ASSESSMENT OF FEDERAL OFFSHORE WIND PERMITTING AND ENVIRONMENTAL REVIEW PROCESSES

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LIST OF ACYONYMS AND ABBREVIATIONS

ACPARS	Atlantic Coast Port Access Route Study
ADLS	Aircraft Detection Lighting System
AIS	Automatic Identification System
AMMM	avoidance, minimization, mitigation, and monitoring
APE	Area of Potential Effects
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
CMECS	Coastal and Marine Ecological Classification Standards
CO2	carbon dioxide
COP	Construction and Operations Plan
CPAPARS	Consolidated Port Approaches Port Access Route Studies
CR	Conservation Recommendations
CVOW	Coastal Virginia Offshore Wind
CVOW-C	Coastal Virginia Offshore Wind–Commercial
CZMA	Coastal Zone Management Act
DEIS	Draft Environmental Impact Statement
DMA	Dynamic Management Area
DNA	deoxyribonucleic acid
DoD	Department of Defense
EA	Environmental Assessment
EFH	essential fish habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FCP	Fisheries Communication Plan
FEIS	Final Environmental Impact Statement
FL	Fisheries Liaison
FR	Fisheries Representative
FSN	Final Sale Notice
G&G	geophysical and geotechnical
GHG	greenhouse gases
HAPC	Habitat Area of Particular Concern
HRVEA	historic resources visual effects assessment
IHA	Incidental Harassment Authorization
kWh	kilowatt-hour
LOA	Letter of Authorization
MA DMF	Massachusetts Division of Marine Fisheries

MARA	marine archaeological resources assessment
MARIPARS	Massachusetts/Rhode Island Port Access Route Study
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement
MPG	Marine Planning Guidelines
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NARW	North Atlantic right whale
NASA	National Aeronautics and Space Administration
NATCP	Native American Tribes Communications Plan
NCCOS	National Centers for Coastal Ocean Science
NEAMAP	Northeast Area Monitoring and Assessment Program
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NM	nautical mile
NMFS	National Marine Fisheries Service
NOx	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NSRA	Navigation Safety Risk Assessment
NTS	Notice to Stakeholders
NVIC	Navigation and Vessel Inspection Circular
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
OCS	Outer Continental Shelf
OREI	Offshore Renewable Energy Installations
OWPEBS	Ocean/Wind Power Ecological Baseline Studies
PAM	passive acoustic monitoring
PARS	Port Access Route Studies
PATON	Private Aid to Navigation
PEIS	Programmatic Environmental Impact Statement
PM	fine particulate matter
PSN	Proposed Sale Notice
PSO	protected species observer
RFCI	Request for Competitive Interest
RFI	Request for Information
ROD	Record of Decision
ROSA	Responsible Offshore Science Alliance
ROV	remotely operated vehicle
RWSC	Regional Wildlife Science Collaborative

SAP	Site Assessment Plan
SAR	search and rescue
SCRAM	Stochastic Collision Risk Assessment for Movement
SHPO	State Historic Preservation Officer
SLVIA	seascape, landscape, and visual impact assessment
SMA	Seasonal Management Area
SMAST	University of Massachusetts Dartmouth School for Marine Science and Technology
SO2	sulfur dioxide
SPI/PV	Sediment Profile Imaging/Plan View
T&Cs	Terms and Conditions
TARA	terrestrial archaeological resources assessment
THPO	Tribal Historic Preservation Officer
TSS	traffic separation scheme
UME	Unusual Mortality Event
US	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
VIA	visual impact assessment
WEA	visual impact assessment
WTG	Wind Turbine Generator
WTRIM	Wind Turbine Radar Interference Mitigation

1 INTRODUCTION

- In the United States (US), offshore wind projects undergo rigorous leasing and permitting processes and have been the subject of research and environmental review by experts across academia, government, and industry for years.
- The federal permitting process, which can span over 7 years, thoroughly assesses the potential impacts of offshore wind projects on navigation, fisheries, national security, wildlife, and other resources. This process results in extensive measures to avoid, minimize, and mitigate those potential impacts, which are imposed through permits and approvals.
- Offshore wind projects provide clean, renewable electricity that reduces air emissions from the electric grid while helping to diversify and improve the reliability of the grid. Offshore wind projects are also expected to support America's energy independence and provide long-term economic benefits.

Over the last decade, the US offshore wind industry has experienced rapid growth. As of January 17, 2025, the Bureau of Ocean Energy Management (BOEM) had approved 11 commercial-scale offshore wind projects totaling more than 19 gigawatts of offshore wind energy.[1] An additional 29 commercial leases had been issued along the East, Gulf, and West Coasts.[2] Three projects in federal waters (Coastal Virginia Offshore Wind-Pilot, South Fork Wind, and Vineyard Wind 1) plus one project in state waters (Block Island) had begun operations. Further, it was estimated that offshore wind projects that were in development as of June 2024 would provide enough electricity to power the equivalent of 22 million homes.[3]

Offshore wind projects provide clean, renewable electricity that reduces air emissions from the electric grid while helping to diversify and improve the reliability of the grid.[4] Offshore wind projects are also expected to support America's energy independence and provide long-term economic benefits. The offshore wind industry has resulted in over $40 billion in industry investments, with over 1,900 supplier contracts.[5] At the end of 2024, the offshore wind industry was projected to support up to 56,000 US jobs by 2030.[6] Many offshore wind projects also include workforce development initiatives to train candidates for offshore wind jobs.

US offshore wind projects undergo rigorous and lengthy leasing and permitting processes and have been the subject of research and environmental review by experts across academia, government, and industry for years. Before issuing offshore wind leases, BOEM conducts a multi-year, multi-step process in collaboration with other agencies, Tribes, and stakeholders to identify areas that are suitable for offshore wind development while avoiding and minimizing potential

impacts to the environment and other users of the Outer Continental Shelf (OCS). Following lease issuance, the offshore wind federal permitting process can span over seven years and includes site characterization and assessment, Construction and Operations Plan (COP) preparation, review of the COP under the National Environmental Policy Act (NEPA), and several other federal reviews and consultations. Through the federal permitting process, the potential impacts of constructing and operating offshore wind projects on navigation, fisheries, national security, marine mammals, birds, and other resources are well documented and analyzed, and extensive measures to avoid, minimize, and mitigate those potential impacts have been imposed on approved projects.

This document presents an overview of key issues that are considered as part of the leasing and permitting of US offshore wind projects. Section 2 provides a detailed review of BOEM's offshore wind area identification and leasing process, and Section 3 describes the multi-step federal permitting and review process for individual offshore wind projects. Section 4 details communication and engagement between offshore wind developers and federally recognized Tribes, agencies, fisheries, and other stakeholders. Sections 5 through 9 describe the potential impacts of offshore wind projects on navigational safety, commercial and recreational fisheries, national security, visual resources and property values, and wildlife (particularly marine mammals, birds, and bats). These sections also describe the numerous measures to avoid, minimize, and mitigate potential impacts that were implemented by BOEM during the area identification and leasing process or are imposed on developers through their permits and approvals. Section 10 briefly summarizes offshore wind developers' plans for data collection, standardization, and sharing. Finally, Section 11 summarizes the key benefits of offshore wind development.

2 OFFSHORE WIND AREA IDENTIFICATION AND LEASING PROCESS

- The Bureau of Ocean Energy Management (BOEM) undertakes a multi-year, multi-step process to identify areas that are suitable for offshore wind leasing while avoiding and minimizing potential impacts to the environment and other users of the Outer Continental Shelf (OCS). This process occurs in collaboration with other federal agencies, Tribes, state agencies, local governments, and stakeholders.
- It typically takes 2–4 years between BOEM initially proposing areas for offshore wind development through a Request for Information (RFI), Call, or Request for Competitive Interest (RFCI) and holding the lease sale (or executing a noncompetitive lease). During this time, there are numerous opportunities for public comment.
- Through the offshore wind area identification and leasing process, BOEM often considerably reduces the area ultimately offered for sale to avoid and minimize impacts to national security, navigation, marine species, and fisheries, among many other considerations. BOEM may further reduce or restrict the area available for development during the project-specific environmental review process.

BOEM's offshore wind area identification and leasing process is a multi-year, multi-step process that includes collaboration with other federal agencies, Tribes, state agencies, local governments, and stakeholders to identify areas that are suitable for offshore wind development while avoiding and minimizing potential impacts to the environment and other users of the OCS (see Figure 1). The area identification process typically begins with the formation of an Intergovernmental Renewable Energy Task Force in states that have expressed interest in offshore wind energy development.[7] Members of the Task Force typically include representatives from federal agencies (e.g., United States Coast Guard [USCG], Department of Defense [DoD], National Marine Fisheries Service [NMFS], Environmental Protection Agency [EPA], United States Army Corps of Engineers [USACE]), federally recognized Tribes, state agencies (e.g., environmental protection agencies, port authorities, and state historic preservation offices), and local governments. The Task Forces collect and share relevant information to help BOEM avoid and minimize potential conflicts when siting lease areas, such as information gathered in Massachusetts' Ocean Management Plan, Rhode Island's Special Area Management Plan, New York State Energy Research and Development Authority (NYSERDA) reports, New Jersey's Ocean/Wind Power Ecological Baseline Studies (OWPEBS), USCG Port Access Route Studies (PARS), etc.[8,9,10,11] All Task Force meetings are open to the public.[12]

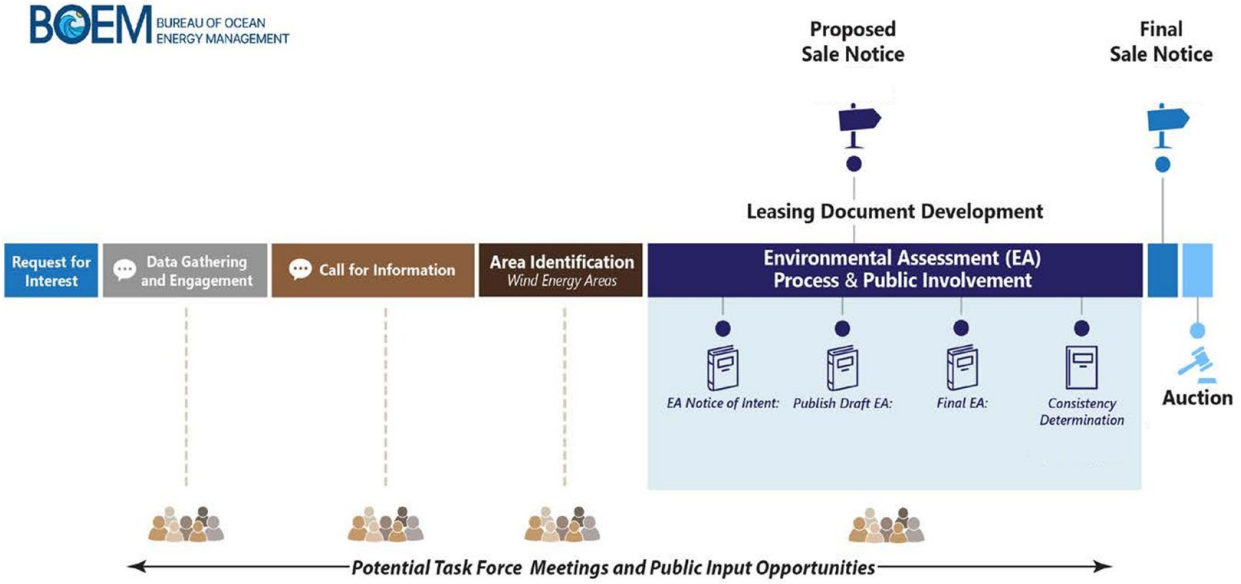

Figure 1 BOEM Offshore Wind Area Identification and Leasing Process (Adapted from BOEM[13])

BOEM often begins the formal leasing process by issuing an RFI (an optional step under 30 CFR § 585.210) to determine if there is competitive interest in potential lease area(s) and invite public comment.[14] Next, the competitive lease issuance process requires the publication of a Call to solicit industry and public input on areas of interest or concern (30 CFR § 585.211).[a] Based on information gathered from the Task Force, responses to the RFI, and/or responses to the Call, BOEM identifies a Wind Energy Area (WEA) for leasing consideration and environmental analysis,[b,15] taking into consideration multiple competing uses and potential effects to human, marine, and coastal environments, and then solicits public feedback on the WEA (30 CFR § 585.212). In September 2021, BOEM modified the area identification process to include the release of draft WEAs for public comment prior to designating final WEAs to provide stakeholders with additional opportunities to provide feedback and to create a more transparent and inclusive process.[16] As part of this enhanced process, BOEM collaborated with the National Oceanic and Atmospheric Administration's (NOAA's) National Centers for Coastal Ocean Science (NCCOS) to employ ecosystem-wide spatial suitability models to identify the most suitable areas for offshore

[a] Leases may alternatively be issued through a noncompetitive process, per 30 CFR §§ 585.230 – 585.232. BOEM would publish an RFCI, provide notice of the proposed lease area, and invite public comment. If, after publishing this notice, BOEM receives no responses indicating competitive interest, BOEM would issue a Notice of Determination of No Competitive Interest (DNCI) and initiate the environmental review process before executing the lease.

