW and DMR resources, NOAA Fisheries resources, the WhaleMap web portal, Right Whale Sighting Advisory System, Seasonal Management Area data, and data from Southeast Fisheries Science Center, Turtle Expert Working Group, Center for Coastal Studies, and peer-reviewed, published scientific literature.

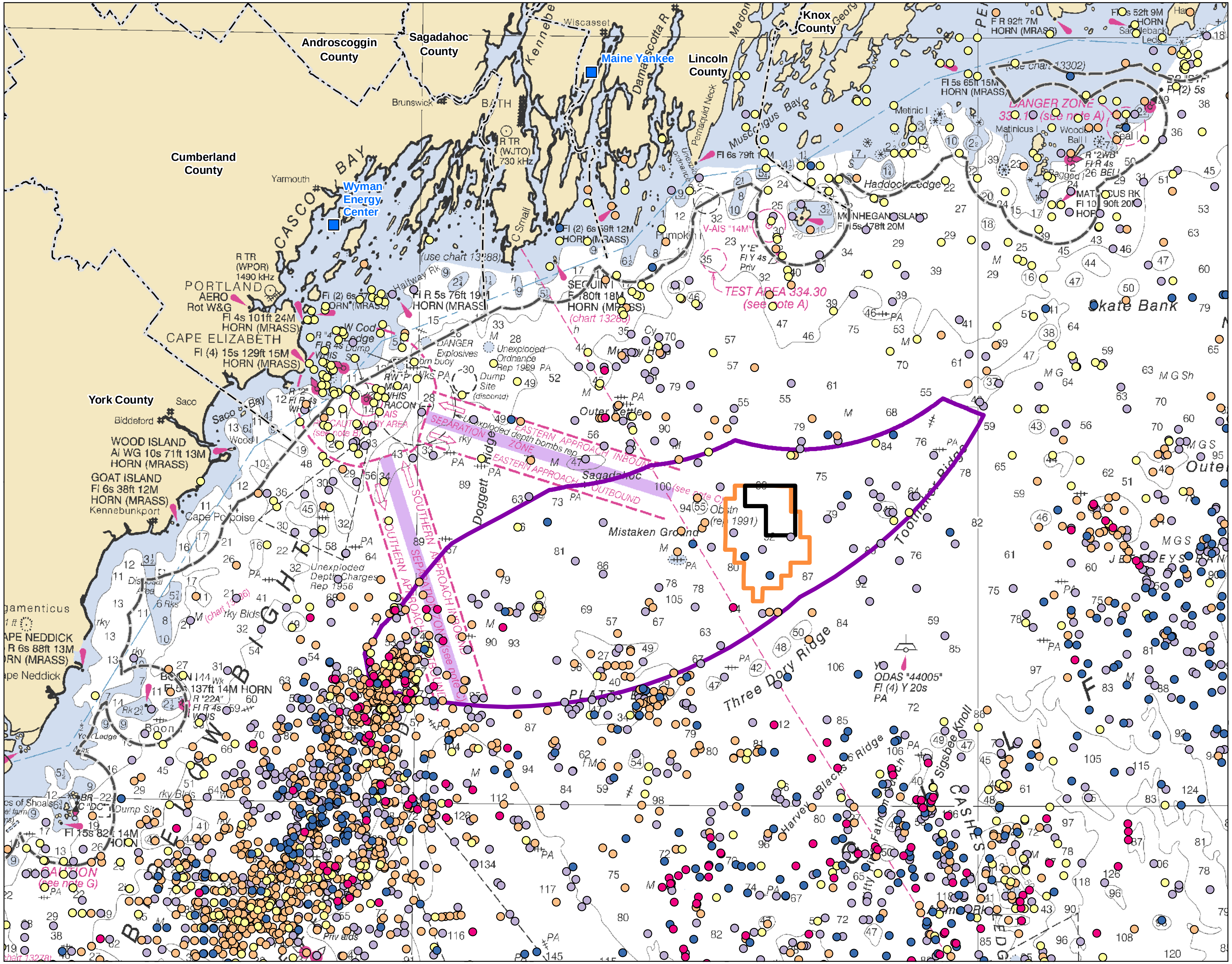


Figure No.
5-5

Title
OBIS Sightings Data for Baleen Whales

Client/Project 195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

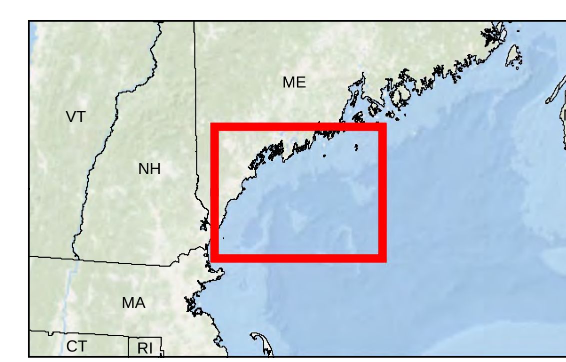
Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend
- Research Array Site
- Narrowed AOI
- Area of Interest (AOI)
- Potential Onshore Connection Points
- County Boundary
- 3-nm State Waters Boundary
- Blue Whale
- Fin Whale
- Humpback Whale
- Minke Whale
- North Atlantic Right Whale
- Sei Whale

N

0 9 Miles
(At original document size of 11x17)
1:570,240

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: Baleen whales data extracted on 11/24/2020 from the Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate (OBIS-SEAMAP).
3. Background: NOAA Chart 13006 West Quoddy Head to New York.



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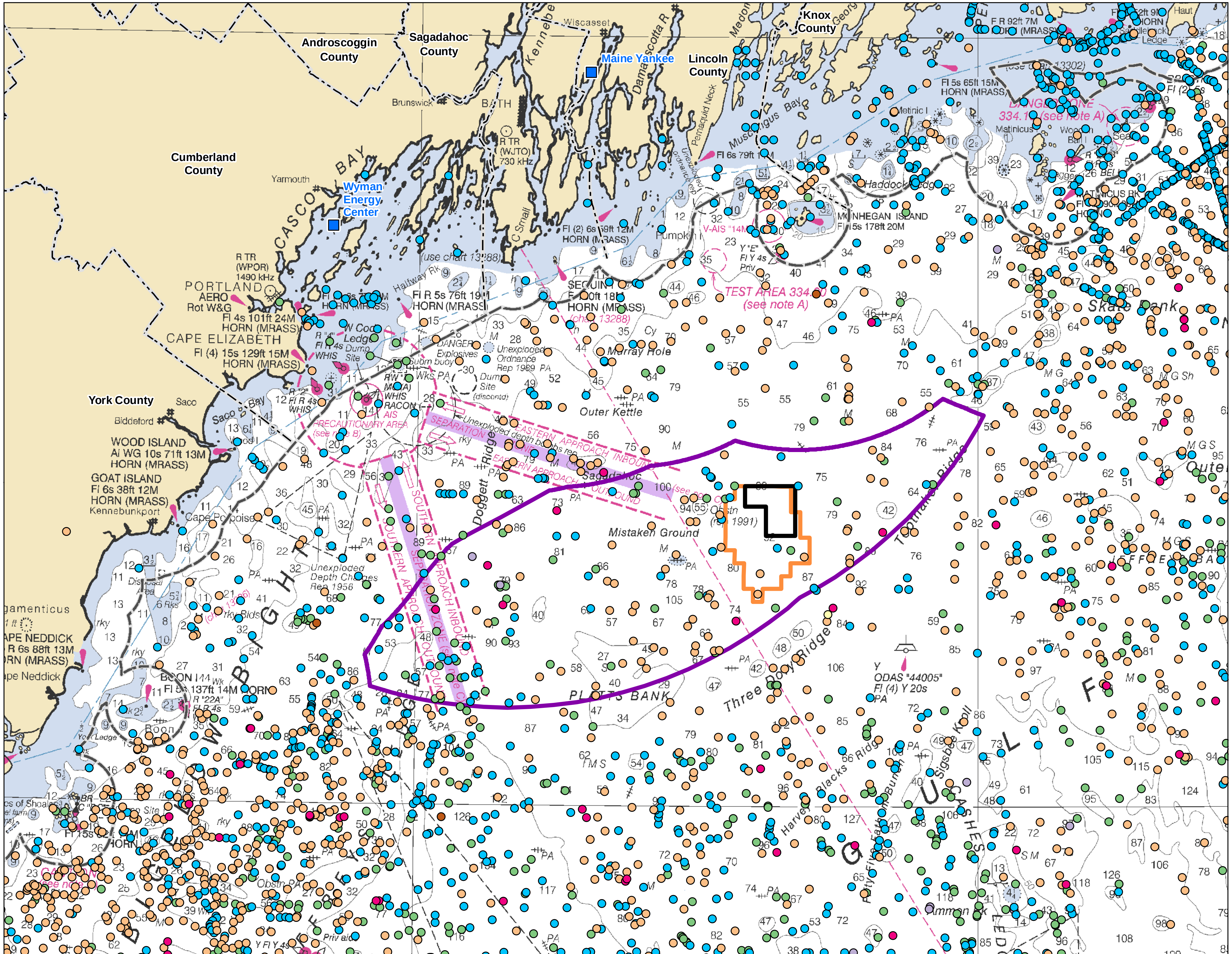


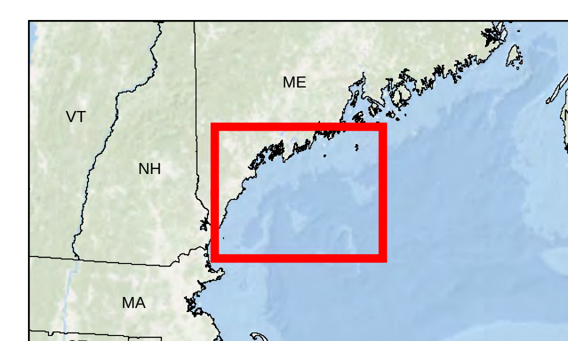


Figure No.

5-6

Title

OBIS Sightings Data for Toothed Whales

Client/Project 195602069

Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend

- Research Array Site
- Narrowed AOI
- Area of Interest (AOI)
- Potential Onshore Connection Points
- County Boundary
- 3-nm State Waters Boundary
- Atlantic White-sided Dolphin
- Bottlenose Dolphin
- Common Porpoise
- Harbor Porpoise
- Long-finned Pilot Whale
- Short-beaked Common Dolphin
- Sperm Whale

N

0 9 Miles
(At original document size of 11x17)
1:570,240

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: Toothed whales data extracted on 11/24/2020 from the Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate (OBIS-SEAMAP).
3. Background: NOAA Chart 13006 West Quoddy Head to New York.

V:\1956\active\195602069\03_data\gis_cad\gis\MXDs\PermitAug2021\02069_5-6_ToothedWhales.mxd Revised: 2021-08-24 By: gcarpentier

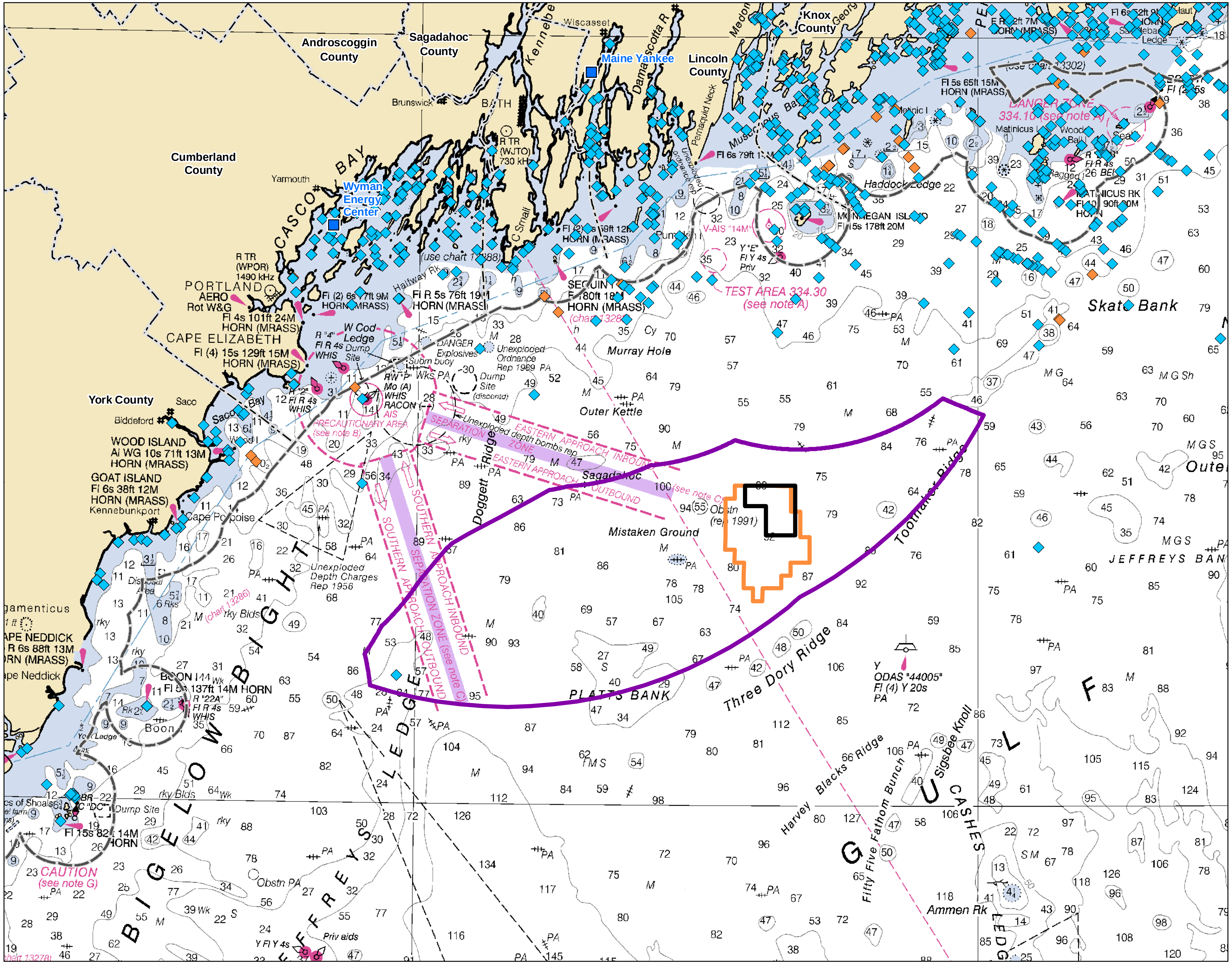


Figure No.
5-7

Title
OBIS Sightings Data for Seals

Client/Project 195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

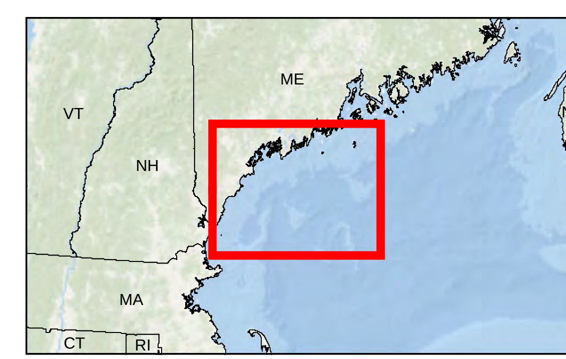
Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend
- Research Array Site
- Narrowed AOI
- Area of Interest (AOI)
- Potential Onshore Connection Points
- County Boundary
- 3-nm State Waters Boundary
- Atlantic Gray Seal
- Harbor Seal

N

0 9 Miles
(At original document size of 11x17)
1:570,240

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: Seal data extracted on 11/24/2020 from the Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate (OBIS-SEAMAP).
3. Background: NOAA Chart 13006 West Quoddy Head to New York.



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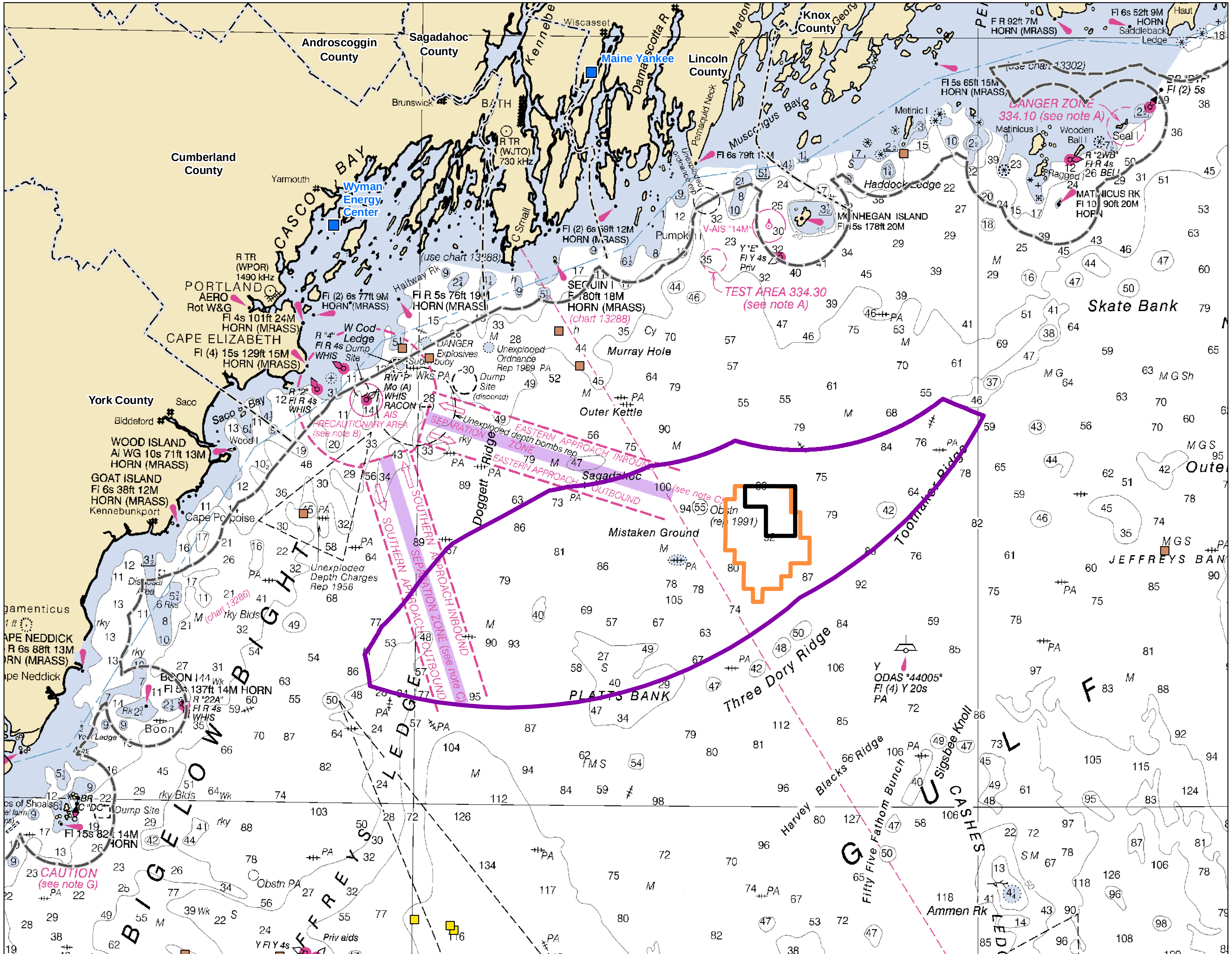


Figure No.

5-8

Title

OBIS Sightings Data for Sea Turtles

Client/Project 195602069

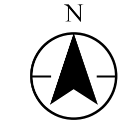
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend

- Research Array Site
- Narrowed AOI
- Area of Interest (AOI)
- Potential Onshore Connection Points
- County Boundary
- 3-nm State Waters Boundary
- Leatherback Sea Turtle
- Loggerhead Sea Turtle

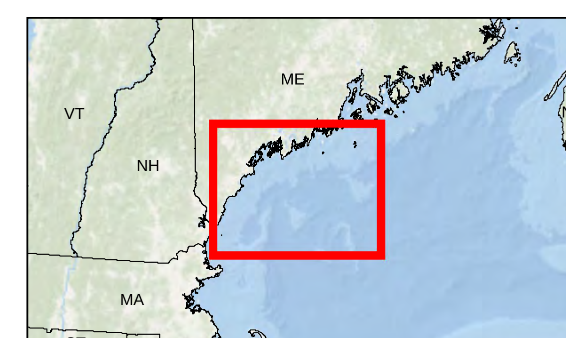


0 9 Miles

(At original document size of 11x17)
1:570,240

Notes

1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: Sea Turtle data extracted on 11/24/2020 from the Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate (OBIS-SEAMAP).
3. Background: NOAA Chart 13006 West Quoddy Head to New York.



Of particular interest and concern, is the federally endangered North Atlantic right whale – a critically vulnerable species in the GOM and globally, as the species' worldwide population estimate has decreased to 356 individuals (Davie 2020). Critical habitat for this species has been designated over approximately 29,763 nm^2 of marine foraging habitat across the GOM and Georges Bank Region and thus overlaps the Research Array Site (NOAA Fisheries 2019a), and a restricted area closed to fishing with vertical buoy lines will be implemented in October 2021 in an area off the Maine coast with increased right whale density. Designated marine protected areas and North Atlantic right whale SMAs have been identified by NOAA Fisheries throughout the U.S. to support the protection of marine mammals and other marine species. There are three SMAs immediately adjacent to each other within the GOM: the Great South Channel, Race Point, and Cape Cod Bay (NOAA Fisheries 2019b). The nearest SMA to the Research Array Site is the Great South Channel, which is approximately 58.5 mi (50.8 nm; 94.1 km) away. NOAA Fisheries has established vessel speed restrictions (vessels greater than 65 ft [19.8 m] must travel at 10 knots or less) within these SMAs at certain times of the year to reduce the potential for collision with North Atlantic right whales (NOAA Fisheries 2020a).

Adult and juvenile North Atlantic right whales forage throughout the continental shelf and slope waters of the northeast, occurring in greatest densities in the western GOM between April to May, and July to October. The area around Jeffreys Ledge (approximately 38.1 mi [33.1 nm; 61.3 km] to the southwest of the Research Array Site) is considered an important foraging ground and may serve as a wintering area from approximately November to January. Based on decades of migration data and studies undertaken on North Atlantic right whales, adults and juveniles may be found foraging in the GOM in any month of the year, or overwintering from November through January; however, even during peak occurrence periods, most sightings are concentrated in the more offshore waters to the west of the Research Array. Critical Habitat Foraging Area Unit 1 for the North Atlantic Right Whale overlaps the Research Array Site.

From 2016 to 2020, elevated mortalities of North Atlantic right whale, humpback whale, minke whale, harbor seal, and gray seal were declared as Unusual Mortality Events (UMEs) (NOAA Fisheries 2020b). UMEs for whale species are generally attributed to strandings, entanglements, and/or vessel strikes and the UME for harbor and gray seals was attributed to infectious disease.

The State of Maine will work with applicable agencies and stakeholders to identify potential impacts to marine mammals and sea turtles from the Research Array and will develop avoidance and/or mitigation measures as necessary and appropriate.

5.6 FISH AND FISHERIES

The GOM is home or a migratory pathway to more than 652 species of fish and a thriving fishing industry (GOM Council on the Marine Environment 2010). Key commercial and recreational fisheries within New England are outlined in the latest *Fisheries Economics of the United States (FEUS)*, which covers a ten-year time period ending in 2016 but was published in 2018 (NOAA Fisheries 2018) with an addendum added in 2019 (NOAA Fisheries 2019c). Key commercial fisheries identified within New England during this latest FEUS analysis included American lobster (*Homarus americanus*), rock crab (*Cancer productus*), sea scallop (*Placopecten magellanicus*), Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), flounders, goosefish, quahog clam (*Mercenaria mercenaria*), softshell clam (*Mya arenaria*), and squid (NOAA Fisheries 2018). Maine commercial fish landings for 2019 as reported by DMR totaled $681,676,199, with 72 percent of those landings attributable to the American lobster fishery (DMR 2019). Figure 5-9 illustrates the multispecies (groundfish) fishing industry densities within the GOM using vessel monitoring systems data from 2011 through 2014 from the Northeast Regional Ocean Council (n.d.) showing commercial fishing density data for the northeast and Mid-Atlantic regions. Although the most recently available Vessel Monitoring System data is from 2015 to 2016, during DMR's interactions with fishing industry representatives, it was reported that fishing activity varies in intensity from year to year, and data from 2011 through 2014 is more representative of groundfish activity than data from 2015-2016.

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as amended in 2007 (16 U.S. Code [U.S.C.] § 1801) is the primary law governing marine fisheries management in federal waters of the U.S. Managed species under the MSFCMA include marine, estuarine, and anadromous finfish; mollusks; and crustaceans. Under the MSFCMA, Regional Fishery Management Councils were established, which are comprised of federal and state officials and governor-appointed representatives of the commercial fishing, recreational fishing, and marine conservation community from each of the states represented on the regional council. In 1996, the MSFCMA was revised and amended to strengthen conservation and increase the focus on sustainability, in part by requiring the identification of Essential Fish Habitat (EFH) (16 U.S.C. 1801-1884). The MSFCMA was again revised and reauthorized in 2007, with additional conservation and management requirements to further the effort to reduce overfishing, support conservation, and improve fisheries science research (16 U.S.C. 1801-1884). Twenty species have designated EFH within the Research Array Site for various life stages (MARCO n.d.; NOAA Fisheries n.d.[a]); see Table 5-3. EFH is designated based on individual species and varies across the GOM depending on individual life history requirements such as habitat and spawning preferences.

