OCS Study
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Summary Report: Best Management Practices Workshop for Atlantic Offshore Wind Facilities and Marine Protected Species

US Department of the Interior
Bureau of Ocean Energy Management
Atlantic OCS Region

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Summary Report: Best Management Practices Workshop for Atlantic Offshore Wind Facilities and Marine Protected Species

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US Department of the Interior
Bureau of Ocean Energy Management
Atlantic OCS Region

DISCLAIMER

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REPORT AVAILABILITY

To download a PDF file of this report, go to https://www.boem.gov/BMP-Workshop-Protected-Species

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List of Abbreviations and Acronyms

AMAPPS	Atlantic Marine Assessment Program for Protected Species
ADD	Acoustic Deterrent Devices
AMAR	Autonomous Multichannel Acoustic Recorder
AWEA	American Wind Energy Association
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
COP	Construction and Operations Plan
DMA	Dynamic Management Area
DOE	Department of Energy
DOI	Department of the Interior
DP	Dynamic Positioning
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
GOM	Gulf of Mexico
HARP	High-frequency Acoustic Recording Package
HARU	Haruphone
HF	High Frequency
HR	High Resolution
HRG	High Resolution Geophysical
IHA	Incidental Harassment Authorization
ITS	Incidental Take Statement
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
LOA	Letter of Authorization
MARCO	Mid-Atlantic Regional Ocean Council
MARU	Marine Autonomous Recording Unit
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
RODEO	Real-time Opportunity for Development Environmental Observations
SAP	Site Assessment Plan
SRS	Sound Reduction System
TTS	Temporary Threshold Shift
USCG	United States Coast Guard
USFWS	U.S. Fish and Wildlife Service
WEA	Wind Energy Area

1 Introduction

1.1 Workshop Introduction

The Bureau of Ocean Energy Management's (BOEM) Office of Renewable Energy Programs held the "Best Management Practices Workshop for Atlantic Offshore Wind Facilities and Marine Protected Species" March 7-9, 2017. The public workshop was hosted at the National Oceanographic and Atmospheric Administration (NOAA) headquarters, in Silver Spring, MD and facilitated by Kearns & West. The workshop informed best management practices (BMPs) for avoiding, reducing, and monitoring impacts to marine protected species from the development of offshore wind on the Atlantic Outer Continental Shelf (OCS). Expert panelists and presenters from the Federal government, offshore wind industry, consultants, academics, and non-profit organizations from the U.S. and Europe presented the current state of the science, tools used to assess impacts, identified outstanding issues, and presented lessons learned on how to best minimize and mitigate impacts.

The workshop focused on identifying issues and presenting science to inform the development of BMPs, specifically mitigation measures, standardized monitoring procedures, and the maintenance and sharing of information.

The workshop objectives were to:

1) Increase understanding of the science and regulations for protecting marine species from the effects of offshore wind development on the Atlantic OCS;

2) Understand the perspectives of stakeholder groups on protected species mitigation and monitoring; and

3) Identify and discuss the best approaches for BMPs to avoid, minimize, and monitor the effects of offshore wind activities on marine protected species.

BOEM did not seek consensus, but may use the outcomes of the workshop to inform Environmental Assessments (EAs) and Environmental Impact Statement (EISs) under the National Environmental Policy Act (NEPA), future guidance to Lessees, areas of future research, and Endangered Species Act (ESA) consultations. The outcomes of the workshop may also be useful to the offshore wind industry when preparing Construction and Operations Plans (COPs) that must identify the use BMPs (585.621(f)) and measures for avoiding, minimizing, reducing, eliminating, or monitoring environmental impacts (30 CFR 585.216(b)(15)). These outcomes may also assist in preparing incidental take applications that may be required under the Marine Mammal Protection Act (MMPA).

This report summarizes the workshop presentations and outcomes. Presentation slides from the workshop are available online here: https://www.boem.gov/BMP-Workshop-Protected-Species/.

1.2 BOEM's Role in Offshore Wind Development

The Outer Continental Shelf Lands Act (OCSLA) gives BOEM responsibility over the exploration and development of offshore energy and mineral resources on the OCS. In 2009, Department of the Interior (DOI) announced final regulations for the OCS Renewable Energy Program, which was authorized by the Energy Policy Act of 2005 (EPAct). DOI's BOEM is responsible for implementing these regulations, which provide a framework for issuing leases, easements and rights-of-way for OCS activities that support production and transmission of renewable energy, including offshore wind, ocean wave energy, and ocean current energy. Since 2013, BOEM has issued 13 leases for commercial-scale offshore wind development offshore the states of Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina. As part of BOEM's management responsibilities, and as required by law, BOEM conducts environmental reviews and creates compliance documents for each major stage of energy development planning on the OCS. Environmental impact determinations are made for each resource, and BOEM considers the effects of activities on the lease (e.g., cable laying, structure installation, lighting, vessel traffic, and survey activities). BOEM is authorized to conduct and oversee environmental studies to inform policy decisions relating to the management of renewable energy development on the OCS, and engage with the public and stakeholders. BOEM is also required to consider mitigation and uses the "mitigation hierarchy:" avoid, minimize, reduce, or eliminate the impact over time.

Environmental assessments utilize the best available science to ensure that all factors related to environmental impacts are captured. BOEM's Environmental Studies Program (ESP) provides some of the information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS. ESP develops, funds, and manages scientific research to inform policy decisions on the development of renewable energy on the OCS. Approximately thirty-five million dollars is spent annually on studies, which includes an emphasis on protecting marine mammals and protected species, and mitigating noise impacts. Research covers physical oceanography, atmospheric sciences, biology, protected species, social sciences and economics, submerged cultural resources and environmental fates and effects.

1.3 Legal and Regulatory Background

OCSLA and the EPAct gives BOEM the authority to implement regulations for renewable energy, which provide a framework for issuing leases, easements, and rights-of-way for OCS activities that support production and transmission, there are a number of other laws and regulations applicable to operations on the OCS. The MMPA and the ESA apply to marine protected species and offshore wind development. These laws are designed to ensure that offshore wind development does not negatively affect marine environments, which includes the marine species found within the offshore development areas. NEPA requires Federal agencies to consider reasonable foreseeable environmental impacts of their actions and solicit public involvement. While there are other laws that apply to offshore wind, this section provides a brief overview of the MMPA, ESA, and NEPA as they pertained to the workshop.

1.3.1 The Marine Mammal Protection Act

Finding that certain species and population stocks of marine mammals were in danger of extinction or depletion, Congress passed the MMPA in 1972. The act's purpose is to protect all marine mammal species and maintain the health and stability of marine ecosystems, especially essential habitats, including rookeries, mating grounds, and areas of similar significance.

The act establishes a general prohibition on take, but does have a system of exemptions and permitting authorities that does allow for take in certain situations (commercial fishing permits, scientific research permits, subsistence hunting in Alaska, protection of personal safety or

> ***"Take" –*** *to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal*
>
> ***"Harassment" –*** *any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal (Level A) or disturb a marine mammal by causing disruption of behavioral patterns (Level B)*

property, and incidental take authorizations (ITAs)). See Table 1 for requirements for take under the MMPA.