[b] On July 30, 2025, BOEM announced it is rescinding all designated WEAs on the OCS.

wind energy development in the Gulf of America, Central Atlantic, Gulf of Maine, and offshore Oregon.[17] For each region, the model combines numerous data layers (e.g., natural and cultural resources, vessel traffic, fishing activity, national security) to calculate a relative suitability score for each grid cell within the study area and generate heat maps that identify areas of relative suitability and conflict.[18,19,20,21]

Once the WEA is identified,[c,22] BOEM prepares an Environmental Assessment (EA) to evaluate the reasonably foreseeable impacts of lease issuance and future site characterization (surveys) and site assessment (installation of a meteorological tower and/or buoys) activities within the proposed WEA in accordance with NEPA. BOEM first issues a Notice to Stakeholders (NTS) or Notice of Intent (NOI) to prepare the EA to obtain public input on significant issues and alternatives to be analyzed in the EA (i.e., the scoping period). BOEM then prepares the Draft EA to assess the potential environmental impacts of activities associated with lease issuance and to address concerns raised during the public scoping period. After the Draft EA is published for public comment, BOEM prepares the Final EA (which addresses public comments received on the Draft EA). Concurrent with its preparation of the EA, BOEM conducts consultations under the Endangered Species Act (ESA), the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the Coastal Zone Management Act (CZMA), and Section 106 of the National Historic Preservation Act (NHPA). If the EA results in a Finding of No Significant Impact (which concludes that reasonably foreseeable effects associated with lease issuance and site characterization and assessment activities would not significantly impact the environment), then the leasing process continues.[23]

Before holding a lease auction, BOEM issues a Proposed Sale Notice (PSN) that describes and solicits feedback on the areas offered for sale, proposed lease stipulations, auction details, criteria for evaluating bids, and award procedures (30 CFR § 585.213). The Final Sale Notice (FSN) incorporates relevant comments on the PSN and provides final information regarding the lease sale (30 CFR § 585.214). BOEM then holds the lease auction and executes leases with the winning bidder(s). A lease does not, by itself, authorize any activity within the lease area; instead, the lease grants the right to develop a Site Assessment Plan (SAP) and COP, which must be approved by BOEM before the lessee can move on to the next stage of the development process.[24] Among

[c] In the EA for offshore wind leases and grants in the Gulf of America, BOEM analyzed the entire Call Area rather than WEAs to provide greater flexibility for future identification of WEAs and to provide NEPA coverage for unsolicited requests for non-competitive commercial or research leases that could be received in the Call Area.

other things, leases stipulate environmental protection measures, include measures related to national security and military operations, and can require the development of Tribal and fisheries communications plans.

As demonstrated in Table 1, it typically takes 2–4 years between BOEM initially proposing areas for offshore wind development through an RFI, Call, or RFCI and holding the lease sale (or executing a noncompetitive lease). As described above, there are numerous opportunities for stakeholder feedback during this multi-year process. For example, over the 4+ years between issuing the RFI and holding the auction for lease areas within the Massachusetts WEA, there were at least five opportunities for public comment, along with numerous public information sessions.[25,26]

Throughout the area identification and leasing process, BOEM often considerably reduces the area ultimately offered for sale to avoid and minimize impacts to national security, navigation, marine species, and fisheries, among many other considerations, as summarized in Table 1. Specific examples of how BOEM has refined potential lease areas to reduce impacts to various resources are provided in Sections 5 through 9. BOEM documents the rationale for excluding certain areas in the Call, Area Identification Memo, EA, PSN, and/or FSN. Importantly, the "Percent of Original Area Offered for Sale" in Table 1 does not account for refinements to the area proposed for development that occurred through Task Force meetings and other consultations before the RFI/RFCI/Call issuance date, nor does it account for measures and/or development restrictions imposed during the project-specific environmental review process to reduce potential impacts (see the notes to Table 1).

Table 1 Summary of BOEM Offshore Wind Area Identification and Leasing Process

Area	Current Lease Areas	RFI/RFCI/Call Issuance Date	Lease Sale Date	Size of Original RFI/RFCI/Call Area (acres)[a]	Size of Area Offered for Sale (acres)	Percent of Original Area Offered for Sale[b]	Key Factors Considered in Identifying Lease Areas (Non-exhaustive)
New England Lease Areas				**~15,876,648**	**1,772,755**	**11%**	
Gulf of Maine	OCS-A 0562, 0564, 0567, 0568 (OCS-A 0563, 0565, 0566, 0569 were unsold)	Aug 2022 (RFI)	Oct 2024	13,713,825	850,082	6%	fisheries, navigation, marine protected species, avian species, sensitive habitats, NMFS surveys, views
Maine Research Lease	OCS-A 0553	Aug 2022 (RFCI)	Aug 2024 (executed lease)	68,320	14,945	22%	navigation
Massachusetts	OCS-A 0500, 0501, 0534, 0561, 0520, 0521, 0522	Dec 2010 (RFI)	Jan 2015 & Dec 2018	~1,884,947	742,978	39%	fisheries, navigation, avian species, sensitive habitats, views
Rhode Island/ Massachusetts	OCS-A 0486, 0487, 0517	Aug 2011 (Call)	July 2013	~209,556	164,750	79%[c]	fisheries, navigation, sensitive habitats
Mid-Atlantic Lease Areas				**~6,509,327**	**1,480,403**	**23%**	
New York Lease Area	OCS-A 0512	Jan 2013 (RFI)	Dec 2016	81,130	79,350	98%[d]	fisheries, navigation, sensitive habitats
New York Bight	OCS-A 0537, 0538, 0539, 0541, 0542, 0544	Apr 2018 (Call)	Feb 2022	1,735,154	488,201	28%	fisheries, navigation, DoD activities, sensitive habitats, marine protected species
New Jersey	OCS-A 0498, 0499, 0570, 0459, 0532	Apr 2011 (Call)	Nov 2015	354,407	343,833	97%[e]	fisheries, navigation, sensitive habitats, avian species, marine protected species, cultural resources, DoD activities
Delaware	OCS-A 0482, 0519	Apr 2020 (RFI)	Nov 2012 (executed lease)	125,255	96,430	77%	fisheries, navigation

Table 1 Summary of BOEM Offshore Wind Area Identification and Leasing Process (Continued)

Area	Current Lease Areas	RFI/RFCI/Call Issuance Date	Lease Sale Date	Size of Original RFI/RFCI/Call Area (acres)[a]	Size of Area Offered for Sale (acres)	Percent of Original Area Offered for Sale[b]	Key Factors Considered in Identifying Lease Areas (Non-exhaustive)
Mid-Atlantic Lease Areas (Continued)							
Maryland	OCS-A 0490	Nov 2010 (RFI)	Aug 2014	175,069	79,707	46%	fisheries, navigation, avian species, cultural resources, sensitive habitats
Central Atlantic	OCS-A 0557, 0558	Apr 2022 (Call)	Aug 2024	3,897,388	277,948	7%	fisheries, navigation, DoD and US Navy activities, National Aeronautics and Space Administration (NASA) activities, sensitive habitats
Virginia	OCS-A 0483	Feb 2012 (Call)	Sept 2013	138,788[f]	112,799	81%	navigation, DoD activities, NASA activities, USACE dredge disposal areas
Virginia Research Lease	OCS-A 0497	July 2013 (RFCI)	March 2015 (executed lease)	~2,135	2,135	100%[g]	navigation
South Atlantic Lease Areas							
North Carolina	OCS-A 0508, 0559, 0545, 0546	Dec 2012 (Call)	March 2017 & May 2022	**~1,220,738**	**232,496**	**19%**	navigation, cultural resources, sensitive habitats, views
Gulf of America Lease Areas							
Gulf of America	OCS-G 37334 (OCS-G 37335, G37336 were unsold)	Nov 2021 (RFI)	Aug 2023	**~50,500,000**	**301,746**	**0.6%**	fisheries, navigation, DoD and US Navy activities, avian species, sensitive habitats

Table 1 Summary of BOEM Offshore Wind Area Identification and Leasing Process (Continued)

Area	Current Lease Areas	RFI/RFCI/Call Issuance Date	Lease Sale Date	Size of Original RFI/RFCI/Call Area (acres)[a]	Size of Area Offered for Sale (acres)	Percent of Original Area Offered for Sale[b]	Key Factors Considered in Identifying Lease Areas (Non-exhaustive)
Pacific Coast Lease Areas							
California	OCS-P 0561, 0562, 0563, 0564, 0565	Oct 2018 (Call)[h]	Dec 2022	**777,848**	**373,268**	**48%**	fisheries, navigation, DoD activities, avian species, marine mammals, cultural resources, views, Tribal resources

Notes:

a. Some RFIs, RFCIs, and Calls did not provide the area proposed for development in acres; these values have been converted to acres and may differ from values publicized elsewhere due to the unit conversion factors employed and rounding.

b. This value does not account for refinements to the area proposed for development that occurred through Task Force meetings and other consultations before the RFI/RFCI/Call issuance date.

c. The Rhode Island/Massachusetts Call Area was significantly smaller than the Massachusetts RFI Area due to areas being removed to address conflicts before the issuance of the Call based on information from Rhode Island's Special Area Management Plan and through consultation with the Rhode Island and Massachusetts Renewable Energy Task Forces.[27] Thus, the reductions to the Rhode Island/Massachusetts Call Area were much smaller when compared to other areas, including the Massachusetts RFI Area.

d. During the area identification process for the New York Lease Area, BOEM identified three key issues: navigational safety, commercial fishing, and visual impacts. BOEM determined that it was more appropriate to address these concerns through mitigation measures and/or development restrictions during the project-specific environmental review process than through further reductions to the area offered for sale.[28] During the project-specific environmental review process for the Empire Wind project, Empire Wind proposed an open area (devoid of wind turbines) in the western portion of the lease area to reduce impacts to the squid fishing industry.[29,30] In the Record of Decision (ROD) for the project, BOEM selected a combination of alternatives to reduce impacts, which incorporated this open area in the western portion of the lease area.[31]

e. The New Jersey Call Area was delineated through consultation with the Bureau of Ocean Energy Management, Regulation, and Enforcement/New Jersey Renewable Energy Task Force using the boundary of New Jersey's OWPEBS. Based on the OWPEBS, before the issuance of the Call, BOEM excluded: 1) the northern portion of the OWPEBS area (which included a major shipping lane, existing cables, high avian densities, shoals, and artificial underwater features); 2) the southernmost section of the OWPEBS area where many shoals and biological resources were concentrated (e.g., birds, marine mammals, sea turtles); 3) the area between the state boundary and the 7 nautical mile (NM) limit due to high avian densities, numerous shipwrecks, reefs, and shoals, and higher activity from recreational and commercial vessels; and 4) additional environmentally sensitive areas based on the OWPEBS.[32]

f. Acreage of the Virginia WEA, which was identified prior to the issuance of the Call.

g. The Virginia Research Lease Area was identified "by consensus after a series of meetings and conference calls among members of the BOEM Virginia Intergovernmental Task Force and maritime industry stakeholders that took place between November 2010 and January 2013, concurrent with the leasing process for the commercial Virginia WEA."[33]

h. Before issuing the Call for commercial wind energy leases within proposed areas off central and northern California, BOEM published the *Potential Commercial Leasing for Wind Power on the Outer Continental Shelf (OCS) Offshore California—Request for Interest* in August 2016 after receiving an unsolicited request for a commercial lease.[34]

3 FEDERAL PERMITTING PROCESS

- The offshore wind federal permitting process can span over 7 years, with roughly 3–5 years for site characterization (surveys), site assessments, and Construction and Operations Plan (COP) preparation, and another approximately 2.5 years or more to navigate through the federal permitting process to approval.
- In addition to BOEM's review of a COP under the National Environmental Policy Act (NEPA), several permits, authorizations, and consultations with other federal agencies are required for offshore wind projects. Many of these reviews involve their own impact assessment, public comment period, stakeholder engagement, and the development of avoidance, minimization, mitigation, and monitoring (AMMM) measures. The potential impacts of offshore wind development are thoroughly assessed and effectively avoided, minimized, and mitigated (as necessary) through these processes in consultation with agencies, Tribes, and stakeholders.
- BOEM's approval of a COP is subject to the Terms and Conditions (T&Cs) of COP Approval, which include numerous conditions related to technical requirements, navigation and aviation safety, national security, protected species and habitat, fisheries, and cultural resources, among others. Ongoing biological survey work (e.g., pre- and post-construction monitoring) is also often required. Overall, COP Approvals contain robust and protective conditions.

Following lease issuance, the federal permitting process for commercial-scale offshore wind projects includes: 1) site characterization and assessment, 2) COP preparation, and 3) NEPA and other federal reviews and consultations (see Table 2). The timeline for this process can span over 7 years, with roughly 3–5 years for site characterization (surveys), site assessments, and COP preparation, and another approximately 2.5 years or more to navigate through the federal permitting process to approval. It is only after these stages are complete that construction and operations can begin.

3.1 SITE CHARACTERIZATION AND ASSESSMENT

After a lease is executed, the lessee can begin conducting site-specific assessments and surveys for a period of approximately 3–5 years to further understand baseline conditions in the project area and inform siting of the offshore facilities (e.g., wind turbine foundations, offshore cables). Site characterization and assessment activities include installation of meteorological buoy(s) to collect site-specific data on winds and currents and comprehensive survey work to characterize the baseline environmental conditions in the project area. These include offshore geophysical and

geotechnical (G&G) surveys to map seabed features and substrate composition (e.g., multi-beam bathymetry, side scan sonar, magnetometer, sub-bottom profiler, cone penetration tests, boreholes, and vibracores). The seafloor data are used to map benthic habitats, identify marine archaeological resources, identify hazards that could affect the installation of facilities, and inform the siting and design of foundations and cables. The lessee also conducts biological surveys to document benthic communities and marine wildlife presence in the project area (e.g., underwater video, benthic grab samples, fisheries surveys, avian surveys, and marine mammal sightings).