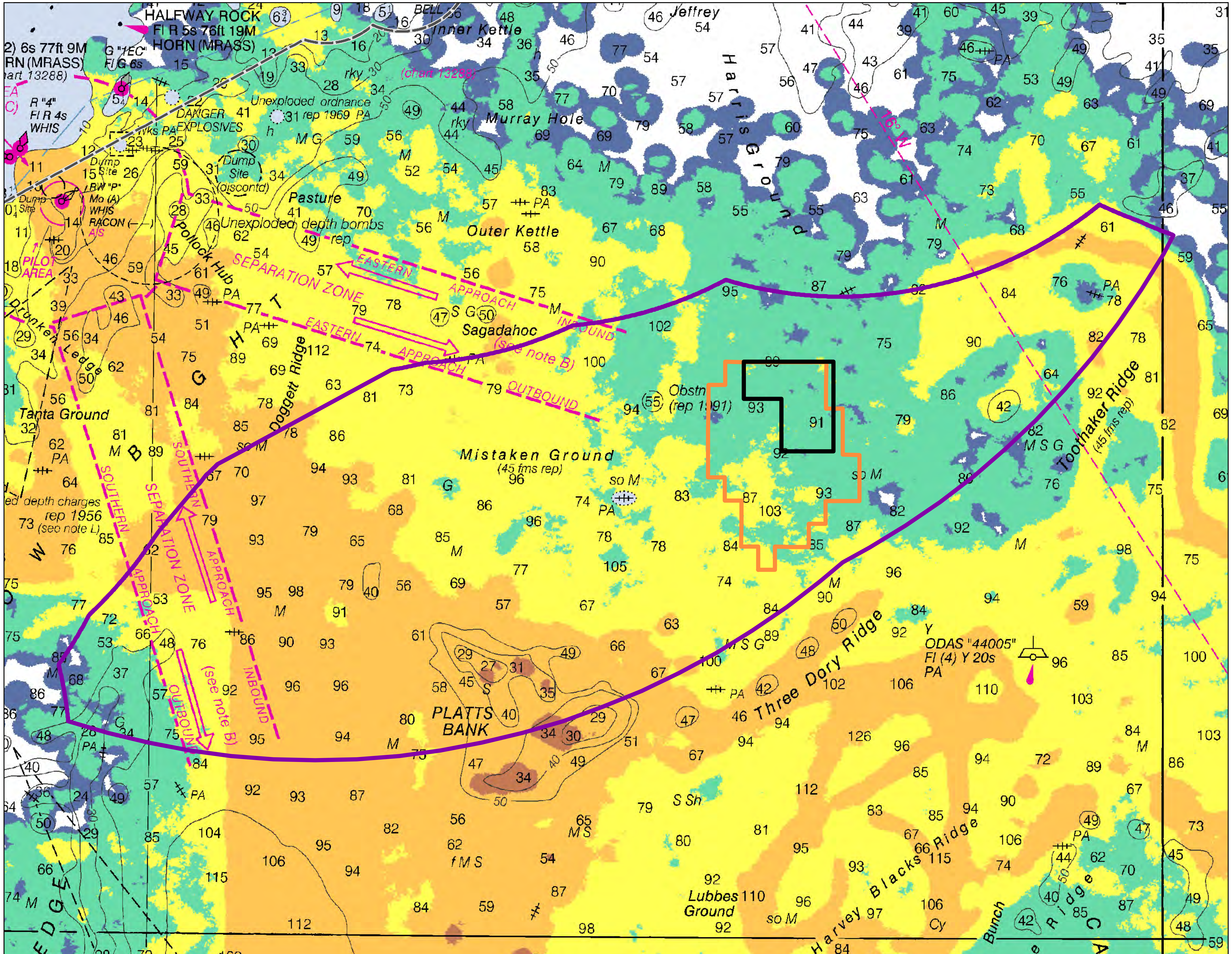


Figure No.

5-9

Title

Fisheries Density

Client/Project 195602069

Maine Research Array
BOEM Lease Application

Project Location

Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend

- Research Array Site
- Narrowed AOI
- Area of Interest (AOI)
- 3-Nautical Mile State Water Boundary

2011 - 2014 Multispecies (groundfish) Fishery Commercial Fishing Vessel Density

- Very High
- High
- Med-Hi
- Med-Low
- Low

N

0 5 Miles

(At original document size of 11x17)
1:316,800

Notes

1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: Northeast Ocean Data Website, Vessel Monitoring Systems (VMS) Commercial Fishing Density Northeast and Mid-Atlantic Regions, Northeast Regional Ocean Council (NROC), 2016.
3. Background: NOAA Chart 13009 Gulf of Maine and Georges Bank.

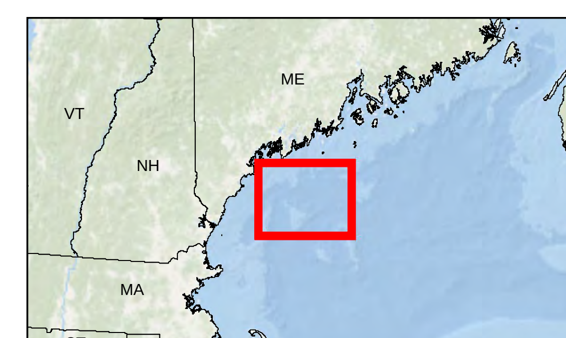


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Table 5-3. Designated EFH in the Research Array Site

Common Name	Scientific Name	Common Name	Scientific Name
American plaice	*Hippoglossoides platessoides*	Monkfish	*Lophius americanus*
Atlantic cod	*Gadus morhua*	Pollock	*Pollachius virens*
Atlantic herring	*Clupea harengus*	Porbeagle shark	*Lamna nasus*
Atlantic wolffish	*Anarhichas lupus*	Red hake	*Urophycis chuss*
Acadian redfish	*Sebastes fasciatus*	Silver hake	*Merluccius bilinearis*
Basking shark[1]	*Cetorhinus maximus*	Smooth skate	*Malacoraja senta*
Bluefin tuna	*Thunnus thynnus*	Spiny dogfish	*Squalus acanthias*
Blue shark	*Prionace glauca*	Thorny skate	*Amblyraja radiata*
Common thresher shark	*Alopias vulpinus*	White hake	*Urophycis tenuis*
Haddock	*Melanogrammus aeglefinus*	Witch flounder	*Glyptocephalus cynoglossus*

Sources: NOAA Fisheries n.d.[a]; MARCO n.d.

Note:

[1] Basking shark sightings were documented during 2005 aerial surveys of Platts Bank (OBIS-SEAMAP Dataset on aerial surveys conducted for upper trophic level predators on Platts Bank, GOM)

Key:

AOI = Area of Interest

In addition to EFH for individual species, the GOM contains habitats managed by NOAA Fisheries including Habitat Areas of Particular Concern, lobster management areas, Habitat Management Areas (HMAs), and groundfish closure areas (DMR 2021) There are five HMAs within the GOM (Eastern Maine, Jeffreys Bank, Ammen Rock, Cashes Ledge, and Fippennies Ledge). The closest HMA to the Research Array Site is the Jeffreys Bank HMA located approximately 20.6 mi (17.9 nm; 33.2 km) away. The AOI is located to the west of Jeffreys Bank HMA and northeast of Cashes Ledge, Ammen Rock and Fippennies HMAs. The AOI overlaps two groundfish closure areas, the Western Gulf of Maine (WGOM) closure area and the GOM Cod Protection Closure II. The next nearest groundfish closure area to the Research Array Site is Cashes Ledge, located approximately 22.0 mi (19.1 nm; 35.4 km) away. The nearest cod protection area is located approximately 6.3 mi (5.5 nm; 10.1 km) west of the Research Array Site. Appendix B provides additional information regarding HMAs and groundfish closure areas.

Generally, lobster fishing targets the migration patterns and availability of lobsters, which typically decreases from inshore to offshore and from shallow to deep (DMR 2021). Lobster fishing generally targets bottom areas with relatively high complexity (*e.g.*, comprising gravel or bedrock), as well as transitions between different habitat types. Areas with complex bottoms include Mistaken Ground, the Eastern Approach Shipping lane, Cusk Ridge, and a series of ridges east of Platts Bank (DMR 2021).

The density of lobster fishing is higher in the northern and eastern portions of the AOI than other areas of the AOI (DMR 2021).

Generally, NOAA Fisheries manages ESA-listed fish and invertebrate species while the USFWS manages inland freshwater species. Five fish species are federally listed under the ESA within the New England/Mid-Atlantic region (NOAA Fisheries n.d.[b]); of these species, two species are expected to occur in the Research Array Site: the Atlantic salmon (*Salmo salar*), and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (NOAA Fisheries 2019d). There are currently no other fish species proposed for federal listing. Appendix B includes a table of ESA and state-listed fish species, along with the geographic range where the species is listed and current listing status. Current threats to fish and fisheries include climate change, bycatch, international trade, cumulative effects of coastal and offshore development, financial and spatial strains on the working waterfront, and increases in vessel traffic.

Outreach to fisheries stakeholders will continue throughout the Research Array's development, including ongoing discussions with fisheries associations, as well as federal and regional partners, to avoid and minimize impacts to the fishing industry to the extent possible.

5.7 AVIAN SPECIES

Bird and bat species within the GOM are managed at both the state and federal level. Birds and bats listed under the Maine Endangered Species Act of 1975 (MESA) receive state protection. The IFW holds management responsibility for fish and wildlife in inland habitats listed under MESA and shares responsibility with the USFWS for fish and wildlife (inland species) listed under the ESA. Section 7 of the ESA is the mechanism by which federal agencies ensure actions do not jeopardize listed species. The USFWS assesses how proposed actions may harm federally protected species and/or their critical habitat and prepares Biological Opinions and Incidental Take Statements when required. BOEM has a Memorandum of Understanding with the USFWS (per Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*) to assess potential impacts to wildlife and to implement mitigation measures, if needed, for offshore renewable energy projects. Not only is harassment or "take" of protected bat species prohibited, but maternity roost trees and bat hibernacula are also protected in Maine under the MESA during the winter season from October 1st to April 30th (IFW 2020). The IFW is involved in multiple ongoing bat surveys within the state (largely land-based) to further understand distributions and threats. Other entities at the federal, state and local level also contribute to the management of bird and bat species and their associated habitats; these include the IFW, Maine Coastal Islands National Wildlife Refuge, National and Maine Audubon Society, the GOM Seabird Watch Group, and Friends of Maine Coastal Islands.

As reported by eBird, the GOM has a high number of bird "hotspots" (areas of high density or areas with high species diversity) along the coast and scattered throughout the GOM (eBird n.d.). The migratory routes of hundreds of seabird, shorebird and songbird species intersect the coast and GOM (Leppold 2016). Regional bird abundance estimates from the Maine Office of GIS and NOAA National Centers for Coastal Ocean Science Marine-life Data and Analysis Team are included in Figure 5-10.

Figure No.

5-10

Title

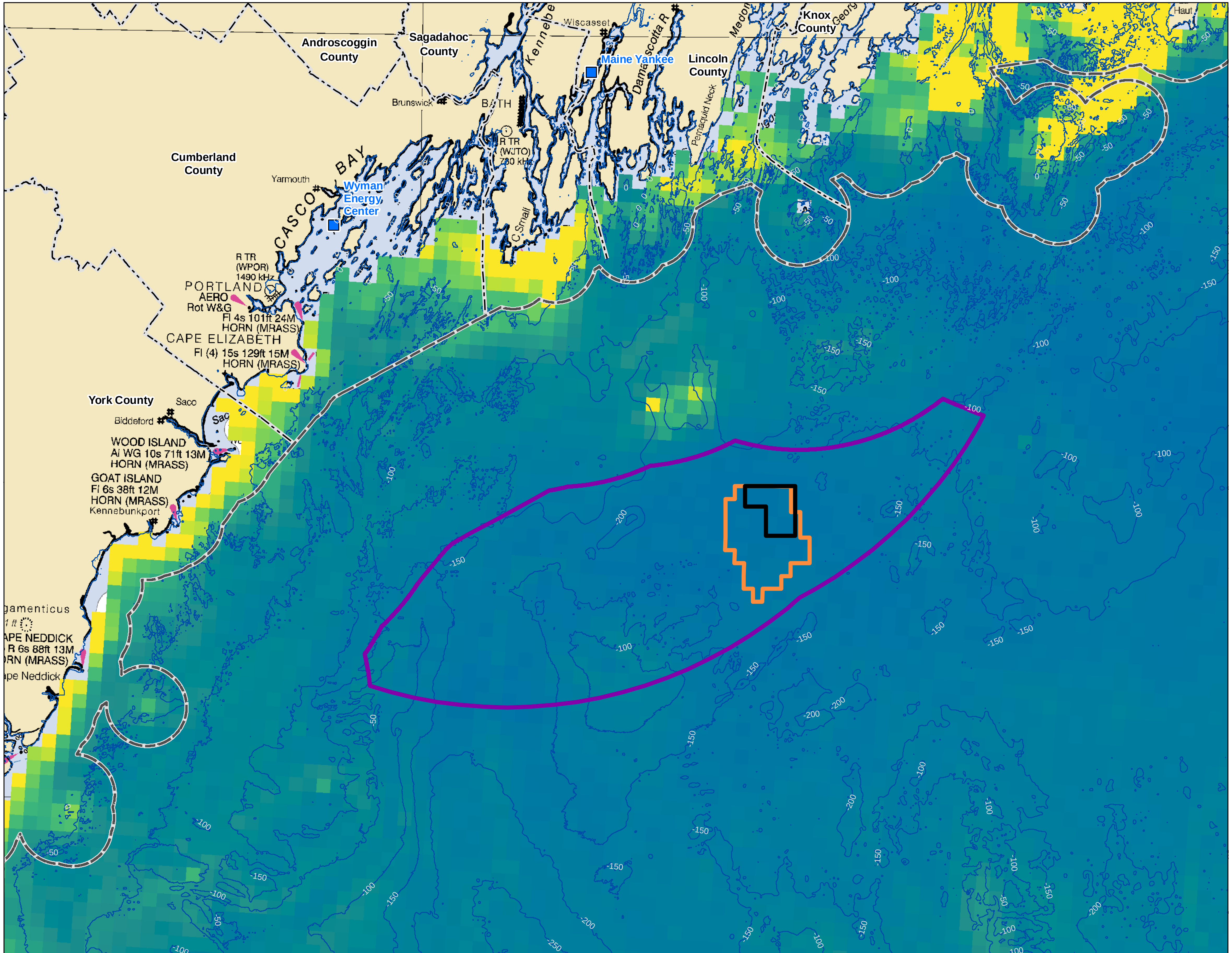
Regional Bird Abundance Estimates

Client/Project 195602069

Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24



Legend

- Research Array Site
- Narrowed AOI
- Area of Interest (AOI)
- Potential Onshore Connection Points
- County Boundary
- 50-m Depth Contour
- 3-nm State Waters Boundary

Total Bird Abundance (see note)

High

Low

Note

For all species together and for each group of species, the total bird abundance is total relative number of individuals per grid 2-km x 2-km cell normalized by the mean of each grid cell. The result is the total predicted relative density in that cell.

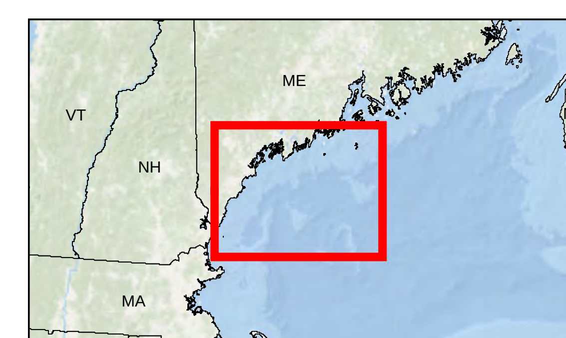
N

0 9 Miles

(At original document size of 11x17)
1:570,240

Notes

1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: MEGIS, NOAA National Centers for Coastal Ocean Science (NCCOS), Marine-life Data and Analysis Team (MDAT).
3. Background: NOAA Chart 13006 West Quoddy Head to New York.



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The GOM hosts over 300 species of seabirds, sea ducks, migrating songbirds, shorebirds, and bats. Although offshore population information from aerial and breeding surveys exists for a limited number of these species in certain locations (*i.e.*, nesting seabird colonies), there are no comprehensive GOM-wide density surveys for all species. Therefore, BRI conducted a desktop analysis using Marine-life Data and Analysis Team models developed by the NOAA National Centers for Coastal Ocean Science (Curtice et al. 2019) and a Maine-specific vulnerability analysis. The Biodiversity Research Institute created a series of maps depicting spatial avian risk for 36 avian species likely to be present within the AOI (or detected within 200 km) based on population vulnerability, collision vulnerability, and displacement vulnerability (Goodale et al. 2021, included as Appendix C). Results suggest there may be a lower potential risk to marine birds in the east-central portion of the AOI, around the deeper waters of Mistaken Ground (a well-known fishing ground) and extending east through Platts Basin for approximately 25–30 mi (21.7-26.0 nm; 40–50 km). In contrast, the shallower areas of the continental shelf tend to have higher concentrations of birds and likely greater potential risk to marine birds. Avian species are highly mobile; therefore, any species likely to be present within the AOI may also be present within the Research Array Site. For additional information on this analysis, please refer to Appendix C.

Additionally, Maine's coastal islands provide nesting places for colonial nesting seabirds, including terns (arctic [*Sterna paradisaea*], common [*Sterna hirundo*], and roseate [*Sterna dougallii dougallii*]), Atlantic puffins (*Fratercula arctica*), black guillemots (*Cepphus grille*), laughing gulls (*Leucophaeus atricilla*), herring gulls (*Larus argentatus*), Leach's storm petrels (*Oceanodroma leucorhoa*), double-crested cormorants (*Phalacrocorax auratus*), and common eiders (*Somateria mollissima*) (USFWS 2019). These islands include Stratton, Outer Green, Jenny, Pond, Eastern Egg Rock, Metinic, Matinicus Rock, Seal, Ship, Petit Manan, and Machias Seal. The USFWS actively manages six seabird colonies in the Maine Coastal Islands National Wildlife Refuge Complex (USFWS 2018). The closest island with a seabird colony to the Site is Outer Green, approximately 39.0 mi (33.9 nm; 62.8 km) from the Research Array Site. For additional information on non-listed bird species potentially present in the AOI and bats known to occur within the state, please see Appendix B.

Three federally listed bird species and one species proposed for federal listing, as well as 8 state-listed bird species, have the potential to occur within the Research Array Site. Protected species with the potential to occur in the Research Array Site are provided in Table 5-4 along with current listing status and associated critical habitat designations

Table 5-4. Federal and State-Listed Bird Species Potentially Occurring within the Research Array Site

Species	Current Listing Status	Critical Habitat Designated? (Y/N)
Arctic tern (*Sterna paradisaea*)	ME Threatened	N
Atlantic puffin (*Fratercula arctica*)	ME Threatened	N
Barrow's goldeneye (*Bucephala islandica*)	ME Threatened	N

Species	Current Listing Status	Critical Habitat Designated? (Y/N)
Black-capped petrel (*Pterodroma hasitata*)	Proposed for ESA Listing	N
Black tern (*Chlidonias niger*)	ME Endangered	N
Great cormorant (*Phalacrocorax carbo*)	ME Threatened (breeding population only)	N
Harlequin duck (*Histrionicus histrionicus*)	ME Threatened	N
Least tern (*Sterna antillarum*)	ME Endangered	N
Piping plover (*Charadrius melodus*)	ESA Threatened ME Endangered	Y[a]
Razorbill (*Alca torda*)	ME Threatened	N
Red knot (*Calidris canutus rufa*)	ESA Threatened	N
Roseate tern (*Sterna dougallii dougallii*)	ESA Endangered ME Endangered	N

Sources: USFWS 2020; IFW 2015; Wolff 2020

Notes:
[a]Although the piping plover has critical habitat established by the USFWS, no critical habitat occurs in or surrounding the AOI.

Key:
AOI = Area of Interest
ESA = Endangered Species Act
ME = Maine
N = No
Y = Yes

There are no designated Important Bird Areas within or near the AOI (Audubon n.d.; Northeast Ocean Data n.d.). The nearest Important Bird Area is Matinicus Rock along the outermost boundary of Penobscot Bay (Audubon n.d.; Northeast Ocean Data n.d.), approximately 35.5 mi (30.0 nm; 55.5 km) from the Research Array Site.

Species location data may inform collision risk and potential displacement effects. Avoidance and minimization measures will be identified and evaluated as necessary and appropriate to reduce potential impacts to bird species from the Research Array. Consultations with the USFWS and IFW will occur to identify and evaluate potential impacts to bats and avoidance and or minimization efforts as necessary and appropriate.

5.8 MILITARY USE AREAS AND AVIATION

The GOM includes several military use areas within the vicinity of the AOI, as illustrated in Figure 5-11. These include the Boston Operating Area (OPAREA), the Offshore Boston Range Complex, and the Submarine Transit Lane Bravo (BSOA). Military OPAREAs typically are areas where the U.S. Navy conducts surface and subsurface training and operations. The Boston OPAREA is one of three OPAREAs included within the Northeast Range Complexes. Activities within these OPAREAs generally consist of training areas, special use airspace, land ranges and stationary land targets, mobile targets and target control facilities, and instrumentation facilities (Ecology and Environment 2016a). Similarly, the Offshore Boston Range Complex primarily consists of surface sea space and subsurface space including special use airspace and danger zones. The Boston OPAREA is part of this range complex, which extends from the shoreline seaward, extending out to the GOM. The subsurface space includes two submarine transit lanes used for safe submarine passage through the OPAREA (Ecology and Environment 2016b). The Submarine Transit Lane Bravo crosses the OPAREA outside the AOI to the southwest.

The State of Maine engaged with the DoD to inform its siting decision for the Research Array within the AOI. As a part of a DoD effort in 2014 to assess the compatibility of offshore wind development with military assets and activities off the coast of Maine, an area that overlaps with the AOI was categorized as a Recommended Wind Exclusion Area. While the published DoD Recommended Wind Exclusion areas are the most recent published reports and remain on the U.S. government mapping tool, the DoD informed the State of Maine that these areas do not accurately encompass current uses, and during consultation, the DoD indicated no objection to the Research Array assuming the Research Array will recognize and comply with site-specific stipulations related to emergency curtailment in cases of potential national security issues.

The Federal Aviation Administration (FAA) designates air space for military activities, including warning areas, restricted airspace, training routes, and operating areas. A special use airspace warning area which covers the entire Site, as illustrated in Figure 5-11. The closest restricted airspace to the Site is the Kennebunk Bush compound, approximately 53.4 mi (46.4 nm; 85.9 km) away.

After coordination with both the DoD and the Military Aviation and Installation Assurance Siting Clearing House, the Clearing House provided a list of requests for inclusion into the design of the project (Appendix D). These requests included: (i) siting the turbines as far east as possible within the AOI to minimize encroachment upon sea trial activities; (ii) use of curtailment during sea trials; (iii) cooperating to assess potential impacts to shipboard radar; and (iv) allowance of the DON to coordinate a review of business entities involved with the project for foreign ownership, influence, or control to protect defense capabilities.

Airspace over the Site will be important to consider and coordination with the FAA, DoD and DON will occur to avoid and minimize potential impacts during the development process.

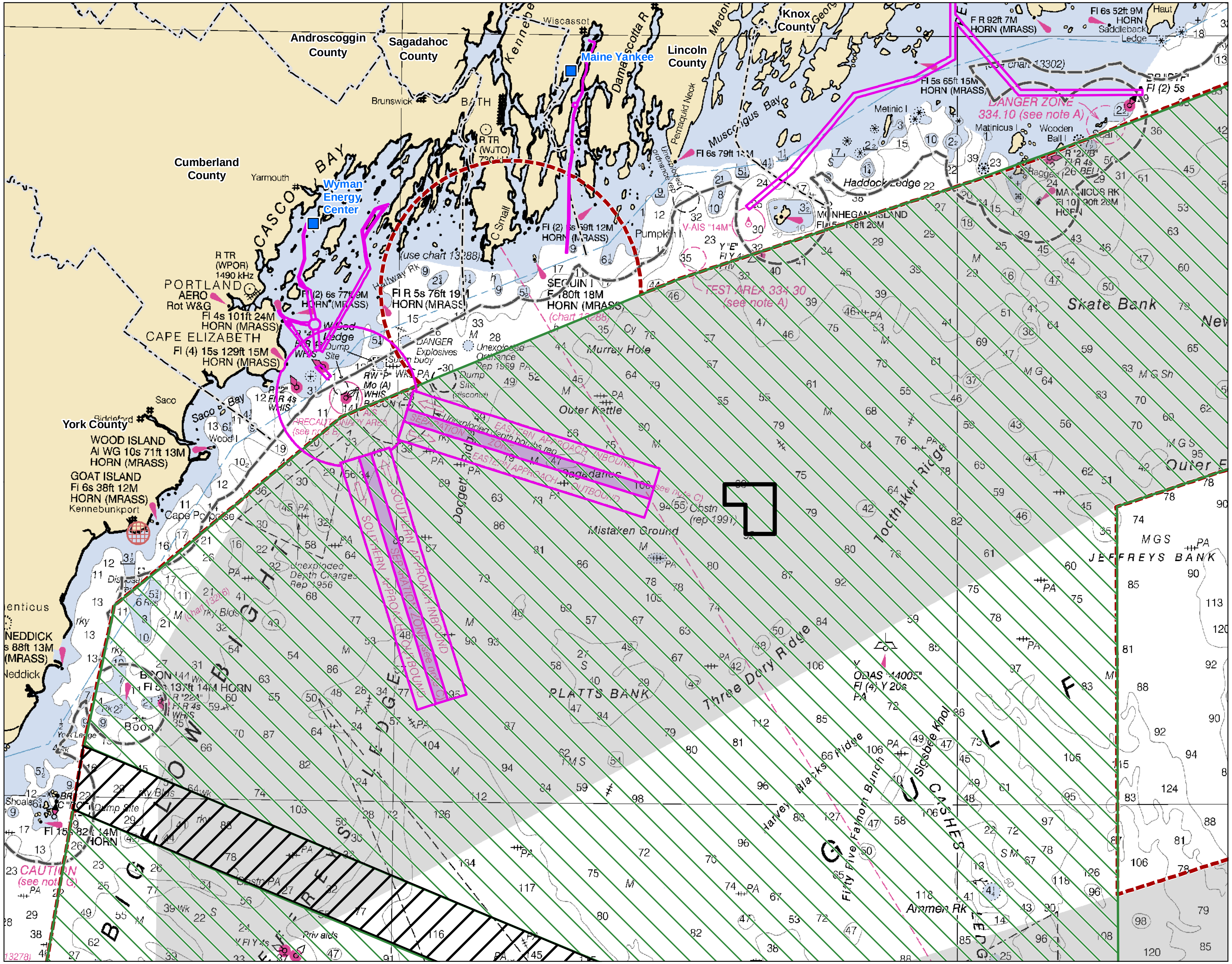


Figure No.

5-11

Title

Military Use Areas

Client/Project 195602069

Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend

- Research Array Site
- Potential Onshore Connection Points
- County Boundary
- 3-nm State Waters Boundary
- Shipping Lane
- Submarine Transit Lane Bravo (BSOA)
- Boston Operating Area (OPAREA)
- Offshore Boston Range Complex Boundary
- Special Use Airspace Warning Area
- Prohibited Airspace (P-67 Bush Compound)

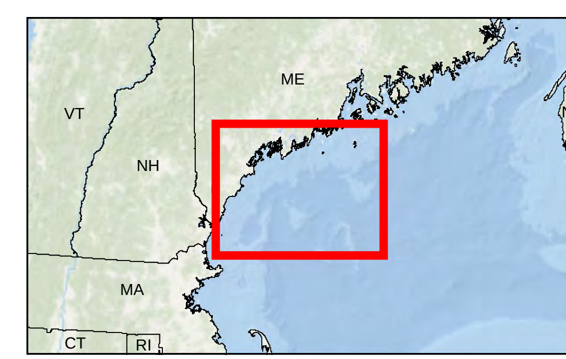
N

0 9 Miles

(At original document size of 11x17)
1:570,240

Notes

1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: MEGIS, FAA, NOAA, NGA, NUWC, Northeast Ocean Data Website
3. Background: NOAA Chart 13006 West Quoddy Head to New York



5.9 VESSEL TRAFFIC AND NAVIGATION

The AOI and Research Array Site are located within proximity to existing shipping and traffic lanes that facilitate both local and international vessel traffic, as illustrated in Figure 5-12. Figure 5-12 includes 2019 annual vessel counts resulting from the summed counts of the following vessel types: cargo, fishing, passenger, tanker, and towing vessels. The more prevalent vessel type, fishing, is described in Section 3.6, and shown in Figure 5-12.

The prominent vessel types that may make port calls at the numerous terminals within the Port of Portland include tank vessels, cruise vessels, container vessels, break bulk/bulk vessels, towing vessels and barges. The following outlines the different vessels and their frequency at or proximal to the port in recent years:

- Very Large Crude Carriers historically made port calls within the Port of Portland but have been virtually dormant in recent years with only five arrivals per year since 2016. Tanker traffic has been in decline for years and is now regularly three to four vessel calls per month.