The major non-fishery activities that typically require a Marine Mammal ITA are those that produce underwater noise. Section 101 allows for the authorization of an incidental take (non-intentional, but not unexpected) of a marine mammal that occurs during otherwise lawful activities, including geophysical surveys, geotechnical surveys, and pile driving.

Incidental take may be authorized upon request for a small number of marine mammals for select activities in specific places if, after public comment:

- Impacts are negligible (on species or stocks);
- There are no un-mitigatable adverse impacts (for subsistence uses); and
- NOAA prescribes the permissible method of take, mitigation measures, and requirements for monitoring and reporting.

Table 1: Requirements for take under the MMPA.

Take is authorized through a Letter of Authorization (LOA) or an Incidental Harassment Authorization (IHA). LOAs are for Level A harassment (serious injury), death, or Level B harassment that is planned for multiple years, are effective for five years, and typically require 12-18 months to process. Rulemaking is required for the specified activities including two public comment periods. IHAs are for Level A or B harassment that occurs during activities that are planned for a year or less, are valid for a maximum of one year, and typically take 180+ days to process. IHAs do not require rulemaking, but do require one 30-day comment period. Both types of authorizations require mitigation, monitoring, and reporting.

Permitting Requirements for Take under the MMPA	**Letter of Authorization (LOA)**	**Incidental Harassment Authorization (IHA)**
Type of Harassment Authorized	Level A (serious injury), death, or Level B harassment planned for multiple years	Level A or Level B harassment for activities planned for a year or less
Effective Period of Permit	5 years	Maximum 1 year
Time to Process Permit Application	12-18 months	180+ days
Rulemaking Required	Yes	No
Amount of Public Comment	2 public comment periods	one 30-day comment period
Mitigation, Monitoring and Reporting Required	Yes	Yes

1.3.2 The Endangered Species Act

Congress passed the ESA in 1973 with the purpose of protecting and aiding the recovery of imperiled species and the ecosystems upon which they depend. Species are listed as endangered (in danger of extinction throughout all or a significant portion of its range) or threatened (likely to become endangered within the foreseeable future). Section 7(a)(2) states “Each federal agency shall…insure that any action authorized, funded, or carried out by such agency…is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species.”

In order to make a determination on whether an action will jeopardize a species or modify habitat, BOEM consults with either NOAA (for marine species) or the U.S. Fish and Wildlife Service (USFWS) (for terrestrial and freshwater species). During this interagency consultation, NOAA or USFWS uses the best available science to produce consultations that are legally defensible, transparent, objective, replicable, and evidence-based. Consultations must have:

- Information on the proposed action;
- Information about the ecological entities (listed species, critical habitat, etc.);
- An assessment method that integrates this information to produce and support a conclusion; and
- A written record of the interactions, deliberations, or analysis that occurred during the consultation process, the information that was (or was not) considered, and any resolution of disagreements.

Consultations can either be informal or formal and must be completed before any final agency action is taken and before offshore wind development begins. Consultations can be done on an individual project (considers the effects of one action), batched (considers the effects of multiple, defined actions), or programmatic (considers effects of an agency’s program and may not have individual actions defined). Informal consultations are completed within 30-60 days and are for Federal actions that have insignificant or discountable effects on listed species and do not adversely affect critical habitat. Formal consultations are completed within 135 days and produce a Biological Opinion, a process that concludes if an action is likely/not likely to jeopardize the existence of one or more species or result in the destruction or adverse modification of critical habitat. If the Biological Opinion determines a species is in jeopardy or habitat will be destroyed or adversely modified, reasonable and prudent alternatives must be developed. If no jeopardy is found, an Incidental Take Statement (ITS) must be included, even if “take” is being exempted. The ITS must outline the amount or extent of take that is expected, measures that minimize the effects of the take on threatened or endangered species, and terms and conditions. Monitoring and reporting is required during project implementation to ensure that take is not exceeded.

1.3.3 The National Environmental Policy Act

The NEPA of 1969 requires the government to consider the impacts to the environment from all major federal actions. NEPA lays out a process for making decisions based on an understanding of the consequences to the environment from a federal action. This process includes environmental assessment of the proposed action as well as public comment.

For offshore wind, there is a four stage process for authorizing wind energy leases that includes: 1) planning and analysis, 2) lease issuance, 3) site assessment, and 4) construction and operation. The planning and analysis stage seeks to identify areas suitable for wind energy leasing. During this phase, BOEM conducts environmental compliance reviews under NEPA and consults with Tribes, States, natural resource agencies, stakeholders, and the public. During the leasing phase, BOEM awards leases through a competitive process, if competitive interest is identified, otherwise a non-competitive process is followed. Commercial leases grant the exclusive right to use the lease area to develop plans and conduct surveys, but do not grant the right to construct facilities. During the site assessment phase, the lessee conducts site characterization surveys and studies. The lessee submits a Site Assessment Plan (SAP), which must be reviewed and approved by BOEM before a meteorological tower and/or buoy can be installed.

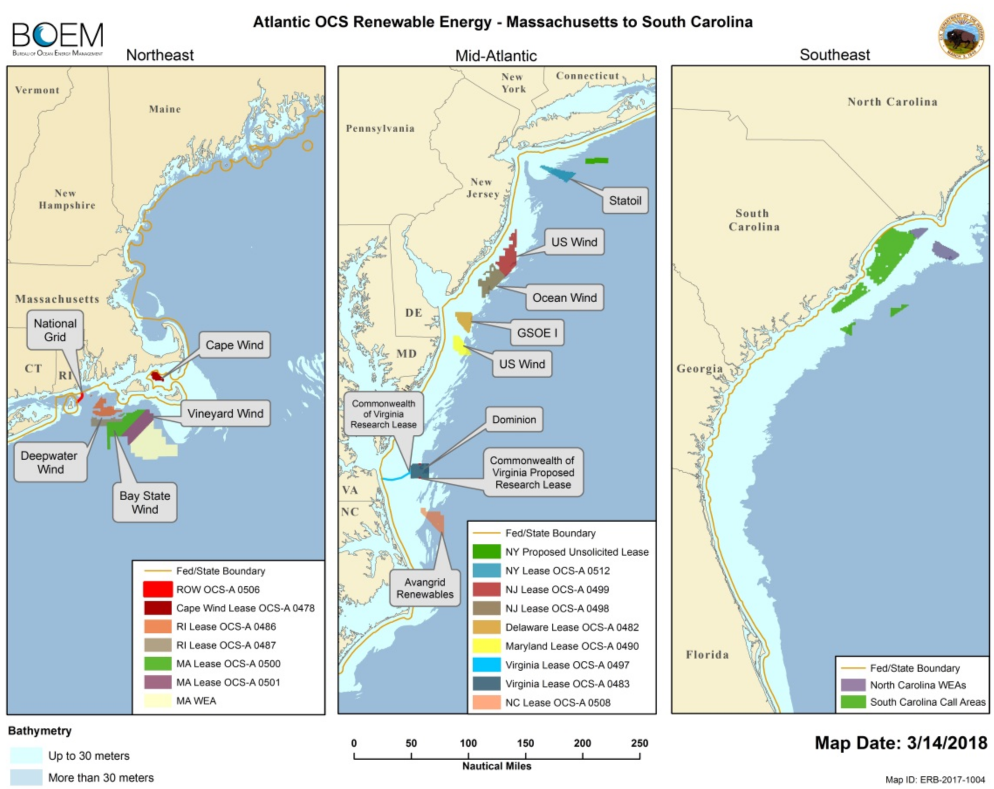
Finally, during the construction and operations phase, the lessee submits a COP, which provides a detailed plan of construction and operation of the wind energy project. As the lead agency, BOEM conducts environmental reviews under NEPA, and consults with stakeholders and the public. For a COP, the NEPA process will likely be documented via an EIS and Record of Decision. For more details on the leasing process, see here: https://www.boem.gov/Commercial-Leasing-Process-Fact-Sheet/.