3.2 CONSTRUCTION AND OPERATIONS PLAN PREPARATION

Once site assessments are complete, offshore wind developers are required to submit a COP detailing the project's design, construction methodology, and operations plans. In addition, a COP must fully assess the potential impacts of the offshore wind project on physical, biological, and socioeconomic resources (as listed in 30 CFR § 585, Subpart F), including water quality, air quality, birds, bats, fish, benthic organisms, marine mammals, sea turtles, threatened or endangered species, terrestrial and marine archaeological resources, navigation, recreational and commercial fisheries, recreation and tourism, land use, and existing coastal and marine habitats and uses. COPs are comprehensive documents that typically include dozens of technical appendices, such as the marine site investigation report (detailing the results of G&G surveys), marine archaeological resources assessment (MARA), terrestrial archaeological resources assessment (TARA), visual impact assessment (VIA) or seascape, landscape, and visual impact assessment (SLVIA), historic properties assessment (often called a historic resources visual effects assessment [HRVEA]), underwater acoustic assessment, essential fish habitat (EFH) assessment, sediment transport modeling report, electromagnetic field modeling report, bird and/or bat risk assessment, and Navigation Safety Risk Assessment (NSRA), among several others. For example, one of the most recent COPs made publicly available (the Vineyard Mid-Atlantic COP posted on January 8, 2025) includes 29 appendices and is comprised of well over 4,600 pages.[35]

BOEM has issued several guidance documents[36] that define the type and level of information necessary in a COP. These cover a variety of topics, including biological survey guidelines, acoustic modeling guidelines, G&G survey guidelines, spatial data requirements, and specific instructions for preparing and submitting COPs. In 2023, BOEM issued guidance known as the "NOI Checklist" to help standardize and clarify the extensive information needed within a COP in order for BOEM to the issue an NOI, which formally begins the NEPA process.[37] As described in the NOI Checklist, "typically, lessees provide significant additional information and background in the initial COP submitted to BOEM beyond what is required in the regulations."

3.3 FEDERAL PERMITS/AUTHORIZATIONS, CONSULTATIONS, AND NEPA REVIEW

BOEM's decision to approve, approve with modifications, or disapprove a COP requires environmental and technical reviews and consultation under NEPA. The NEPA process typically takes more than two years and includes four major steps: 1) issuance of an NOI, 2) preparation of a Draft Environmental Impact Statement (DEIS), 3) preparation of a Final Environmental Impact Statement (FEIS), and 4) issuance of a Record of Decision (ROD).[38] The NEPA process includes significant opportunities for public engagement and agency review, particularly during the comment periods following the issuance of the NOI and DEIS. Comments received during the scoping period (after issuance of the NOI) are considered while preparing the DEIS, developing alternatives, and analyzing cumulative impacts. Similarly, comments received on the DEIS are considered, responded to, and attached as an appendix in the FEIS. Throughout the review period, BOEM sends numerous rounds of comments and information requests to the developer to obtain necessary project details to complete their review and prepare the DEIS and FEIS. Subject matter experts at federal agencies and environmental consultancies work together to identify data gaps, describe the affected environment, and evaluate project impacts both locally and cumulatively within a region.

Additionally, several permits, authorizations, and consultations with other federal agencies are required for offshore wind projects. Table 2 lists common federal permits, authorizations, and consultations, although others may be needed. Many of the required reviews involve their own project documentation, impact assessment, public comment period, stakeholder engagement, and the development of AMMM measures. Further, offshore wind projects are also subject to state, regional, and/or local review.

Table 2 Typical Federal Permits, Authorizations, and Consultations for Offshore Wind Projects[39]

Agency	Permit/Authorization/Consultation
NOAA NMFS	Incidental Take Authorization (Incidental Harassment Authorization [IHA] or Letter of Authorization [LOA]) under the Marine Mammal Protection Act (MMPA), 16 USC §§ 1361 et seq. For an LOA, NMFS must issue Incidental Take Regulations.[40]*
	Consultation under Section 7 of the ESA, 16 USC §§ 1531 et seq.*
	EFH consultation under the MSFCMA, 16 USC §§ 1801 et seq.*
NOAA Office of National Marine Sanctuaries	Consultation under the National Marine Sanctuaries Act.

Table 2 Typical Federal Permits, Authorizations, and Consultations for Offshore Wind Projects (Continued)

Agency	Permit/Authorization/Consultation
USACE	Individual permit under Section 10 of the Rivers and Harbors Act of 1899, 33 USC § 403.
	Permit under Section 404 of the Clean Water Act, 33 USC § 1344.
	Permit under Section 103 of the Marine Protection, Research, and Sanctuaries Act, 33 USC § 1401 et seq. (if needed).
	Section 408 permission pursuant to Section 14 of the Rivers and Harbors Act of 1899, 33 USC § 408 (if needed).
EPA	National Pollutant Discharge Elimination System (NPDES) permit(s) under the Clean Water Act, 33 USC §§ 1251 et seq. (An individual permit may be needed for an offshore converter station's seawater cooling system; a general permit may be needed for onshore construction activities).
	OCS Air Permit under Section 328 of the Clean Air Act.
United States Fish and Wildlife Service (USFWS)	Consultation under Section 7 of the ESA, 16 USC §§ 1531 et seq.*
	Consultation under the Fish and Wildlife Coordination Act.
BOEM and other consulting parties	Consultation under Section 106 of the NHPA.
Relevant state agencies	CZMA Concurrence, 16 USC §§ 1451 et seq.
Federal Aviation Administration	Determination of No Hazard (if needed for components/activities within 12 NM of shore).
USCG	Private Aid to Navigation (PATON) Permits.
DoD	Military Aviation and Installation Assurance Siting Clearinghouse review.
Tribes/Tribal Nations	Government-to-government Tribal consultations.

* These permits, authorizations, or consultations are discussed further in the "Key Environmental Reviews and Consultations for Wildlife" section.

At the end of the NEPA process, BOEM publishes a ROD on the Environmental Impact Statement (EIS), usually jointly with USACE and/or NMFS. The ROD documents BOEM's decision to approve, approve with modifications, or disapprove the COP as well as USACE's and/or NMFS's decision to issue their respective permits/authorizations. The ROD also details the project alternatives that were considered and selected as well as the AMMM measures that BOEM intends to include as T&Cs of COP Approval.

Once the NEPA process is completed, BOEM can approve the COP. BOEM's approval of a COP is subject to the T&Cs of COP Approval (see 30 CFR § 585.628(f)(1)) and the developer must submit annual reports certifying compliance with the T&Cs of COP Approval (see 30 CFR § 285.633). The

T&Cs of COP Approval include numerous technical conditions, navigation and aviation safety conditions, national security conditions, conditions related to protected species and habitat, conditions related to fisheries, and conditions related to cultural resources, among others. Ongoing biological survey work is also often required, with requirements for pre-construction sampling as well as multiple years of post-construction monitoring during which regular reports are provided to agencies like BOEM, the United States Fish and Wildlife Service (USFWS), and NMFS. Many of these T&Cs are developed through consultations (e.g., ESA consultation, EFH consultation) and coordination with other federal agencies (e.g., NMFS, USFWS, USCG). Overall, COP Approvals contain robust and protective conditions. For example, the T&Cs of COP Approval for South Fork Wind (one of the first offshore wind projects in federal waters) contained 66 pages of T&Cs while the T&Cs of COP Approval for SouthCoast Wind (one of the most recent COP Approvals) contained 79 pages of T&Cs.[41,42]

Prior to the project-specific environmental review process described above, BOEM may also conduct a regional environmental review for offshore wind development in multiple lease areas in a Programmatic Environmental Impact Statement (PEIS). Programmatic reviews, such as the one conducted for the New York Bight and the one currently underway for California, ensure that cumulative/regional impacts are fully considered, establish a framework for tiering of project-specific environmental analyses, and identify and analyze programmatic AMMM measures. [43,44] In the ROD for the New York Bight PEIS, BOEM identified 58 AMMM measures that could be applied to the six New York Bight lease areas, in an effort to reduce impacts and provide consistency across the lease areas and provide transparency for Tribal Nations, cooperating agencies, the public, and lessees.[45]

Key Environmental Reviews and Consultations for Wildlife

As referenced in Table 2, additional reviews and authorizations occur under the Marine Mammal Protection Act (MMPA), ESA, and MSFCMA, which provide meaningful processes for the implementation of additional, significant protective measures for wildlife.

In 1972, the MMPA[46] established a national policy to protect marine mammal species and population stocks. Under the MMPA, NMFS may allow incidental (unintentional, but not unexpected) takes[d] of marine mammals for certain activities.[47] For offshore wind projects, NMFS may authorize incidental harassment for small numbers of some species, but NMFS does not authorize take in which an animal is killed or injured beyond the point of recovery.[48] NMFS may

[d] The MMPA defines “take” as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal," and harassment is defined as any act of pursuit, torment, or annoyance that has the potential to injure or disrupt the behavioral patterns of a marine mammal or marine mammal stock in the wild.

grant incidental take through a Letter of Authorization (LOA), which authorizes some level of take for up to five years, or an Incidental Harassment Authorization (IHA), which authorizes short-term harassment for activities planned for up to one year. An LOA or IHA can only be issued after a public comment period and if NMFS determines that takes will be small in number, will have negligible impacts on species or stocks, and will not have an unmitigable adverse impact on the availability of species or stock for subsistence uses of Alaksa Natives.[49,50] The number of takes authorized is determined through extensive spatial modeling of sound exposure and animal movement, using several thresholds to determine different levels and types of impact (behavioral versus [vs.] injury, temporary vs. permanent, instantaneous vs. accumulated over time) combined with the best available science about seasonal population densities for each species that might occur in the project area. LOAs and IHAs include extensive and protective monitoring and mitigation requirements. For example, the LOA issued to New England Wind includes over 46 pages of T&Cs.

The ESA was passed in 1973 and was created to protect endangered species and those likely to become endangered in the future as well as the ecosystems they depend on.[51] Federal agencies are legally required to consult with USFWS and/or NMFS if their proposed activities may affect ESA-listed species, including whales. During the offshore wind permitting process, BOEM will prepare Biological Assessments for both NMFS (for fish and most marine mammals that are ESA-listed) and USFWS (for terrestrial species, birds, and some marine mammals[e] that are ESA-listed).[52,53] At the end of agency review, NMFS and USFWS will prepare Biological Opinions that describe whether the proposed action will jeopardize the existence of ESA-listed species or their designated Critical Habitat. These documents typically include extensive measures to reduce the chance of take, which are then incorporated into the T&Cs of COP Approvals.

In addition to endangered species, NMFS also consults on fish species that fall under the MSFCMA. The MSFCMA, first passed in 1976, is the primary law that governs marine fisheries management in US federal waters.[54] The Sustainable Fisheries Act of 1996 recognized the importance of healthy habitat for commercial and recreational fisheries by establishing new requirements for fishery management councils to identify and describe EFH and to protect, conserve, and enhance EFH for the benefit of fisheries. The EFH regulations were updated in 2002 to allow fishery management councils to designate Habitat Areas of Particular Concern (HAPCs), which are specific areas within EFH that have extremely important ecological functions and/or are especially vulnerable to disturbance. A consultation with NMFS is required whenever a federal agency works in an area that will affect EFH.[55]

[e] USFWS has jurisdiction over sea otters, Pacific walruses, polar bears, and West Indian manatees.

BOEM and NMFS coordinate at multiple points throughout the EFH consultation process for offshore wind projects. The agencies have developed a template together that describes what needs to be included in an offshore wind project's EFH Assessment in order to be deemed complete.[56] This template is a living document that is periodically reviewed and updated, and it includes pre-approved content that is meant to be included in EFH Assessments. NMFS also has a technical assistance document intended to aid BOEM and lessees in providing the information needed to appropriately assess EFH impacts from offshore wind projects.[57] In an effort to standardize the way seafloor information is collected, analyzed, and presented so that site-specific baseline habitat data are available for their assessments, NMFS coordinated with BOEM and developers to provide updated recommendations for mapping fish habitat.[58] These recommendations provide an important framework for regional analysis as they standardize the use of the Coastal and Marine Ecological Classification Standards (CMECS) in mapping areas of different substrate types, which is an important component of the EFH Assessment.

In addition to developing templates, technical guidance documents, and recommended data standards, NMFS provides feedback on project-specific EFH Assessments through the consultation process.[59] NMFS encourages BOEM and developers to meet with NMFS early in the process to facilitate an understanding of NMFS's resource concerns and information needs for the EFH consultation process.[60] Once BOEM's EFH Assessment is submitted to NMFS, NMFS reviews it and provides EFH Conservation Recommendations (CRs) to BOEM. Then, BOEM provides a detailed response to NMFS describing how each of the CRs will or will not be applied for the project. The CRs that BOEM fully or partially adopts are incorporated as T&Cs of COP Approval. For a sampling of approved offshore wind projects, Table 3 lists the number of CRs provided by NMFS that fall under BOEM's jurisdiction (rather than another federal agency's jurisdiction), the number of proposed CRs that were **not** adopted by BOEM, and an explanation for why those CRs were not adopted (where that information could be gleaned). As illustrated in Table 3, BOEM typically adopts most EFH CRs that are within their jurisdiction. USACE and/or EPA may also review EFH CRs that pertain specifically to the activities they authorize and may adopt the CRs into their permit approvals.

Table 3 Summary of NMFS Conservation Recommendations Not Adopted by BOEM for Select Offshore Wind Projects

Offshore Wind Project	# of NMFS CRs under BOEM Jurisdiction[a]	# of CRs Not Adopted by BOEM[b]	Rationale[c]
Vineyard Wind 1[61,62]	12	1	BOEM collaborated with NMFS throughout the EFH consultation process and adopted portions of most CRs. CR #9 involved seasonal pile driving restrictions for inshore squid and was determined to be infeasible, given construction logistics considerations. BOEM applied more protective measures where practicable, modified some CRs in response to NMFS comments, and specifically adopted portions of CR #1, #10, and #11 involving habitat characterization and monitoring.
South Fork Wind[63]	15	2	Two CRs were not adopted because they were not a part of the proposed project and thus were outside of BOEM's regulatory authority. Other measures were partially rejected due to technical and economic feasibility concerns.
Empire Wind 1 & 2[64]	27	2	CR #1 was not adopted because only a limited number of wind turbine locations are feasible for pile driving due to geotechnical constraints. CR #19 was not adopted because a time of year restriction on construction activities from April 1 through July 31 to protect longfin squid is not economically or technically feasible because BOEM prohibited all pile driving between January 1 and April 30. This January 1 to April 30 pile driving restriction, while primarily focused on the highly endangered North Atlantic right whale (NARW), will also confer benefits to spawning longfin squid in April. BOEM partially adopted CR #21 because NMFS did not provide criteria to identify a level of impact and assess if mitigations are sufficient; instead, BOEM required the lessee to follow the sound field verification criteria in the Empire Wind Proposed Rule for Incidental Take Authorization and the Empire Wind Biological Opinion. Additionally, BOEM determined the micrositing of wind turbines and offshore substations, as discussed in CRs #2, #3, and #15, to be technically and economically infeasible. Thus, BOEM did not require the lessee to develop a wind turbine or offshore substation micrositing plan.