- Cruise ships frequent Portland Harbor, Bar Harbor and periodically Penobscot Bay from late-May to early October. In Portland leading up to 2020, cruise ship port calls exceeded 100 visits. Cruise lines ceased all operations in 2020 due to the COVID-19 pandemic. Cruise operations continues to be significantly impacted in 2021 with only small coastal passenger vessels in operation. When the cruise industry returns, two to three vessels per week are expected in the summer months and five to seven vessels per week in September and October.

- A weekly container service operated by Eimskip provides service to Portland from Europe via Halifax, Nova Scotia.

- Cargo vessels sporadically call at the Sprague (Merrill's) terminal in Portland.

- Infrequently, U.S. Navy destroyers (DDG-Class) operate from Bath Iron Works and transit several times per year from the mouth of the Kennebec River to conduct sea trials in the GOM.

- Fishing vessels tend to stay away from typical deep-draft commercial vessel routes into the port and tend to deploy gear/traps outside of those areas.

In July 2015, the USCG completed a Port Access Route Study that produced planning guidance to assist offshore developers and marine planners with evaluating the navigational impacts of projects with multiple permanent fixed structures. Recommendations were based on generic deep draft vessel maneuvering characteristics and account for the minimum distances for larger vessels to maneuver in emergency situations. Based on the Port Access Route Study, the USCG published *Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations* (USCG Guidance) which recommends placement of offshore renewable energy sites relative to Traffic

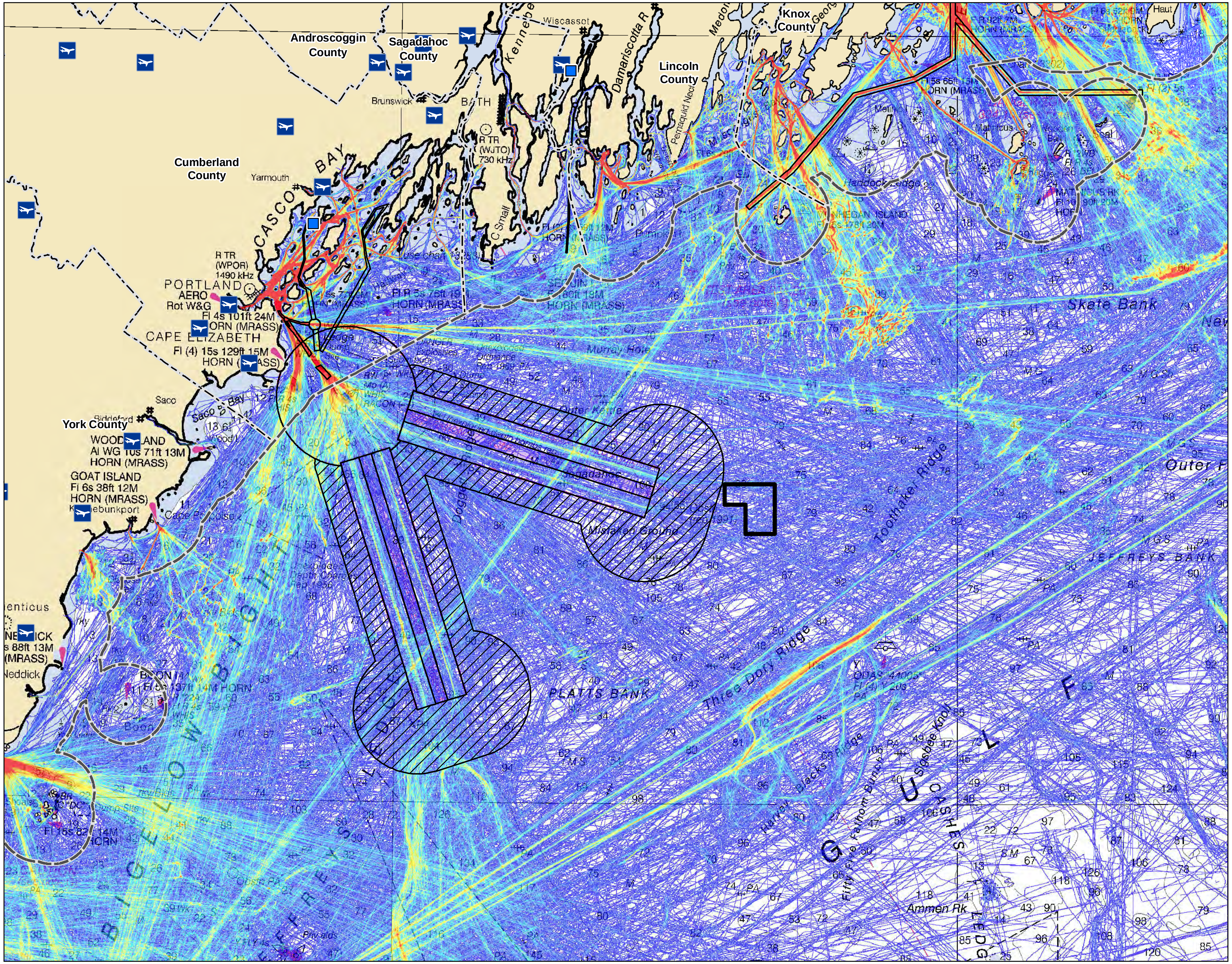


Figure No.
5-12

Title
Vessel Traffic and Airports

Client/Project
195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

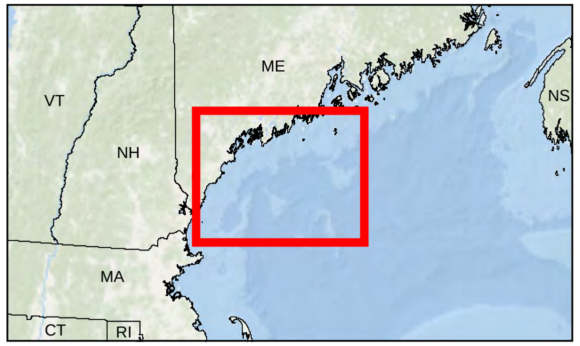
Legend
- Research Array Site
- Potential Onshore Connection Points
- County Boundary
- 3-nm State Waters Boundary
- Airport
- Shipping Lane
- Shipping Lane Separation Buffer

2019 Annual Vessel Counts (see note 2)
- 1 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- >30

N

0 10 Miles
(At original document size of 11x17)
1:570,240

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. 2019 annual vessel counts are the summed counts of the following vessel types: cargo, fishing, passenger, tanker, and tug/tow vessels.
3. Data Northeast Regional Ocean Council (NROC) Northeast Ocean Data, https://www.northeastoceandata.org/data-download/
4. Background: NOAA Chart 13006 West Quoddy Head to New York.



Separation Scheme (TSS)s as well as Closest Points of Approach (CPA) to sites. The USCG's recommended buffer zone from TSSs is 2 nm and from the terminus of TSSs is 5 nm. The USCG's recommended CPA to sites under ideal conditions is 0.5–1 nm and under less ideal conditions is ≥ 2 nm.

Codified in 33 CFR § 167.50-53, the Port of Portland utilizes a TSS as an international traffic management system to facilitate safe and efficient deep draft ocean going vessel traffic patterns in busy and/or confined waterways. The TSS in the approaches to Portland consist of a precautionary area (with a radius of 5.45 mi upon the latitude/longitude 43°31.60′ N, 70°05.53′ W, excluding areas within separation zones and traffic lanes), an Eastern approach (0.5 mi wide with a 1 mi separation zone), and a Southern approach (1.5 mi wide with a 1 mi separation zone). The Eastern approach is used by ships entering/exiting the Atlantic Ocean from Europe and cruise ships transiting between Portland and Bar Harbor. The Eastern approach is closest to the Research Array Site and therefore the most relevant. Ships entering/exiting the southeastern U.S. or South America use the Southern approach. Other vessels that regularly call on the Port of Portland that do not typically use the TSS include coastal tankers, towing vessels and barges.

In June 2021, Marine Compliance Solutions, LLC conducted a preliminary assessment of commercial deep draft vessel traffic patterns in the AOI in 2019 based on manual interpretation of AIS data compiled by the Northeast Regional Ocean Council. In total, approximately 143 ships accessed the AOI, with approximately 81 using the TSS Eastern approach. Results by vessel type, with a margin of error of ± 5 vessels, are as follows:

- Approximately 31–36 cargo ships accessed the AOI; of these, 26 used the TSS and 8 were en-route to/from Penobscot Bay.
- Approximately 50–55 tank ships accessed the AOI; of these, 23 used the TSS, 27 were en-route to/from St. John, New Brunswick to/from points south, and 3 were en-route to/from Penobscot Bay.
- Approximately 38–43 cruise ships accessed the AOI; of these, 32 used the TSS and 8 crossed the AOI in random patterns.
- Approximately 11 towing vessels and barges accessed the AOI; none used the TSS and all were en-route to/from Penobscot Bay.

Marine Compliance Solutions, LLC concluded that regional traffic density is relatively light compared to other regions (*e.g.*, Boston and New York harbors) with few meeting or crossing instances anticipated in confined areas. The weekly container service operated by Eimskip does not use the TSS Eastern approach. The Research Array Site is 28.9 mi (25.1 nm; 46.5 km) from the Port of Portland's precautionary area, measured from its closest point. The Research Array Site is 6.5 mi (5.2 nm; 10.5 km) from the terminus of the TSS Eastern approach and 6.0 mi (5.2 nm; 9.7 km) from the terminus of the TSS buffer zone, measured from its closest point. The turbines themselves will be farther than these distances and the exact distance from the TSS to the nearest turbine will depend on the final turbine layout. The Research Array Site exceeds the USCG's recommended CPA for vessels entering/exiting the TSS of 2 nm.

In April 2021, BOEM issued *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development*[15], which provides lighting and marking recommendations for wind projects. BOEM reviews project lighting and marking plans in consultation with other federal agencies as part of its review and approval process. Once the plan is approved, BOEM may request more detailed information under 30 CFR 585.701. According to BOEM, project lighting and marking must be safe, not interfere with other OCS uses, not harm natural and historic resources, and use best available and safest technology as well as best management practices. Recommendations in BOEM's guidelines for marine lighting and marking include marking turbines for conspicuous and distinct day and night recognition, turbine foundations be painted yellow, facilities have flashing yellow lights, and significant peripheral points be marked with quick flashing yellow lights.

The State of Maine has selected the location of the Research Array Site carefully, with navigational safety among the most important considerations. The State of Maine believes that, with navigational charting, lighting and marking in consideration of BOEM's guidelines, and a variety of other methods, the proposed location will not restrict, impede, or create a navigational hazard for safe passage of any deep-draft commercial vessels transiting in or out of the Port of Portland. The Research Array Site is outside the recommended 5 nautical mile buffer extending from the terminus of the TSS and maintains the 2 nm buffer of the CPA for vessels entering or exiting the Eastern TSS approach to the Port of Portland. The Portland Pilots and numerous other waterway users have been made aware of the proposed location and have not expressed concerns with the exception of ensuring that the array is adequately lit and marked on the appropriate navigation charts. The State of Maine intends to continue assessing the risks related to navigational safety of the Research Array with maritime stakeholders, including ongoing coordination with BOEM, USCG and other relevant active waterway stakeholders and agencies. If necessary, various safety measures to minimize potential conflicts regarding vessel traffic will be identified, discussed and evaluated. These measures may include exclusion zones, approved safety lighting, or communication protocols with vessel operators of installed infrastructure.

5.10 EXISTING INFRASTRUCTURE AND OTHER SPATIAL CONSTRAINTS

The GOM includes a variety of pre-existing subsea infrastructure including cable and pipeline areas, shipping lanes, ferry routes, aids to navigation, anchorage areas, unexploded ordnance areas, high frequency radar locations, ocean disposal sites, and ocean energy demonstration sites (MARCO n.d.;

[15] 2021 Lighting and Marking Guidelines (boem.gov)

Northeast Ocean Data n.d.). As illustrated in Figure 5-13, no existing infrastructure has been identified within the Site that will preclude lease.

The closest known infrastructure, an unexploded ordnance area, is approximately 25.7 mi (22.3 km, 41.4 nm) from the Site. The closest high frequency radar location is 48.0 mi (41.7 km, 77.2 nm) from the Site.

A specific interconnection point has not yet been determined at this stage of project development. If the Wyman Station site in Casco Bay were to be selected as a landfall location, there are 9 possible cable and pipeline area crossings, as illustrated in Figure 5-13. However, not all will be crossed by a single export cable as many could be avoided during the design phase of a project. For a landfall location associated with Maine Yankee (Wiscasset, ME on the Sheepscot River), it could be possible to avoid crossing any cable and pipeline areas. Future project siting and design will also need to consider existing ocean disposal and ocean energy demonstration sites to avoid such spatial constraints.

Spatial constraints such as these will be important to identify and assess to avoid potential constraints on development. Coordination with the agencies currently managing these existing resources will be important to avoid or minimize potential impacts to existing infrastructure.

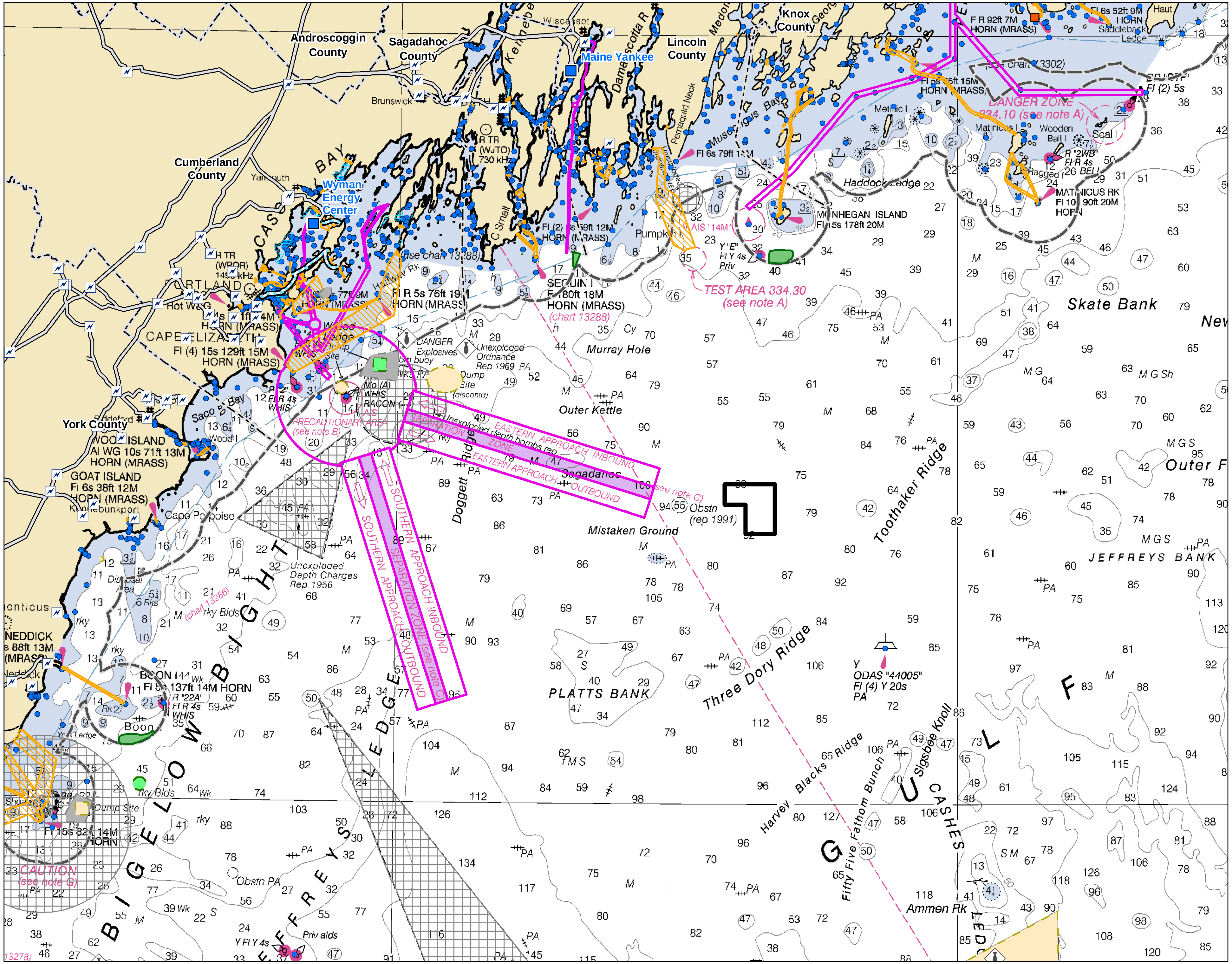


Figure No.
5-13

Title
Existing Infrastructure and Other Constraints

Client/Project 195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

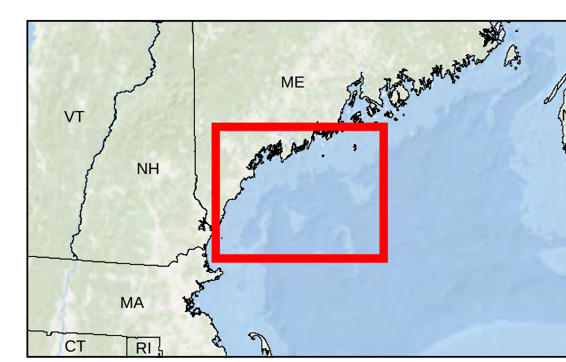
Legend
- Research Array Site
- Potential Onshore Connection Point
- County Boundary
- 3-nm State Waters Boundary
- Aids To Navigation
- High Frequency Radar Location
- Substation
- Transmission Lines
- Ferry Route
- Ocean Energy Demonstration Site
- Anchorage Area
- Cable and Pipeline Area
- Shipping Lane

Ocean Disposal Site
- Available
- Discontinued
- Unknown
- Unexploded Ordnance Location
- Unexploded Ordnance Area

N

0 9 Miles
(At original document size of 11x17)
1:570,240

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: MEGIS, NOAA, USGS, Homeland Infrastructure Foundation Level Database, Northeast Ocean Data Website
3. Background: NOAA Chart 13006 West Quoddy Head to New York.



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5.11 VISUAL AND CULTURAL RESOURCES

The visual landscape within the AOI consists of open ocean with no known permanent physical structures in federal offshore waters (other than the subsea infrastructure previously described in Section 5.10). Due to the distance from shore, offshore structures installed within the AOI are not expected to be visible from shore. The curvature of the earth aids in reducing the visual landscape of offshore turbines from shore. Nighttime visibility of offshore structure lighting is likely to be dependent on the intensity and dimmability of the lights and aircraft detection lighting systems. Additional factors such as relative humidity and precipitation also affect visibility over long distances (Terrence J. DeWan & Associates 2018).

Cultural resources within the AOI and surrounding waters are illustrated within Figure 5-14. . Many of the "wrecks and obstructions" illustrated within Figure 5-14 are vaguely documented or unknown "obstructions" (Northeast Ocean n.d.). One documented shipwreck is located within 13.5 mi (11.7 nm; 21.7 km) of the Site (see Figure 5-14) named the *Lottie Merchant*. Additional wrecks in the vicinity include the *Catawanteak* located approximately 3.3mi (2.9 nm; 5.3 km), the *St. Christopher* located approximately 26.0 mi (22.6 nm; 41.8 km), the *Bohemian* located approximately 19.5 mi (16.9 nm; 31.4 km), and the *Hartwilson* located approximately 24.0 mi (20.9 nm; 38.6 km) from the Site. There are also many wrecks and obstructions within the Casco Bay area, many labeled as "unknown" (Northeast Ocean n.d.).

Maine has many cultural resources along the coastline and inland. Figure 5-14 illustrates known cultural resources proximal to the AOI and within coastal and inland Maine. Prior to future development, the Project will coordinate with federal and state agencies such as BOEM, the Advisory Council on Historic Preservation, the Maine State Historic Preservation Office, and Maine Native American tribes regarding potential impacts to cultural and historic resources to avoid, minimize and mitigate impacts.

Prior to future development, a Visual Impact Assessment will be prepared for the Research Array to determine potential visual impacts on historic resources from WTGs and other infrastructure. A full analysis of all historic properties and consideration of possible impacts will occur, during which Section 106 consultation under the National Historic Preservation Act will be conducted. If it is determined during the Section 106 review process that adverse effects to historic properties will occur, project proponents will work with BOEM and other consulting parties to avoid, minimize, and mitigate these potential impacts. Similarly, geophysical, geological, and historic surveys will be conducted at the Research Array and along the cable route and landing to identify and minimize project effects on pre- and post-Columbian cultural resources.

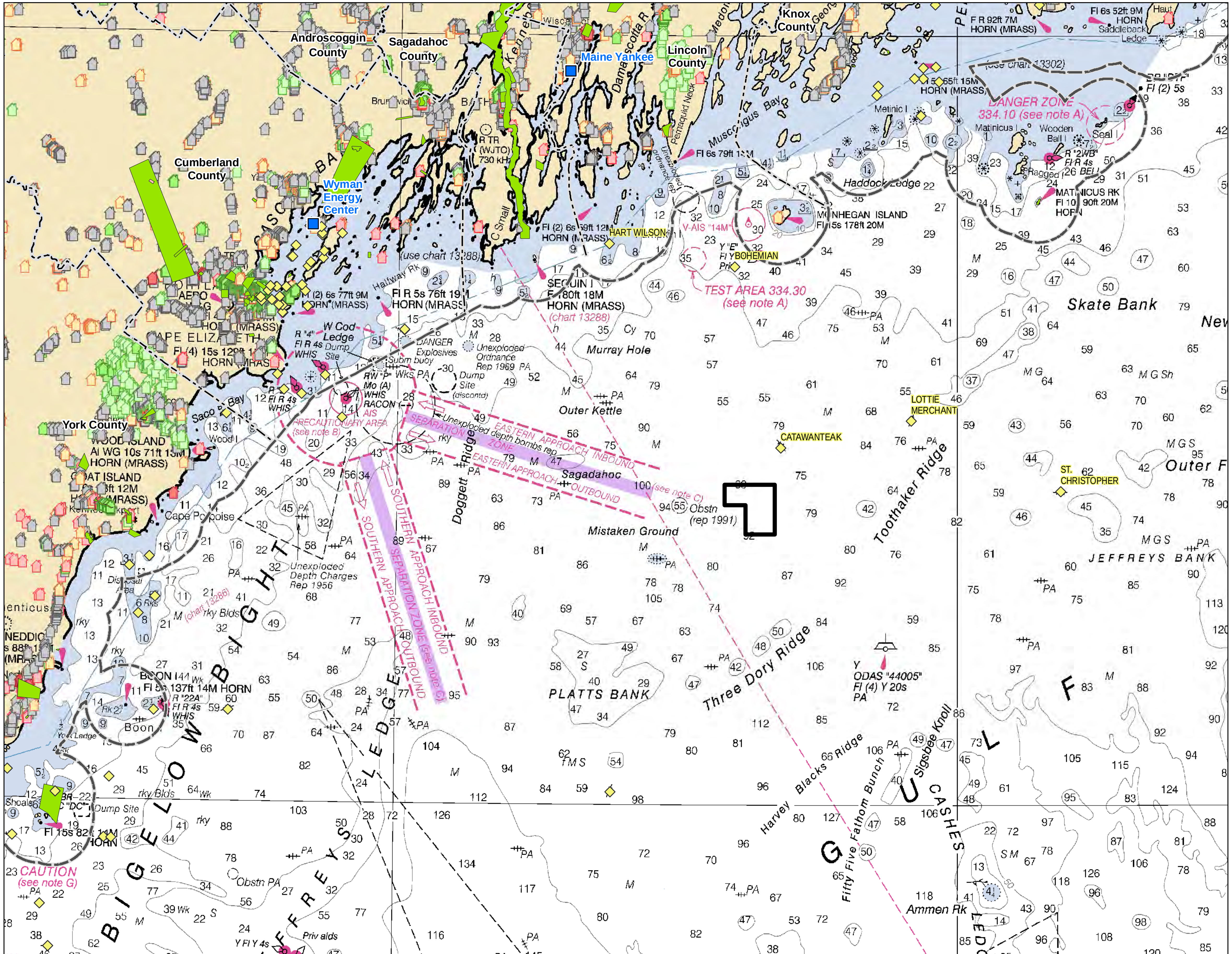


Figure No.
5-14

Title
Cultural Resources

Client/Project — 195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend

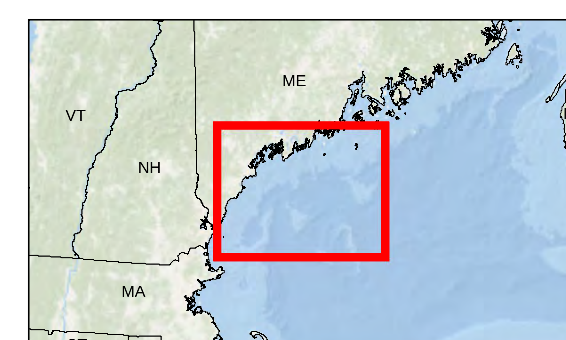
- Research Array Site
- Potential Onshore Connection Points
- County Boundary
- 3-nm State Waters Boundary
- Wrecks And Obstructions
- National Register Historic Places
- National Register Historic Places Districts and Properties

State Historic Properties
National Registry Status

- Not Eligible
- Not Determined
- Unknown
- Eligible
- Listed
- Historic District

N

0 — 9 Miles
(At original document size of 11x17)
1:570,240



Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: MEGIS, NOAA, NPS, Northeast Ocean Data website
3. Background: NOAA Chart 13006 West Quoddy Head to New York.

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6.0 Site Nomination

The proposed lease area for the Research Array Site is located 23.4 mi (20.3 nm; 37.7 km) from the nearest point of land, Monhegan Island, Maine, measured at its closest point, and 28.8 mi (25.0 nm; 46.3 km) from the nearest point on the mainland, Cape Small (Figure 6-1). The coordinates for each corner of the lease area are shown below in Table 6-1. The proposed lease area is approximately 15.2 square miles (9,696.4 acres; 11.4 square nm; 3,924.0 hectares) and consists of 24 aliquot-blocks and 6 partial aliquot-blocks (Table 6-2).