2 Protected Species and Offshore Wind Development

2.1 Identifying Effects to Protected Species

Development of offshore wind could have potential impacts to marine species. Figure 1 shows the planning areas and existing leases for offshore wind development. These areas also coincide with important areas for protected species. Identifying affected species and habitats, as well as the potential source and route of impacts to protected species helps gather the necessary data for environmental reviews under NEPA. BOEM regularly consults with NOAA and the USFWS to gather the best available science to make determinations regarding impacts to species and habitats. The workshop provided an opportunity for stakeholder coordination, so BOEM could better understand how offshore wind development affects protected species and better understand ways to minimize impacts to species. This section presents species of interest that were the focus of the workshop (protected species), activities associated with offshore wind, and what is known about effects of offshore development on protected species.

Figure 1: Map of planning areas and existing leases for offshore wind. The Atlantic OCS is divided into three planning areas: the Northeast, Mid-Atlantic, and Southeast.



2.1.1 Species of interest

For this workshop, the focus was on protected species found in the Atlantic, including threatened and endangered sea turtles and whales (Table 2), and all other marine mammals. Even though endangered and threatened species are highlighted as a priority, the status of some stocks of marine mammals may also need particular attention in some geographic areas.

Table 2: ESA listed species relevant to the workshop.

Threats, recovery goals, and recovery challenges are listed for each species focused on during the workshop. Although listed species of fish may be affected by offshore wind activities, these species were not the focus of this workshop.

Species	ESA Status	Threats/Historical Decline	Recovery Goals	Recovery Challenges
Sea Turtles	• Green – threatened • Loggerhead – threatened • Kemp's Ridley – endangered • Leatherback – endangered • Hawksbill – endangered	• Overexploitation (harvest of eggs and animals) • Environmental stressors • Fishery bycatch	• Address threats	• Wide distribution across international jurisdictions • Multiple life stages across vast habitats
North Atlantic Right Whale	• Endangered • Two designated critical habitat areas (Northeast and Southeast U.S.)	• Vessel collisions • Entanglement • Habitat degradation • Contaminants • Climate and ecosystem change • Noise • Disturbance from whale-watching activities	• Minimize injury and mortality from ship strikes and fishery interactions • Protecting essential habitats • Minimize vessel disturbance • Continue international ban on hunting and other directed take • Monitor population size and trends in abundance • Maximize efforts to free entangled/stranded animals	• Slow reproduction • Increased mortality and sub-lethal effects on survival due to entanglement
Sperm Whales	• Endangered	• Vessel collisions • Fishery interactions • Disturbance from noise • Pollutants • Commercial whaling (historical)	• Sufficient and viable populations in all ocean basins • Significant threats are addressed	• Global distribution • Deepwater
Fin, Blue, and Sei Whales	• Endangered	• Vessel collisions • Fishery interactions • Historical whaling • Reduced prey abundance due to overfishing (Fin) • Habitat degradation • Disturbance from noise • Long-term changes in climate • Pollution	• Sufficient and viable populations in all ocean basins • Significant threats are addressed	• Global distribution • Deepwater

2.1.2 Activities associated with offshore wind development

Offshore wind development activities include geophysical surveys, geotechnical surveys, foundation installation, cable installation, operation and maintenance, and decommissioning. There are a number of different types of equipment used and different types of data that are collected (e.g. geophysical, cultural resources, benthic habitat identification, etc.). Typical offshore geophysical survey work includes multibeam depth sounders, side- scan sonar, magnetometers, and sub-bottom profilers (boomers and sparkers). Exposure of marine mammals to certain levels of underwater noise from the use of certain geotechnical and high resolution geophysical (HRG) survey equipment during surveys may require a letter of authorization (LOA).

The foundation type and method of securing it to the seafloor varies based on water depth and substrate. Piled foundations include monopiles and jacket foundations, while non-piled foundations include gravity and floating foundations. The most common foundation type in European waters is a monopile, which requires a steel pile to be driven into the seafloor. For water depths 15-60 meters, newer gravity based foundations can be used and do not require piling; however, this requires leveling the sea floor, which is difficult to do on hard-bottom sea floors. As the size of turbines (rotors) get larger, the number of turbines required to meet energy goals will decrease. As turbine size increases, the spacing between turbines is also increasing. This could potentially reduce the amount of pile driving needed, but spacing considerations will also need to be addressed, especially when it comes to integration with important environmental areas and shipping lanes. Currently, real-time monitoring is required for HRG surveys and will be an important mitigation strategy as industry moves toward 24/7 pile driving of turbine foundations.

Before any of these activities can occur, environmental reviews and permitting must be completed (as discussed above). Permitting is typically conducted on a project-by-project basis and impacts are evaluated via submitted plans and permit applications. During the planning process, developers may not have all the specific details for constructions plans, such as turbines size and foundation type, that will be used in a particular project. To address the possible range of project activities and their potential impacts, envelope permitting allows a developer to provide a range of potential turbines, foundations, and impacts, including commercial and supply-chain issues. Additionally, envelope permitting helps streamline permitting by considering the maximum reasonable project scenario; thus, reducing the number of subsequent permit revisions and reviews as long as future project changes fall within the envelope of the analysis considered for the permit or approved plan. The "envelope approach" will be considered in the future for U.S. permitting and will be integrated into the NEPA process (see https://www.boem.gov/Draft-Design-Envelope-Guidance).

2.1.3 Effects of development on protected species

Offshore wind development potential threats to protected species include:

- Vessel collision;
- Benthic habitat loss (potential feeding areas);
- Increased fishing pressure around structures, incidental capture/entanglement;
- Marine debris;
- Dredging/bottom-scouring or leveling;
- Spread of non-native species;
- Potential disruption of oceanographic features (i.e. surface currents);
- Water quality (habitat) degradation/contaminants;
- Noise;
- Displacement from or attraction to structures; and
- Energetic loss due to displacement.

These effects may be variable depending on timing, size of facility, as well as environmental and biological factors. However, there are protective measures that can be taken to reduce the threats to protected species. For example, soft start for pile driving, reducing vessel speeds, using trained protected species observers, time area closures, and exclusion zones.