Table 3 Summary of NMFS Conservation Recommendations Not Adopted by BOEM for Select Offshore Wind Projects (Continued)

Offshore Wind Project	# of NMFS CRs under BOEM Jurisdiction[a]	# of CRs Not Adopted by BOEM[b]	Rationale[c]
Atlantic Shores South[65]	32	4	CRs were not adopted, and others were not fully adopted, because of technical and economic feasibility concerns or they were outside of BOEM's or the Bureau of Safety and Environmental Enforcement's (BSEE's) authority to enforce. CR #17 included specific requirements for the disposal of debris encountered during a site preparation grapnel run, which was not adopted as proposed. However, BOEM required the lessee to submit a Pre-Lay Grapnel Run Plan that includes a description of debris removal and disposal methods to ensure that debris is responsibly disposed of. CR #29 restricted continuous (24 hours/day) pile driving but was not adopted as proposed. BOEM notes that nighttime pile driving may be authorized with the concurrence of a nighttime monitoring plan, but that continuous pile driving is extremely unlikely and is likely not feasible.
SouthCoast Wind [66,67]	34	9	CRs were not adopted, and others were not fully adopted, because of feasibility concerns or CRs were outside of BOEM's or BSEE's authority to enforce. CRs #9, #11, and #14 involving the relocation and design specifications of the converter station as well as inter-array cable seabed preparation and installation were specifically determined to be infeasible. The remaining CRs were outside of BOEM's or BSEE's authority to enforce.
New England Wind[68,69]	32	9	CRs were not adopted, and others were not fully adopted, because of technical and economic feasibility concerns or because they were outside of BOEM's regulatory authority.

Notes:

a. This excludes CRs that are under USACE's jurisdiction (e.g., activities in state waters) and/or EPA's jurisdiction.

b. BOEM fully or partially adopted all other CRs put forward by NMFS under their jurisdiction.

c. The ROD for each offshore wind project was used in developing this table, except for Vineyard Wind 1, where information on CRs proposed and adopted came from the Vineyard Wind 1 FEIS. Additional rationale for excluding CRs for SouthCoast Wind and New England Wind came from their respective EISs.

National Historic Preservation Act and Tribal Consultation

Concurrently with the NEPA review process for COPs, BOEM conducts a review of offshore wind projects under Section 106 of the NHPA to identify and assess a project's potential effects on historic properties and identify measures to resolve any adverse effects. Historic properties can include historic shipwrecks, sunken aircraft, submerged and onshore archaeological sites, and historic buildings and districts.[70] Earlier offshore wind projects (e.g., Vineyard Wind 1, South Fork

Wind) followed the traditional Section 106 process at 36 CFR § 800.3 through 800.6. For more recent offshore wind projects, BOEM has been using the NEPA substitution process to fulfill Section 106 obligations (see 36 CFR § 800.8(c)) to improve efficiency, allow earlier and more direct input from consulting parties, and provide a more meaningful approach to government-to-government consultation with Tribes.[71]

The Section 106 process begins with the identification of consulting parties, which include appropriate State Historic Preservation Officers (SHPOs), Tribal Historic Preservation Officers (THPOs) and other Tribal representatives, the Advisory Council on Historic Preservation, the applicant, local governments, and other individuals and organizations with a demonstrated interest in the proposed project (i.e., the "undertaking") (see 36 CFR § 800.2). Throughout the Section 106 process, BOEM typically holds multiple meetings with the consulting parties, including Tribes that choose to participate. BOEM identifies and assesses historic properties within the undertaking's Area of Potential Effects (APE) using input from consulting parties and the developer's cultural resource reports, such as the MARA, TARA, and HRVEA. The developer's cultural resource reports must also identify proposed measures to avoid, minimize, or mitigate any adverse effects to historic properties (including any adverse visual impacts), which are then further refined in consultation with BOEM and the consulting parties and memorialized in a Memorandum of Agreement (MOA). An MOA is a binding commitment, and its stipulations are incorporated as T&Cs of COP Approval.[72] Measures included in an MOA can include, but are not limited to, avoiding marine archaeological resources by an appropriate buffer, conducting archaeological monitoring in archaeologically sensitive areas during onshore construction, adhering to Historic Property Treatment Plans, and implementing Unanticipated Discovery Plans.[73]

During the Section 106 process, BOEM is required to consult with any Tribe that attaches religious and cultural significance to historic properties that may be affected by the undertaking (see 36 CFR § 800.2). Tribes are provided with the opportunity to review the TARA, MARA, HRVEA, and draft MOA. Many binding measures included in MOAs are intended to directly address Tribal needs. For example, three MOAs for New England projects (Revolution Wind, New England Wind, and Sunrise Wind) include requirements to provide scholarships and training for Tribal resource stewardship, coastal resilience studies and/or habitat restoration, and cultural resource studies and data collection.

Outside of the Section 106 review of a COP, BOEM also meets with Tribes during the area identification and leasing process (see Section 2) and holds government-to-government meetings with the Tribes.[74,75,76,77] BOEM's Tribal Consultation Guidance, which was first issued in 2014 and last updated in 2024, establishes BOEM's procedures for consultation with Tribes.[78] Additionally, offshore wind developers often conduct their own Tribal outreach. For example, Vineyard

Offshore employs dedicated Tribal leads who serve as the company's primary points of contact for Tribal communities[79] and has entered into a historic Tribal Benefit Agreement with the Mashpee Wampanoag Tribe.[80] As described in Section 4, more recent offshore wind projects have developed Native American Tribes Communications Plans (NATCPs) that outline developers' plans to engage with federally recognized Tribes.

4 LESSEE COMMUNICATION AND ENGAGEMENT PLANS

- Over time, BOEM has incorporated more stipulations regarding communication and outreach into offshore wind leases. In 2017, BOEM began requiring developers to prepare a publicly available Fisheries Communication Plan (FCP) that describes the strategies the lessee plans to use for communicating with fisheries stakeholders.
- Since 2022, BOEM has also required that lessees create and adhere to Native American Tribes Communications Plans (NATCPs) and Agency Communication Plans through stipulations in their leases. Leases also require lessees to make reasonable efforts to consult with federally recognized Tribes and other potentially affected parties and to submit progress reports that provide updates on the lessee's communication efforts.
- Offshore wind developers recognize that communication and outreach are critical to responsible project development and engage with Tribes, agencies, fisheries stakeholders, mariners, local communities, and other stakeholders throughout project development. These engagement efforts are typically documented in a developer's COP.

Over time, BOEM has incorporated more stipulations regarding communication and outreach into offshore wind leases. Beginning with the Empire Wind Lease OCS-A 0512 in 2017,[81] BOEM began requiring developers to prepare a publicly available FCP that describes the strategies the lessee plans to use for communicating with fisheries stakeholders. BOEM included guidance on the development and contents of the FCP as part of their 2020 *Guidelines for Providing Information on Fisheries Social and Economic Conditions for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585*.[82] BOEM's 2023 fishery survey guidelines also strongly encourages lessees to engage in outreach to potentially affected fishing groups during fisheries survey plan development.[83]

Since 2022, BOEM has also required that lessees create and adhere to NATCPs and Agency Communication Plans through stipulations in their leases. These leases also require lessees to make reasonable efforts to consult with federally recognized Tribes and other potentially affected parties (e.g., coastal communities, educational and research institutions, non-governmental organizations, mariners, other ocean users, etc.) and to submit progress reports that provide updates on the lessee's communication efforts with federally recognized Tribes, agencies, fisheries, and other affected stakeholder or ocean user groups.[84,85,86] Attachment 2 of BOEM's "NOI Checklist" provides guidance on the schedule and structure of engagement among the lessee, BOEM, other federal agencies, and federally recognized Tribes.[87] In addition, BOEM's *Draft Guidelines and Instructions for Native American Tribes Communications Plan Development*

Required by BOEM New York Bight Leases (OCS-A 0537–0544) and Carolina Long Bay Leases (OCS-A 0545–0546) recommended that lessees develop joint NATCPs to minimize the burden on Tribes interested in staying informed about multiple projects within a region.[88] The New York Bight leaseholders subsequently coordinated to develop a joint NATCP.[89]

Regardless of whether communication plans are required in a developer's lease, offshore wind developers recognize that stakeholder outreach is critical to responsible project development and engage with Tribes, agencies, fisheries stakeholders, mariners, local communities, and other stakeholders throughout project development. This engagement is typically documented within their COPs. COPs typically include appendices detailing stakeholder outreach and communications, with some providing over 50 pages of specific stakeholder engagements and meetings.[90,91] All approved COPs include FCPs, many of which are also provided on the developer's website and updated regularly. Outreach to the fishing industry and mariners is often described in a developer's NSRA (an appendix to the COP). For example, some developers hold regular "Port Hours" to provide opportunities for fishermen to meet with their Fisheries Liaisons (FLs).[92,93,94] Tribal outreach and coordination occurs throughout the permitting process, as detailed in Section 3.3. Offshore wind developers also conduct outreach with local communities. For example, some developers hold community information sessions (e.g., Empire Wind and NYSERDA Open House and Union Apprenticeship Awareness Day);[95] hold office hours;[96] have established dedicated community outreach centers (e.g., Atlantic Shores' Educational and Community Outreach Center);[97] and engage with local communities through education and workforce development initiatives.[98,99,100]

For offshore wind projects that have been approved by BOEM, the T&Cs of COP Approval detail continued public communication requirements throughout construction and operations, including fisheries communication and outreach. The T&Cs of COP Approval typically require the lessee to develop and maintain a project website that contains monthly construction notices, an FCP, project-specific information from Local Notices to Mariners, and a method for the public to register questions and comments. For several projects, the T&Cs of COP Approval also require a summary of any consultation and outreach with resource agencies and the fishing industry (e.g., notifications to mariners) in several technical plans (e.g., Pre-Lay Grapnel Run Plan, Sand Bedform Removal Plan, Boulder Identification and Removal Plan). As described previously, BOEM enforces these conditions by requiring the developer to submit annual reports certifying compliance with the T&Cs of COP Approval.

5 NAVIGATIONAL SAFETY

- Navigational safety is a key factor in BOEM's offshore wind area identification and leasing process. BOEM has refined most potential lease areas due to navigational concerns based on input from the US Coast Guard (USCG) as well as port authorities and other marine users.
- The potential impacts of offshore wind projects on navigational safety are assessed through numerous Port Access Route Studies (PARS), Environmental Impact Statements (EISs), Navigation Safety Risk Assessments (NSRAs), and other independent studies. These potential impacts are avoided through the lease area identification process, minimized through the design of wind turbine layouts, and mitigated through the numerous T&Cs contained within COP Approvals.

Navigational safety is a key factor in BOEM's offshore wind area identification and leasing process. During this process, USCG serves as a subject matter expert for maritime safety, security, and mobility as well as national defense and protection of the marine environment.[101] USCG is a member of BOEM's Intergovernmental Renewable Energy Task Forces; reviews RFI Areas, Call Areas, and WEAs for conflicts relating to navigational safety, site conditions, resources, and other uses; and serves as a cooperating agency during the NEPA review of BOEM's EAs.[102] As shown in Table 1, BOEM has refined most potential lease areas due to navigational concerns based on input from USCG as well as port authorities and other marine users. For example, based on USCG comments on the Massachusetts RFI Area, BOEM excluded areas within 1 nautical mile (NM) of the traffic separation scheme (TSS) from the Massachusetts Call Area.[103] Based on consultation with USCG, the New Jersey lease areas offered in the PSN were reduced from the Call Area primarily to alleviate navigational safety concerns resulting from vessel transits out of New York Harbor.[104]

USCG has conducted multiple PARS that consider the impacts of offshore wind development on vessel routing measures and navigation. When developing a PARS, USCG "actively seeks and considers the views of the maritime community, environmental groups and other interested stakeholders" and there are opportunities for public comment.[105] In 2011, USCG began the Atlantic Coast Port Access Route Study (ACPARS) to address potential navigational safety risks associated with offshore wind development and to support future marine spatial planning efforts.[106] A key outcome of the ACPARS was the development of Marine Planning Guidelines (MPGs) to aid in initial area identification and to assist offshore wind developers in designing their project layouts and evaluating navigational impacts.[107] BOEM subsequently considered the MPGs when identifying potential lease areas.[108] In 2023, USCG published the Consolidated Port

Approaches Port Access Route Studies (CPAPARS) that summarized the findings of numerous other PARS along the US East Coast, many of which specifically considered offshore wind development. In the CPAPARS, USCG concluded that, "The recommendations in this report provide a system of safety fairways, traffic separation schemes, and precautionary areas that do not conflict with any lease area auctioned by BOEM."[109] Based on the ACPARS and CPAPARS, USCG issued a Notice of Proposed Rulemaking to designate shipping safety fairways along the Atlantic Coast, which are designed to keep traditional navigation routes free from fixed structures, in order to "facilitate offshore development, preserve traditional shipping routes, protect maritime commerce, and maintain navigational safety amidst growing offshore activity along the Atlantic Coast."[110]

USCG's most recent MPGs and wind turbine layout guidelines can be found in Enclosures 4 and 5 of Navigation and Vessel Inspection Circular (NVIC) No. 02-23, CH-1 *Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations (OREI) on the Outer Continental Shelf (OCS).* Enclosure 5 acknowledges that, "The size and shape of each lease area will be different, and the size and spacing of wind turbines within individual lease areas will be different based on various factors including bathymetry, power generation contracts, and the number of Wind Turbine Generators (WTG) needed to make the project viable" but recommends that "Each windfarm should be organized in straight rows and columns, creating a grid pattern consisting of two or more lines of orientation."[111] All offshore wind projects with COP Approvals have layouts that are predominately or entirely comprised of a grid pattern with two distinct lines of orientation.