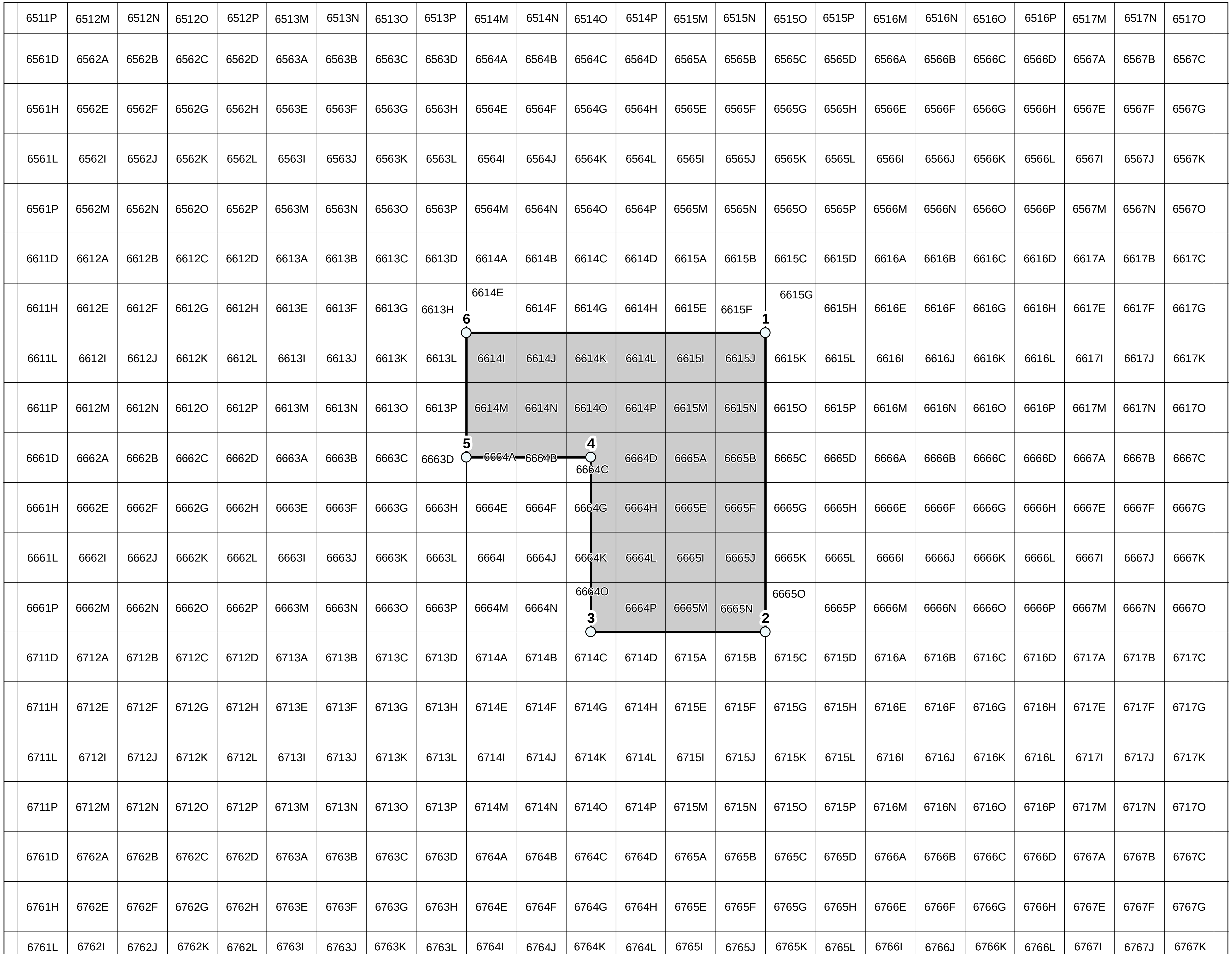


Figure No.
6-1

Title
Maine Research Array
Proposed Lease Area

Client/Project 195602069
Maine Research Array
BOEM Lease Application

Project Location
Federal Waters off the Coast of Maine

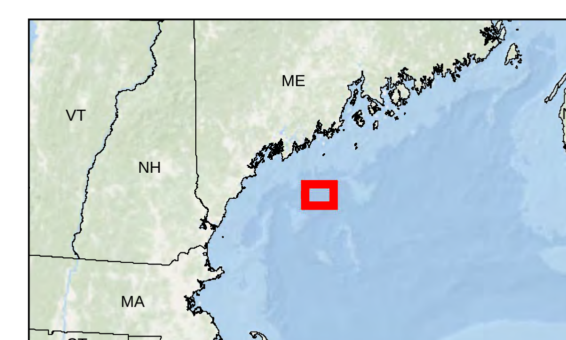
Prepared by GC on 2021-08-23
TR by EW on 2021-08-24
IR Review by SBG on 2021-08-24

Legend
- Research Array Site
- BOEM Aliquot

N

0 1.5 Miles
(At original document size of 11x17)
1:95,040

Notes
1. Coordinate System: NAD 1983 UTM Zone 19N
2. Data Sources: MEGIS, NOAA
3. Background: NOAA Chart 13006 West Quoddy Head to New York.



V:\1956\active\195602069\03_data\gis_cad\gis\MXDs\PermitAug2021\02069_6-1_LeaseAliquots.mxd Revised: 2021-08-25 By: gcarpentier

Table 6-1. Proposed Lease Boundary Coordinates

ID*	Latitude	Longitude	Latitude (DMS)	Longitude (DMS)
1	43.41692	-69.334084	43° 25' 0.912" N	69° 20' 2.701" W
2	43.352357	-69.333729	43° 21' 8.485" N	69° 20' 1.425" W
3	43.352195	-69.385312	43° 21' 7.901" N	69° 23' 7.124" W
4	43.390313	-69.385554	43° 23' 25.127" N	69° 23' 7.993" W
5	43.390183	-69.422468	43° 23' 24.657" N	69° 25' 20.885" W
6	43.416627	-69.422652	43° 24' 59.857" N	69° 25' 21.546" W

*See Figure 6-1 for ID reference.

Table 6-2. Proposed Lease Blocks

Aliquot ID	Aliquot Blocks	Partial Aliquot Blocks
6614	I, J, K, L, M, N, O, P	
6615	I, J, M, N	
6664	D, H, L, P	A, B, C, G, K, O
6665	A, B, E, F, I, J, M, N	

7.0 Conformance with State Energy Planning

The Research Array is one of the actions that implements Maine's energy and environmental policy direction as outlined in the Maine Offshore Wind Initiative.

In 2019, the Governor signed bipartisan legislation to address climate change and require investment in clean energy, including decreasing greenhouse gas emissions by 45 percent by 2030 and 80 percent by 2050, and requiring 80 percent renewable energy by 2030 with the goal of 100 percent by 2050. Harnessing the unequaled wind resources off the coast of Maine is a critical component of Maine's climate, clean energy, and economic goals. Further, this effort is of importance in the GOM, where surface temperatures peaked in 2020 and have been warming faster than nearly every other body of water in the world, creating a substantial threat to our traditional fishing industries.

With some of the highest sustained wind speeds in the world, the OCS of the GOM has great potential for generating clean energy and economic opportunity for Maine, as offshore wind investment in the U.S. is estimated to be considerable over the next decade. In Maine's 10-year Economic Development Strategy and a recent Clean Energy Economy report from the Governor's Energy Office, the development of Maine as a hub for offshore wind development was identified as a key opportunity to grow and attract economic development to Maine. This Research Array is an investment in research and development, a catalyst for achieving those goals, and the Maine Legislature recently passed and the Governor signed legislation supporting this development. The Research Array encourages the State of Maine to set forth a balanced agenda that maximizes economic benefits for Maine people while creating a culture of innovation that creates a foundation for future leadership in this growing industry.

Designating a small-scale array in the GOM represents a measured, deliberative approach that allows the State of Maine to engage the fishing industry's expertise to minimize potential harms and maximize the benefits to Maine people from offshore wind. This was further recognized in LD 336, which passed in 2021 with bipartisan support by the Maine Legislature, which declared the Research Array is in the state's public interest. The Research Array is part of the ongoing Maine Offshore Wind Initiative announced by Governor Mills in 2019. That broad initiative includes an assessment, called the Port Infrastructure and Market Potential Assessment, led by the Maine Department of Transportation (Maine DOT), the Governor's Energy Office, and the Department of Economic and Community Development to evaluate the port of Searsport, Maine as a central point for assembly and supply chain support for offshore floating wind turbines. In October 2020, the State of Maine received a grant from the U.S. Economic Development Agency for the Initiative to support long-term planning for offshore wind with fishery, business, environmental and science representatives, as well as assessing port and infrastructure needs and evaluating the supply chain, manufacturing, and workforce opportunities. Finally, in December 2020 the Maine Climate Council, established in 2019 by the Governor and state Legislature, released a four-year action plan, *Maine Won't Wait*, for reducing greenhouse gas emissions.

That plan specifically identifies responsible offshore wind development as a key component of reducing energy related greenhouse gas emissions (Maine Climate Council 2020).

This Research Array is evidence of Maine's full investment in initiatives that evaluate the opportunities for responsible offshore wind development in the GOM.

8.0 Qualifications Document

This application is being submitted by the State of Maine through the Governor's Office of Innovation and the Future, in coordination with the Governor's Energy Office, as a state government agency of the State of Maine. The State of Maine is requesting a research lease pursuant to 30 CFR 585.238(a), which provides that research leases may only be held by a state or federal agency for renewable energy research activities that support the future production, transportation, or transmission of renewable energy. This Section provides a statement of the State's qualifications to hold a renewable energy lease on the OCS pursuant to 30 C.F.R. part 585, including §§ 585.106, and 585.107.

The State of Maine is uniquely qualified to advance the Research Array given the State's experience with renewable energy. The State routinely reviews the development, construction and operations of clean energy projects, including over 900 MW of wind, climate-related and clean energy requirements set by the Legislature and signed by the Governor. Maine has an extensive understanding of the unique and economically important environment in the GOM and expertise working with traditional marine users who have worked and recreated on these waters for generations. See Appendix E for Maine's State Certification.

For this Project, the State of Maine is collaborating with the developer New England Aqua Ventus, LLC, a partnership of global leaders in offshore wind energy, and research partners, including UMaine and other affiliates, each of whom are profiled in more detail below. These partners and more will provide world-class experience in offshore wind, research, and technology.

8.1 LEGAL ELIGIBILITY

The State of Maine is legally qualified to hold a federal lease issued by BOEM. See 30 C.F.R. § 585.106(a)(6). The Governor's Office of Innovation and the Future was established under the laws of the State of Maine, 5 M.R.S. §§ 3101 *et seq*. The Director of the Governor's Office of Innovation and the Future is authorized by 5 M.R.S. §§ 3106 & 3201(5), with the consent of the Governor, to enter into agreements with the federal government to support the development of the state's economy and energy resources and the conservation of its natural resources.

8.2 TECHNICAL CAPABILITY

8.2.1 State of Maine

The State of Maine has extensive experience with floating offshore wind and is well poised to successfully manage the proposed Research Array. Beginning more than 14 years ago, Governor Baldacci and with unanimous support by the legislature, took steps to recognize the opportunity for offshore wind power development to reduced dependence on imported fossil fuels, and create short and long term economic and employment benefits for Maine citizens.

In 2008, Governor Baldacci launched the Ocean Energy Task Force to review opportunities for offshore wind in Maine; members included 17 experts with experience in marine resources management and conservation. The final report recommended that "Maine make a major commitment to preparing the way for the development of its offshore wind, tidal, and wave power" and set forth ambitious offshore wind targets.

In April 2010, in response to the report of the Ocean Energy Task Force, the Legislature enacted the Ocean Energy Act with unanimous support in the House and the Senate, which set a goal of 5,000 MW by 2030 and promoted research for commercialization of ocean energy resources. Also during this time, Maine published the Maine Offshore Wind Report[16] examining economics and policy, electrical grid integration, environmental and marine research, and construction and assembly.

In 2010, with consistent endorsement from the Legislature and with the strong support of Senator Susan Collins and the entire Maine Congressional delegation, Governor Baldacci and the Legislature, UMaine, the State of Maine and the DOE increased funding for development of the UMaine technology and ultimately a demonstration project. UMaine committed to five years of study, which eventually resulted in the 2013–14 launch and operation of a 1/8th scale, UMaine VolturnUS technology turbine in the GOM, the first ever floating wind turbine in the U.S.

Building off the 1/8th experience, UMaine is pursuing the deployment of a full-scale floating foundation for a wind turbine in State waters known as the Monhegan Demonstration Project. In support of the project, in 2019 the Legislature passed, and Governor Mills signed, a law requiring the Maine Public Utilities Commission to approve a long-term contract for the project off of Monhegan Island.

To further Maine's more than decades-long effort to become a global leader in offshore wind, in 2019 Governor Mills launched the Maine Offshore Wind Initiative. The Initiative, a comprehensive strategy combining planning, research, public/private partnerships, port analyses, and regional collaboration, is led by the Governor's Energy Office, with the support of several other state agencies. Maine has already received a $2.167 million grant from the U.S. Economic Development Agency to create an economic development plan, or "roadmap," for the offshore wind industry in Maine. The roadmap encompasses

[16] OfficialOffshoreWindReport-223111.pdf | Powered by Box

comprehensive studies of Maine’s strengths and weaknesses related to infrastructure, workforce, policy, law, technology, and financing. The Research Array represents a critical component of the roadmap because it serves as an offshore laboratory to study how offshore wind can best fit with lobstering, fishing, and marine life. The Research Array thus builds on and compliments the roadmap because it serves as an offshore laboratory to study how offshore wind can best fit with lobstering, fishing, and marine life.

In 2021, the State of Maine took a number of important steps to solidify its commitment to responsible floating offshore wind research and development. The Governor signed LD 336, which passed the legislature with bipartisan support, and directs the Maine Public Utilities Commission to work with the utilities to negotiate a power purchase agreement for up to 144 MW from the Research Array. In response to concerns raised by the fishing industry about potential offshore wind development in state waters, where up to 75 percent of lobster activity occurs, the Governor introduced legislation to limit new offshore wind projects in state waters, which are three miles from the coast, prioritizing future offshore wind development for federal waters. LD 1619, as enacted, prohibits new full-scale offshore wind projects in state waters and sets a clear path forward for interconnecting federal projects into State of Maine managed waters. The law also establishes an Offshore Wind Research Consortium to strategically manage the research strategy for the array, with engagement from stakeholders, including the fishing industry.

The Governor’s Energy Office, in partnership with agencies across the state government, will bring forward technical, scientific, economic, and policy staff that can advance the development of this project and the associated research the State will pursue at the site.

8.2.2 UMaine

UMaine is an important partner to the State of Maine on the Research Array. Since 2006, UMaine has been involved in evaluating the GOM as a source of renewable energy generation to secure domestic energy supply and create local economic opportunities, while reducing the environmental impact of fossil fuel use on the environment. UMaine's Advanced Structures and Composites Center has led the technical development and innovation focused on floating structures to support offshore wind turbines, resulting in specific designs that can be manufactured domestically (in Maine and the U.S.) and are cost competitive with other fuel sources or imported technology. In 2010, the VolturnUS floating concrete hull was patented, and as discussed above, the 1/8th scale version operated successfully for 14 months during Maine's harsh winter storms, demonstrating the validity of the design. In 2013, UMaine was selected by the DOE Advanced Technology Demonstration Program to support the development of the Monhegan Demonstration Project which would utilize the VolturnUS concrete floating hull and have a target deployment of 2023. The Advanced Structures and Composites Center has become a recognized leader in floating offshore wind and other renewable technology research and development.

Throughout this effort, the UMaine School of Marine Sciences has led the environmental and ecological investigation of the 1/8th scale turbine, as well as the evaluation of potential interactions of clean energy with traditional marine users and stakeholders. UMaine's Physical Oceanography Group has decades of experience with their Ocean Observation buoy program as part of the NERACOOS/IOOS programs which collects real time metocean data throughout the GOM and provides a platform for new sensor/sensing applications and development. The School of Marine Sciences also has experts utilizing satellite and other remote data integrated in a wide variety of numerical models for the GOM evaluating circulation and current models. Fisheries scientists lead a variety of stock assessments for commercially important species as well as endangered and protected species. As a Land Grant, Sea Grant, Space Grant institution, the Maine Sea Grant program has coast-wide programs and extension agents that work directly with a wide variety of stakeholders within the coastal and marine communities supporting efforts to understand the complementary and competing socio-economic uses in these environments. UMaine's Law School also has faculty/practitioners who have direct experience with the National Environmental Policy Act, permitting and Jones Act issues that are guiding various Maine offshore wind efforts.

UMaine's research and development activities exceed $100 million in expenditures, largely through federal grants and contracts with agencies such as the National Science Foundation, The DOE, U.S. Department of Commerce- (NOAA, U.S. Economic Development Administration, and National Institute of Standards and Technology), U.S. Department of Defense and the U.S. Department of Agriculture. Funding for offshore wind energy alone through the DOE exceeds $20 million in the last 10 years and current awards include funding to build the first U.S. commercial floating turbine under the DOE Advanced Technology Development program ($35 million) and a recent U.S. DOE award investigating the use of semi-taut synthetic mooring systems for floating turbines. In addition, UMaine's School of Marine Sciences and Maine Sea Grant program leads oceanographic, ecological and fisheries related research in the GOM with typical federal funding through the U.S. Department of Commerce-NOAA averaging $5 million/year over the last decade.

8.2.3 New England Aqua Ventus

New England Aqua Ventus is a joint venture of Diamond Offshore Wind (DOW) and RWE Renewables (RWE). NEAV has partnered with UMaine to advance its innovative VolturnUS concrete floating hull technology. Given long history of supporting the UMaine floating offshore wind technology program, the State intends to partner with NEAV on the Research Array.

8.2.3.1 DOW

DOW is a wholly owned subsidiary of Diamond Generating Corporation (DGC), which is wholly owned by the Mitsubishi Corporation. DGC, based in Los Angeles, California, has been in the independent power producer business in North America since its inception in 1999, and before that as Diamond Energy since 1988. Recent projects include Valley Energy Center, a 680 MW, natural gas combined-cycle electric generating station located in Wawayanda, New York, for which DGC supported the financing, development, construction oversight, and operation and maintenance, and the Westmoreland Generating Station, a 940 MW natural gas, combined-cycle electric generating station located in in Westmoreland County, PA, for which DGC was involved in financing and construction management.

DGC has in recent years made several strategic acquisitions in the U.S. market including Nexamp and BETM that bring significant capabilities in commercial renewable energy development and wholesale energy market services, including for New York Independent System Operator, Inc. DGC's development approach is founded in a long-term ownership philosophy that is evident throughout DGC's project development, construction, and operations strategies. DGC's multi-decade track record in the U.S. market has proven it to be a good neighbor and corporate citizen, with a history of safety and reliability.

Mitsubishi Corporation, DGC's parent company, was an early pioneer in the offshore wind sector, and was the first Japanese company to enter the offshore wind transmission market in Germany and the UK. The company is shifting to the development of renewable energy in its power generation business. Mitsubishi Corporation is Japan's largest trading company, with over 79,000 employees and deep experience across infrastructure, finance, energy, machinery, chemicals, and a variety of other sectors. Diamond Generating Europe (DGE), a sister company of DGC, also wholly owned by the Mitsubishi Corporation, has been involved in offshore wind power generation in Europe since 2013 with over 5 gigawatts (GW) of installed capacity in over 11 countries. DGE first entered the offshore wind market with the acquisition of a 50 percent interest in the 129 MW offshore wind farm 'Luchterduinen' off the coast of the Netherlands in between the towns of Noordwijk and Zandvoort from Dutch utility company, Eneco. At the same time, DGE and Eneco entered into a long-term strategic partnership for the further joint development of offshore wind projects in Europe (Eneco was ultimately acquired by Mitsubishi Corporation in 2020). On the back of this partnership, DGE's offshore wind portfolio has since then expanded with the acquisition of an interest in the 370 MW Norther offshore wind farm in Belgium, the 680 MW Borssele sites III and IV in the Netherlands, and the 950MW Moray East project in Scotland.

8.2.3.2 RWE

RWE is one of the world's leading renewable energy companies. Driving the expansion of renewable energy in more than 20 countries on 5 continents, RWE has onshore and offshore wind farms, photovoltaic plants and battery storage facilities with a combined capacity of approximately 9 GW in operation. From 2020 to 2022, RWE Renewables targets to grow its renewables portfolio to 13 GW of net capacity, with growth in wind and solar energy production specifically. RWE Renewables Americas, a subsidiary of RWE, ranks among the top 10 onshore wind companies in the U.S. Already active in onshore wind and photovoltaic renewable generation, E.ON Climate and Renewables, as RWE’s predecessor, has developed and constructed more than 3,800 MW of renewable capacity in the U.S. since 2007. RWE’s goal is to deliver renewable energy from technologies that address the growing concern about energy security, energy affordability, and climate change.

RWE is one of the global leaders in offshore wind, with offshore wind operational experience since 2001. RWE owns alone or with joint venture partners 37 offshore wind projects of a total capacity of 5 GW in operation and 15 GW in development or construction phases. These projects cover a full spectrum of technologies with near shore / far shore projects, turbine sizes from 2 to 14 MW, and various foundation types and technologies including fixed bottom and floating. RWE is building on its offshore wind experience to become a leader in floating wind, aiming to have 1 GW of floating capacity by 2030 and a multi-gigawatt global pipeline to be deployed in the 2030s and beyond. RWE is developing or constructing three floating offshore wind demonstration projects, which utilize different foundation types, for future commercialization.

RWE is experienced in all phases of offshore wind projects, including origination (winning auctions), initial screening of potential sites, evaluation of seabed and wind conditions, securing of project and property rights, environmental permitting and impact assessment, technical planning, securing of grid connection, construction permitting, installation of foundations and wind turbines, connection to onshore grid, commissioning, operations and maintenance, and decommissioning or repowering.

8.3 FINANCIAL CAPABILITY

As stated in 30 CFR 585.238(g), there is no acquisition cost for a research lease. The State of Maine is in strong financial standing, with Moody’s Investors Service and S&P Global Ratings recently affirming Maine’s strong credit ratings and stable outlooks on the State of Maine’s general obligation debt. Moody’s affirmed both their Aa2 rating and stable outlook while S&P affirmed their AA rating and stable outlook. In recent months, Maine’s nonpartisan Revenue Forecasting Committee upgraded the State’s General Fund revenue forecast to a level surpassing the amount of revenue that had been forecasted prior to the onset of the pandemic.

Affiliates of the developer have each been independently qualified as leaseholders by BOEM. The developer and State of Maine will provide any documentation of financial capacity requested by BOEM and meet all financial obligations prior to lease issuance.

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Appendix A Research Framework

Maine Floating Offshore Wind Research Array

Research Framework

A research framework to support the State of Maine's application for a federal research lease from the Bureau of Ocean Energy Management

State of Maine

Governor's Energy Office

September 2021

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Acknowledgements

This document reflects the work of multiple parties, including the State of Maine (Governor's Energy Office, Department of Marine Resources, and the Department of Inland Fish and Wildlife), the University of Maine, the Biodiversity Research Institute, the Consensus Building Institute, and the many interested parties who participated in video work sessions or dockside conversations about the Maine Floating Offshore Research Array. Special thanks to Drs. Damian C. Brady, Wing Goodale, Habib Dagher, Anthony Viselli, Iain Stenhouse, and James Ward for their vision and expertise in helping to develop this Research Framework.

1. Summary

The Maine Floating Offshore Wind Research Array (hereafter the Research Array) is a small-scale project, sized to allow empirical evaluation of an array of floating offshore wind turbines operating in the ocean environment at a scale that surfaces and potentially resolves interactions that will become manifest in commercial scale projects. The Research Array provides an unprecedented opportunity to research how floating offshore wind can be optimized to co-exist with current ocean uses, including the fishing industry, and with the marine ecosystem and will allow for a vast suite of research objectives to be met far beyond what typically is accomplished at a commercial project. The Research Array will directly address concerns around potential interactions with commercial activities such as fisheries and navigation; be a research laboratory to understand ecological stressors; provide an opportunity to understand potential socioeconomic impacts and opportunities; allow for workforce education and training to ensure that the clean energy economy is accessible to those currently working in traditional industries; develop a supply chain for floating offshore wind; and be an incubator for innovative technology development that will optimize co-existence with other ocean users and the environment, reduce costs, and the improve safe operations of floating offshore wind.

Research conducted at the Research Array will focus around three core themes: human dimensions, ecosystem and environment, and technology development. These will fill existing data gaps, be open sourced, and inform future potential floating offshore wind development in the Gulf of Maine and elsewhere. The proposed research framework discussed in this document 1) details specific areas of research, 2) provides representative questions that will be refined through further investigation, including stakeholder processes, and 3) demonstrates the great value and enormous potential of the Research Array. The research framework augments existing research, monitoring, and impact assessment guidance[1] for offshore wind, with specific focus on floating technologies and priority needs for the Gulf of Maine.

In time, the research framework will be implemented by a Research Consortium. The State will establish such a Consortium to coordinate and manage the research for the Research Array, including the development of a prioritized research strategy. The Consortium will be developed in coordination with state and federal agencies and external scientific experts to develop an approach that is open, inclusive, and informed by regional and scientific entities with input from the fishing industry and Maine stakeholders. The Consortium will also be developed in coordination with the State's Offshore Wind Roadmap stakeholder groups and will be tasked with ensuring that the research meets the broad goal of optimizing co-existence of floating offshore wind with the human and ecological environment.

This document provides an initial outline of the potential scope of the research to be undertaken on the Research Array. Ideas presented here, and their implementation, are meant to go above and beyond expected studies to support commercial development and would be carefully considered with respect to their alignment with the State's research strategy and compliance with the Bureau of Ocean Energy

[1] See list of examples of existing guidance in Resources section.

Management (BOEM) and lease operator, health and safety rules and regulations, permits, and operation and maintenance procedures.

2. Introduction

Maine is pursuing an ambitious approach to reduce carbon dioxide emissions and combat climate change. A central pillar of Maine's strategy is increasing clean energy resources, including the thoughtful development of offshore wind energy, given the over 50 gigawatts of potential wind energy resource in the Gulf of Maine. Due to its deep waters, generating wind energy in the Gulf of Maine will require the use of floating offshore wind turbines, a technology that is still advancing and requires scientific study about its potential effects on Maine fisheries and the marine environment.

To support responsible offshore wind development in the Gulf of Maine, Maine is pursuing a federal lease for the Research Array in the Gulf of Maine. This state-led approach is designed with the goal of bringing the fishing community, scientists, and other key stakeholders together to develop and advance studies around key research questions, the results of which will support better understanding of how to best support co-existence of offshore wind with Maine's coastal communities, fishing industry, and natural resources.

2.1. Research Goals and Objectives

Conducting detailed research at the Research Array will be critical to reducing uncertainty and informing the responsible development of future projects in the Gulf of Maine. Studies conducted at the Research Array will add to work being conducted by existing regional and national research consortia, such as the National Offshore Wind Research and Development Consortium (NOWRDC)[2], Responsible Offshore Science Alliance,[3] Regional Wildlife Science Entity[4], New York State Energy Research and Development Authority's (NYSERDA) Fisheries Technical Working Group[5], and NYSERDA's Environmental Technical Working Group,[6] as well as coordinating with Gulf of Maine wide studies identified in BOEM's environmental studies plan.[7] Most of these consortia include the offshore wind industry, fishing, government and scientific representatives. Research and monitoring at the Research Array will be coordinated with existing regional efforts to answer questions about cumulative impacts across species' geographic ranges, and to leverage additional resources toward shared goals. Within this regional framework, the Research Array will prioritize research on floating offshore wind in the Gulf of Maine. The goal and objectives of research at the Research Array are as follows:

- ***Goal:***
  - ***To optimize the co-existence of floating offshore wind with the human and ecological environment.***

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[2] https://nationaloffshorewind.org/
[3] https://www.rosascience.org/
[4] https://www.nyetwg.com/regional-wildlife-science-entity
[5] https://www.nyftwg.com/
[6] https://www.nyetwg.com/
[7] https://www.boem.gov/sites/default/files/documents/environment/environmental-studies/SDP_2022-2023.pdf

- *Objectives:*
  - ***Reduce conflicts with existing ocean uses, including fisheries.***
  - ***Support education, workforce and supply chain development.***
  - *Maintain coastal community culture and heritage while creating socioeconomic opportunities.*
  - ***Monitor ecosystem change at the Research Array and inform future projects by providing recommendations for socially and environmentally responsible development.***
  - ***Advance floating wind technology and reduce the levelized cost of offshore wind energy.***

2.2. Stakeholder Driven Effort

The State is committed to working with fishing communities, coastal and maritime groups, natural resource experts, and other relevant stakeholders to shape the development of the research questions through a comprehensive stakeholder engagement process. The initial research framework was developed as the result of stakeholder outreach conducted to date and future developments of the research strategy will be carried out through an inclusive and transparent manner through the future Research Consortium and through the stakeholder driven Maine Offshore Wind Roadmap, which is developing and implementing a comprehensive plan for offshore wind development.[8]

2.3. Interdisciplinary Approach

Research at the Research Array will be interdisciplinary. Studies will simultaneously address sector specific questions and will be integrated across research themes to broadly improve the understanding of how to reduce conflicts between offshore wind and other ocean users and the marine environment while maximizing positive interactions or benefits. The research framework provided here focuses on three core areas: human dimensions (*i.e.,* fisheries, navigation, workforce training, supply chain development, and socioeconomic consideration), ecosystem and environment, and technology development (Figure 2-1). All three of these research themes will require individual study and further investigation, yet a coordinated interdisciplinary effort will ensure a necessary cross-pollination of findings that will support the broad goal of responsible floating offshore wind development.