Underwater noise from survey, construction, and operation of offshore wind is perhaps the greatest threat to protected species. Human activities on and in the ocean produce noise that can travel a long distance from the source of the noise. Marine species rely heavily on sound, and rising ambient sound levels affect their hearing abilities and limit marine species communication range and ability to sense the environment.

For the NARW in particular, there are a number of conservation efforts that have been recognized to reduce the threat level. Mandatory vessel speed reduction in Seasonal Management Areas (SMAs) and voluntary speed reductions in Dynamic Management Areas (DMAs) during certain times of the year and mandatory ship reporting systems helps to reduce vessel collisions with NARWs. Shipping lanes have been modified based on NARW movements. Other efforts include aircraft surveys and NARW alerts, outreach and education, and stranding response.

2.2 Perspectives

This section presents perspectives of government, industry, non-governmental organizations, and the academic/scientific community regarding their role in offshore wind development as well as how species can be protected while furthering the development of offshore wind.

2.2.1 Government perspective

BOEM has the responsibility for overseeing development of energy on the OCS. This responsibility entails leasing potential areas for development, working with other federal agencies and developers to comply with NEPA and other environmental laws (such as developing an EA or EIS and through interagency consultations for ESA and MMPA compliance), reviewing developer plans (SAP and COP), establishing monitoring protocols, and ensuring mitigation measures are carried out.

> ***Best management practices (BMPs)*** *are practices recognized within their respective industry, or by Government, as one of the best for achieving the desired output while reducing undesirable outcomes.*

The plans developers submit must demonstrate that proposed activities will be conducted in a manner that will use BMPs to reduce impacts to marine species. BMPs include mitigation measures that would apply across all projects, but there also may be site specific mitigations. Alternatives to the proposed action must are included under NEPA that may, in part, consider different mitigation and monitoring measures.   Mitigation measures are further refined through stakeholder input and federal consultations (such as ESA and MMPA consultations) and incorporated into the project design as a condition of COP approval. Categories of mitigation measures under NEPA include:

- Avoiding the impact altogether by not taking a certain action or parts of an action;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating the impact over time by preservation and maintenance operations by the life of the action; and
- Compensating for the impact by replacing or providing substitute resources or environments.

Mitigation measures to date largely fall within avoiding and minimizing impacts to protected species and their habitats identified through the NEPA process. In particular, sensitive or vulnerable habitats and threatened and endangered species may receive additional attention. NARWs are a highly endangered species that have been afforded specific attention in offshore lease planning. Currently, NARW mitigation measures have been developed by BOEM for the pre-construction data collection phases on OCS leases regarding vessel operations and avoiding or minimizing exposure to underwater sounds associated with data collection activities (Figure 2).

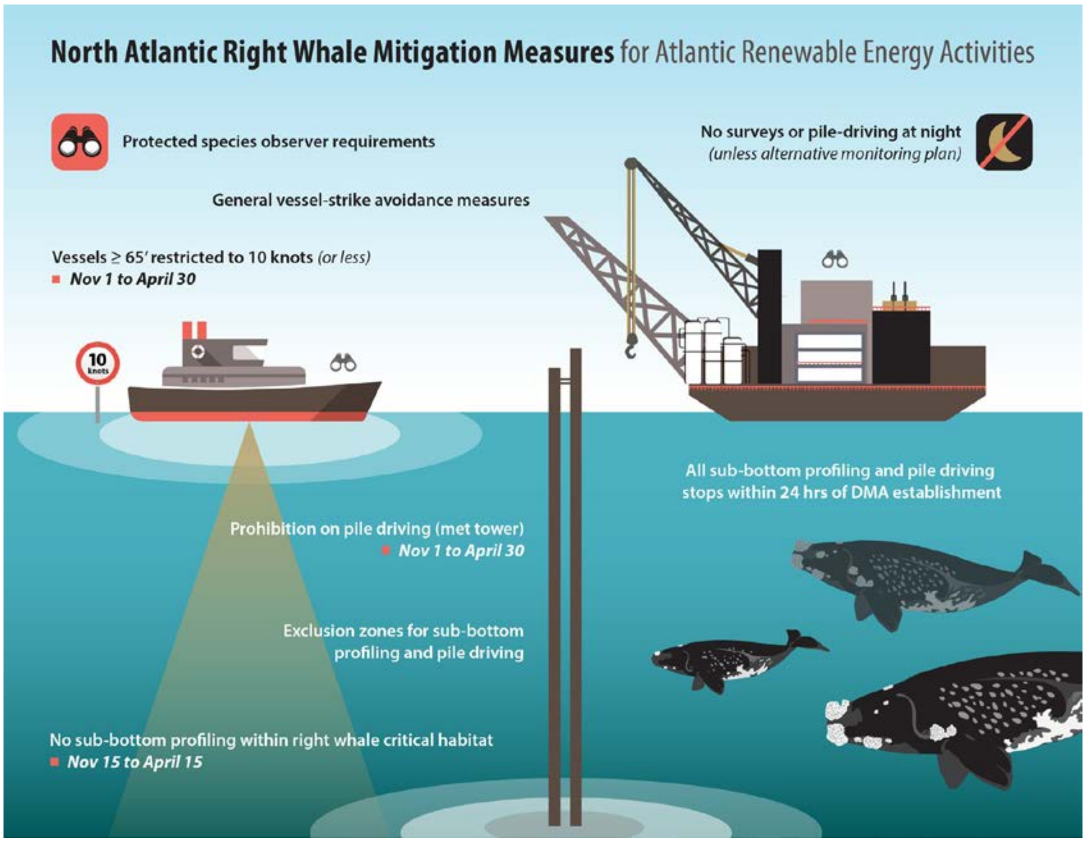


Figure 2: North Atlantic Right Whale Mitigation Measures

BOEM is interested in developing BMPs for the construction and operations phase of lease development. Examples of BMPs for the construction and operations phase could be associated with reducing exposure to pile driving noise, reducing the potential effects of vessel operations, establishing monitoring requirements (e.g., PAM and visual monitoring requirements), and implementing a post-construction monitoring strategy. BOEM also monitors to ensure proper implementation and compliance with BMPs. The monitoring also serves to study effectiveness of mitigation measures for future projects, remedy non-effective or failed mitigation, and detect unforeseen impacts. Table 3 provides an overview of responsibilities for the development of offshore wind.

Table 3: BOEM responsibilities and developer responsibilities for the development of offshore wind.