As part of their COP, offshore wind developers must prepare an NSRA to assess the project's potential impacts on navigational safety and vessel traffic and identify appropriate mitigation measures, which is then reviewed by experts at BOEM and USCG.[112] USCG has developed a standard process for preparing and reviewing NSRAs, which can be found in Enclosure 3 of NVIC 02-23, CH-1.[113] The NSRA must assess the potential increased risk of collision, allision, and grounding resulting from the presence of wind turbines and offshore substations. The NSRA also evaluates potential changes in vessel routes and traffic density, impacts to search and rescue (SAR) activities, and effects on marine radar, such as obscuring potential targets and creating false or ghost targets.[114,115] The NSRA also identifies measures to mitigate marine radar interference from offshore wind projects, which can include enhanced training on radar operation and installation, marking wind turbines with Automatic Identification System (AIS), use of radar reflectors on small vessels, and use of reference buoys, among other possible mitigations.[116,117,118] The Wind Turbine Radar Interference Mitigation (WTRIM) Working Group (a collaboration of several federal agencies and partners) is also working to address wind turbine radar interference.[119]

Based upon USCG's review of the NSRA, relevant COP sections, and BOEM's EIS, USCG provides recommendations to BOEM regarding impacts, alternatives, and mitigation measures related to navigational safety, vessel traffic, and USCG missions. During the NEPA process, BOEM may identify alternatives to address navigational impacts in consultation with USCG that could ultimately be selected as the preferred alternative and approved. For example, for the Vineyard Wind 1 project, BOEM approved a combination of alternatives, including Alternative D2 (East-West and One-Nautical-Mile Turbine Layout Alternative), which required that the wind turbine layout be rearranged in a north-south/east-west orientation with 1 NM spacing between positions, consistent with USCG's recommendations in the Final Massachusetts/Rhode Island Port Access Route Study (MARIPARS).[120]

USCG also provides input to BOEM on the T&Cs of COP Approval. All COP Approvals include T&Cs related to navigational safety, such as requirements for lighting, marking, and signaling, blade/nacelle control (in the event of a nearby emergency), wind turbine layout and structure micrositing, submission of as-built cable plans, submission of Notices to Mariners, and submission of a plan describing all planned mitigations to be implemented to minimize any adverse impacts to navigation while installation is ongoing.

Overall, the potential impacts of offshore wind projects on navigational safety have been assessed through numerous PARS, EISs, NSRAs, and other independent studies, avoided through the lease area identification process, minimized through the design of wind turbine layouts, and mitigated through the numerous T&Cs contained within COP Approvals.

6 COMMERCIAL AND RECREATIONAL FISHERIES

- Commercial and recreational fisheries are a key consideration when identifying areas for potential offshore wind development, and fishermen have been invited to provide input throughout all stages of BOEM's lease area identification process. The total commercial fisheries revenue within "All Atlantic Wind Lease Areas" reported by the National Marine Fisheries Service (NMFS) for 2013–2022 was 1.0–2.0% of the commercial fisheries landings revenue in the New England, Mid-Atlantic, and South Atlantic regions, which indicates that the lease areas are sited outside of the most productive fishing grounds.
- All offshore wind projects with COP Approvals have layouts that are predominately or entirely comprised of a grid pattern with two distinct lines of orientation to facilitate safe navigation and continued fishing within the lease areas. Fishing is not prohibited within offshore wind turbine arrays, except for within temporary safety zones established by USCG during construction and potentially during certain maintenance activities.
- Offshore wind developers employ Fisheries Liaisons (FLs), use Fisheries Representatives (FRs), staff survey vessels with fishermen or fisheries' experts, and/or hire scout vessels to conduct outreach to the fishing industry and minimize interactions with fishing vessels/gear.
- The potential impacts of offshore wind projects on commercial and recreational fisheries have been assessed through numerous COPs, EISs, and other independent studies. These potential impacts are avoided through the lease area identification process, minimized through the design of wind turbine layouts and offshore cables, and mitigated through the numerous T&Cs contained within COP Approvals, including compensatory mitigation.

As demonstrated in Table 1, commercial and recreational fisheries are a key consideration when identifying areas for potential offshore wind development, and fishermen have been invited to provide input throughout all stages of BOEM's lease area identification process. For example, in response to comments from the American Alliance of Fishermen, the City of New Bedford's Mayor, and the Commonwealth of Massachusetts on the Massachusetts RFI Area, BOEM excluded OCS blocks east of the 70° longitude line (which included the Nantucket Lightship Habitat Closure Area) from the Massachusetts Call Area to protect valuable fisheries resources.[121] Comments received on the PSN for the New York Bight lease areas resulted in the removal of several areas that overlap with both fishing activity and sensitive seafloor features identified by NMFS and other stakeholders and resulted in no lease areas being offered within 2.5 NM of the Mid-Atlantic Scallop Access Area.[122] During the Gulf of Maine area identification process, BOEM excluded

several important fishing areas and habitats from the final WEA (including Lobster Management Area 1 and important groundfish areas) based on feedback from stakeholders (including the fishing industry).[123]

Additionally, offshore wind developers have spent over a decade conducting outreach to the fishing industry.[124] Offshore wind developers prepare project-specific FCPs, which outline their methods for engaging with and disseminating project information to the fishing industry, including the use of FLs and FRs. The FLs, who are typically employed by offshore wind developers, serve as a developer's primary point of contact with the fishing industry. FRs are typically active fisherman or groups representing active fishermen and are responsible for communicating fisheries concerns and input to offshore wind developers.[125] To minimize interactions between offshore wind survey activities and fishing vessels/gear, many developers staff survey vessels with fishermen or fisheries' experts to facilitate communication with nearby fishing vessels on-site and in real-time. Several developers also employ fishing vessels as scout vessels to locate and identify fishing gear deployed in and around project areas to further reduce interactions with fishing vessels/gear.[126] Developers use the input gathered through their fisheries outreach team to inform the siting of their facilities, measures to reduce potential impacts to fishery resources, and the development of fisheries monitoring plans. Developers also collaborate with fishermen through organizations such as the Responsible Offshore Science Alliance (ROSA).[127]

In general, irregular wind turbine layouts outperform regular layouts in terms of energy production, as overall wake losses are reduced.[128] However, as the permitting of the first offshore wind projects in the Massachusetts and Rhode Island/Massachusetts WEAs progressed, fishermen and other ocean users expressed the need for more uniform wind turbine layouts to accommodate vessel transits, fishing, and SAR operations. In response, in 2019, five offshore wind developers proposed (and ultimately adopted) a collaborative regional turbine layout across their adjoining lease areas where turbines would be spaced in east-to-west rows and north-to-south columns with 1 NM spacing between positions. This layout, which is consistent with USCG's recommendations in the MARIPARS, eliminated 30% of the area's potential energy production.[129] As described in Section 5, all offshore wind projects with COP Approvals have layouts that are predominately or entirely comprised of a grid pattern with two distinct lines of orientation to facilitate safe navigation and continued fishing within the lease areas. Fishing is not prohibited within offshore wind turbine arrays, except for within temporary safety zones established by USCG during construction and potentially during certain maintenance activities.

Potential impacts and benefits to commercial and recreational fisheries are analyzed in each project's COP, BOEM's EIS, and typically also through the federal CZMA process. Potential impacts include displacement of fishermen from traditional fishing areas, changes in the distribution, abundance, and composition of fish species in an area, navigational safety impacts, damaged

fishing gear, increased operational costs, and economic losses.[130] The amount of commercial fishing revenue that would be "exposed" as a result of offshore wind development (i.e., the fishing revenue from a project area that would be foregone if fishermen choose to no longer fish there and cannot recapture that revenue in a different location)[131] is typically estimated based on NMFS's "Socioeconomic Impacts of Atlantic Offshore Wind Development," which summarizes historical annual landings data and revenues for each lease area.[132] Additional data sources from state fisheries agencies are also often used. Between 2013–2022, the total commercial fisheries revenue within "All Atlantic Wind Lease Areas" reported by NMFS[133] was 1.0–2.0% of the commercial fisheries landings revenue in the New England, Mid-Atlantic, and South Atlantic regions.[134,f] This indicates that the lease areas are sited outside of the most productive fishing grounds. Offshore wind development can benefit fisheries through developers' collection of fisheries data and funding of fisheries research, workforce development and employment opportunities, and foundations functioning as artificial reefs (resulting in increases in biodiversity and abundance of fish).[135,136]

Outside of the permitting process, several studies have assessed the potential benefits and impacts of offshore wind development on fisheries, such as NMFS's 2023 report *Fisheries and Offshore Wind Interactions: Synthesis of Science*.[137] ROSA's "FishFORWRD" database provides a catalog of all East Coast research, monitoring efforts, and stated research needs related to offshore wind, fish, and fisheries and includes over 220 projects.[138]

These studies and assessments have identified numerous measures to reduce impacts to fisheries, such as consolidating infrastructure, burying offshore cables, using "trawl-friendly" cable protection with tapered or sloped edges, using nature inclusive designs that create suitable habitat for native species through the shape or type of materials used, depicting facilities on navigational charts, establishing gear loss compensation procedures, and more.[139] All COP Approvals include T&Cs related to commercial fisheries and for-hire recreational fishing, including requirements for developers to establish fisheries compensation and mitigation funds and to participate in the Federal Survey Mitigation Program. For example, the Vineyard Wind 1 and Coastal Virginia Offshore Wind–Commercial (CVOW-C) projects were each required to provide over $40 million in fisheries compensation and mitigation funds.[140,141] More recently, BOEM finalized guidance for mitigating the impacts of offshore wind projects on commercial and for-hire recreational fisheries, which incorporates feedback gained through two comment periods and seven workshops and identifies standards for determining compensatory mitigation.[142] Eleven East Coast states have been working together, in collaboration with the fishing community

[f] Based on values adjusted to 2024 dollars using the GDP Implicit Price Deflator.

and offshore wind developers, to establish a regional fund administrator for fisheries compensatory mitigation.[143] On the West Coast, the California Offshore Wind and Fisheries Working Group is working to develop a statewide strategy for avoidance, minimization, and mitigation of impacts to fisheries, including a framework for compensatory mitigation.[144]

Overall, the potential impacts of offshore wind projects on fisheries have been assessed through numerous COPs, EISs, and other independent studies, avoided through the lease area identification process, minimized through the design of wind turbine layouts and offshore cables, and lastly, mitigated through the numerous T&Cs contained within COP Approvals, including compensatory mitigation.

7 NATIONAL SECURITY

- The Department of Defense's (DoD's) Military Aviation and Installation Assurance Siting Clearinghouse leads DoD interaction with BOEM and coordinates with BOEM at every stage of the offshore wind planning, permitting, and development process to ensure that offshore wind projects are compatible with military activities.
- Mitigation measures related to national security are adopted in mitigation agreements with DoD and/or as T&Cs of COP Approval. These can include providing funding to DoD to deploy technical mitigation to its radar systems, curtailing operations if needed in an emergency for national security or defense purposes, allowing DoD and the US Navy to assess risks of foreign investment and foreign material vendors, and coordinating with the US Navy on the use of certain sensing and acoustic monitoring devices. These robust measures effectively address national security concerns.

The DoD's Military Aviation and Installation Assurance Siting Clearinghouse ("Clearinghouse") leads DoD interaction with BOEM and coordinates with BOEM at every stage of the offshore wind planning, permitting, and development process to ensure that offshore wind projects are compatible with military activities.[145,146] DoD analyzes potential impacts to military operations and readiness, including flight operations research, development, testing, and evaluation and training.[147] Without mitigation and deconfliction, wind turbines may impact radar systems used for defense as well as maritime navigation and safety by altering detection sensitivity, obscuring potential targets, and generating false or ghost targets.[148,149] These potential impacts can be mitigated through siting in coordination with DoD and other relevant agencies and technical modifications to radar systems, which reduce clutter and false targets.[150] The presence of wind turbines may also obstruct low-level flight routes and training areas and vessel movement (both surface and subsurface) during military exercises.

Through the Clearinghouse, DoD participates in BOEM's Task Force to identify areas for wind energy development that do not conflict with military operations and readiness. As shown in Table 1, BOEM refined potential lease areas in the New York Bight, Central Atlantic, and Gulf of America and offshore Virginia, New Jersey, and California based on input from DoD. For example, DoD identified compatibility concerns for the New York Bight Call Area related to homeland defense radar, training exercises, and storm tracking, and these concerns led to BOEM subsequently reducing the size of the proposed lease areas (see Table 1). [151]

Once leases are executed, offshore wind projects are subject to project-specific review by the Clearinghouse.[152] Through this process, mitigation measures related to national security are adopted in mitigation agreements with DoD and/or as T&Cs of COP Approval. Mitigation requirements include providing funding to DoD to deploy technical mitigation to its radar systems to reduce potential effects, curtailing operations if needed in an emergency for national security or defense purposes, agreeing to indemnify and save harmless the US against all claims of impacts to the project from military operations, allowing DoD and the US Navy to assess risks of foreign investment and foreign material vendors, and coordinating with the US Navy on the use of certain sensing and acoustic monitoring devices.[153,154,155] These robust measures effectively address national security concerns.[156] In the mitigation agreements for Vineyard Wind 1 and South Fork Wind, DoD concluded that, "the [radar mitigation] terms below will allow the mutual goals of the parties to be met, including the protection of the [air traffic control radar] ASR-8, which promotes national security, and protection of the National Airspace System, while supporting military readiness."[157,158]

8 VISUAL IMPACTS AND PROPERTY VALUES

- In several regions, BOEM considered the visual impacts of offshore wind projects during the area identification process.
- The visual impacts of offshore wind projects are thoroughly assessed and avoided, minimized, and mitigated during the project-specific federal environmental review process under NEPA and the National Historic Preservation Act (NHPA) as well as during the state permitting process.
- Evidence from communities near offshore wind projects, in both the US and abroad, indicates that the potential impacts to the local economy (such as effects on property values and tourism) are often neutral to positive.