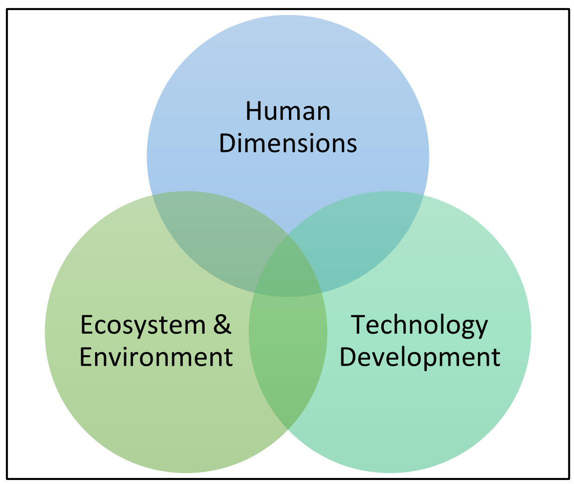

Figure 2-1. The Three Core Research Themes

[8] https://www.maine.gov/energy/initiatives/offshorewind/roadmap

2.4. Unique Opportunities of the Research Array

The Research Array will provide unique opportunities to design studies intended to specifically inform commercial scale floating offshore wind projects. To date, current U.S. Department of Energy (U.S. DOE) demonstration projects and research leases have involved one to two turbines, which limits the ability to study array scale displacement, fishing practices within an array, and other topics. Since the Research Array will include up to 12 turbines, it will be built at a scale where the results of research will be directly applicable to large-scale projects in U.S. waters. The lease area is shaped to allow the eventual array to be configured in a fashion that is best suited to support research goals, potentially including clusters of turbines, transit zones and control areas. Final array layout will result from consultations with stakeholders, subject matter experts, developers, balancing costs and research goals, all while meeting all health and safety requirements, design standards, and necessary minimization measures. For example, the turbines could be laid out in a double line, a square, or a pod type layout some of which can provide better implementation of, or evaluation of, different technical or compatibility solutions, potentially including multiple anchor types, better fishing access, better merchant vessel transit or better prototypical layouts for future commercial scale offshore wind arrays. Researchers will be provided access to the array to test novel passive and active monitoring equipment and conduct controlled experiments that might not be feasible on commercial projects, such as testing multi-sensor systems to detect bird collisions or the interaction of different fishing gears with a variety of mooring designs.

3. Framework Development Methods and Question Refinement Process

3.1. Process for Developing the Framework

This framework was developed through input from subject matter experts and state agencies, and extensive public outreach efforts. The Maine Governor's Energy Office (Governor's Energy Office) hosted a series of subject-based workshops on the Research Array to both elicit and address questions of siting and research. The stakeholder input was the basis to develop a list of key questions, which informed the basis for this document. The framework outlines a starting point for developing a full research strategy, which may or may not include all aspects of the framework.

3.2. Stakeholder Process to Refine Research Questions

The research questions will be further refined through a stakeholder process and expert input. Governor Mills has directed the Governor's Energy Office to work directly with interested stakeholders, including federal and state partners and the fishing industry, to support development of a research program that will have the greatest value to Maine and the floating offshore wind industry. The State is fully committed to engaging stakeholders, in particular commercial fishing interests, who are an integral part of both the state's overall economy as well as the local economy in Maine's coastal communities, in the development of the research program.

3.3. Considering Research in Relation to Permitting

Studies at the Research Array will be broken into distinct needs based on project development phase (*i.e.*, pre-construction, construction, operations and maintenance, and decommissioning). To support permitting, there will be a series of required site characterization studies focused on quantifying the existing uses, fisheries, and wildlife that may interact with the project. These studies will help inform the development of measures that may eliminate or reduce potential impacts. Similar studies would be developed for use in the construction and operational stages. Once the project is built, short-term monitoring will be needed to validate wind resource and impact assessments, and there will also be opportunities for long-term research. Broadly, this research framework is inclusive of all project phases, and provides a framework that will allow for coordinated and integrated research throughout the life of the project. Moreover, the framework is designed so that research questions may adaptively change as questions are answered and new monitoring methods are developed.

Some of the research and monitoring will be funded by the developer in accordance with standard practice of commercial sites, while other research and monitoring that go above and beyond that standard practice may be funded by the government and/or private foundation grants.

3.4. Desktop Studies and Modeling to Refine Research Questions

Along with stakeholder outreach, a critical step in both refining research questions and supporting the permitting of the Research Array will be the use of desktop studies and modeling to predict how existing human and ecological uses may be affected. Examples of modeling include: using Automatic Identification System (AIS) large vessel tracking data and other data sources to model use by mariners and effects on navigation and how these may change with different turbine spacing; predicting how different turbine spacing and/or configuration may change impacts on birds, bats, and cetaceans; and using passive acoustic data to predict the timing of cetacean exposure to the Research Array. Collectively, these modeling efforts, along with monitoring and a formal gap analysis to identify missing data, will support triangulation around the top priority research questions.

4. Research Theme 1: Human Dimensions

Floating offshore wind energy will be a vital component of both the U.S. and Maine's needed efforts to reduce carbon dioxide emissions from fossil fuel energy production and the associated contributions to climate change. However, this important renewable energy source must be developed in a manner that is as harmonious as possible with existing uses of the Gulf of Maine. Many in the maritime, fisheries, and coastal communities will interact with offshore wind either directly around the Research Array, or indirectly through support services. For some, offshore wind will provide economic opportunities, while for others, this novel industry has the potential to affect how they use the ocean. The State is interested in engaging with individuals and studying how the project interacts with individuals, workers, and communities. Research at the Research Array will be instrumental in understanding where both human conflicts and opportunities exist, particularly with respect to the following four sub-topics: fisheries, vessel traffic and navigation, socioeconomic impacts on coastal communities, as well as supply chain and workforce development.

4.1. Fisheries

4.1.1. Wind Farm Design to Optimize Co-Existence with Fisheries

Floating offshore wind is significantly different from fixed-bottom offshore wind and floating foundations will be located in habitats that are different from where fixed bottom foundations have been historically located. There is no well-established data set anywhere in the world to draw upon to help determine best practices in terms of floating wind farm design that will allow fisheries to co-exist as much as practicable. Co-existence is important to the State because fisheries represent a greater percentage of the State's economy than almost any other state.

One goal of the fisheries research theme is to establish what general arrangements of wind farms and turbines might be more conducive to allowing different types of fishing near and within a wind farm as depicted in Figure 4-1. Interaction between researchers, fisheries representatives, engineers, and technology experts will help inform the eventual turbine configuration to be incorporated into the Research Array design.

This area of research will also address wind turbine spacing, potential incorporation of transit lanes (including evaluation of the potential for mobile gear fisheries to operate within transit lanes) and mooring and anchor design. There will also be extensive analysis of mooring line configuration and materials to determine which approaches best balance the needs of fishing, technological viability, and Maine's ecosystem and economy.

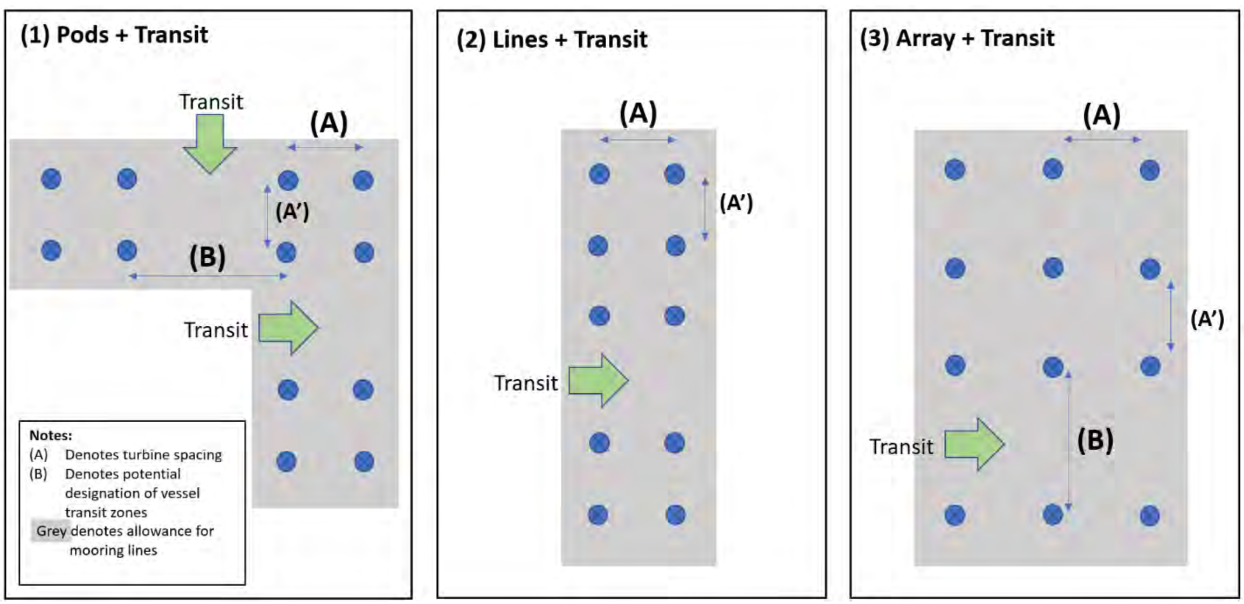

Figure 4-1. Potential Array Configurations

An example of the potentially significant impact that design can have on fisheries is evident in Figure 4-2, which shows the potential mooring line scope reduction that may result from changing the mooring design from steel catenary to synthetic semi-taut designs. This may offer considerable insight into how to maintain the Gulf of Maine's significant fishing interests.

This research sub-theme will also include evaluation of, and potentially implementation of, gear insurance or replacement programs to address gear conflicts.

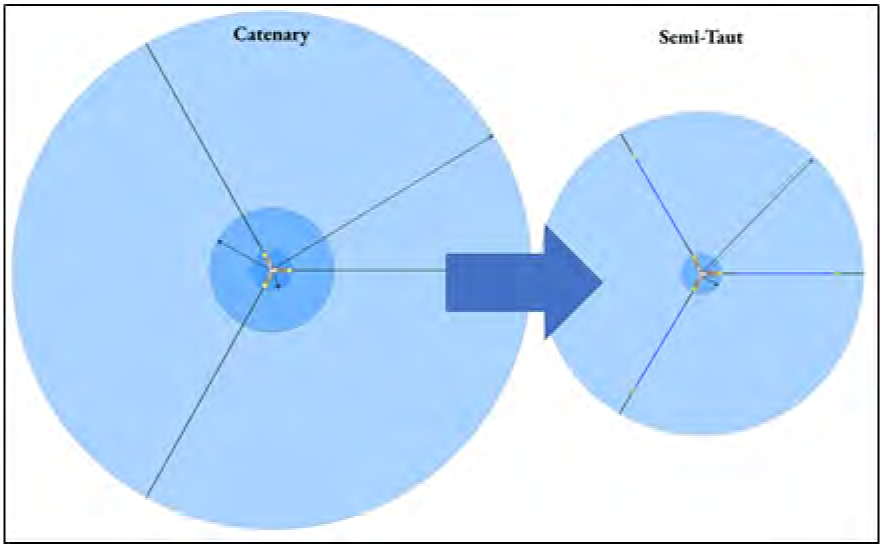

Figure 4-2. Potential Mooring Designs Showing the Indicative Scope of Anchor Lines for a Steel Catenary Mooring Design (left) Relative to Semi-taut Mooring Design (right)

Representative research questions on optimizing co-existence with fisheries:

- *What array configuration will be the most hospitable to various types of fishing?*
- *Are certain configurations more or less likely to create restricted zones inaccessible to fishing due to navigational or insurance concerns?*
- *What types of mooring lines are best suited to accommodate fishing and are technically and economically feasible?*
- *Through semi-structured interviews with the fishing community, mooring spacing that will best allow mobile gear to continue to operate will be established.*

These representative questions, and other questions listed in this document, will be explored throughout the different phases of development.

4.1.2. Evaluation of Wind Farm Impacts to Fisheries

Fisheries representatives, ocean stakeholders, and offshore wind developers have articulated a number of questions about how offshore wind projects may interact with fisheries and habitats during operations. These questions include the extent and feasibility of burying the electric cable; the extent to which mooring lines become buried over time and/or interact with the sea floor; electromagnetic fields (EMF) impact on ground fish and American lobster; vibration; gear entanglement risk; nearby population change for individual species; and reef effect.

One of the specific areas of research needed is evident in Figure 4-3. This figure depicts the movement of mooring lines over time. During normal operation, mooring lines will occupy a discrete radius in the water column ((A) Normal). During annual storms the upwind mooring line will lift off the sea floor ((B) Annual). During more extreme storms, progressively more of the mooring line will lift off the sea floor (Sections (C) Extreme and (D) 500-year Storm). The extent to which cable remains buried nearest the anchor will be evaluated in detail to validate expectations that significant portions will become buried and remain buried shortly after installation (the extreme design conditions are expected to occur only 0.02 percent of any given year). In addition, the zone ((A) Normal) that uplifts often is of particular interest to determine what impact this has on the sea floor and whether this impact could be reduced through mooring line design choices.

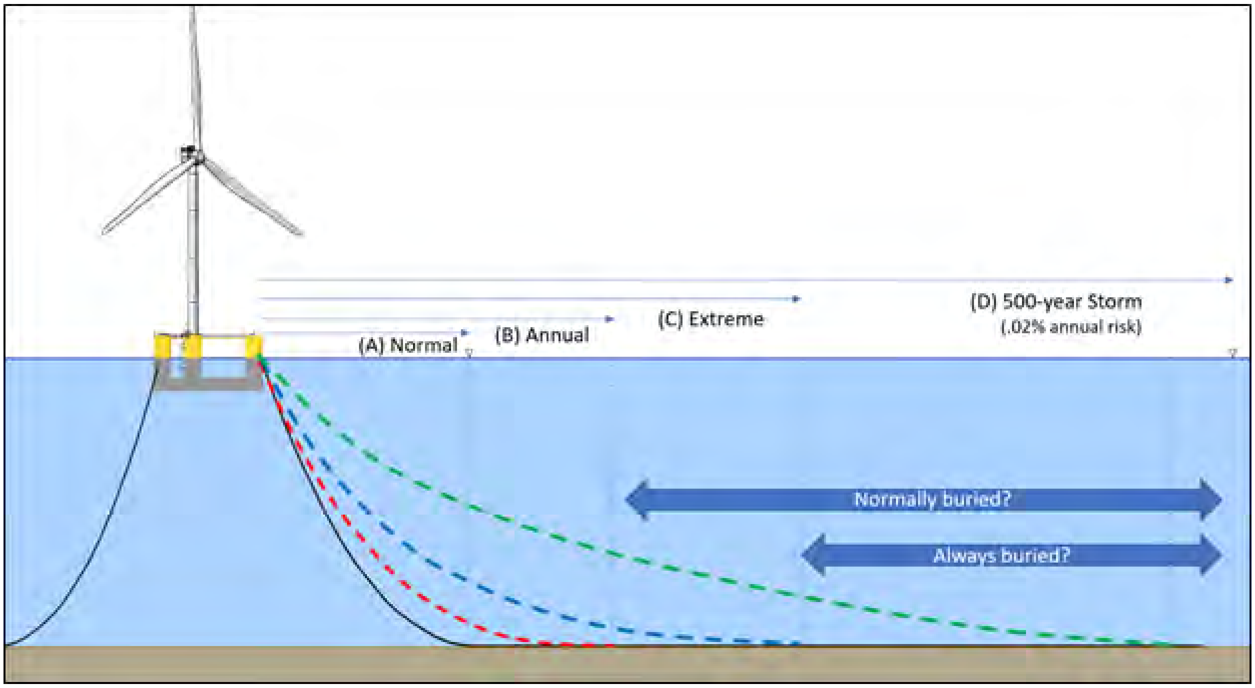

Figure 4-3. Mooring/Fisheries Intrusion-Release Dynamic

Representative research questions on wind farm impacts to fisheries:

- *What portion of the mooring lines will become buried over time and will this enable greater use of mobile or fixed gear operations within the array?*
- *To what extent will effort be displaced? Will landings be impacted within and near the array?*
- *Does entanglement occur with the mooring system and if so, how can it be detected and removed efficiently?*
- *What impact does the array have on fishing opportunities and landings within and near the array?*

4.1.3. Monitoring and Communication Protocols to Enhance Co-Existence

Fisheries representatives have questioned the ability to operate near and within a wind farm. One area of study includes whether the potential for fishing in and around turbines increases over time. As the wind farm settles into the ocean environment, as discussed above, the mooring lines in particular may present less of an obstacle to fisheries. This area of research will involve the monitoring of changes in impacts over time, and between project phases (*e.g.*, construction and operations), as well as the establishment of a communications protocol to better inform fisheries operations near and within the wind farm. For example, should a storm be forecast, it may be possible over time to predict the degree of uplift that the upwind mooring line will experience in the storm. This prediction could yield an advisory to lobster fishermen to remove gear that has the potential to become entangled. This research area may also include a method of sensing if gear has become entangled, so that it can be removed before becoming an obstacle to other fisheries or marine mammals. Ultimately, a goal will be to provide periodic GPS location advisories to fishermen. Protocol, content and method of advisory will be developed.

Representative research questions on monitoring protocols to enhance co-existence:

- *What protocols are useful to communicate with fisheries?*
- *What advisories are useful to different fisheries?*
- *How can gear entanglement be detected?*
- *How can entangled gear be removed quickly?*

Coordination between the research and fishing community has a long history in the Gulf of Maine. The fisheries research questions will be integrated with ecosystem-based questions and will be refined through fishing industry outreach. The questions will be focused on increasing the understanding of key issues identified by the fishing community. The methods could include field surveys (*e.g.*, trawl surveys, trap surveys, and remotely operated vehicle surveys), acoustic tracking of fish species through migratory routes, vessel tracking, and stakeholder interviews. Studies around fisheries will be a key basis for guiding all aspects of future floating offshore wind development, including siting, mooring systems, and turbine orientation and spacing.

4.2. Vessel Traffic and Navigation

The Gulf of Maine is utilized by many types of vessels – from small fishing boats to large cruise ships and military vessels. During macro-siting of the Research Array within a broader area of interest within the Gulf of Maine, marine traffic and navigation (including fisheries and merchant vessels as well as U.S. Department of Defense areas) were assessed and considered, resulting in selection of a location where these activities and factors are generally limited. However, questions remain regarding how the micro-siting and layout of the Research Array (*i.e.*, spacing and orientation) will affect the navigation of cargo, fisheries (*i.e.*, commercial and recreational), passenger, tug-tow, tanker, and other vessels. The Research Array site provides the ability to study, at a small scale, the ability of wind farms to safely operate in reasonable proximity to established vessel traffic areas and to demonstrate compatibility with shipping, as has already been demonstrated extensively in Europe with fixed bottom foundations. The small-scale Research Array can help answer questions about changes in traffic levels, the ability of vessels to proceed and navigate near wind turbines as part of normal operating conditions, how navigation is affected in extreme weather conditions, and how vessels navigate around array service vessels that are transiting to and from the Research Array. In addition, it will be important to work with the U.S. Coast Guard to design studies around how search and rescue operation can be conducted around offshore wind turbines, particularly in heavy seas. A variety of methods may be used, such as interviews, polls, AIS tracking, active and simulated scenarios (*e.g.,* search and rescue), and surveys. The results of this research will directly support siting of commercial Wind Energy Areas, development of protocols, and best management practices. This area of research will benefit from the multi-turbine array proposed in this project to inform operation of true commercial scale projects.

Representative questions related to vessel traffic and navigation:

- *Does the array have any effects on navigation?*
- *How do maintenance vessels interact with other vessels within the area?*
- *Which navigational radar systems are effective in the array?*

4.3. Socioeconomic Impacts on Coastal Communities

As offshore wind is a novel industry, coastal communities naturally have many opinions, questions, and concerns about it, and these can vary greatly by individual community. These questions are currently being raised all along the Atlantic coast of the U.S. With the Research Array, Maine would be well positioned to gain insight into the positives and negatives of floating offshore wind for coastal communities. For some, there will be new economic opportunities, such as jobs, supply chain opportunities, or turbine tourism, while for others there may be an expectation of negative change that may or may not be actualized. The State will engage with communities and individuals to learn how the Research Array may impact jobs for heritage industries like fishing and tourism and culture. Using mixed methods, including longitudinal qualitative interviews, polls, well-established models like the Jobs and Economic Development Impact model from the National Renewable Energy Laboratory, and other socioeconomic analyses, the Research Array will provide an important opportunity to study how floating offshore wind can be developed to optimize co-existence with existing ocean users and bring the greatest tangible benefits to coastal communities.

Representative questions related to socioeconomic research:

- *How does the creation of the Research Array impact jobs? How many additional jobs and what kind of jobs are created by the Research Array?*
- *What impact does the Research Array have on fishing-related shore-side infrastructure and coastal communities?*
- *Does the Research Array increase or decrease tourism? For example, what changes occur to recreational fishing in the region?*
- *Are real estate values in coastal areas adjacent to the transmission and interconnection components of the Research Array affected?*

4.4. Supply Chain and Workforce Development

Offshore wind offers many direct and indirect (*i.e.*, supply chain) job opportunities. Floating offshore wind in particular offers unique supply chain opportunities in construction and serial fabrication, installation, and operations and maintenance. Some positions within this supply chain will require adapted or specialized skills, and workforce education and training are needed to support the creation and retention of expertise for siting and permitting, community and fisheries relations, construction, manufacturing, maintenance, and monitoring jobs for Maine workers in this industry. Training opportunities will be created at many levels, including vocational technical schools for high school students, community college programs, special university-level programs, and workforce re-education programs. The Research Array will provide opportunities to research which supply chain elements and work sectors have the most opportunities specific to floating offshore wind, and what innovations in supply chain development, workforce development and new worker attraction – including diversity, equity and inclusion factors –

will help Maine companies and workers adapt and develop for this sector. These new supply chain elements and jobs, while specifically supporting the Research Array, will start a pipeline of opportunities to support offshore wind development in Maine, along the Atlantic coast, and beyond.

Representative questions related to supply chain and workforce development:

- *What are the unique offshore wind job opportunities for floating offshore wind?*
- *Which existing industries can transition to the offshore wind supply chain, particularly for floating offshore wind?*
- *What jobs skills are required and which training programs are needed?*

5. Research Theme 2: Ecosystem and Environment

How the ecosystem, including fish and wildlife, respond to fixed bottom offshore wind turbines has been well studied in Europe at both the individual foundation/turbine level and within a configured array. They have found that some species may collide with turbines, while other species avoid the turbines altogether. Avoidance has the potential to cause a barrier to migration or cause individuals to be displaced from valuable habitat. Some species have been found to be attracted to turbines. These effects can be seen both above and below water with fish, marine mammals, birds, and bats. The new hard substrate of fixed bottom turbines has also been shown to change the habitat and cause a "reef effect". Marine life also has the potential to respond to EMF and operational noise (Figure 5-1).

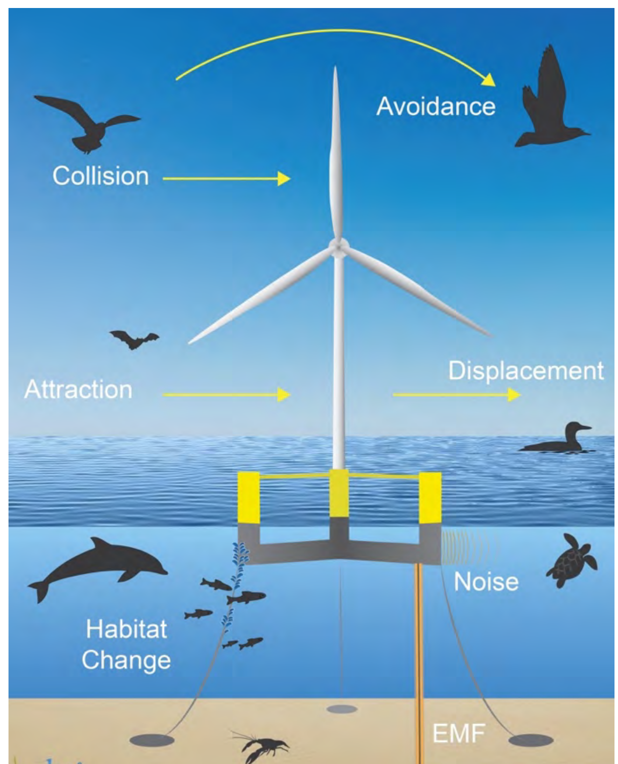

Figure 5-1. The Potential Effects of Floating Offshore Wind on Ecosystems

However, there has been far less data collected to date with respect to ecosystem interactions with floating offshore wind turbines. Research conducted at the Research Array will begin to fill in those gaps. While European research provides a solid base of understanding of how the ecosystem may respond to offshore wind, the studies have been focused on fixed bottom technology and substantial questions remain on how the ecosystem may be affected by floating turbines. In addition, fixed foundations tend to be in shallow waters (*i.e.,* <100 meters) while floating is proposed for much deeper waters. Local ecosystems in deeper waters are distinct from shallow water ecosystems typically associated with fixed bottom turbines.

Research during the project phases is needed in three core areas to understand the interactions of the ecosystem with floating offshore wind energy to inform future projects. We need to improve our understanding of 1) the occurrence of species around the array and how occurrence patterns change through time; 2) the potential stressors of floating offshore turbines; and 3) how to optimize the co-existence of ecosystems with floating offshore wind turbines and associated components in the Gulf of Maine (Figure 5-2).