Area of Responsibility	BOEM Responsibilities	Developer Responsibilities
Mission/Planning	Oversees OCS energy development, including compliance with associated Federal Regulations	Submits detailed plan to BOEM providing a description of the proposed activities, as well as a description of resources, current status and how they could be affected by the proposed activities.
Mitigation	Ensures mitigation measures are incorporated into project design	Demonstrates that proposed activities, including mitigation measures, will be conducted in a manner that will follow BMPs
Environmental Review	Conducts site specific environmental review and consultations	Submits detailed information to assist BOEM with complying with NEPA and other environmental laws
Monitoring	Develops monitoring strategy	Implements monitoring activities, which: ensures BMP compliance, studies effectiveness of the action, remedies non-effective or failed mitigation, and detects unforeseen consequences

2.2.2 Industry perspective

The offshore wind industry currently has interests on both the Atlantic and Pacific OCS. Industry works with regulators, agencies, and non-governmental organizations (NGOs) to ensure successful delivery of the offshore renewable energy program. This collaboration entails sharing knowledge and technical advancement in the industry as well as successful application of mitigation. The Offshore Wind Strategy Committee of the American Wind Energy Association (AWEA) is very involved with regulatory perspectives and helping agencies move strategies forward that are intended to promote wind energy. The committee works with the current Administration and federal agencies to ensure the regulatory and permitting regime is sufficient and streamlined, and supports delivery of the DOI and Department of Energy (DOE) National Offshore Wind Strategy.

From an environmental standpoint, the industry works with environmental NGOs and other key stakeholders to address specific issues, including potential impacts to protected species and habitats. The Offshore Wind Strategy Committee has established working groups to address specific issues, such as a technical working group on marine mammals/NARW. In relation to marine mammals, AWEA holds regular meetings to provide industry updates; discuss issues of common concern, conservation priorities, approaches to impact assessment and mitigation measures, regulatory requirements, and approaches to project life cycle and survey techniques; identify new datasets and scientific understanding; share information, lessons learned, and best practices; explore best ways forward to apply scientific knowledge and lessons learned in context of species and habitats; and discuss individual project level discussions independently.

The offshore wind industry is interested in continuing to streamline the development of offshore wind while protecting marine species and maintaining flexibility for projects. The industry identified several areas for further collaboration/development, including 1) linking impact assessment to key issues and risks identified, 2) discussing whether improvements can be made in modeling techniques/application to better understand behavioral impacts to marine species, 3) developing an "envelope approach" to permit projects, 4) reducing unintended impacts on other environmental areas (e.g., mitigation in one area may impact a different area), 5) moving a tax policy forward for offshore wind, and 6) sharing lessons learned from the early U.S. projects and the European industry sector.

2.2.3 Non-governmental organization (NGO) perspective

Several NGOs including the Natural Resources Defense Council, National Wildlife Federation, and the Wildlife Conservation Society provided their perspectives on environmental concerns across a range of species and habitats, including the previously mentioned impacts to protected species. Some of these concerns were characterized as direct impacts to species, including vessel collisions, noise from pile driving, and short-term and potential long-term displacement from important habitat. Other concerns were characterized as cumulative effects. While it is important to move towards a clean energy future, offshore wind must be developed in an environmentally responsible manner to protect marine life. NGOs are working collaboratively with offshore wind developers to meet these environmental challenges, including the protection of sensitive species throughout the development pipeline and generating baseline knowledge useful for informing the development of BMPs.

The status of NARWs was highlighted as particular cause for concern and a need for BMPs, especially in relation to developing NARW-targeted mitigation measures. NARWs have been in decline since 2010, and the latest data indicates that they are likely in decline and on an extinction trajectory if this trend continues. Previous research has shown that there is considerable overlap between areas proposed for development and seasonal foraging grounds

(Northeast) and migratory corridor (Mid-Atlantic), and future development may potentially overlap with calving grounds (Southeast). The NARWs will travel through multiple wind energy projects during each stage of their annual migration. The most effective mitigation for NARWs is to separate development activity from animals, and particularly from mothers and calves. NGOs and Deepwater Wind worked together to develop a construction plan for the Block Island Wind Farm that avoided pile-driving during times of greatest concern for NARW in the area, setting a strong precedent for future US offshore wind projects. NGOs and developers have collaboratively developed a formal voluntary agreement concerning the Site Assessment and Characterization stage of development for the Northeast, and another for the Mid-Atlantic. These agreements are in the process of being updated based on best available science, and agreements are being drafted for the Construction and Operations and Maintenance stages of development. The agreements are viewed as mutually beneficial in that they reduce co-occurrence of protected species with development activities, provide flexibility to developers, and remove roadblocks to development.

In general, there are important considerations with respect to marine mammals and other marine species when considering mitigation measures. First, there are data gaps in species distribution for many marine mammals and their biologically important habitats. Generation and integration of multiple sources of data, specifically passive acoustic and visual survey data, are needed to support the development of relevant BMPs. Some examples were provided for the NY offshore planning area (see presentation). Second, while some data on impacts exist for certain marine mammal species, such as harbor porpoises and harbor seals, from offshore wind farm operations in Europe (see German and UK experience sections), little to no direct evidence is available about the possible impacts of operations on baleen whale behavior. This represents a significant knowledge gap and requires that agencies and developers utilize adaptive management, monitoring, and data sharing to address it.

Third, there is also a significant need for application of new technologies to reduce noise levels at the source to lessen the severity of potential impacts at the outset. Fourth, both long-term and cumulative impacts require in- depth evaluation to inform decision-making and plausible alternatives. For example, habitat displacement resulting from construction and operations could lead to increased risk of ship-strikes. Impacts should be analyzed both for individual areas, across multiple wind energy areas (WEAs), and at varying stages of the development process. Lastly, environmental assessments should be designed to capture the potential for long-term impacts, including those at the population- (e.g., long-term impacts on health and fitness) and ecosystem-levels (e.g., larval dispersal, habitat modification, etc.).

2.2.4 Academic/Scientific perspective

The academic/scientific community has an integral part to play in the information available to inform planning offshore wind development. Scientists and academic researchers carry out important studies and research cruises that characterize species and habitats; develop maps, models, and data products; and provide other data and information to BOEM. Information provided by scientists is used to develop an EIS or EA, biological opinions, and marine data portals. All of which support BOEM's decision-making process and aid in the development of BMPs.

For example, the project "Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico" collected baseline data using shipboard surveys and aerial surveys for marine mammals and oceanic conditions. This data was used to create maps of survey effort and observations, which were combined with oceanographic data to produce statistical models of cetacean presence. These models were used to create density maps (estimated number of animals per square kilometer) and uncertainty maps. The results have had a direct impact on planning and implementation of various sectors: the U.S. Navy for take estimations, NOAA for MMPA permitting, BOEM for development of the OCS programmatic EIS, and regional planning bodies to develop regional ocean plans.

2.3 Lessons Learned from Offshore Wind in Europe

Europe is much further advanced in deployment of offshore wind than the U.S. This section presents the experiences of a conservation agency in the United Kingdom and industry in Germany regarding the development of offshore wind and presents lessons learned that may be applicable to the U.S.

2.3.1 United Kingdom

Europe has seen a large growth in offshore wind. Approximately 91% of the global offshore wind energy is located offshore of Europe, and 40% of that resource is located in the United Kingdom (UK). The size of wind farms is also growing, from the first windfarm in the world built in 1991 off Denmark with only a few small turbines to some of the planned developments which will include hundreds of large turbines. Before 2016, the average wind farm was well below 500 MW. Today, the average size of consented (approved) wind farms is 600 MW and average size of planned wind farms is 900 MW.