As with any aboveground development, an offshore wind project has the potential to alter visual characteristics and scenic values within its viewshed. This is the case for both offshore and onshore elements of the project. BOEM has considered visual impacts during the area identification process, including the preparation of visual simulations and hosting open houses for stakeholders to provide feedback on those simulations in certain regions (see Table 1).[159,160,161,162] For example, after holding open houses to present visual simulations of example offshore wind projects within the Call Areas offshore North Carolina, BOEM excluded areas within 10 NM of shore from the Wilmington West WEA to address stakeholders' visual concerns.[163,164] BOEM also excluded areas from the Gulf of Maine Final WEA due to visual impact concerns for Acadia National Park.[165]

As part of their COPs, developers prepare a VIA or an SLVIA to assess the project's potential visual impacts to scenic values, the visual character of communities, and the viewshed from historic and cultural resources in accordance with BOEM guidance.[166,167,168] The VIA/SLVIA includes viewshed modeling to identify areas with potential visibility of the offshore facilities and visual simulations of the offshore facilities from key observation points. BOEM also requires the preparation of an HRVEA (or similar assessment), which is subject to review by SHPOs and other consulting parties through the Section 106 of the NHPA process.[169] BOEM then assesses the project's visual impacts as well as the cumulative visual effects of other reasonably foreseeable offshore wind projects (with cumulative visual simulations) in the project's EIS and through a Cumulative Historic Resources Visual Effects Analysis. State reviews of offshore wind projects and their associated transmission infrastructure also include consideration of visual impacts.

These multiple levels of review provide for robust community involvement and result in the consideration of several potential measures to avoid and minimize visual impacts. During the NEPA process, BOEM may identify alternatives to reduce visual impacts. For example, for the Maryland Offshore Wind Project, BOEM identified Alternative D (No Surface Occupancy to Reduce Visual Impacts), which would have excluded positions within 14 miles of the shoreline, but did not ultimately select this alternative due to the reduction in potential energy production and marginal reduction of visual impacts.[170] For the Vineyard Wind 1 project, BOEM approved a combination of alternatives, including Alternative C (No Surface Occupancy in the Northernmost Portion of the Project Area) to reduce visual impacts.[171] The Section 106 process typically results in an MOA that prescribes measures the developer will implement to reduce visual impacts to historic properties. These include painting wind turbines no lighter than RAL 9010 pure white and no darker than RAL 7035 light gray to reduce daytime visibility and using an Aircraft Detection Lighting System (ADLS) to automatically activate aviation obstruction lights when aircraft approach the structures to reduce the duration of nighttime lighting.[172,173] Frequently, an onshore substation is the primary aboveground onshore element for offshore wind projects. Measures to reduce visual impacts from onshore substations are further developed though the state permitting process and can include siting onshore substations where vegetative buffers can be maintained, using slender gray lightning masts, limiting nighttime lighting, considering the color of building materials to minimize visual contrast, and designing aesthetically pleasing site fencing.

Interest in visual impacts is frequently driven by communities and property owners who are concerned about maintaining local scenic attributes and property values as well as impacts to tourism. A 2018 study by BOEM found that offshore wind projects would affect the public's experience on beach trips, alter trip behavior, and generate curiosity trips; however, at the distance of most lease areas from shore, negative impacts were largely counteracted by benefits from the projects functioning as tourist attractions.[174] Evidence from communities near offshore wind projects, in the US and abroad, indicates that the potential impacts to the local economy are often neutral to positive.[175,176,177,178] In particular, a 2022 study[179] found no evidence of negative impacts to property values resulting from views of the Block Island Wind Farm. In the coastal communities near offshore wind projects, climate change is likely the most severe economic threat to coastal property values and public infrastructure, and short-term property values are most sensitive to housing supply and demand.[180]

9 WILDLIFE

While this section focuses on marine mammals, birds, and bats, the potential impacts of offshore wind projects on other wildlife resources (e.g., fish, benthic organisms, sea turtles, and other threatened or endangered species) are thoroughly assessed in developers' COPs, in BOEM's EISs, and through other federal reviews and consultations, as described in Section 3.

9.1 MARINE MAMMALS

- While marine mammals may occur in the vicinity of offshore wind lease areas, they are unlikely to experience adverse effects in large numbers due to strategic placement of Wind Energy Areas (WEAs) to avoid critical habitats and sensitive areas, relatively rare occurrences of many species or stocks in the project areas, and the abundant protective measures incorporated into COP Approvals, Letters of Authorization (LOAs) or Incidental Harassment Authorizations (IHAs), and related monitoring plans. For example, the LOA issued to New England Wind includes over 46 pages of mitigation, monitoring, and reporting requirements.
- Protective measures include noise mitigation measures (e.g., temporal/spatial restrictions on noise-generating activities, ramp-up/soft-start, noise abatement systems), vessel strike avoidance measures (which are more restrictive for offshore wind-related vessels than for other vessels), and monitoring, reporting, and compliance requirements. These measures are developed with input from regulatory agencies, conservation groups, and other stakeholders.
- Researchers and natural resource managers have found no evidence that offshore wind development has contributed to increased strandings or marine mammal mortalities. The primary threats to marine mammals—entanglement in fishing gear and vessel strikes—are longstanding problems that pre-date the beginning of offshore wind work.

While marine mammals may occur in the vicinity of offshore wind lease areas, they are unlikely to experience adverse effects in large numbers due to strategic placement of WEAs to avoid critical habitats and sensitive areas (see Table 1), relatively rare occurrences of many species or stocks in the project areas, and the abundant AMMM measures incorporated into COP Approvals, LOAs or IHAs, and related monitoring plans. For example, as described in Section 3.3, the LOA issued to New England Wind includes over 46 pages of mitigation, monitoring, and reporting requirements.

Many of the marine mammal species on the East Coast are rare or uncommon near project areas. For example, there are 41 species or stocks that could potentially occur in the New York Bight WEA with the following levels of occurrence:

- 23 rare = limited records exist for some years
- 4 uncommon = occurring in low numbers or on an irregular basis
- 6 regular = occurring in low to moderate numbers on a regular basis or seasonally
- 8 common = occurring consistently in moderate to large numbers[181]

All marine mammal species in US waters are protected by the MMPA, and five marine mammal species near the WEAs off the US East Coast are considered threatened or endangered under the ESA, including the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), North Atlantic right whale (NARW) (*Eubalaena glacialis*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*).

Some of the primary threats to marine mammals include vessel strikes[182] (primarily from shipping and other large vessels with unregulated speeds), entanglement with commercial fishing gear,[183] and habitat loss or changes due to climate change impacts.[184] Before most offshore wind activities began, three large whale species (the critically endangered NARW,[185] the humpback whale, and the minke whale) began experiencing Unusual Mortality Events (UMEs) in approximately 2016/2017. NMFS declares a UME when an unexpectedly high proportion of a species' population is experiencing mortality or serious injury.[186] Available data show that these UMEs were not caused by offshore wind development, as the increase in strandings do not align spatially or temporally with offshore wind site assessment or construction activities, but rather with changes in global shipping patterns and marine mammal foraging behaviors.[187] For example, of the 157 NARW individuals recorded in the UME to date, 127 individuals (~81% of the total)[188] were killed or injured by vessel strikes or entanglement in commercial fishing gear. According to NMFS,[189] the Department of Energy,[190] and leading experts in the field of marine science and conservation,[191] there are no known links between the UMEs or large whale deaths/strandings and any offshore wind activities.

The main impact-producing factors from offshore wind development that could potentially affect marine mammals include noise (from pile driving and other construction activities, vessel traffic, high-resolution geophysical surveys, operations, and site preparation activities), vessel strike risk, potential changes in habitat or prey availability, and secondary entanglement in snagged marine debris or fishing equipment. These topics are extensively analyzed in each project's COP and BOEM's EIS, and, as described further below, there are many AMMM measures developed with input from regulatory agencies, conservation groups, and other stakeholders to reduce potential impacts to negligible levels.

In addition, several cross-discipline research efforts have been underway for decades to establish the science needed to effectively evaluate impacts to marine mammals. Specifically for noise, BOEM's Environmental Studies Program was the first government entity to conduct studies on anthropogenic noise impacts on marine life. Over the past 30 years, BOEM has invested over $95 million on studies related to protected species and underwater noise through four general research themes: 1) empirical laboratory and field studies; 2) literature reviews, syntheses, and workshops; 3) sound source verification and modeling; and 4) impact monitoring.[192] In 2020, BOEM established the Center for Marine Acoustics,[193] which is an organization of acoustic modeling experts and bioacousticians intended to build models, fill data gaps, set exposure guidelines and standards, and improve policy and management initiatives related to anthropogenic sound impacts and mitigation. In January 2024, BOEM and NMFS released a NARW and Offshore Wind Strategy[194] to protect and promote the recovery of endangered NARWs, while continuing to responsibly develop offshore wind energy. This strategy identifies a number of actions under three main goals: 1) mitigation and decision-support tools; 2) research and monitoring; and 3) collaboration, communication, and outreach. Coordinated efforts between BOEM, NMFS, the offshore wind industry, and groups like the New York State Environmental Technical Working Group[195] and the Regional Wildlife Science Collaborative (RWSC)[196] allow for the collection and application of the best available scientific data and insights to inform monitoring and mitigation efforts.

Finally, one area of active research regarding offshore wind and whales is assessing how infrastructure in the water will affect local and regional hydrodynamics. This is a potential concern because changes in currents and frontal features may change prey distribution patterns in important feeding areas for some species. The National Academy of Sciences studied this in 2024 to better understand the effect of offshore wind development in the Massachusetts WEA on currents and prey distribution for NARWs around Nantucket Shoals.[197] The report acknowledged uncertainty in this area of research but concluded that the scale of effects from ongoing climate-induced changes in the region is much larger than the potential impacts of offshore wind infrastructure on the hydrodynamics of the ecosystem.

Noise Mitigation Measures

Marine mammals rely on sound for communication, navigation, and feeding, so exposure to anthropogenic noise can have both behavioral and physiological effects.[198,199] Increased use of the sea for commercial shipping and fishing, geophysical surveys, naval warfare, research, and recreational activities has resulted in higher levels of noise pollution over the past few decades. This noise pollution can range from high intensity and acute, such as underwater explosions, to low-level and chronic, such as engine noise from ships.[200]

The potential sound generated by offshore wind-related activities is extensively modeled and compared against robust hearing thresholds established by academics, NOAA, and the US Navy. Additionally, both COP Approvals and LOAs or IHAs include extensive AMMM measures to reduce noise impacts to negligible levels. For example, the SouthCoast Wind Request for Incidental Take Regulations contained 24 pages describing mitigation measures related to noise,[201] and Empire Wind's COP Approval included 54 pages of T&Cs related to protected species and habitats, many of which included noise-related AMMM measures. Most noise mitigation measures that offshore wind developers are required to follow fall into two broad categories: 1) approaches to reduce the likelihood of marine mammal presence near sound-generating activities; and 2) methods to reduce the sound that is emitted into the environment (see Table 4).

Table 4 Measures Implemented for Offshore Wind Projects to Avoid or Minimize Noise Impacts[202]

Category	Noise Mitigation Type	Description
Reducing likelihood of marine mammal presence	Temporal or spatial restrictions	Avoiding pile driving or other discrete noise-generating activities during times of year or in areas where aggregations of marine mammals are known to occur reduces sound exposure.
	Visual monitoring by protected species observers (PSOs)	Trained specialist observers visually monitor for marine mammal presence within pre-defined zones around activities in order to cease operations if a marine mammal comes close enough to experience sound exposures above threshold levels. The clearance zones (which need to be cleared for a set duration before activities can start) and shutdown zones (within which marine mammal presence would trigger cessation of activities) are based on data collected from hydroacoustic modeling and the sound thresholds of the species likely to be present. This applies to both pile driving and certain geophysical survey activities that produce noise.
	Passive acoustic monitoring (PAM)	This approach detects vocalizations using underwater microphones (hydrophones), which is necessary for species that do not surface often or when monitoring occurs under suboptimal visual monitoring conditions.
	Ramp-up/soft-start	Ramp-up or soft-start procedures aim to deter animals from a site and minimize the risk of auditory injury with a gradual increase of sound intensity prior to full operations. Sounds generated at lower levels are intended to cause animals to avoid the area during the generation of sound at full intensity.

Table 4 Measures Implemented for Offshore Wind Projects to Avoid or Minimize Noise Impacts (Continued)

Category	Noise Mitigation Type	Description
Reducing the sound emitted	Reducing sound production during pile driving	Reducing sound emissions could potentially be achieved during the project design stage by choosing low sound alternatives to impact pile driving for foundation installation. This could include installing different foundation types that do not need piling (subject to commercial and technical viability) or using vibratory piling, which emits lower intensity sound, to replace some of the impact pile driving needed.
	Noise abatement systems	Sound-dampening technology reduces the intensity of sound either nearby or at some distance from the pile. There are a variety of technical systems in use and in development,[203] such as single or double bubble curtains, noise mitigation screens, and hydro sound dampers.

As discussed further below, in addition to the measures listed in Table 4, offshore wind developers are also required to conduct sound field verification, or measurements of the actual sound produced during construction activities (e.g., pile driving), to confirm that potential impacts from actual sound levels are consistent with anticipated impacts from modeled sound levels.

Monitoring, Reporting, and Compliance

COP Approvals and LOAs or IHAs also include detailed monitoring, reporting, and compliance requirements. For example, the New York Bight PEIS ROD includes the following measures, which are broadly representative of typical offshore wind requirements:

- Reporting of all NARWs observed at any time by protected species observers (PSOs) or personnel on any project vessel or during any project-related activities;
- Long-term passive acoustic monitoring (PAM) of ambient noise and animal vocalizations in the lease area for one year before, during, and at least three years following construction, or alternatively, the lessee can elect to contribute to BOEM's Environmental Studies Program;
- PSO reporting requirements during G&G and biological surveys and site assessment/data collection activities, including monthly reports during activities and a final survey report within 90 days of completion;
- PSO reporting requirements during construction, including weekly, monthly, and annual reports of pile driving, noise abatement, and PSO activities; and

- Sound field verification to document the levels of sound propagation from foundation installation to verify that the modeled acoustic fields are within expected ranges. If levels exceed agency-identified ranges to regulatory thresholds, the lessee must take mitigative actions in consultation with the federal permitting agencies.