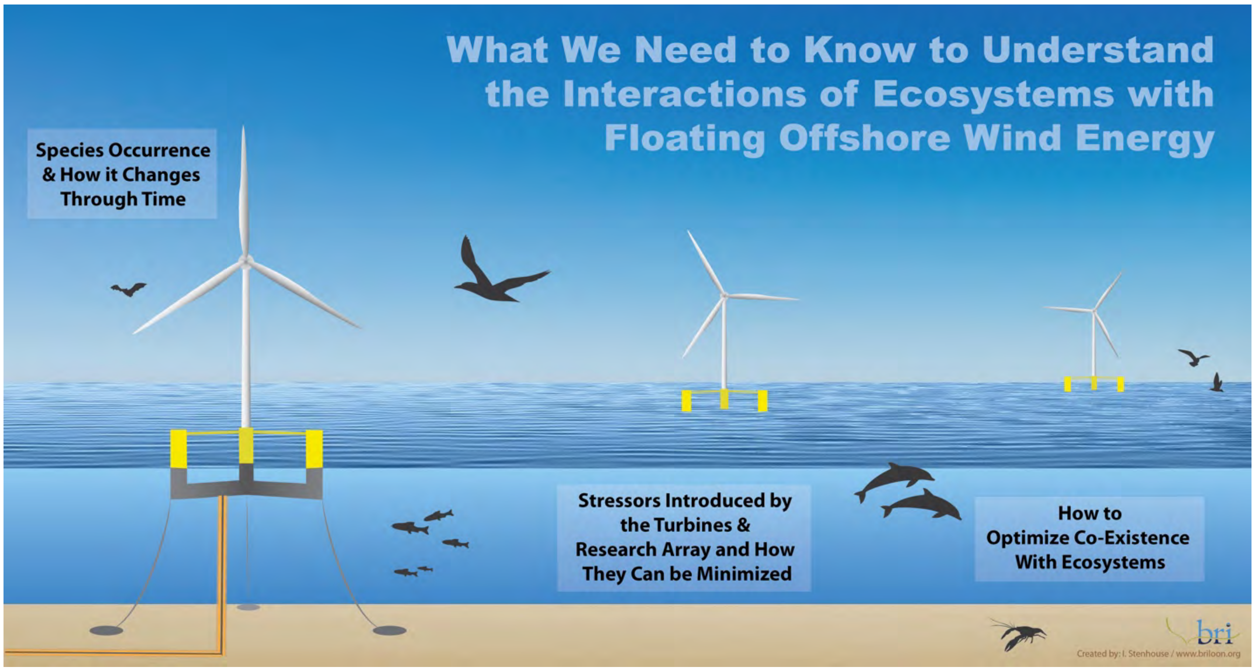

Figure 5-2. Research Questions to Understand the Interactions of Ecosystems with Floating Offshore Wind Energy

5.1. Occurrence Questions

Given existing data gaps on wildlife use of the Gulf of Maine, the first step in understanding the effects of floating offshore wind is to develop a basic understanding of spatial and temporal species distribution. Research questions around occurrence will focus on developing a baseline understanding of the abundance and distribution of species around, above, and below the Research Array; how abundance compares to other areas in the Gulf of Maine; and how species composition and the ecosystem change through time, especially in response to shifting distributions resulting from climate change. These research questions can be explored using traditional and novel survey methods (*e.g.,* passive acoustics, boat-based surveys, high-resolution trawl surveys, individual wildlife tracking, radar, thermal imagery, modeling, and other methods). Studying these questions will be critical to identify which species and ecosystem processes may be affected by floating offshore wind and will help inform proactive measures to reduce impacts.

Representative questions related to occurrence research:

- *Do cetaceans avoid or swim through the Research Array?*
- *Are bats present in the Research Array and how does use relate to weather and time of year?*
- *How do fish and wildlife distribution and abundance in the Research Array change (i.e., in reference to known seasonal migrations and patterns) in response to different project phases, climate change, and other ecological stressors?*

5.2. Turbine and Research Array Questions

For the wildlife that will be exposed to offshore wind in the Gulf of Maine, the second set of questions focuses on understanding aspects of the turbines that may be stressors. Floating offshore wind is a novel technology that is built on shore and towed to the final location. This approach will minimize many of the potential localized construction effects on the marine ecosystem observed with fixed foundations installed at sea. However, there are many questions about what types of stressors may be present with floating turbines and if these impacts are direct or indirect. The nature of the Research Array will allow for traditional hypothesis-driven research design to study how turbine design may affect biofouling, sea floor disturbance, noise attenuation, EMF, lighting, and other aspects of floating offshore wind development and what those effects are on wildlife. Identifying these stressors and developing an understanding of how those stressors could be minimized, will help inform environmentally responsible development at future projects.

Representative questions related to turbine and Research Array:

- *Will floating turbines require different lighting from fixed bottom turbines and if so, what are the potential effects to birds and bats including listed species?*
- *How does the Research Array change the baseline noise levels and if so, what are the potential effects to marine species?*
- *Are whales at risk of secondary entanglement with derelict fishing gear caught on the Research Array cables?*
- *Does EMF of dynamic or buried cables alter the behavior of benthic resources?*
- *How can stressors to species be avoided or minimized?*

5.3. Optimizing Co-existence with the Ecosystem Questions

Often research around offshore wind is divided into studies on particular taxonomic groups, but species-specific studies can mask the complex interactions that occur in the ecosystem, including oceanographic changes than may affect the abundance of plankton, fish, and the benthic community. These underwater changes have the potential to affect marine bird and marine mammal foraging opportunities, and potential exposure to floating turbines. Therefore, the ecological research questions at the Research Array will be interdisciplinary in nature and will focus on coordinated and contemporaneous data collection to allow for ecological modeling.

Site selection can be an important factor in minimizing conflict with wildlife. The Research Array site selection process identified and removed from siting consideration areas near Platt's Bank, a feature that can cause local upwelling and consequent increases in phytoplankton and forage fish production. A key ecosystem-based question for the research framework to address will be how floating offshore wind development may alter the benthic community, oceanography, and species within various trophic levels. A variety of methods will be used, including oceanographic buoy deployment, remote sensing using satellite imagery, grab sampling, imaging, underwater remotely operated vehicle, VHF radio-tagging, radar, and passive and active acoustics. Collectively, developing a deep understanding of the ecosystem change around the turbines, and potential direct and indirect effects, will support developing recommendations for future projects.

Representative questions related to optimizing co-existence with the ecosystem:

- *Are there surface current changes that impact larval/plankton community due to these structures?*
- *Are marine birds attracted to the turbines because of increased foraging opportunities?*

6. Research Theme 3: Technology Development

The fabrication, manufacturing, installation, and maintenance supply chain as well as the service industry associated with fixed bottom foundations is well established in Europe. This set of industrial practices serves as the basis for fixed bottom foundation project development in the U.S. The U.S. floating offshore wind industry has no similar experience basis to draw upon. The Research Array provides a test bed for technology innovation and demonstration that will allow designs, deployment methods and procedures, as well as operations and maintenance methods and procedures to be proved out and refined at a pilot scale, resulting in lower costs, enhanced offshore safety, and more reliability for future larger scale projects.

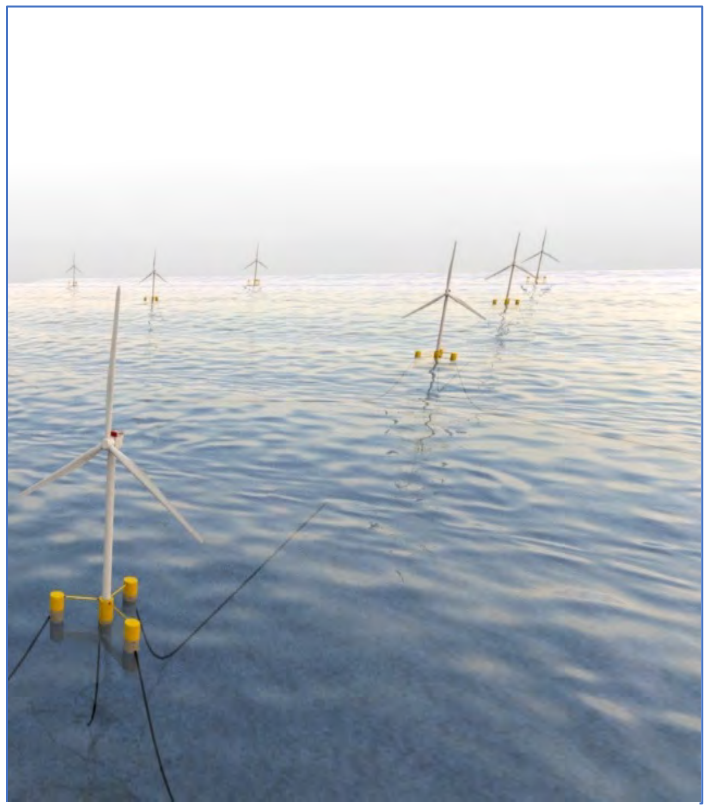

Figure 6-1. Artistic Rendering of the Array

While one goal is the optimization of floating offshore wind technology, from moorings, to hulls, to control systems, there are also important objectives of improving safety, reliability, decreasing the costs of energy, and minimizing impacts to humans and the environment. With large structures in the open ocean, there is an opportunity to use technology to support the environmental and ecological monitoring as well as study climate, weather, and metocean conditions. Monitoring human activities proximate to the Research Array can help optimize co-existence, navigation, and new vessel design, and inform future supply chain and workforce development opportunities.

Deployment of floating offshore wind turbines at the Research Array (Figure 6-1) also provides a unique opportunity to develop a laboratory test bed for addressing many of these technology challenges at a scale that is sufficient to surface issues associated with full commercial scale projects and allow solutions to be tested and refined.

It is expected that the Research Array could become a test bed that will further goals of both the State of Maine and the U.S. DOE Wind Energy Technologies Office[9], and the NOWRDC[10]. Table 6-1 shows how potential research areas will map to the existing U.S. DOE and NOWRDC programs. Technology research programs can lead to improvements in floating turbine system performance, reliability, and ultimately lower the Levelized Cost of Energy.

Table 6-1. Mapping of Potential Technical Research Areas to Existing National Research & Development (R&D) Programs

Research Area Description	Applicable U.S. DOE Wind Energy Technology Office Research Topic Areas	Applicable National Offshore Wind R&D Consortium Roadmap 2.0 Pillars
1. Turbine Scaling and Light Weighting	Topic Area 1	Pillar 1
2. Advanced Manufacturing	Topic Area 2	Pillar 3
3. Whole Plant Performance and Design	Topic Area 3	Pillar 1 & 3
4. Science of Atmospheric and Oceanographic Conditions	Topic Area 4	Pillar 2
5. System Installation, Operation, Maintenance, and Reliability	Topic Area 5	Pillar 3
6. OSW Design Standards and Validation Activities	Topic Area 6	
7. Wildlife and Environment Impacts and Solutions	Topic Area 7	
8. Radar Impacts and Solutions	Topic Area 8	Pillar 3
9. Siting Research and Development	Topic Area 9	
Key: Green highlighting indicates high applicability of the Research Array to existing research goals (where the Research Array creates unique opportunity to study elements that cannot otherwise be addressed on projects using fixed bottom foundations).		

6.1. Technology, Manufacturing and Deployment Methods and Cost Optimization

Worldwide, there are no clearly established leading floating offshore wind designs or manufacturing, deployment, and service methods. The planned size of the Research Array is intended to be large enough to allow designers, developers, contractors, port operators, and marine service companies to collaborate to identify and solve commercialization issues in a fashion that optimizes for the balance of local job creation and cost. Planned dissemination of findings is significantly different than even a similarly sized commercial project, in that normal operating procedure would involve the developer holding most findings confidential for their own competitive advantage. The planned consortium approach is specifically formulated to overcome this commercial bias and make findings available for public benefit. Deployment of approximately 12 turbines allows for problem solving of serial production issues that center on designing and building foundations optimized for constructability and functionality in the Gulf of Maine and to serve as a model for implementation for all Northeastern states. For instance, concrete

[9] Wind Energy Technologies Office, U.S. DOE. Multi-Year Program Plan, Fiscal Years 2021-2025. U.S. DOE, Washington DC, 2020.

[10] National Offshore Wind Research & Development Consortium. Research and Development Roadmap Version 2.0. NOWRDC, New York, 2019.

casting, yard set-up, marine infrastructure, foundation launching, installation, and towing methods developed in this project will be portable for commercial follow-on projects and help identify and resolve challenges, as well as inform the development of a supply chain and workforce for floating offshore wind.

It is planned that the Research Array will utilize the VolturnUS concrete floating hull design developed over the past decade with investment from the U.S. DOE, University of Maine, and the State. The design has undergone 1:50 scale model tests, 1:8 scale field testing offshore, and a single 11 megawatt unit will be tested in 2023. The plans to take the VolturnUS technology to the commercial level allowing for additional design improvements to be made, farm-scale optimization, and additional third party reviews of the design and engineering tools (e.g., OpenFAST[11] shown in Figure 6-2) by American Bureau of Shipping. The result will be a commercial ready system for use in larger offshore wind farms with a validated engineering solution, design methods, and proven track record to accelerate the floating offshore wind turbine industry by reducing design risk and development time. It is anticipated that by taking this one foundation type through to deployment at scale, many of the systemic findings will be transferable to other foundation technologies, thus helping to advance the progress of floating offshore wind nationwide.

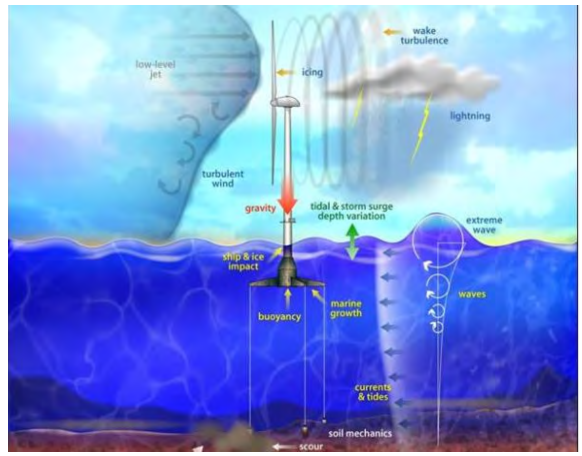

Figure 6-2. Numerical Modeling Inputs for National Renewable Energy Laboratory's OpenFAST

The Research Array will also allow for the design and testing of floating turbines' control systems, for both individual turbines and the overall project, in order to maximize power production, reduce turbine fatigue loading, and improve security. This research will be a collaborative effort with wind turbine manufacturers and researchers to understand advanced controls for floating turbines through ongoing work with the National Renewable Energy Laboratory and the U.S. DOE ARPA-e as part of the Floating Offshore-wind and Controls Advanced Laboratory program.

[11] Jonkman, J., 2021. Functional Requirements for the WEIS Toolset to Enable Controls Co-Design of Floating Offshore Wind Turbines. National Renewable Energy Laboratory, Golden, CO, 2021.

Figure 6-3. FOWT Inspection Drones

In addition, once operational, the Research Array will provide a controlled setting where new operations and maintenance technologies and techniques can be proven. Evaluation and implementation of these technologies will build on existing research programs at University of Maine, with the ultimate goal of lowering the cost of energy through reducing operation and maintenance costs and improving turbine efficiency. This includes advancement of instrumentation packages on each turbine that captures performance, environmental, and structural health data, which can lead to lowering operational and maintenance costs by reliably tracking the actual health of the structure, providing operators with data to determine optimal service intervals based on specific platform health, and lowering operations cost.

Routine inspections and basic repairs for offshore wind farms present logistical and financial challenges to developers. The costs of transporting specialists and their required equipment on a regular basis are not trivial to the overall cost of the project. The difficulties of accessing parts of the structure and high cost of the inspection make this a perfect opportunity for the development of inspection techniques utilizing drones, both aerial and sub-sea. This approach is being developed for land-based turbines and civil infrastructure inspections and has great potential for expansion into the marine sector.

Most of the research goals in this topic area require an array that is large enough to truly surface the issues associated with commercial scale projects.

Representative questions related to technology, manufacturing and deployment:

- *Can a foundation design be optimized for fabrication and deployment in the Gulf of Maine?*
- *What mooring and anchor design is most efficient for the Gulf of Maine?*
- *What shoreside infrastructure is required to accommodate serial production and deployment?*
- *How can monitoring technology advancements improve safety and efficiency?*

6.2. Evaluate Technical Solutions that can Maximize Co-existence

Commercially available technical options and cost optimized solutions are not necessarily in harmony with co-existence of floating offshore wind alongside other ocean users. This area of research will include researching and evaluating technical solutions that will in fact foster co-existence. This area of research will be specifically designed to cause designers that are otherwise working to drive costs down, to also consider co-existence as a priority. This includes some fundamental wind farm design issues such as array configuration, turbine spacing, array orientation, necessity of transit lanes and anchor/mooring line arrangement.

This will also include an analysis of navigation considerations to ensure safe operations such as incorporating aids to navigation, communications, and the incorporation of a safe harbor or harbors into the array design. Navigation solutions will draw upon evaluation of systems and procedures used in offshore wind projects in Europe in close proximity to shipping lanes as depicted in Figure 6-4, as well as systems and procedures that have been successfully utilized in offshore oil and gas development in the Gulf of Mexico where thousands of platforms have co-existed with shipping, service and fishing for decades.

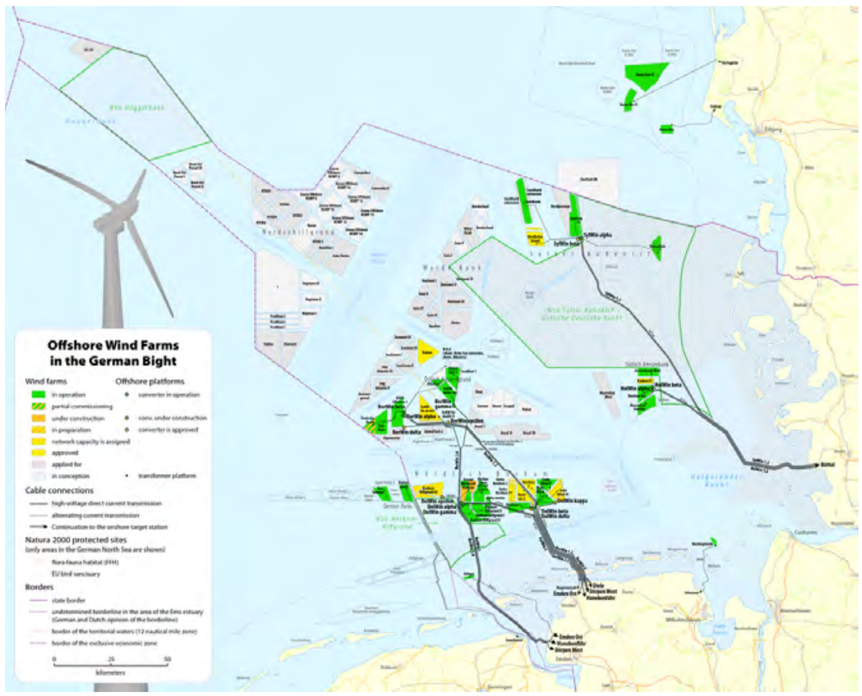

Figure 6-4. Map of German Offshore Wind Farms in Close Proximity to Shipping Lanes

(Source: https://commons.wikimedia.org/wiki/File:Map_of_the_offshore_wind_power_farms_in_the_German_Bight.png)

Representative questions related to reducing cost and maximizing co-existence:

- *What layout of the Research Array is a prototype for future commercial scale projects that is both cost effective and maximizes co-existence?*
- *What aids to navigation will mitigate risks to ocean going vessels and what is the cost of those aids?*
- *What is the cost premium (if any) to optimize mooring line and anchor systems to best foster inner-array fishing?*

- *What communications protocols are necessary to inform other ocean users of changing conditions (i.e., movement in mooring lines during storms, availability of safe harbors) and what is the cost of those communications protocols?*

6.3. Design and Implement Environmental Monitoring Technology

The presence of a wind farm in the open ocean with access to power and high-speed communications creates a unique opportunity to implement environmental monitoring technology that might otherwise be cost prohibitive. This area of research will specifically build upon work outlined in Section 4.1.3, and design and implement monitoring systems that can evaluate the hypotheses resulting from work in Section 5.3. As a first step, baseline studies of existing ecosystems and fishing activities will take place as part of normal permitting processes. It is anticipated that certain baseline studies may include longer duration studies than would otherwise be typical of an offshore wind project in order to enhance the value of post-construction monitoring. Longer-duration monitoring of the response of ecosystems and the fishing community to floating offshore wind will require the development and refinement of monitoring technologies as well as testing avoidance and minimization technologies that are not common for arrays using fixed bottom foundations. Therefore, a key component of research at the Research Array will be testing and validating various methods to ensure that fisheries and ecosystems can be accurately monitored, and that the information gained can be used to inform future projects. Given the wind farm will function as an open ocean research post, it may also become valuable to expand research beyond offshore wind to include gathering data around conservation efforts, resource management, and climate change in the Gulf of Maine.

The need to monitor changing conditions of the sea floor is unique to floating offshore wind. The foundation and mooring lines are dynamic, and their footprint is larger than fixed bottom foundations. Monitoring floating offshore wind and its interaction with the ecosystem will require new and/or substantially different systems and processes than would otherwise be used for fixed bottom foundations. This area of research will include designing and implementing systems that can monitor in real time and over time sea floor conditions in the areas under the foundations and mooring lines over time. Monitoring may involve detecting the frequent changes of the sea floor and evaluating the impact of those changes on the foundation and mooring lines. The mooring lines may change position and depth, particularly during storms. How and when these changes are communicated to vessel operators is important to both foster inner array fishing and maintain safety.

The Research Array also presents an opportunity to monitor the organisms present at and below the seabed near and within the array. Monitoring how organisms use habitats underneath floating platforms will require new technology or modifications to existing technology as well as new methods due to the unique physical challenge of dynamic mooring lines. Similarly, monitoring the interaction of organisms in the water column and above the water in the offshore environment (*i.e.*, birds and bats) will require new technology or modifications to existing technology traditionally employed at onshore wind energy projects. This topic area will require innovative research surrounding biological monitoring technologies and methods tailored to floating wind technology.

Representative monitoring methods questions:

- *What remote sensing technologies, such as satellite imagery, oceanographic buoys, remotely operated vehicles, drones, passive and active acoustics, autonomous underwater vehicles, and combinations thereof, will be effective at monitoring below water interactions between floating offshore platforms and mooring systems and fish and marine mammals?*
- *What are effective methods to collect data on fisheries in the Research Array?*
- *What are effective methods to avoid, minimize, and monitor volant wildlife exposure and collision vulnerability?*

7. Sources of Funding for the Proposed Research Projects

Funding for research and monitoring will come from multiple private and public sources. Basic site characterization surveys and data necessary to support permitting will be funded by the developer, which is standard for proposed commercial offshore wind projects. Funding for research beyond standard practice and/or focused on deepening the understanding of the interactions of floating wind and the ecological environment will primarily come from other sources, including public and private funds. The State has budgeted $1 million (M) in a one-time allocation to establish a Research Consortium (see Section 8.0), as well as an additional $2 M per year for two years to establish fisheries, offshore wind, and northern right whale research and monitoring capabilities in the Gulf of Maine. Federal agency funding aligns with many research areas, including several included in BOEM's Environmental Studies Program. The University of Maine has a deep history of advancing its projects by working with both federal and state agencies along with industrial partners to advance its research efforts. These funding sources have been successfully implemented for the New England Aqua Ventus I demonstration project, which has resulted in over $70 M in government investment and $100 M in industrial investment. Significant funding opportunities and awards related to floating turbine research are planned by the U.S. DOE, ARPA-e, and the NOWRDC as stated in their respective roadmaps. Each project addresses specific U.S. DOE and NOWRDC objectives as illustrated in Table 6-1. A key goal of the Research Consortium will be to build on the work already conducted and partner with local, regional, and national organizations and agencies to secure funding to advance key components of the research strategy for the Research Array; in turn, meeting the goals of the Research Array for the State of Maine and contributing to the advancement of floating offshore wind elsewhere.

8. Research Consortium: Informing Future Floating Offshore Wind Projects

The State will establish a consortium to coordinate and manage the research for the Research Array, including the development of a research strategy and management of research priorities and projects. The consortium will be developed in consultation with state agencies and external scientific experts to develop an approach that is open, inclusive, and informed by regional and scientific entities with input from Maine stakeholders, including the fishing industry. The consortium will be developed in coordination with the State's Offshore Wind Roadmap stakeholder groups and will be tasked with ensuring that the research at the Research Array meets the broad goal of optimizing co-existence of floating offshore wind with the human and ecological environment.

The consortium will take an interdisciplinary approach to research and monitoring related to floating offshore wind and its interactions with the Gulf of Maine. The consortium will adopt or adapt existing data standards, develop new data standards if existing standards are not available, develop an open access integrated database, and schedule routine reporting to ensure full transparency of the consortium. The consortium will develop and implement an integrated approach to offshore wind research that can inform future floating offshore wind projects. Deliverables will include specific recommendations and best practices for future floating offshore wind development projects, as well as prioritized lists of additional research needs, and open public access datasets. Collectively, research at the Research Array will facilitate responsible and cost-effective development of floating offshore wind by identifying opportunities and challenges to the human environment, developing methods to avoid and minimize impacts to the ecosystem, and lowering the costs and risks of floating offshore wind energy.

Resources

All Our Energy, American Bird Conservancy, Audubon New York, Audubon Society of Rhode Island, Connecticut Audubon Society, Conservation Law Foundation, Defenders of Wildlife, International Fund for Animal Welfare, Mass Audubon, National Audubon Society, National Wildlife Federation, Natural Resources Defense Council, New Jersey Audubon, NY4WHALES, Southern Environmental Law Center, Surfrider Foundation and Whale and Dolphin Conservation. 2020. Baseline Data Collection and Environmental Monitoring of Offshore Wind Projects. October. https://www.nrdc.org/sites/default/files/data-collection-environmental-monitoring-offshore-wind-projects-20201021.pdf

BOEM. 2019. Guidelines for Information Requirements for a Renewable Energy Site Assessment Plan. https://www.boem.gov/sites/default/files/renewable-energy-program/BOEM-Renewable-SAP-Guidelines.pdf

BOEM. 2020. Information Guidelines for a Renewable Energy Construction and Operations Plan. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf

Copping, A.E., and L.G. Hemery, editors. 2020. *OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World*. Report for Ocean Energy Systems (OES). DOI: 10.2172/1632878.

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Appendix B Site Characteristics

APPENDIX B. SITE CHARACTERISTICS

MARINE MAMMALS AND SEA TURTLES

The following resources were reviewed to assess the presence of potential marine mammals and sea turtles within the Area of Interest (AOI):

- The Mid-Atlantic Regional Council on the Ocean (MARCO), Northeast Ocean Data Portal, MarineCadastre, National Oceanic Atmospheric Administration (NOAA) National Centers for Environmental Information, and other applicable online data portals;
- The GOM Council on the Marine Environment reports titled GOM in Context, State of the GOM Report and Commercial Fisheries State of the GOM Report;
- The Wave Hindcast Database focusing on the Atlantic North West and Oceanweather's hindcast model output, *Global Reanalysis of Ocean Waves United States (U.S.) East Coast*;
- Ongoing UMaine and NOAA buoy data within the GOM associated with the Northeast Regional Association of Coastal Ocean Observing systems (NERACOOS);
- The Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) sightings data available within the GOM which ranges from 2012 to 2020 (OBIS-SEAMAP 2020);
- The U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation Web Tool (IPaC) and Maine Department of Inland Fisheries and Wildlife (IFW) endangered and threatened species list;
- North Atlantic right whale (*Eubalaena glacialis*) Seasonal Management Area (SMA) data, established Dynamic Management Areas (DMAs), WhaleMap web portal data, and the Right Whale Sighting Advisory System;
- NOAA Fisheries Southeast Fisheries Science Center (SEFSC) Sea Turtle Stranding and Salvage Network Reports;
- OBIS-SEAMAP Dataset on aerial surveys conducted for upper trophic level predators on Platts Bank, GOM;
- Publicly available resources provided on webpages from the following entities: the NOAA National Marine Fisheries Service (NOAA Fisheries), USFWS, U.S. Geological Survey, Turtle Expert Working Group (TEWG), IFW, Maine Department of Marine Resources (DMR), Center for Coastal Studies; and

- Peer-reviewed, published scientific literature.