The UK has strict measures to protect marine mammals. Habitats Directive Article 12 (http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm) which protects all cetaceans from killing, injury, and disturbance throughout their range. There is also additional protection to particularly important habitats for cetaceans. This expansion has also underscored the importance of siting wind farms away from areas where conflicts might arise. In addition to considerations such as where it's windier, closer to a grid connection, and with suitable geology for foundations, it is crucial to understand where potential conflicts with nature conservation might arise and try to avoid these. For example, a leasing area offshore Edinburgh, Scotland conflicted with several protected sites for seabird colonies. The government as well as NGOs advised the regulator of the risk to the seabirds; however, the wind farms were consented with the risk deemed acceptable. As a result, an NGO took the Scottish government to court, which added costs, uncertainties, and delays to projects. More recently, important habitats have been identified and designated as protected areas after wind farms have been planned and consented, which results in reviewing consents and potential delays.

Collaboration between the different stakeholders, industry and government in particular is paramount when planning and assessing environmental risk. The Collaborative Offshore Wind Research into the Environment (COWRIE) program and the more recent Offshore Renewables Joint Industry Program (ORJIP) are two examples of initiatives designed to facilitate and produce strategic collaborative research into the impact of offshore wind development on the environment and to develop best practice.

In the past 10 years, government and industry have learned lessons regarding Environmental Impact Assessments (EIAs). In the beginning, uncertainty about the potential impacts from offshore wind developments led to the inclusion of every possible effect in an EIA, with little prioritization. This, combined with little guidance on how to conduct the EIAs, resulted in EIAs published in volumes, each with hundreds of pages. In the Netherlands and Germany by contrast, there has been much more government involvement in the assessment process and the EIAs there are considerably smaller and more focused, with effects that can be effectively mitigated by being scoped out at an early stage.

Monopiles are the preferred foundation type in the UK that most wind farms have utilized. In the UK, and the rest of the North Sea there are large numbers of harbor porpoise in the areas where wind farms are being built and this species seems to be particularly sensitive to impulsive noise from piling. Noise propagation modelling is an integral part of assessments, in helping to determine mitigation zones, and in predicting the area of possible disturbance. There are still many sources of uncertainty with regards to the greatest sources of variability in piling noise at the source and its propagation. Uncertainty also lies in how porpoise displacement is influenced by received sound levels and by other factors such as distance to source, behavioral context, etc. There have been a few studies in Denmark, Germany, and the UK that looked at changes in porpoise and seal distribution during piling and those studies have been pretty consistent in showing that animals are displaced from an area with a radius of around 20km from the pile, but effects up to 50km with gradually proportionally less animals affected the further away from the pile. One of the questions at the moment is whether this deterrence distance will hold for larger diameter monopiles/ larger hammer energies planned in offshore waters.

The Joint Nature Conservation Committee (JNCC), together with other agencies in the UK, have adapted the JNCC seismic guidelines and issued a protocol for minimizing the risk of injury to marine mammals from piling noise. This involves the use of Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM); with the commencement of piling delayed if marine mammals are spotted within the mitigation zone. There is also a ramp up procedure to gradually increase hammer energy and duty cycle so that any animals still in the vicinity have time to move away.

Acoustic deterrent devices (ADDs) are also used in some cases and there is evidence that some devices are effective in deterring seals and harbor porpoise from the potential injury zone. There is an ongoing industry funded project which undertook controlled exposure experiments, and preliminary results suggest that a certain type of ADD also works for minke whales. Protocols for the use of ADDs will now be developed, and it is possible that some future wind farm installations may use these devices in some European waters instead of MMOs/PAM.

Other mitigation measures may include seasonal restrictions. In the UK there are well established restrictions to protect herring spawning, but none so far for marine mammals, like in the Netherlands for example. Concurrent piling of adjacent piles to reduce the spatial and temporal footprint of disturbance is also recommended. Reducing piling noise at source has so far not been a requirement in UK waters. However, the German requirement to keep noise propagation from pile driving below a certain threshold has driven a lot of research and development into coming up with effective methods to reduce noise. Some of this mitigation is proving very expensive and resource intensive, so the challenge now is to come up with cost effective methods. Political will is needed to drive research and development. Any form of mitigation should be coupled with monitoring of its effectiveness.

Industry prefers to maintain flexibility regarding installation methods until after consent. This flexibility, however, means more uncertainty for the assessment of risk, which in turn means more uncertainty on how noise should be managed. In order to give industry flexibility and to keep the cost of energy down, the government in the UK has been slow to attach specific noise management conditions to licenses. However, this may compound uncertainty, which could increase risk and lower chances of securing the necessary finance. The UK is beginning to understand the consent process needs to include clear timeframes for key decisions regarding noise management.

A Scottish study, funded by industry and the government, showed the importance of pre-consent monitoring. The study used existing long-term time series data on the individual seal vital rates as well as tags to track seal movement and location to better understand which areas the seals were using preferentially and when. The effect of disturbance at the level of the individual animal is a key knowledge gap, and pre-consent monitoring has the potential to be able to detect changes to those parameters. Tagging technology is rapidly progressing and now tags can even measure heart rate and the size of prey.

Other pre-consent monitoring involves characterizing abundance and distribution in an area of interest, which can be of particular value if little is known about species in the area.

However, due to the high levels of natural variability for some species, it is essential that adequate scales are chosen to be able to put any local changes into context of wider changes to populations. For many large and wide ranging populations, it would be very difficult to distinguish the effects of offshore wind development from the effects of other pressures with typical before/after surveying.

Resources might be better spent on validating predictions of disturbance by focusing monitoring just before and during piling and just after. In the UK, pre-consent surveys for marine mammals were mostly added onto bird surveys. Because sampling was chosen with birds in mind and because detectability of marine mammals is lower, the resulting estimates were of low precision. The low precision also reflected the natural variability in distribution of these animals.

The Joint Cetacean Protocol coordinated by JNCC (http://jncc.defra.gov.uk/page-5657) has aimed to gather survey data from a variety of sources, including government, industry, NGOs, and academia. This includes a great amount of survey effort over the last 20 years. Only data that met a series of standards were included. This, together with the analyses and modeling that followed, provided average distributions and densities for the seven most abundant species in UK waters. This will help provide standardized abundances and will inform the relative importance of areas during EIAs and when identifying areas which require further survey effort.

JNCC also manages a database developed to collect and compile data on the occurrence of impulsive noise in UK waters, from pile driving, seismic surveys, and other sources such as military sonar and explosives. Patterns, trends, and hotspots of noise will be identified, which should help with assessing the potential for cumulative effects on populations. Wind farm developers are required to provide information to the noise registry as part of their license conditions. Other license conditions may require actual noise measurements to validate EIA predictions. To help with comparisons, standards for piling noise measurement have been agreed and published

Monitoring needs to have a specific end point and should add value to the process. For example, the JNCC is seeking funding to review all the noise measurements taken during construction of UK windfarms to try and improve our understanding of what may influence piling sounds levels and propagation. The best monitoring programs have been when developers and government collaborate. Joint funding and carefully chosen species and sites should prove more successful than monitoring or research being undertaken independently in each of the wind farms. Opportunities to establish those cross government/industry initiatives should be sought and encouraged.