Vessel Strike Avoidance

Vessel strikes to marine mammals are linked to vessels of all types and sizes, including commercial shipping, fishing, and boating. The number of vessel trips generated by offshore wind projects vary by project, but have been estimated at 1–15 trips per day during construction and 1–3 trips per day during periodic maintenance cycles within the operations phase.[204] With nearly 15,000 merchant vessels transiting the waters off the East and West Coasts of the US in a year,[g,205] each offshore wind project will contribute a small fraction of additional vessel traffic over existing merchant vessel traffic on a yearly basis.

An important measure to avoid vessel strikes is employing PSOs or dedicated visual observers onboard vessels to monitor waters for animals during transit. PSOs are required primarily for G&G surveys in the offshore wind and oil and gas industries, nearshore dredging and disposal, underwater construction or demolition, and explosive blasting. PSOs or dedicated trained visual observers are typically required for vessels in transit to offshore wind project areas. For some projects, like Empire Wind, real-time PAM is also required in addition to visual monitoring prior to and during transit when traveling at speeds greater than 10 knots; this level of monitoring is not required for most other transiting commercial or shipping vessels.[206]

Another important measure to reduce or avoid vessel strikes to NARWs is to implement vessel speed restrictions. Off the US East Coast, all vessels greater than or equal to 65 feet in length are required to transit at a speed of 10 knots or less throughout 10 designated Seasonal Management Areas (SMAs) between Massachusetts and Florida during certain months of the year.[207,208] NMFS also designates voluntary Dynamic Management Areas (DMAs) and Right Whale Slow Zones. DMAs become active when groups of foraging NARWs are visually observed gathered in groups of three or more individuals within a discrete area. A Right Whale Slow Zone[209] becomes active after NARWs are visually and/or acoustically detected. Both DMAs and Right Whale Slow Zones remain active for 15 days after triggering, and vessels are requested to transit these areas at 10 knots or less.

[g] Ship sightings data are from 2015 and include vessels less than 500 gross tonnage to over 60,000 gross tonnage.

Unlike other vessels, all offshore wind-related vessels, regardless of size, are required by the terms of their federal authorizations to transit throughout the SMAs at a speed of 10 knots or less. Likewise, offshore wind vessel speed restrictions in DMAs and Right Whale Slow Zones are not voluntary and instead are mandated through the T&Cs of COP Approval, LOAs, and IHAs. Other vessels are not federally required to adhere to voluntary speed restrictions within DMAs and Right Whale Slow Zones,[210] although their compliance is encouraged, and some states like Massachusetts have designated their own slow down zones. Another example of a conservative vessel strike avoidance measure that has been included in LOAs for offshore wind projects is that project vessels, regardless of size, must reduce speeds to 10 knots or less for at least 24 hours when a NARW is sighted at any distance by any project-related personnel or acoustically detected by PAM.[211]

Entanglement Mitigation Measures

Entanglement in commercial fishing fixed gear has been identified as one of the leading causes of mortality of NARWs for over 30 years, with rates of serious entanglement increasing since the mid-1990s.[212] Offshore wind projects have limited potential to cause primary entanglement via structures in the water, as fixed-bottom foundations (e.g., monopiles, jackets) do not pose an entanglement risk and offshore submarine cables are typically buried. If the use of floating foundations progresses, it is expected that the mid-water system of inter-array cables will have large diameters and will be heavy enough that they cannot loop around marine life.[213]

Another potential source for primary entanglement is through equipment used during offshore wind site characterization and environmental surveys. Entanglement risk is typically minimized by using NMFS-approved weak links on all buoy lines, keeping all mooring lines at the shortest practicable length, and using rubber sleeves and other devices to prevent lines from looping or having the ability to wrap around large marine animals.[214] In addition, survey vessels deploying fixed gear (i.e., trap or pot sampling gear deployed on the seabed) must have disentanglement equipment available and follow protocols for the safe release of any captured animals. Some offshore wind developers are designing their fisheries monitoring plans specifically to reduce entanglement risk by using on-demand (ropeless) gear, which do not use vertical lines to mark gear location.[215,216] Offshore wind developers are required to sample fish populations with short trawl surveys at slow towing speeds to limit the risk of entanglement, and any protected species that are entrapped must be reported to NMFS within 48 hours.

Ghost gear, which is abandoned, lost, or otherwise discarded fishing gear,[217] is a secondary entanglement risk to marine life if it snags on offshore wind infrastructure. There is limited information available on evaluating secondary entanglement risk at this time;[218] however, T&Cs of COP Approval conservatively include requirements for periodic surveys of turbine foundations to check for and remove abandoned fishing gear or other marine debris.

Marine Mammals Summary

Continuous advancements in monitoring and mitigation have played a key role in reducing the potential for adverse impacts to marine mammals from the development of offshore wind. As outlined above and in Table 4, offshore wind projects are rigorously reviewed and include dozens of measures to minimize potential impacts from noise, vessel strikes, and secondary entanglement. The integration of multiple mitigation and monitoring strategies, such as the use of real-time PAM systems, and improvements in data collection and standardization optimizes the offshore wind industry's ability to mitigate effectively and inform regulatory decision-making with respect to offshore wind.

Generally, requirements to protect marine mammals from offshore wind development are more stringent than those for other marine activities. As discussed previously, the most common causes of mortality and injury to marine animals across all sources are vessel strikes and entanglement with ropes or fishing gear. To reduce the risk of collision, vessels that are used for offshore wind activities are required to observe various speed restrictions, including restrictions that are voluntary for other vessels. Further, offshore wind vessels must have dedicated PSOs or trained lookouts onboard to watch for marine mammals during surveys, construction activities, and transiting, which is a requirement that goes above and beyond most other marine industries. To mitigate primary and secondary entanglement risks, offshore wind developers will perform fisheries surveys with equipment designed to prevent entanglement and will monitor underwater infrastructure for snagged gear or other marine debris during operations.

While there has been public concern[219] that underwater sound from offshore wind pre-construction surveys or pile driving during construction is contributing to whale deaths along US beaches, this is not supported by any scientific evidence.[220] G&G surveys and construction activities do produce noise, but most of these sounds are less impactful than other anthropogenic sound sources as they emit for shorter durations and at lower intensities than equipment and methods used during oil and gas activities (e.g., seismic surveys using airguns) or military applications (e.g., tactical sonar).[221,222] Researchers and natural resource managers have found no evidence that offshore wind development has contributed to increased strandings or marine mammal mortalities.[223]

9.2 BIRDS AND BATS

- Although collision of birds and bats with offshore wind turbines is possible, the risk is considered low for many bird species that fly outside the rotor swept zone or exhibit avoidance behavior and for most bats, which are expected to be relatively uncommon offshore.
- During the offshore wind area identification and leasing process for several regions, BOEM excluded certain areas due to bird presence, thereby minimizing collision risk from the start.
- The potential impacts of offshore wind projects on birds and bats are rigorously assessed during the federal permitting process for every COP, and effective measures are incorporated in the T&Cs of COP Approval to reduce potential impacts. Some of these measures include using perching deterrents, adhering to light abatement standards, and requiring monitoring and reporting.

Hundreds of species of birds use the offshore environment, including shorebirds, wading birds, pelagic birds, and migratory songbirds. Although collision with offshore wind turbines is a potential risk to birds, many species consistently fly below or above the rotor swept zone and are therefore at low risk of collision.[224] Additionally, certain species typically fly around areas with wind turbines rather than through them (macro-scale avoidance) or actively avoid wind turbines (meso-scale avoidance) and/or spinning blades (micro-scale avoidance) when passing through a wind turbine array, which also limits their risk.[225] Further, during the offshore wind area identification and leasing process, BOEM has excluded certain areas due to bird presence, thereby minimizing collision risk from the start (see Table 1).[226] For example, when identifying the Maryland RFI Area, BOEM removed several OCS blocks in response to concerns raised by the Maryland Department of Natural Resources, including concerns regarding bird concentrations.[227] BOEM excluded an area of high sea duck occurrence from the Massachusetts WEA to avoid impacts to the valuable habitat.[228] Based on recommendations from USFWS, BOEM excluded areas within 20 NM from shore from the WEAs in the Gulf of America to mitigate potential impacts to migratory birds.[229]

The potential direct and indirect impacts of offshore wind projects on birds are rigorously assessed during the federal permitting process. Each COP characterizes bird populations through surveys and desktop analyses and assesses project-specific risk from offshore wind development. In addition to the assessment included in the COP, BOEM typically assesses collision risk for the ESA consultation using the deterministic Band Model[230] and/or a stochastic model (the Stochastic Collision Risk Assessment for Movement [SCRAM] model)[231] for three federally listed bird species

(piping plover [*Charadrius melodus*]*, rufa* red knot [*Calidris canutus rufa*], and roseate tern [*Sterna dougallii*]) on the Atlantic OCS to estimate the annual likelihood of collision and the annual number of collisions with rotating turbine blades.[232]

Recent studies of offshore wind projects in the US, Europe, and United Kingdom show low collision rates and indications of effective micro-avoidance maneuvers by birds, with reports of between zero and six collisions in the various year-long/multi-year studies.[233,234,235] Collision risk is likely overestimated in widely-used European collision risk modeling tools, given that the basic version of the Band Model does not take into account low seabird flight heights.[236,237] In other words, the risk of collision is weighted evenly across the rotor sweep zone in the basic model, regardless of the height at which a particular species tends to fly, and the actual risk may be lower based on bird flight patterns or avoidance behavior.[238]

Although bat use of the offshore environment is not well understood, bat presence offshore is generally thought to be limited, with significantly lower activity levels offshore than onshore. While some bat detections have occurred in offshore waters where wind turbines may be located, especially during spring and fall migrations,[239,240,241] most overwater bat flights are expected to occur close to shore.[242] Some research suggests that bats visit offshore structures to feed as the use of artificial light attracts their insect prey,[243,244] which could increase the potential risk of collision. However, based on available data, bat collision risk is expected to be low offshore. A study published in 2021 found that there have been zero known bat fatalities at existing offshore wind energy facilities worldwide.[245] Bats may also be impacted from onshore construction due to habitat disturbance and/or tree clearing activities, but these potential effects are addressed during the federal permitting process and mitigation measures often include time of year restrictions on certain onshore construction activities to limit risks to bats.

Decades of research on US bird and bat population biology and ecology have identified key threats from wind energy construction and operations and developed strategies to mitigate impacts. Multiple low-cost strategies for reducing collision risk from offshore wind projects already exist and have been incorporated in the T&Cs of COP Approval. Some of these measures include using perching deterrents and submitting a Bird Perching Deterrent Plan to BOEM and the Bureau of Safety and Environmental Enforcement (BSEE), adhering to light abatement standards, and requiring monitoring and reporting.[246] Extensive Avian and Bat Post-Construction Monitoring Plans are often required in the T&Cs of COP Approval to better understand bird and bat presence near the offshore wind infrastructure. Other measures include annual bird and bat mortality reporting on both vessels and structures throughout the life of projects.[247]

Importantly, even environmental "watch dog" groups like the Audubon Society publish statements in support of offshore wind, stating "Two-thirds of bird species in North America will face extinction unless we tackle climate change. That is why Audubon supports the swift deployment of diverse renewable energy resources to decarbonize the economy and stabilize the climate."[248] The Department of Energy's Synthesis of Environmental Effects Research project found that many species at risk of collision are in decline because of existing stresses, such as the effects of climate change and human activity.[249] To put the impacts of offshore wind on birds into perspective, Audubon's Bird and Offshore Wind Report notes that "up to 46% of all seabird species—and as many as 380 million individual birds—are at risk from the following three threats: invasive species, fishing activity fatalities, and climate change. In stark contrast, all forms of energy production (including offshore wind) and mining were found to impact only 10% of species, typically with medium or low magnitude of impacts."[250]

In conclusion, although collision with offshore wind turbines is possible, the risk is considered low for many bird species that fly outside the rotor swept zone or exhibit avoidance behavior and for most bats, which are expected to be relatively uncommon offshore. The potential direct and indirect impacts of offshore wind projects on birds and bats are rigorously assessed during the federal permitting process for every COP, and effective measures are utilized to reduce potential impacts. Environmental conservation-focused groups dedicated to protecting birds and bats agree that potential offshore wind impacts can be effectively and affordably mitigated.

10 PLANS FOR DATA COLLECTION AND SHARING

- BOEM has published several guidance documents that specify recommendations for offshore wind data collection, standardization, and sharing. These guidelines span several topics, including avian species, marine mammals, sea turtles, fish, benthic habitats, G&G data, archaeological and historic property information, spatial data, and pre- and post-construction monitoring.
- BOEM and NMFS have collaborated on recommendations for monitoring and mitigation methods, essential fish habitat (EFH) assessment documentation, a North Atlantic right whale (NARW) and Offshore Wind Strategy, and passive acoustic monitoring (PAM) data collection and storage. NMFS has additional recommendations that are considered during the COP preparation and NEPA process.
- The T&Cs of COP Approval for offshore wind projects typically require several monitoring plans to assess the effects of project construction and operation on various resources, such as fisheries monitoring plans, avian and bat monitoring programs, benthic survey plans, and PAM plans. As part of these conditions, BOEM often includes requirements for data collection and dissemination.