Species

Thirty-nine marine mammal species and four sea turtle species have the potential to be present within Western North Atlantic Outer Continental Shelf Region which includes the AOI. These species are listed below in Table 1. Also provided in Table 1 are the associated stocks (for marine mammals), the current federal, state, estimated population sizes, and relative occurrences within the AOI.

Similarly, all four species of sea turtles included in Table 1 have been documented in the GOM. These species are not likely to be year-round inhabitants due to low water temperatures in the GOM in winter months. Only two sea turtles are observed within the GOM with regularity: the leatherback and loggerhead sea turtles (GOM Council on the Marine Environment 2010; NOAA Fisheries n.d.[a]; OBIS-SEAMAP 2020). The green sea turtle has been documented around Cape Cod; however, it is not regularly observed in the GOM (GOM Council on the Marine Environment 2010). And, although the Kemp's ridley sea turtle has been documented within the GOM in the past, there have been no sightings from 2012 to 2020 (OBIS-SEAMAP 2020). During aerial surveys for upper trophic level predators on Platts Bank, no sea turtles were sited (Wolff 2020). Sea turtles utilize the GOM as foraging grounds and are generally considered migrants through the area (GOM Council on the Marine Environment 2010; Shoop 1987), likely foraging on resident seagrass and kelp beds.

Similarly, sea turtle strandings in New England in recent years have been steadily increasing (Associated Press 2019). The majority of these strandings occur off Cape Cod with few strandings reported by the NOAA Fisheries SEFSC Sea Turtle Stranding and Salvage Network Reports within the GOM (NOAA Fisheries 2020a). Sea turtle strandings are generally thought to be caused by cold stun. When temperatures drop in the fall, sea turtles can become hypothermic and stop swimming.

Table 1 Marine Mammals and Sea Turtles Potentially Occurring in the Regional Waters of the Western North Atlantic OCS and the GOM

Species	Faunal Category	Stock	Current Listing Status	Estimated Stock Population[a]
Species Likely to have a Common or Regular Occurrence within the AOI				
Blue whale (*Balaenoptera musculus*)	Baleen Whale	Western North Atlantic	ESA Endangered MMPA Depleted	402
Fin whale (*Balaenoptera physalus*)	Baleen Whale	Western North Atlantic	ESA Endangered MMPA Depleted	7,418
Humpback whale (*Megaptera novaeagliae*)	Baleen Whale	GOM	MMPA Depleted	1,396

Species	Faunal Category	Stock	Current Listing Status	Estimated Stock Population[a]
North Atlantic right whale (*Eubalaena glacialis*)	Baleen Whale	Western North Atlantic	ESA Endangered MMPA Depleted	428[b]
Sei whale (*Balaenoptera borealis*)	Baleen Whale	Nova Scotia[b]	ESA Endangered MMPA Depleted	6,292
Minke whale (*Balaenoptera acutorostrata*)	Baleen Whale	Canadian Eastern Coast	NA	24,202
Sperm whale (*Physeter catodon*)	Toothed Whale	North Atlantic	ESA Endangered MMPA Depleted	4,349
Long-finned pilot whale *(Globicephala melas)*	Toothed Whale	Western North Atlantic	NA	39,215
Short-beaked common dolphin (*Delphinus delphis*)	Toothed Whale	Western North Atlantic	NA	178,825
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Toothed Whale	Western North Atlantic	NA	93,233
Common bottlenose dolphin (*Tursiops truncatus*)	Toothed Whale	Western North Atlantic, offshore	MMPA Depleted	62,851
		Western North Atlantic, Northern migratory coastal	MMPA Depleted	6,639
Harbor porpoise (*Phocoena phocoena*)	Toothed Whale	GOM/Bay of Fundy	NA	95,543
Harbor seal (*Phoca vitulina*)	Seal	Western North Atlantic	NA	75,834
Gray seal (*Halichoerus grypus*)	Seal	Western North Atlantic	NA	27,131
Leatherback Sea Turtle (*Dermochelys coriacea*)	Sea Turtle	--	ESA Endangered	Global total average estimate of 426,000, Northwest Atlantic DPS estimate of 31,380 adult males and females, and between 34,000 and 36,000 estimated nesting females in the US
Loggerhead Sea Turtle (*Caretta caretta*)	Sea Turtle	--	ESA Threatened	Global total average estimate of 314,000, Western North Atlantic adult female

Species	Faunal Category	Stock	Current Listing Status	Estimated Stock Population[a]
				population estimate of 38,334, and between 40,000 and 50,000 estimated nesting females in the US
Species Not Commonly Expected within the GOM in the Vicinity of the AOI				
Pygmy sperm whale (*Kogia breviceps*)	Toothed Whale	Western North Atlantic	NA	7,750[d]
Dwarf sperm whale (*Kogia sima*)	Toothed Whale	Western North Atlantic	NA	
Beluga whale (*Delphinapterus leucas*)	Toothed Whale	Beaufort Sea	ESA Endangered	39,258
Bowhead whale (*Balaena mysticetus*)	Baleen Whale	Western Arctic	ESA Endangered MMPA Depleted	16,100
Northern bottlenose whale (*Hyperoodon ampullatus*)	Toothed Whale	Western North Atlantic	NA	Unknown
Cuvier's beaked whale (*Ziphius cavirostris*)	Toothed Whale	Western North Atlantic	NA	21,818[e]
Mesoplodont beaked whales (*Mesoplodon spp*)	Toothed Whale	Western North Atlantic	NA	21,818[e]
Killer whale (*Orcinus orca*)	Toothed Whale	Western North Atlantic	MMPA Depleted	Unknown
False killer whale (*Pseudorca crassidens*)	Toothed Whale	Western North Atlantic	MMPA Depleted	1,791
Pygmy killer whale (*Feresa attenuata*)	Toothed Whale	Western North Atlantic	NA	Unknown
Short-finned pilot whale (*Globicephala macrorhynchus*)	Toothed Whale	Western North Atlantic	NA	28,924
Melon-headed whale (*Peponocephala electra*)	Toothed Whale	Western North Atlantic	NA	Unknown
Risso's dolphin (*Grampus griseus*)	Toothed Whale	Western North Atlantic	NA	35,493
Fraser's dolphin (*Lagenodelphis hosei*)	Toothed Whale	Western North Atlantic	NA	Unknown
White-beaked dolphin (*Lagenorhynchus albirostris*)	Toothed Whale	Western North Atlantic	NA	536,016

Species	Faunal Category	Stock	Current Listing Status	Estimated Stock Population[a]
Pantropical spotted dolphin (*Stenella attenuata*)	Toothed Whale	Western North Atlantic	NA	6,593
Clymene dolphin (*Stenella clymene*)	Toothed Whale	Western North Atlantic	NA	4,237
Striped dolphin (*Stenella coeruleoalba*)	Toothed Whale	Western North Atlantic	NA	67,036
Atlantic spotted dolphin (*Stenella frontalis*)	Toothed Whale	Western North Atlantic	NA	39,921
Spinner dolphin (*Stenella longirostris*)	Toothed Whale	Western North Atlantic	MMPA Depleted	4,102
Risso's dolphin (*Grampus griseus*)	Toothed Whale	Western North Atlantic	NA	35,493
Rough toothed dolphin (*Steno bredanensis*)	Toothed Whale	Western North Atlantic	NA	136
Harp seal (*Pagophilus groenlandicus*)	Seal	Western North Atlantic	NA	Unknown
Hooded seal (*Cystophora cristata*)	Seal	Western North Atlantic	NA	Unknown
Ringed seal (*Phoca hispida hispida*)	Seal	Alaska[f]	ESA Threatened MMPA Depleted	171,418
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	Sea Turtle	--	ESA Endangered	Global total average estimate of 21,000 and between 7,000 and 9,000 estimated nesting females in the US
Green Sea Turtle (*Cheloria mydas*)	Sea Turtle	--	ESA Threatened	Global total average estimate of 1,002,000, Northwest Atlantic DPS nester 167,424 total estimated abundance, and between 85,000 and 90,000 estimated nesting females in the US

Notes:
[a]Current NOAA Fisheries Stock Assessments for each marine mammal species were used for estimated populations per NOAA Fisheries 2020a. For sea turtles, a variety of resources were consulted to determine population estimates, including the Sea Turtle Conservancy, the State of the World's (SWOT) Reports, the TEWG, and published literature.
[b]Although the population estimate for the north Atlantic right whale presented here is the estimate presented in the latest

Species	Faunal Category	Stock	Current Listing Status	Estimated Stock Population[a]
published NOAA Fisheries Stock Assessment (NOAA Fisheries 2020a), more recent numbers have recently been made publicly available and have not yet been incorporated into an updated stock assessment. The estimated population is likely lower than what is represented here at approximately 356 individuals (Davie 2020). Key: ESA = Endangered Species Act GOM = Gulf of Maine MMPA = Marine Mammal Protection Act NA = not applicable AOI = Area of Interest Sources: NOAA Fisheries 2020b; Davie 2020; SWOT 2020; TEWG 2007; Clapham et al. 2003; McAlpine et al. 1999; Stevick and Fernald 1998; Marine Mammal Commission 2020; Center for Coastal Studies 2019; NOAA Fisheries and USFWS 2013; Richards et al. 2011; Sea Turtle Conservancy 2020a, 2020b, 2020c, 2020d; Seminoff et al. 2015, Whale Net n.d.; Wolff 2020				

Northern Right Whale Tracking

NOAA Fisheries may also establish voluntary Dynamic Management Areas (DMAs) based on visual sightings of the species if three or more are seen within a discrete area. There are currently (in May 2021), active DMAs in Massachusetts Bay and Cape Cod Bay, but these are by nature constantly changing, and are updated by NOAA Fisheries approximately every hour. Furthermore, NOAA Fisheries created a Right Whale Sighting Advisory System (NOAA Fisheries n.d.[b]) and multiple contributors (including Woods Hole Oceanographic Institution, the New England Aquarium, Canadian Whale Institute, Ocean Tracking Network, and others) created an interactive WhaleMap (https://whalemap.ocean.dal.ca/) to report and view right whale observations (Johnson 2018).

FISH AND FISHERIES

Multispecies Trawl Survey Data

Northeast Fishery Science Center (NEFSC) Trawl Survey data was used by Duke University to create interpolations of species abundance as part of the Marine-Life Data Analysis Team model. The 10 most abundant species are shown in Table 2. These species represent species accessible by trawl surveys which are considered consistent with patterns of broad distributions within the GOM.

Table 2 Top 10 Species by Mean Abundance within the AOI

Fall		Spring	
Species	Log kg/tow	Species	Log kg/tow
Spiny dogfish (*Squalus acanthias*)	3.2	Acadian redfish (*Sebastes fasciatus*)	2.18
Acadian Redfish (*Sebastes fasciatus*)	2.5	Silver hake (*Merluccius bilinearis*)	2.15

Fall		Spring	
Silver hake (*Merluccius bilinearis*)	2.5	American lobster (*Homarus americanus*)	1.53
Atlantic herring (*Clupea harengus*)	1.9	American plaice (*Hippoglossoides platessoides*)	1.49
Northern shrimp (*Pandalus borealis*)	1.7	Haddock (*Melanogrammus aeglefinus*)	1.37
Red hake (*Urophycis chuss*)	1.7	Alewife (*Alosa pseudoharengus*)	1.37
American plaice (*Hippoglossoides platessoides*)	1.6	Atlantic herring (*Clupea harengus*)	1.32
Alewife (*Alosa pseudoharengus*)	1.5	Spiny dogfish (*Squalus acanthias*)	1.23
White hake (*Urophycis tenuis*)	1.4	Red hake (*Urophycis chuss*)	1.15
American lobster (*Homarus americanus*)	1.1	Witch flounder (*Glyptocephalus cynoglossus*)	0.79
Key: AOI = Area of Interest kg/tow = kilograms per tow Source: DMR 2021			

Fishery Management Plans

The New England Fishery Management Council conserves and manages fishery resources from 3 to 200 miles (mi) (3 to 174 nautical miles [nm], 5 to 322 kilometers [km]) off the coasts of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut. Federal fisheries within the New England Region are managed by both NOAA Fisheries and the New England Fishery Management Council under nine fishery management plans (FMPs). These FMPs include: northeast multispecies (groundfish), sea scallops, monkfish, Atlantic herring, small mesh multi-species, spiny dogfish, red crab, northeast skate complex, and Atlantic salmon (NOAA Fisheries 2018). Two of these FMPs, the spiny dogfish and monkfish, are developed in conjunction with the Mid-Atlantic Fisheries Management Council. The Atlantic States Marine Fisheries Commission (ASMFC) also has jurisdiction over interstate fisheries and their management plans are implemented through state regulations that apply in federal waters. The ASMFC coordinates the FMP for American lobster. Anadromous fish species that occur in Maine are managed by DMR and NOAA Fisheries below head of tide.

Commercial and Recreational Fisheries

Major commercial fisheries specifically in the GOM include groundfish, herring, lobster, scallop, soft-shell clam, and tuna (GOM Council on the Marine Environment 2013). The fishing industry relies on other working waterfront business along the GOM (encompassing approximately 16 mi (14 nm, 26 km) of working waterfront), including those providing bait, fuel, ice, and other services allowing them to operate their business (Maine Coast Fishermen’s Association 2020). Active ports within the GOM are also key to the industry. The top ten Maine ports documented for commercial fishing landings from 2015 to 2019 were Stonington, Vinalhaven, Portland, Friendship, Beals, Spruce Head, Bass Harbor, Harpswell, Jonesport, and Owls Head (DMR 2019a). Furthermore, the aquaculture industry in Maine and is the second largest producer of marine aquaculture products in the U.S. and Canada (GOM Association n.d.). Aquaculture sites within the GOM are located in State waters along the coastline and include the following species: Atlantic salmon, oysters, clams, sea scallops, kelp, and mussels (GOM Association n.d.). The following species have been investigated for aquaculture purposes in the GOM but have yet to reach commercial scale production: Atlantic halibut (*Hippoglossus hippoglossus*), Atlantic cod, Atlantic and shortnose sturgeon (*Acipenser oxyrhynchus oxyrhynchus, Acipenser brevirostrum*) and bay scallop (*Argopecten irradians*).To monitor commercial landings in support of fisheries management, NOAA Fisheries has developed an analytical tool that summarizes landings by species, gear type, home port and fishery. NOAA Fisheries provided economic data to the DMR from 2008 through 2018, including the top five Fishery Management Plans (FMPs) within the AOI (presented in), the top 10 species likely to be impacted within the AOI (presented in), and the landings by port by the 26 ports which could be potentially impacted by activity within the AOI (presented in Table 5).

Table 3 Eleven-year Totals (2008-2018) for the Top Five Federal Fishery Management Plans in the AOI.

Fishery Management Plan	Pounds	Value
Atlantic Herring (*Clupea harengus*)	40,423,000	$15,539,000
Northeast Multispecies	11,289,000	$6,603,000
Non-Federal FMP	991,000	$627,000
Monkfish (*Lophius americanus*)	806,000	$2,079,000
American lobster (*Homarus americanus*)**	653,000	$2,833,000
Totals	54,162,000	$27,681,000

Notes:

** Reported lobster landings and value are significantly underestimated as a limited number of lobster vessels have permits that require VTRs to be submitted.

Key:

AOI = Area of Interest

FMP = Fishery Management Plan

VTR = vessel trip report

Source: NOAA Fisheries economic data provided to DMR, as cited in DMR 2021.

Table 4 Eleven-year Totals (2008-2018) for the Top Ten Species Most Likely to be Impacted by Activities within the AOI.

Species	Landings	Value
Atlantic herring (*Clupea harengus*)	40,423,437	$6,602,649
Pollock (*Pollachius pollachius*)	5,727,901	$5,806,637
White hake (*Urophycis tenuis*)	1,486,658	$2,291,471
Cod (*Gadus morhua*)	1,369,713	$3,011,353
American plaice (*Hippoglossoides platessoides*)	1,043,771	$2,054,177
Monkfish (*Lophius americanus*)	808,231	$2,091,053
Spiny dogfish (*Squalus acanthias*)	789,124	$153,814
American Lobster (*Homarus americanus*)	655,609	$2,844,213
Ocean perch / redfish (*Sebastes alutus* and *Sciaenops ocellatus*)	649,469	$381,440
Haddock (*Melanogrammus aeglefinus*) roe	518,779	$882,733
Totals	53,472,692	$26,119,540

Key:
AOI = Area of Interest

Source: NOAA Fisheries economic data provided to DMR, as cited in DMR 2021

Table 5 Eleven-year Totals (2008-2018) for the Ports Likely to be Impacted by Activities within the AOI.

Port	Landings	Value
Portland	30,174,528	$14,014,152
Rockland	10,292,020	$1,676,075
Gloucester	4,802,068	$3,226,107
New Bedford	1,608,011	$503, 352
Port Clyde	844,852	$759,013
Harpswell	748,848	$997,065
Boston	634,124	$872,820
Vinalhaven	398,247	$68,293
Cundy’s Harbor	391,649	$653,721
Cape Porpoise	369,645	$408,351

Port	Landings	Value
Portsmouth	365,830	$519,195
Kennebunkport	322,770	$364,246
South Bristol	203,942	$74,713
Friendship	132,199	$244,811
Boothbay Harbor	95,324	$224,947
Saco	71,939	$67,578
Sebasco Estates	40,740	$28,248
Bailey Island	31,400	$113,443
Rye	19,527	$31,470
Tenants Harbor	6,720	$20,373
Newington	4,309	$1,098
Spruce Head	2,193	$9,759
Scituate	1,030	$1,408
Cushing	539	$2,751
Bremen	508	$463
All Others	3,620,826	$3,438,628
Totals	55,183,788	$28,322,080
Key: AOI = Area of Interest Source: NOAA Fisheries economic data provided to DMR, as cited in DMR 2021		

Lobster Fishing Industry

The economic data outlined in the above tables may not accurately reflect the actual values for the Maine lobster fishery. Federal permit holders that are designated as "lobster only" are not currently required to report through the vessel monitoring system (VMS) and/or the vessel trip reports (VTR); only 3% of Maine lobster license holders and 16% of the federal lobster trap permit holders are required to report through these avenues (DMR 2021). The State of Maine began implementing the Harvester Logbook Program in 2008. Harvester reporting provides data specific to the lobster fishery and from 2008 through 2018, the program collected effort and catch data from a subsample of 10% of each Maine license type in each of Maine's seven fishing zones (DMR 2021). Between 650 and 700 harvesters were chosen annually during this timeframe (2008–2018) and the Harvester Logbook Program entered approximately 30,000 records annually. Landings and value for the AOI for 2016 through 2018 were then calculated by estimating the annual landings and values per square mile for the portions of each of Zones E, D, F, and F/G per square mile that overlap with the AOI. Estimates assumed that the lobster landings were distributed uniformly. The AOI was estimated to provide 1.5 million pounds of lobsters worth approximately $7.3 million annually, as reported in Table 6. In 2018, the ASMFC announced it will require 100% electronic reporting by 2024. Improved harvester reporting in Maine occurred in 2019 and those data are currently being analyzed (DMR 2021).

Table 6 Estimated Annual Pounds and Value for Lobster within the AOI from 2016–2018 as cited in DMR 2021.

Method	Period	Pounds per Year	Value per Year
NOAA economic data (VTR and dealer)	2008-2018	59,601	$258,565
Maine DMR (harvester and dealer)	2016-2018	1,530,276	$7,321,477

Key:
DMR = Department of Marine Resources
NOAA = National Oceanic Atmospheric Administration
VTR = vessel trip report

Source: DMR 2021

Recreational Fishing

Recreational fisheries within the GOM are monitored through the Marine Recreational Information Program (MRIP) Survey which consists of several independent surveys including the Access Point Angler Intercept Survey, the Fishing Effort Survey, the For-hire Telephone Survey, and the Large Pelagics Survey (DMR 2019b). Preliminary 2019 data shows four recreational fishing types (charter boat, party boat, private/rental boat, and shore) totaled 1,692,845 recreational fishing trips in 2019 (DMR 2019b).

Key recreational fisheries within New England, according to the latest Fisheries Economics of the United States, included Atlantic cod (*Gadus morhua*), Atlantic mackerel, bluefin tuna (*Thunnus thynnus*), bluefish (*Pomatomus saltatrix*), little tunny (*Euthynnus alletteratus*), scup (*Stenotomus chrysops*), striped bass (*Morone saxtilis*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), and tautog (*Tautoga onitis*) (NOAA Fisheries 2018).

Protected Fish Species

NOAA Fisheries manages ESA-listed fish and invertebrate species while the USFWS manages inland freshwater species. Table 7 includes ESA-listed fish species that may occur within the GOM, along with the geographic range where the species is listed and the current listing status.

Table 7 Federal and State-Listed Fish Species Potentially Occurring in the AOI

Species	Where Listed	Current Listing Status	Critical Habitat Designated (Y/N)
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	GOM DPS	ESA Endangered	Y
Atlantic salmon (*Salmo salar*)	GOM DPS	ESA Endangered	Y
Giant Manta Ray (*Manta birostris*)	Throughout its range	ESA Threatened	N
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	Throughout its range	ESA Threatened	N
Shortnose Sturgeon (*Acipenser brevirostrum*)	Throughout its range	ESA Endangered	N
Cusk (*Brosme brosme*)	Throughout its range	ESA Candidate	N

Key:
AOI = Area of Interest
DPS = distinct population segment, as designated by NOAA Fisheries
ESA = Endangered Species Act
GOM = Gulf of Maine
ME = State of Maine
N = No
Y = Yes

Source: NOAA Fisheries 2020c, n.d.[c]

In addition to EFH for individual species, the GOM includes habitats managed by NOAA Fisheries including Habitat Areas of Particular Concern (HAPC) and lobster management areas. Three HAPCs are designated by NOAA Fisheries within the GOM, including Cashes Ledge, Jeffreys & Stellwagen Banks, and Inshore Juvenile Atlantic Cod sites (MARCO n.d.; Northeast Ocean Data n.d.). No HAPCs intersect the AOI; Cashes Ledge it to the east and Jeffreys Ledge is just south of the AOI. Stellwagen Bank is located even further south of the AOI, extending northward from the tip of Cape Cod to Cape Ann, Massachusetts. However, the Inshore Juvenile Atlantic Cod sites are geographically widespread throughout the Gulf of Maine and located in nearshore rock and vegetated habitats. This species will need to be considered when selecting possible transmission landfall locations. Shellfish management areas are also present within the GOM, including Lobster Management Area 1 which overlaps the AOI.

AVIAN SPECIES

Birds

Many species of terrestrial birds, shorebirds, wading birds, and waterfowl/seabirds are likely to be present within the AOI, with over 300 species of seabirds, sea ducks, migrating songbirds, shorebirds, and bats (Leppold 2016). These include the following: shearwaters, jaegers, skuas, gannets, gulls, loons, ducks, cormorants, puffins, razorbills, guillemots, eiders, petrels, and terns (World of Birds 2013; USFWS 2012; Bar Harbor n.d.). Other seasonal and/or rare birds known to utilize the GOM as habitat include the Bonaparte's gull (*Chroicocephalus philadelphia*), black-legged kittiwake (*Rissa tridactyla*), red-necked phalarope (*Phalaropus lobatus*), red phalarope (*Phalaropus fulicarius*), caspian tern (*Hydroprogne caspia*), foresters tern (*Sterna forsteri*), black tern (*Chlidonias niger*), dovekie (*Alle alle*), harlequin duck (*Histrionicus histrionicus*), thick-billed murre (*Uria lomvia*), black-headed gull (*Chroicocephalus ridibundus*), Cory's shearwater (*Calonectris borealis*), and ancient murrelet (*Synthliboramphus antiquus*) (Bar Harbor n.d.).

The northeast U.S. is known for an abundance of bird species and migrations. Maine is part of the Atlantic Flyway, which was established by the USFWS to facilitate management of migratory birds and their habitats. Each designated flyway has a council of representatives advised by technical committees to evaluate population and habitat information for migratory bird conservation (USFWS 2020). Numerous seabird species have migratory pathways through the GOM and proximal to the AOI, including the northern gannet (*Morus bassanus*), which migrates through the GOM in fall and spring with some nearshore migrations during the winter (MARCO n.d.; Northeast Ocean Data n.d.); the red-throated loon (*Gavia stellata*), which has documented migrations within the GOM in spring and winter (MARCO n.d.; Northeast Ocean Data n.d.); and surf scoter (*Melanitta perspicillata*), which has documented migrations through the GOM in spring. As reported by eBird, the GOM has a high number of bird "hotspots" (areas of high density or areas with high species diversity) along the coast and scattered throughout the GOM (eBird n.d.). The migratory routes of hundreds of seabird, shorebird and songbird species intersect the coast and GOM (Leppold 2016).

Bats

Eight species of bats are known to occur within the state of Maine. These include both migratory tree bats such as the silver-haired bat (*Lasionycteris noctivagens*), eastern red bat (*Laiurus borealis*), hoary bat (*Lasiurus cinereus*), as well as cave-hibernating bats such as the little brown bat (*Myotis lucifungus*), big brown bat (*Eptesicus fuscus*), tri-colored bat (*Pipistrellus subflavus*), eastern small-footed bat (*Myotis leibii*), and northern long-eared bat (*Myotis septentrionalis*) (IFW 2020; IFW 2004). These species are often found flying around human habitations and forested areas, with hibernation occurring in large trees, caves, mine shafts, tunnels, attics, and old wells (IFW 2004). One bat species, the northern long-eared bat is both federally and state-listed as Endangered and may be present within the AOI. The species does not have an established critical habitat. Two additional bat species are state-listed and may be present within the AOI: the little brown bat (State Endangered) and the eastern small-footed bat (State Threatened). The remaining five species are Special Concern.

With the exception of the tri-colored bat, all eight species known to occur within the state of Maine have the potential to occur over the Atlantic Ocean, and with the exception of eastern pipistrelle and the eastern small-footed bat, these species have been documented offshore (Hatch et al. 2013; Pelletier et al. 2013; Sjollema et al. 2014; Stantec 2016; Dowling et al. 2017; Ecology and Environment 2017). Platteeuw (2017) reported bats 53 miles (46 nm; 85 km) offshore in the Dutch North Sea, and in the Atlantic Ocean, bats have been recorded up to 100 mi (87 nm, 161 km) offshore (Stantec 2016).

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Appendix C Marine Bird Use of the Area of Interest

Supporting Siting of the Maine Research Array

– Marine Bird Use of the Area of Interest –

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1 Summary

The State of Maine is going through a deliberate stepwise process of identifying a 16 square mile area for the Maine Research Array within a broader area of interest. The siting process includes locating areas with the least conflict with existing uses and natural resources, including birds. To support the siting process, Biodiversity Research Institute (BRI) conducted a desktop study using existing marine bird abundance models to identify areas of lower relative use of species that are vulnerable to collision or displacement and species of greater conservation concern. The results indicate that an area around "Mistaken Ground" has relatively lower use by vulnerable marine bird species, likely due to the areas distance from shore, water depth, and lack of significant underwater features.