Cumulative effects assessment and management of pressures from different industries is a challenge. In the UK, there are several regulators for the different industries and administrations resulting in poor coordination and communication across sectors. A framework for assessing cumulative effects needs to be developed to address this issue. but little progress has been made. However, there is currently an initiative for developing such a framework through collaboration between the different countries bordering the North Sea. Two fundamental elements for this are: 1) the choice of management units for the populations to be assessed, and 2) the approach for modeling the consequences of disturbance on population trajectories. There is much uncertainty regarding the impact of disturbance on individuals' vital rates (survival, reproduction) which is a fundamental step in modeling impacts at the population level. Two approaches have been developed in the last few years. In Interim Population Consequences of Disturbance (iPCOD), the effects of disturbance on vital rates are estimated through expert elicitation. Disturbance Effects on the Harbor Porpoise Population of the North Sea (DEPONS) uses an agent based model, in which the vital rates emerge from animal movements, foraging, and energy budgets.

2.3.2 Germany

Germany has a lot of experience with all aspects of offshore wind. A crucial aspect for offshore wind projects in Germany is noise, with a specific focus on the harbor porpoise. While Germany does not have conservation zones per se, there are measures that are applied to different zones throughout the year. Germany has federal laws forbidding injuring an individual harbor porpoise or significantly disturbing the population. In 2013, the Federal Ministry for the Environment formulated the Noise Mitigation Concept, which set threshold levels for noise. Since 2015, pile driving is limited to 180 minutes per pile per day.

Noise mitigation concepts in Germany include noise prognosis, deterrence, noise mitigation, and monitoring/control of efficiency. Noise prognosis refers to the assessment of potential noise generation during foundation installation. Deterrence refers to the displacement of animals from area of high noise levels by means of soft start (gradual ramp up) of equipment or use of deterrence devices. Soft starts depend on the installation method (impulse piling or vibration), installation type (monopiles or jackets), and soil conditions. Deterrence devices such as pingers and seal scarers are effective, low cost, and easy to use, but the type and duration must be carefully chosen (supplemental information since the workshop has shown seal scarer devices are effective for deterring porpoises but not seals).

Noise mitigation depends on installation methods, installation type, soil conditions, site environmental parameters (currents and water depth), as well as weather conditions (weather windows and operational limits). Although the effectiveness of any noise mitigation system depends on the site conditions, these systems can be very effective but have some associated issues that need to be considered in their implementation/requirements (e.g., downtime for bad weather and failures of the system and other constraints). The installation method and installation type deserve additional exploration.

In Germany, developers are looking at a variety of foundations and installation types, but most of them are still in development and are prototypes. Even if the prototypes are successful, site-specific factors (e.g., water depth, soil conditions, and currents) and project specifics (e.g., schedule, ship availabilities, logistics) still play a part in selection of the foundation type. Types of alternative foundation and installation types Germany is looking into:

- **Jacket with suction bucket:** The wind industry has limited experience with this foundation type, the long- term impact of cyclic/dynamic loads is unknown, and comprehensive knowledge of soil conditions is necessary.
- **Gravity based:** This foundation is used mainly nearshore in low water depth and solid soil conditions must be present. Several installation steps are needed (seabed preparations, installation, ballasting with rocks, etc.,) and there is a big impact to the seabed.
- **Drilled foundations:** There have been several concepts developed in the past, but no new development at present.
- **Floating foundations:** This foundation type is a deep water solution, but the wind industry has no experience with this type of foundation and requires the foundation to be anchored on the seafloor.
- **Vibrated monopiles:** This foundation type has less bearing capacity than driven piles. Sudden resistance might require a change to impulse piling. Currently, vibration installation is not allowed in Germany and the last meters have to be driven. While there is lower noise impact, it is unknown if there are other frequency level impacts.
- **Blue piling hammer:** This type of hammer has the possibility to generate lower noise, but a full-scale offshore test is still needed (planned for 2017).

In Germany, experts are debating different approaches to noise mitigation systems. Currently, there are three main types of noise mitigation approaches: the Bubble curtain system, the shell-in-system, and other (pile wrapped with foam, hydro-sound damper, resonator system, and HydroNas™). These systems are costly (10-30% of foundation installation costs) and delays in operation due to noise mitigation can lead to a loss in revenue and increased costs. Social, economic, and environmental costs/benefits need to be taken into account with these systems, as does the crew safety when using these systems. Several additional vessels are needed for noise mitigation, which increases costs, health and safety risk, and potential environmental impact. There are constraints and important factors to consider for the use of these systems, including:

- No state of the art system available for water depths greater than 40 meters;
- A limited number of suppliers and systems;
- Technical challenges and health/safety risks;

- Increased resource use, disturbance, and emissions;
- Noise mitigation frequency still is neglected; and
- Weak evidence for impacts on species/individuals/populations;

When it comes to monitoring, Germany has standards and regulations for measuring noise from offshore development. Germany utilizes hydrosound measurements; defined long-term monitoring stations pre-, during, and post-construction; aerial and ship based surveys. The Offshore Forum Wind Energy, an industry group, sponsored an assessment of offshore pile driving effects on harbor porpoise abundance in the German Bight, which addressed, "What is the magnitude of disturbance caused by pile-driving on harbor porpoise and does that matter for the viability of the German Bight population?" The "Study on the effects of construction of the first eight offshore wind farms in Germany on harbor porpoises 2010-2013" (GESCHA) found that there were no negative consequences for harbor porpoise populations, abundance increased in two of the four study areas; no cumulative effects or indication of adaptation or being more sensitive as a result of increased pile driving in the time period of the study; animals tended to avoid the pile driving areas for a short time, with a clear distance-based gradient; and even in areas with >155 dB, some animals remained present. The results of the study show that the overall effect of mitigation was not that different between areas with and without mitigation measures, which begs the question of "how much mitigation is needed?"

Germany has vast experience with offshore wind development. Lessons learned from the German industry experience include:

- The cost of energy needs to be taken into account. Heavy environmental restrictions can reduce investor confidence and regulations aimed only at the offshore wind industry can put an economic imbalance on the sector as compared to others (e.g., oil and gas).
- Cost reduction targets should be kept in mind when choosing environmental regulations.
- Early transparency in regulation is crucial for proper project planning.
- The government needs to confirm what it is trying to mitigate for, and thoughts and exceptions need to be given for safety, weather, and sound reduction system failure.
- Mitigation measures should be based on a clear evidence-based rationale that can be reviewed and updated with new evidence.
- An assessment for costs and benefits of noise mitigation and renewable energy needs to be holistic. Costs for noise mitigation systems run 18-43 million Euros ($21-50 million USD), and the increased numbers of crew and protected species observers needed also entails associated safety considerations.