BOEM has published several guidance documents that specify recommendations for data collection, standardization, and sharing. BOEM's survey and data collection guidelines span several topics, including avian species, marine mammals, sea turtles, fish, benthic habitats, G&G data, archaeological and historic property information, and spatial data.[251,252] While these guidelines are primarily focused on surveys and assessments that developers perform to support their SAPs and COPs, they can also inform pre- and post-construction monitoring of offshore wind projects (see Appendix 1). In addition, BOEM and NMFS have collaborated on recommendations for monitoring and mitigation methods,[253] EFH assessment documentation,[254] a NARW and Offshore Wind Strategy,[255] and PAM data collection and storage.[256] NMFS has additional recommendations that are considered during the COP preparation and NEPA process for offshore wind projects, including data recommendations for EFH habitat mapping,[257] commercial fisheries assessments,[258] ESA information needs,[259] and technical guidance for assessing sound impacts.[260]

Groups such as ROSA and RWSC collaborate with offshore wind industry representatives, academic researchers, state and federal agencies, environmental non-governmental organizations, fishermen, and other stakeholders on data collection, standardization, and sharing. ROSA has published studies and guidelines on fisheries data storage, offshore wind monitoring, and data sharing policies.[261] ROSA's "FishFORWRD" database provides a catalog of all US East

Coast research, monitoring efforts, and stated research needs related to offshore wind, fish, and fisheries.[262] RWSC has published studies on long-term and archival storage of PAM data, criteria for evaluating data repositories, and essential metadata guidelines for offshore wind and wildlife data.[263] RWSC also has a database of research projects and data collection activities, with a focus on research addressing the potential impacts of offshore wind projects.[264]

The T&Cs of COP Approval for offshore wind projects typically require several monitoring plans to assess the effects of project construction and operation on various resources, such as fisheries monitoring plans, avian and bat monitoring programs, benthic survey plans, and PAM plans. As part of these conditions, BOEM often includes requirements for data collection and dissemination. For example, the T&Cs of COP Approval for SouthCoast Wind and CVOW-C require that all avian tracking data be stored, managed, and made available to BOEM and USFWS following the protocols and procedures outlined in USFWS' *Guidance for Coordination of Data from Avian Tracking Studies* and that PAM data be collected and processed following RWSC's best practices for long-term and archival PAM data.[265,266,267] Additionally, projects' T&Cs of COP Approval, as well as IHAs and LOAs, specify extensive requirements for the collection and reporting of PSO data.

Fisheries monitoring plans are typically developed and revised through the state and/or federal permitting processes. Appendix 1 provides a summary of data standardization and sharing in fisheries monitoring plans for a sample of offshore wind projects (South Fork Wind, Vineyard Wind 1, CVOW, and Empire Wind). A review of these monitoring plans indicates that the studies are being conducted in accordance with BOEM's fishery survey guidelines, regional protocols (e.g., Northeast Area Monitoring and Assessment Program [NEAMAP]), regional guidance (e.g., ROSA guidelines), and/or with input from appropriate stakeholders (e.g., fishermen and research institutions). This review also suggests that several developers designed their surveys and sampling methods to align with existing regional datasets so that the data generated can be compared to existing data and ongoing regional studies. Some developers also proactively share their fisheries survey reports on their websites.[268,269,270]

11 BENEFITS OF OFFSHORE WIND DEVELOPMENT

- There are many environmental benefits of offshore wind, including global public health and climate benefits resulting from reductions in regional power grid emissions as well as localized environmental benefits such as increased recreational fishing through the artificial reef effect.
- Offshore wind is a domestic energy source that increases energy reliability, reduces vulnerabilities to climate change, and increases national energy security by reducing reliance on foreign energy sources.
- Offshore wind creates good-paying American jobs across a diverse range of supply chain industries. The offshore wind industry has resulted in over $40 billion in industry investments and, at the end of 2024, was projected to support up to 56,000 US jobs by 2030.

The benefits of offshore wind energy have been recognized for decades. First and foremost, offshore wind is an abundant, renewable resource that creates energy without burning fuel or emitting air pollution.[271] By reducing reliance on and displacing electricity from fossil fuel power plants, the clean energy from offshore wind projects will reduce emissions of greenhouse gases (GHGs) and other air pollutants from the regional power grid. According to the US Department of Energy, lifecycle GHG emissions from offshore wind projects are approximately 2–4% of the lifetime emissions of coal, oil, and natural gas power plants, with a median of 19 grams of carbon dioxide (CO_2) per kilowatt-hour (kWh) for offshore wind compared to 1,001, 840, and 486 grams of CO_2 per kWh for coal, oil, and natural gas, respectively.[272] A reduction in GHG emissions will help mitigate the effects of climate change, which include more frequent and dangerous storms, increased flooding, severe heat waves and droughts, warming oceans and sea level rise, ocean acidification, changes in growing seasons and agricultural productivity, shifts in species' distributions, and increases in energy system costs.[273,274,275] Offshore wind energy will also reduce regional emissions of harmful air pollutants such as nitrogen oxides (NOx), sulfur dioxide (SO_2), and fine particulate matter ($PM_{2.5}$), which lead to premature death, cardiovascular and respiratory disorders, cancer, and absenteeism at school and work[276,277,278] and cause acid rain and ground-level ozone/smog.[279,280]

A 2024 study by Resources for the Future, an independent nonprofit research institution, projected the development of 32 planned or proposed offshore wind projects off the US Atlantic and Gulf Coasts, which could produce 2.5% of all energy generation in the US and Canada. The

authors examined how those offshore wind projects would affect other electricity generation capacity, emissions, health, costs for electricity and natural gas customers, profits, and net government revenues in the year 2035. Their modeling results indicated that:

> *... the offshore wind farms' estimated net benefits are positive, with an estimated benefit-to-cost ratio of 14 to 1. Generation from the offshore wind farms disproportionately reduces natural gas and coal-fueled generation, causing large emissions reductions. Further, the emissions reductions tend to be upwind of densely populated areas. Consequently, the offshore wind farms reduce annual estimated US premature deaths from airborne particulate matter and ground-level ozone by 520 per year. Black, Hispanic, and low-income Americans account for a disproportionately large share of the premature deaths avoided, as do residents of the New York City area. The offshore wind farms reduce worldwide projected future deaths from climate change by 1,600 per year of their operation.*[281]

Besides global public health and climate benefits, offshore wind is a domestic energy source that creates good-paying American jobs across a diverse range of supply chain industries. The offshore wind industry has resulted in over $40 billion in industry investments, including investments in steel production, shipbuilding, and the supply chain, with over 1,900 supplier contracts across 40 states.[282] At the end of 2024, the offshore wind industry was projected to support up to 56,000 US jobs by 2030.[283] In addition, domestic offshore wind development reduces reliance on foreign energy sources, thus increasing national energy security. According to the Intergovernmental Panel on Climate Change's 2023 Synthesis Report, energy generation diversification (e.g., wind, solar, small-scale hydroelectric) will also increase energy reliability and reduce vulnerabilities to climate change.[284]

There are also other environmental benefits from offshore wind development. Site characterization surveys and monitoring work are collecting data about the seafloor and marine species abundance and distribution across large swaths of the OCS that have not been studied at this level of detail before, which is invaluable for understanding regional ecology. In addition, installing infrastructure on relatively flat, softbottom seafloor can cause an artificial reef effect around turbine foundations; this involves the colonization of hard surfaces underwater by attached biological organisms (e.g., mussels, barnacles), which can further attract structure-oriented fish (e.g., cod) as well as other species following prey. The Block Island Wind Farm has become a popular destination for recreational fisherman due to this reef effect attracting fish to the turbine foundations.[285]

As demonstrated throughout this assessment, the offshore wind leasing and permitting process is rigorous and results in extensive measures to avoid, minimize, and mitigate potential impacts to navigation, fisheries, national security, marine mammals, birds, and other resources. There is a clear consensus across many federal and state agencies, scientific disciplines, subject matter experts, research organizations, and environmental nonprofit groups that, due to the severity of climate change consequences on biological and socioeconomic systems, the benefits of offshore wind development far outweigh any drawbacks. As stated by The Nature Conservancy, a nonprofit organization with a focus on conservation biology and preserving the environment, "Offshore wind is a renewable energy technology that will be critical to decarbonizing electricity, making our communities and oceans healthier and our energy resources more reliable around the world."[286]

APPENDIX 1 DATA STANDARDIZATION AND SHARING IN FISHERIES MONITORING PLANS FOR SELECT OFFSHORE WIND PROJECTS

SOUTH FORK WIND

South Fork Wind has two plans to assess the potential impacts of the installation and operation of the project on fish and invertebrates: the New York State (NYS) Fisheries Study Work Plan and the South Fork Wind Fisheries Research and Monitoring Plan. The NYS Fisheries Study Work Plan was developed through partnerships with research institutions and universities and took into account BOEM's 2019 fishery survey guidelines[287] and ROSA's 2021 framework for fisheries monitoring.[288] It involves a passive telemetry study and a bottom otter trawl survey along the offshore export cable route to examine the effects of cable installation and energization on commercially, ecologically, and recreationally important species. The bottom otter trawl survey was designed to be consistent with sampling techniques and protocols used in other regional bottom otter trawl surveys. The survey design is modeled after the NEAMAP survey to ensure compatibility with the long-term regional dataset. The surveys use the same net design, trawl doors, and tow and sampling protocols to ensure compatibility with both the NEAMAP and NMFS trawl surveys, as recommended by ROSA.[289]

The South Fork Wind Fisheries Research and Monitoring Plan was developed in accordance with BOEM's 2019 fishery survey guidelines[290] along with recommendations from the Rhode Island Coastal Resources Management Council,[291] NYSERDA,[292] and the Massachusetts Division of Marine Fisheries (MA DMF).[293] The plan was developed in partnership with local research institutions and universities, and with input from the fishing community. Originally, the fisheries portion of the plan included four demersal fisheries studies (gillnet, beam trawl, ventless lobster trap, and ventless fish pot surveys) and an acoustic telemetry survey. The fisheries portion of the plan was updated in 2023, and the gillnet survey was replaced with a mechanical jigging feasibility study and a passive acoustic telemetry study. The benthic portion of the plan includes hard bottom, soft bottom, and novel surfaces surveys that include sediment profile imaging and remotely operated vehicle (ROV)-based underwater video. Each of these studies include their own details on data entry, reporting, analysis, and management. The South Fork Wind Fisheries Research and Monitoring Plan[294] contains a section on data sharing, which was added in response to feedback from NOAA, MA DMF, the New York State Department of Environmental Conservation, and the Rhode Island Department of Environmental Management. In short, data will be made available on an annual cycle, after the data undergo rigorous quality assurance and quality control criteria. To obtain the data, requestors need to provide a brief proposal describing

the data being requested, the intended use of the data, and the potential work products that will result from use of the data. Requests will be processed internally and, if appropriate, data will be distributed depending on the nature of the request.

VINEYARD WIND 1

Vineyard Wind 1's "Fisheries Studies and Science" webpage[295] provides details for four ongoing surveys: 1) acoustic monitoring of highly migratory species; 2) lobster ventless trap, black sea bass, and plankton surveys;[296] 3) bottom trawl surveys;[297] and 4) drop camera surveys.[298] For the ventless trap and larval surveys, Vineyard Wind 1 partnered with the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST) and the Massachusetts Lobstermen's Association to design the surveys, and also conducted a black sea bass study at the recommendation of MA DMF. For the bottom trawl survey, Vineyard Wind 1 partnered with SMAST again to adapt protocols from the regional NEAMAP[299] surveys so the survey results will follow a consistent framework and facilitate data integration. The fundamental goal of the SMAST drop camera surveys is "to provide fishery resource managers, marine scientists and fishing communities with an independent assessment of scallop resources and associated habitats. The survey techniques were developed collaboratively with scallop fishermen and apply quadrat sampling methods based on diving studies" that have been occurring since the 1990s and match those used in the New England Fisheries Management Council's scallop stock assessment, ensuring the use of an extensively reviewed method and regional data compatibility.[300]

In addition, SMAST conducted a peer review process for the Vineyard Wind 1 fisheries monitoring plans that included three outside fisheries scientists, six commercial fishermen, and two recreational fishermen. All the fisheries survey methods and results to date were reviewed and critiqued by the group, culminating in a virtual meeting open to the public. This open platform provided an opportunity for any additional comments or concerns about the fisheries monitoring plans to be heard.[301] Overall, the consensus from the peer review and public meeting was that the monitoring surveys were well designed and implemented, the data can be used for regional impact assessments, and the collaborative review process combining scientific and fishermen perspectives was commended.[302]

COASTAL VIRGINIA OFFSHORE WIND

CVOW published a 2024 Atlantic surfclam monitoring survey report authored with the Virginia Institute of Marine Science and Rutgers University.[303] Several other poster presentations and reports resulting from work done in conjunction with pre-construction monitoring surveys are freely available for review on the CVOW Resources website.[304] In 2025, CVOW submitted their Fisheries Mitigation and Monitoring Plan Report to BOEM, BSEE, NMFS, USACE, and the Virginia Marine Resources Commission, which summarized the implementation of the plan that BOEM

had approved with their COP. This report describes the progress made on establishing a pre-construction baseline for the analysis of impacts on three key species: black sea bass, channeled whelk, and Atlantic surfclam. CVOW partnered with individuals across the commercial fishing industry to incorporate their vessels and equipment into the surveys. A data sharing plan is not detailed, but it appears that summary reports will be made available on the CVOW website as they are finished.

EMPIRE WIND

Empire Wind has its Fisheries and Benthic Monitoring Plan[305] posted on its website, which details survey methods and design for eight studies: 1) trawl survey, 2) baited remote underwater video survey, 3) environmental DNA sampling, 4) acoustic telemetry, 5) sea scallop plan view camera surveys, 6) stereo camera underwater imagery along novel hard bottom substrates, 7) Sediment Profile Imaging/Plan View (SPI/PV) and sediment sampling to detect structure-associated organic enrichment, and 8) SPI/PV to detect physical disturbance of soft sediments associated with cables. This plan was developed in accordance with BOEM's 2019 fishery survey guidelines and ROSA's 2021 framework for fisheries monitoring. The plan includes a dedicated section on data management, reporting, and sharing, which explains where the data will be housed and how data will be made available upon request.

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