2 Introduction

With offshore wind energy generation representing a significant opportunity for Maine's energy and economic future, the State has announced its intention to apply for the country's first offshore floating wind Research Array in the Gulf of Maine. Research will allow the State, the fishing industry, and many others to learn about potential impacts of floating offshore wind together, in order to ensure Maine develops this industry in a manner that capitalizes on our innovative technology and abundant resources, while protecting our interests, industries, environment, and values.[1]

To support the State in identifying a location for the Research Array within an area of interest that has the fewest conflicts with marine bird use, BRI conducted a desktop analysis using existing bird abundance models and a Maine specific vulnerability analysis. BRI presented the methods and received feedback from stakeholders during online workshops and reviewed the methods with the Maine Department of Inland Fisheries and Wildlife (MDIFW). Below, we provide an overview of the methods, a summary and interpretation of the results, and spatial outputs of the analysis.

3 Methods

A series of three maps were created that indicate spatial avian risk across three categories: population vulnerability (PV), collision vulnerability (CV), and displacement vulnerability (DV) for species believed to use the proposed Maine Research Array "Area of Interest", using version 2 of the Marine-life Data and Analysis Team (MDAT) marine bird relative density and distribution models (hereafter MDAT models; Curtice et al. 2016). Seasonal predictions of density were developed by NOAA for BOEM to support Atlantic marine renewable energy planning. Version 2 of these models are available directly from Duke University's Marine Geospatial Ecology Lab MDAT model web page[2]. The MDAT analysis integrated survey data (1978–2016) from the Atlantic Offshore Seabird Dataset Catalog with a range of environmental variables to produce long-term average annual and seasonal models.

[1] https://www.maine.gov/energy/initiatives/offshorewind/researcharray
[2] http://seamap.env.duke.edu/models/mdat/

Vulnerability rankings PV, CV, and DV risks were each independently evaluated for all possible species where data was available to support estimates. Researchers in Europe and the U.S. have assessed the vulnerability of birds to offshore wind facilities and general disturbance by combining ordinal scores across a range of key variables (Willmott et al. 2013, Furness et al. 2013, Wade et al. 2016, Fliessbach et al. 2019). The purpose of these indices is to prioritize species in environmental assessments (Desholm 2009), and provide a relative rank of vulnerability (Willmott et al. 2013).

The population vulnerability (PV) score was determined using Partners in Flight (PiF) "continental combined score" (CCSmax), a local "state status" (SSmax) using the maximum of state threatened and endangered status and "species of greatest conservation need" (SGCN) score, adult survival score (AS), and the regional population score (POP) – an annual measure of the population using the study area and the Marine-life MDAT models. This approach is based on methods used by Kelsey et al. (2018) and Fliessbach et al. (2019). Each factor included in this assessment (CCSmax, SSmax, AS, and POP) is added together (PV=CCSmax+SSmax+AS+POP) and rescaled 0–1.

CCSmax is included in scoring because it integrates various factors PiF uses to indicate global population health. *SSmax* is included to account for local conservation status, which is not included in the CCSmax. *AS* is included because species with higher adult survival rates are more sensitive to increases in adult mortality. The POP component was included as a metric for population use of the study area relative to the rest of the "population" based on MDAT model relative density estimates.

The collision vulnerability (CV) assessment includes scores for nocturnal flight activity, diurnal flight activity, avoidance, proportion of time within the rotor swept zone (RSZ), maneuverability in flight, and percentage of time flying (Willmott et al. 2013, Furness et al. 2013, Kelsey et al. 2018). The assessment process conducted here follows Kelsey et al. (2018) and includes proportion of time within the RSZ (RSZt), a measure of avoidance (MAc), and flight activity (NFA and DFA). All factors were added together (CV=RSZt+MAc+(NFA+DFA)/2) and rescaled to 0–1.

RSZt is included in the score to account for the probability that a bird may fly through the RSZ. The proportion of animals within the RSZ was estimated using methods similar to Johnston et al. (2014) by modeling flight heights using a smooth spline and integrating across the height range to estimate proportion of the animals using the RSZ. Flight height data was taken from the Northwest Atlantic Seabird Catalog (NWASC). The RSZ was assigned the values 25–250 m based on recent example turbine configurations. MAc is included to account for macro-avoidance rates that would decrease collision risk. The scores used in the assessment were based on Willmott et al. (2013), but updated to reflect the most recent empirical studies (Krijgsveld et al. 2011, Cook et al. 2012, 2018, Vanermen et al. 2015, Skov et al. 2018), and indices (Garthe and Hüppop 2004, Furness et al. 2013, Bradbury et al. 2014, Adams et al. 2016, Wade et al. 2016, Kelsey et al. 2018).

NFA and DFA include scores of estimate percentage of time spent flying at night (NFA) and during the day (DFA) based on the assumption that more time spent flying would increase collision risk. The NFA scores were taken directly from Willmott et al. (2013). The DFA scores were calculated from behavioral observations from the NWASC within 200 km of the research array study area. Per Kelsey et al. (2018), the NFA and DFA scores were equally weighted and averaged.

The displacement vulnerability (DV) assessment accounts for two factors: (1) disturbance from ship/helicopter traffic and the wind facility structures (MAd); and (2) habitat flexibility (HF; Furness et al. 2013, Kelsey et al. 2018). Empirical studies indicate that for some species, particularly sea ducks, avoidance behavior may change through time, and several years after projects have been built some individuals may forage within the wind facility. The taxonomic specific text indicates if there is evidence that displacement may be partially temporary. The displacement vulnerability scores (DV=MAd+HF) are rescaled to 0–1.

MAd is included to account for behavioral responses from birds that lead to macro-avoidance of wind facilities, and that have the potential to cause effective habitat loss if birds are permanently displaced (Fox et al. 2006). The MAd scores used in the assessment were based on Willmott et al. (2013), but updated to reflect the most recent empirical studies (Krijgsveld et al. 2011, Cook et al. 2012, 2018, Vanermen et al. 2015, Skov et al. 2018), and indices (Garthe and Hüppop 2004, Furness et al. 2013, Bradbury et al. 2014, Adams et al. 2016, Wade et al. 2016, Kelsey et al. 2018). The scores are the same as the MAc scores described above, but, following methods from Kelsey et al. (2018), are inverted. HF accounts for the degree to which a species is considered a habitat generalist (i.e., can forage in a variety of habitats) or a specialist (i.e., requires specific habitat and prey type). The assumption is that generalists are less likely to be affected by displacement, whereas specialists are more likely to be affected (Kelsey et al. 2018). The values for HF used in this assessment were taken from Willmott et al. (2013).

Vulnerability categories (PV, CV, DV) were used to weight annual MDAT modeled species density estimates to provide an annual estimate of total avian risk across the proposed Maine Research Array area. MDAT models were created for 47 avian species, but only 36 were used in this assessment, based on species detected within 200 km of the research area. To create a single annual risk map for each vulnerability metric, we first standardized each annual MDAT density models so total density for any species is one (1); weighted each species model by the vulnerability metric (0 to 1); and summed these weighted species models across all species to yield a final total risk model by vulnerability category for birds. Final maps were created using ArcMAP 10.8.1 (ESRI, Inc.).

4 Results and Discussion

4.1 Bird abundance and distribution maps

Results indicate that there may be lower potential risk to marine birds in specific portions of the study area. Models of marine bird density based solely on the unweighted MDAT model data (Figure 1) suggest construction of turbines within an area in the east-central portion of the Maine Research Array planning area, around the deeper waters of “Mistaken Ground” and extending east from there through Platts Basin for about 25–30 miles (40–50 km) provide the lowest potential risk to marine birds in general (areas in blue). In contrast, the shallower areas of the continental shelf tend to have higher concentrations of birds and likely greater potential risk to marine birds, as demonstrated by the two major banks (Jeffreys Ledge and Platts Bank) being clearly highlighted in red (Figure 1). Weighting the model results by population vulnerability (PV; Figure 2), displacement vulnerability (DV; Figure 3), and collision vulnerability (CV; Figure 4), all confirm that this central section provides the lowest risk to marine birds.

Risk, as demonstrated in this analysis, is mostly driven by marine bird abundance across the area (Figure 4), with elevated risk due to the potential for collision reducing the area of lowest risk to three smaller subareas in the east-central portion (Figure 3). The easternmost subarea overlaps with the wind exclusion area (red hatching), however, leaving the two remaining areas over Mistaken Ground as the likeliest areas to minimize potential conflict with marine birds.

4.2 Considering predictor variables in MDAT models

Since the MDAT models were developed using environmental predictor variables, a separate analysis of covariates in the area of interest was not conducted. The MDAT models used a suite of predictor variables as long-term climatologies, which were used to model relative avian density by species and season across the Atlantic OCS. However, the focus was not on determining the ecological relationship to species, but rather to develop the best predictive models with the least error, and as such, the relationships between predictors and modeled density are not always clear.

Six categories of predictor variables were employed in this work: survey, temporal, geographic, bathymetric, oceanographic, and atmospheric. Predictors accounted for the way data was collected, temporal change in density of species, spatial variation in density, bathymetric effects, as well as environmental factors that can influence ocean dynamics and productivity. Despite the inclusion of 40 predictor variables in the models, only some were consistently more important to the models across many species, including: survey transect, day and year, distance to land, depth, chlorophyll *a*, sea surface temperature, turbidity, and wind stress. The first predictors are related to spatial and temporal components of the models and clearly show change in distributions across space and time within and across years. Distance to land is typically correlated with depth, but also takes into account the raw distance from the coast and in some cases colonies for locally-breeding species. Some species are typically found coastally (e.g., Common Eider, Black Guillemot), whereas some species are found almost always in the offshore environment far from shore (e.g., Great Shearwater, Atlantic Puffin in winter), but in general species density tends to decrease with increasing distance from shore. Chlorophyll *a*, sea surface temperature, turbidity, and wind stress, may all relate directly or indirectly to prey availability and/or abundance. These factors are complex and may affect species differently depending on the season. Given the complexity of these relationship, BRI determined that an independent analysis of the variables would be challenging and would be unlikely to provide additional insight into marine bird use of the area of interest.

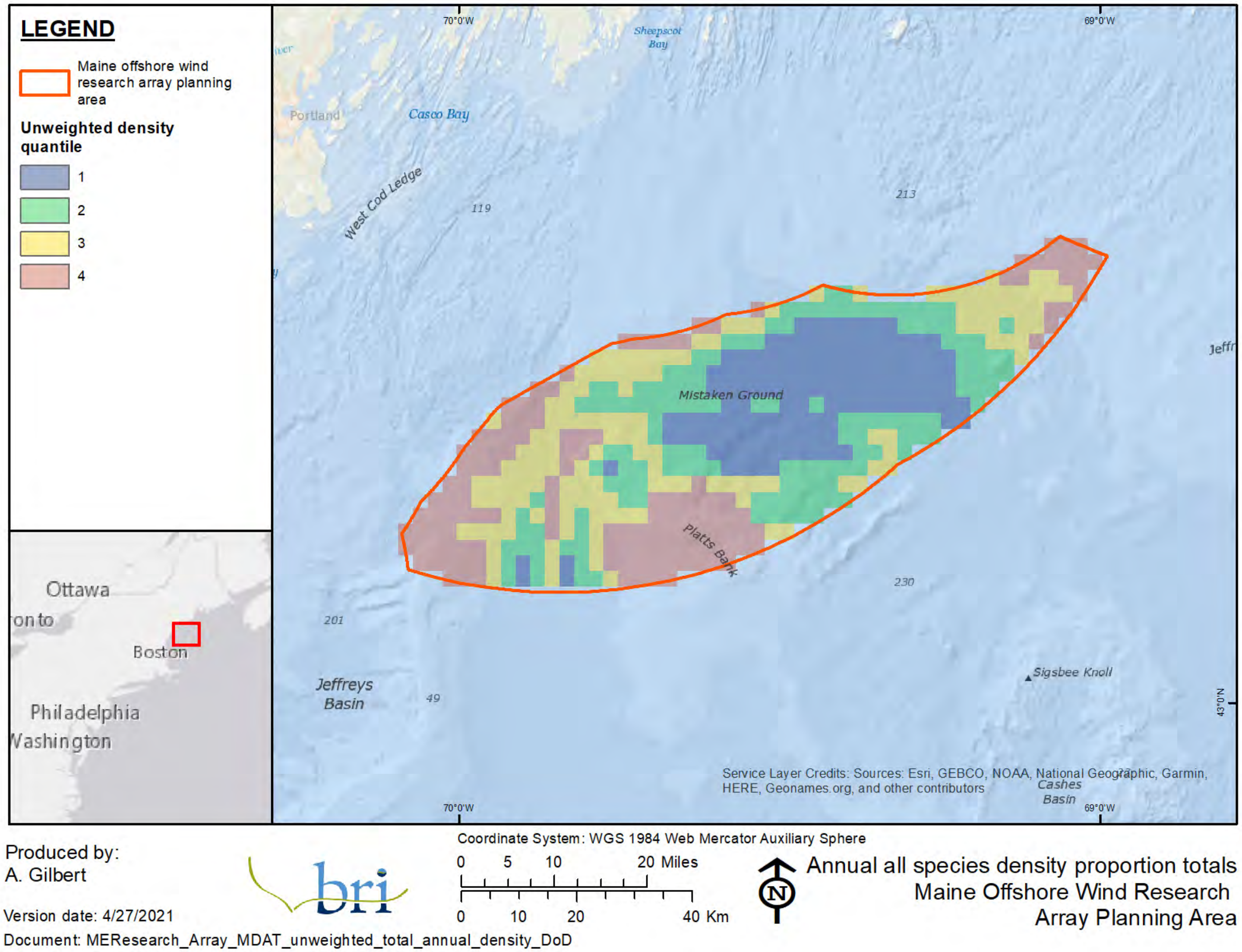

Figure 1. Unweighted MDAT models. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

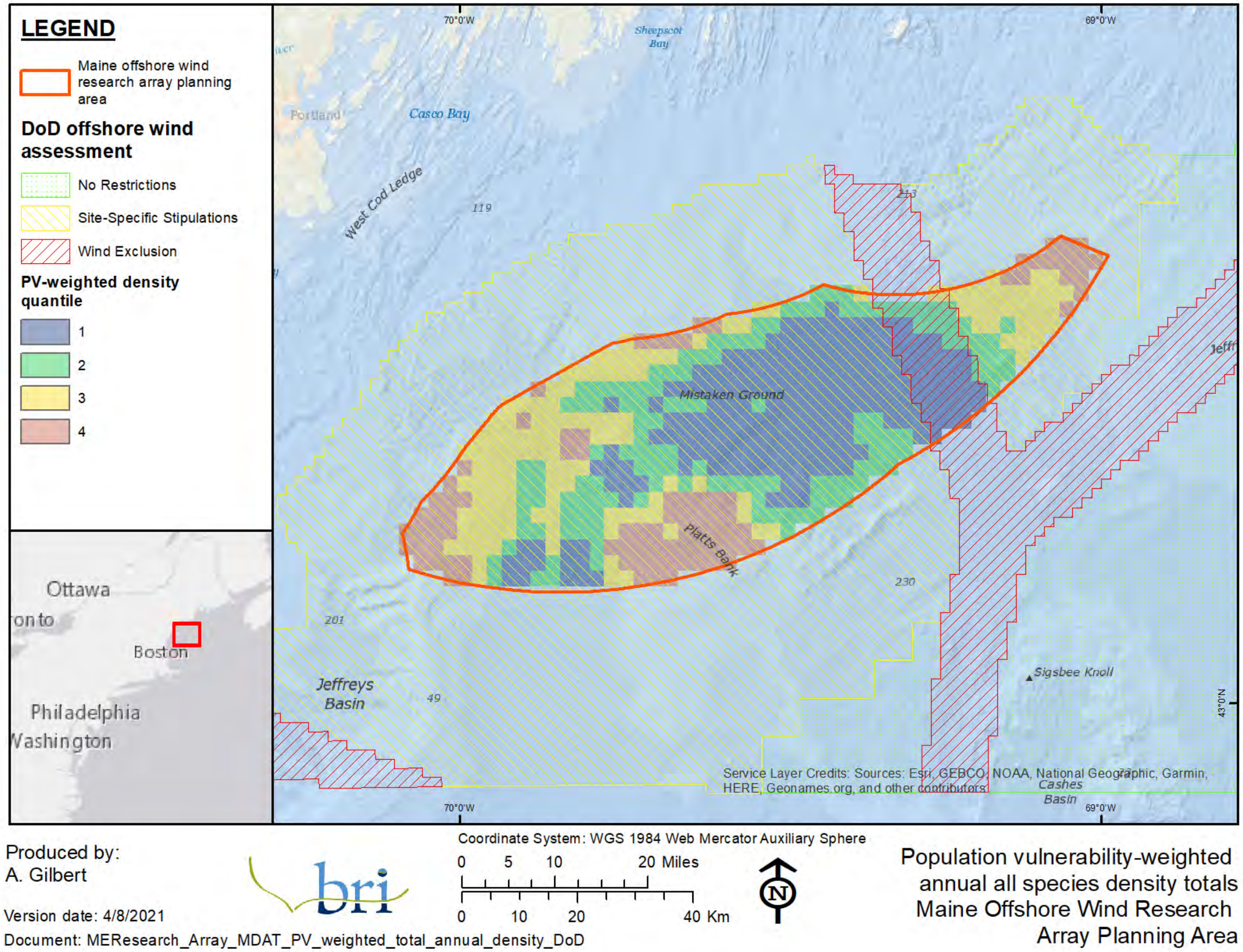

Figure 2. MDAT models weighted by population vulnerability. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

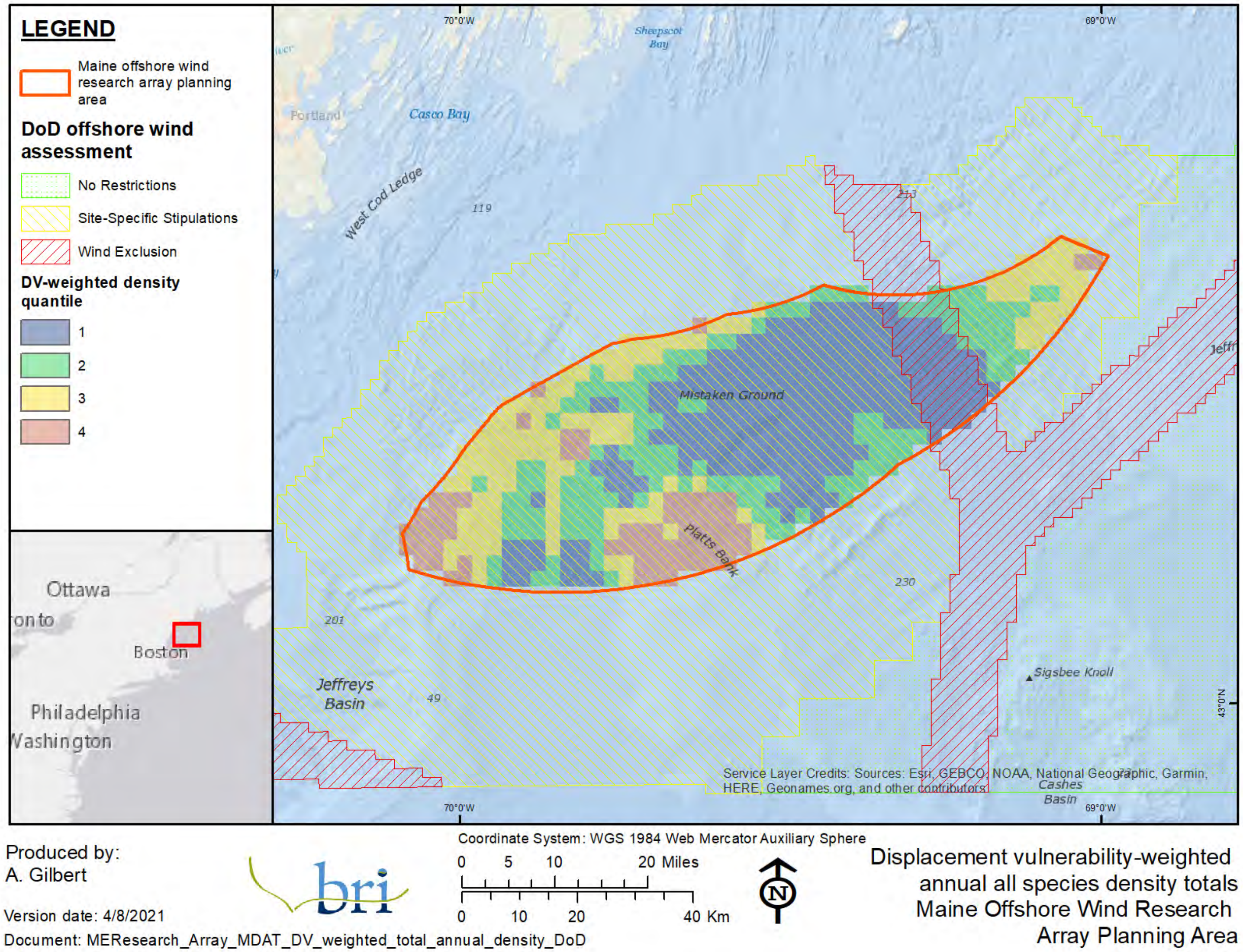

Figure 3. MDAT models weighted by displacement vulnerability. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

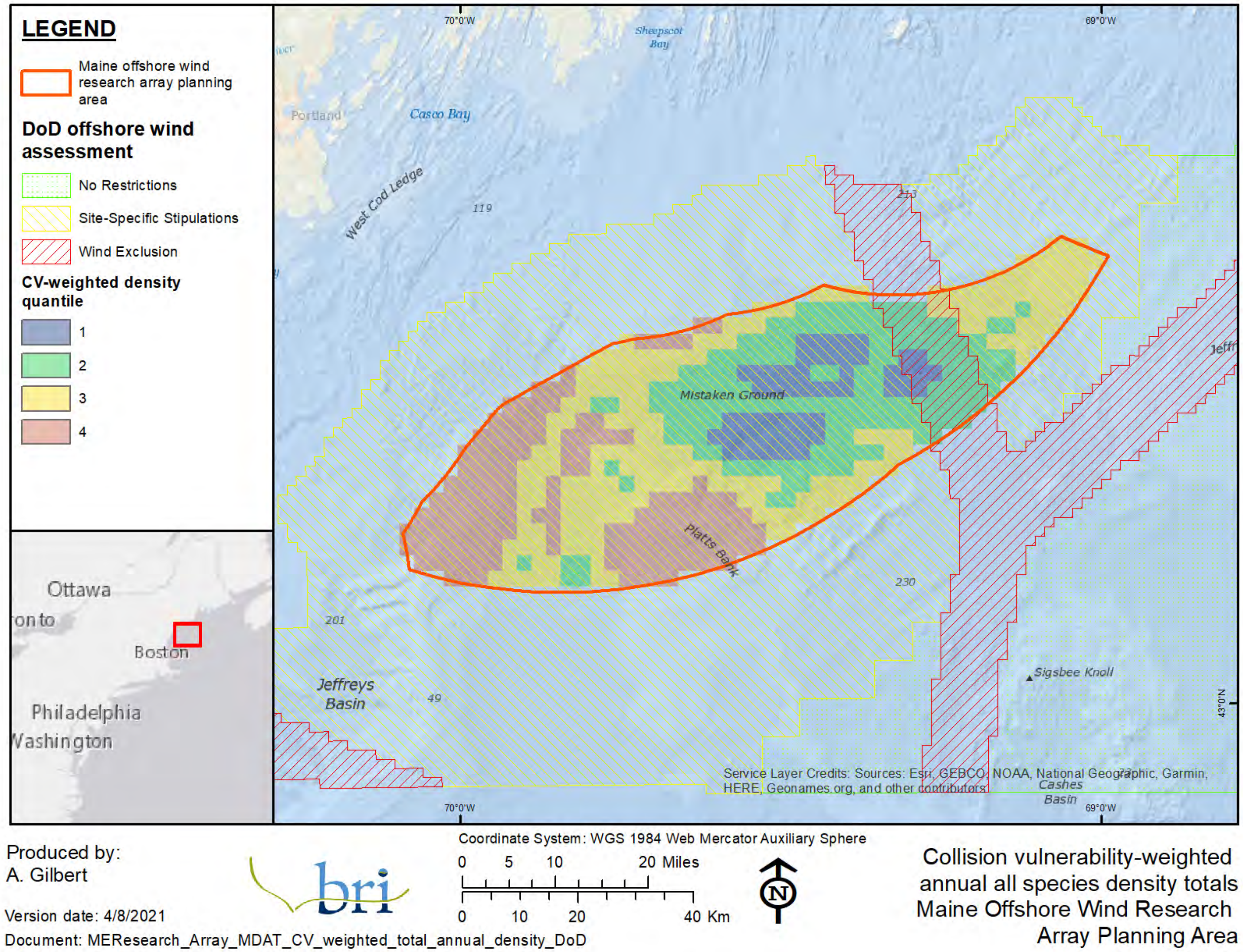

Figure 4. MDAT models weighted by collision vulnerability. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

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Appendix D Department of Defense Consultation Letter

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

SUSTAINMENT

20 August, 2021

Celina Cunningham
Deputy Director
Governor’s Energy Office
State of Maine

Dear Ms. Cunningham,

As requested, the Military Aviation and Installation Assurance Siting Clearinghouse coordinated within the Department of Defense (DoD) a review of the State of Maine Offshore Wind Research Project. The results of our review identified minimal impacts to DoD’s mission, however, would request some provisions and future coordination on this project.

The Department of the Navy (DON) requests the inclusion of the following actions into the project plans:

- Site the wind turbines as far east as possible in the proposed lease area to minimize encroachment upon DON sea trial activities.
- Agree to the curtailment (not spinning) of the wind turbines during sea trials. Estimated requirement for curtailment is 250 hours/year.
- Cooperate with the DON to assess the potential for wind turbines to impact shipboard radar.
- Allow the DON the ability to coordinate a review of business entities of those involved with the project for foreign ownership, influence or control in order to protect defense capabilities.

- DON POC: Matthew Senska: matthew.senska@navy.mil; 571-970-8400

Thank you for the opportunity to coordinate on this research project. We are providing the contact information to facilitate requested continued coordination, but the Clearinghouse retains oversight when you require DoD input. If you have any questions, please contact me at steven.j.sample4.civ@mail.mil or at 703-571-0076.

Sincerely,

Steven J. Sample
Executive Director
Military Aviation and Installation
Assurance Siting Clearinghouse

Appendix E State Certification

STATE OF MAINE
GOVERNOR'S OFFICE OF POLICY INNOVATION AND THE FUTURE
181 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0181

HANNAH PINGREE
DIRECTOR

CERTIFICATION

I, Hannah Pingree, do hereby certify:

THAT I, acting on behalf of the State of Maine, through the Governor's Office of Policy Innovation and the Future (GOPIF), am authorized to give this certification to the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM);

THAT GOPIF was established under the laws of the State of Maine, and the Director of GOPIF, with the consent of the Governor, is authorized through 5 M.R.S. §§ 3106 and 3201(5) to enter into agreements with the federal government to support the development of the State's economy and energy resources and the conservation of its natural resources;

THAT I have the consent of the Governor to sign this certification and the lease contemplated by the attached Application for an Outer Continental Shelf Renewable Energy Research Lease;

THAT documents submitted to BOEM may be executed by:

Hannah Pingree, Director

09/22/21

Date

Hannah Pingree
Director
Governor's Office of Policy Innovation and the Future
State of Maine

Seen and agreed to:

09/22/21

Date

Dan Burgess
Director
Governor's Energy Office
State of Maine

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