Technical/logistical constraints from the German experience include:

- Installation schedule/time is difficult to plan due to delays, prolongation, and changes caused by design and manufacturing (design certification, steel plate delivery) and installation (onshore loading delays due to weather, crane failure, or process incidents; offshore equipment failure coupled with difficulties in complying with the 180 minute pile driving time regulation; weather; geotechnical conditions).
- Installation type is fixed a year before construction and there is no possibility of changing the type.
- Installation sequence is fixed once manufacturing (one year before construction) and construction has started (e.g., due to cable planning, set of foundations adjusted to ship bearing capacity).
- Noise mitigation systems can decrease deck space and lead to increased installation time due to a higher number of installation cycles.
- Many alternative installation techniques are still under development, so installing a pile to complete depth is not always predictable for all techniques.
- Offshore work needs to be planned in detail and approved by all parties, which limits the possibility for short- time changes.
- Health and safety is a high priority for all companies and the introduction of any mitigation tool could lead to an increased health and safety risk.

2.3.3 Challenges, data gaps, and next steps in Europe

Uncertainty is a challenge for wind energy development. Siting is important for the viability of a wind farm and uncertainty about habitats near a farm impacts the viability for projects at large. There is a lot of uncertainty around piling noise and propagation, which underscores the need for more studies. When it comes to mitigation, industry prefers flexibility. However, flexibility means more uncertainty for the assessment of risk and managing noise. Another challenge is ensuring environmental responsibilities are upheld, while also ensuring regulations do not drive up the cost of energy excessively.

To address these challenges, more research and development is needed in several areas. More data is needed to characterize offshore habitats, on piling noise and noise propagation, and on mitigation measures for avoiding acoustic impacts. Furthering joint/collaborative research efforts will help address some of the challenges noted above. For example, the Joint Cetacean Protocol, conducted by the Joint Nature Conservation Committee, used visual and digital at-sea effort related data collected from academic, NGO, and industry sources. Data analysis was conducted on the seven most distributed species in UK waters and distribution maps were created from the effort.

The UK marine Noise Registry is a study looking to collect data on passive noise in UK waters. Additionally, ensuring government buy-in is essential to ensure research and development in these areas is undertaken, regulations are transparent, and excessive regulation does not drive up energy costs.

Next steps for European offshore wind development are to explore installation methods. There are promising alternatives to current installation spreads, and more research and development could push these methods out of prototype stages and into pilot projects. Additionally, there have been efforts to discuss collaboration around the North Sea and developing a Cumulative Effects Assessment (CEA) framework.

2.4 Domestic Lessons Learned

Block Island Wind Farm off the coast of Rhode Island is the U.S.'s first offshore wind farm. The U.S.'s first "steel in the water" is an important step for developing offshore wind on the OCS. This section presents monitoring results and lessons learned from that experience that may be useful in expanding offshore wind on the OCS.

2.4.1 Verification of Monitoring Results from Block Island Wind Farm

The construction of the Block Island the wind farm allowed developers and agencies to gain experience and collect data that can be applied to other projects. When it comes to sound propagation, there is greater potential for interaction of sound with the marine environment as sound travels farther from the source. For example, sound propagation varies by depth and there may be very little interaction with the seafloor in deep waters. Predicting how sound propagates from offshore wind activities is part of the permitting process, which helps estimate take and establish exclusion zones. Field measurements help determine the received levels animals may experience at different distances and depths from the source. These measurements are a data fitting exercise and the analysis must be completed and reported before pile driving resumes. The measurements must be easy to conduct in the field, but also robust, accurate, and conservatively account for variation in the surrounding environment.

There are three models for the analysis completed for the Block Island Wind Farm and include the geometric, empirical, and first principles models. The geometric model used was the Practical Spreading Model, which measured sound at one location in a far field. This model is the easiest, but has low confidence in its accuracy at predicting actual sound propagation measured in the field. The empirical model included a regression analysis of in situ measurements taken at multiple ranges from the source and results were used to get an estimate of spreading coefficient. This model is better than the geometric model, but likely overestimated near field and does not account for environmental interactions. Site-specific improvements could be made with an additional fitting term. The First Principles model (e.g., Parabolic Equation) used measurements from multiple ranges, and isopleths were determined using a wave equation solution. This model had the highest confidence in its predictive ability and provided more information, but it was also the most computationally intensive.

3 Effects of Offshore Wind Development and Monitoring

3.1 Introduction to Underwater Noise

Offshore development generates noise that has the potential to harm or disturb protected species. BOEM is trying to understand the effects of energy development on the acoustic soundscape, including looking at behavioral disturbance of marine species. This section provides an introduction to underwater noise, presents the effects of underwater noise on marine species, and explains the marine mammal acoustic technical guidance.

3.1.1 Noise from offshore activities

Noise-producing activities associated with the development of offshore wind facilities include: HRG surveys, vessel traffic, construction (e.g., pile driving), operation, and maintenance. The noise from these activities has the potential to harass or disturb protected species.

There are three general zones of influence that may be characterized for any sound: the zone of audibility, the zone of responsiveness, and the zone of injury. The injury zone corresponds to Level A harassment under the MMPA or harm under the ESA and is generally a smaller area near the sound source. This area is always mitigated through one or more measures. The zone of responsiveness is an area where animals might be disturbed or harassed (Level B under the MMPA). The level of disturbance depends on how far from the sound source an animal is (animals closer to the sound will be disturbed more than animals further away), but may vary with species, life history stage, and other considerations. This area may be monitored for behavior of animals, but does not always warrant a shut-down. The zone of responsiveness is typically large for loud sound sources such as pile driving; therefore, visual monitoring can be limited. The zone of audibility is the area where an animal can hear the sound, but does not respond in any detectably harmful way. This area is not monitored or mitigated.

BOEM's objectives for mitigating and monitoring of underwater noise are to: 1) identify effective and practicable mitigations to minimize or avoid potentially harmful acoustic impacts from noise-producing activities; 2) understand how to mitigate and monitor acoustic impacts from both day and night activities; 3) understand how to assess effectiveness of mitigation techniques; and 4) discuss standard data protocols, management, and data sharing.

3.1.2 Effects of underwater noise

Sound is a primary means of communication, foraging, navigating and predator avoidance for marine mammals and other marine species. Different species and individuals respond to sounds differently and at different times. Various cetacean species have been shown to alter vocalization frequencies or their behavior in the presence of ship noise and other anthropogenic activities depending on their behavioral state (e.g., foraging, migrating, resting, or breeding). Consequences/cost of noise exposure on an animal's health or success (e.g., behavioral, hearing damage, systemic or reproductive effects) are largely unknown, especially on the population level. Cumulative impacts of sound exposure remain a concern for marine species.

Currently, BOEM requires measures to avoid injury in marine mammals and sea turtles. However, other effects (such as behavioral, reproductive, cumulative, and physiological) may be worthy of consideration for future mitigation, such as monitoring for stress hormones to gauge animal health, looking at secondary effects such as increased ship strikes, monitoring for cumulative effects, as well as conducting small-scale studies on sea turtles to explore health information.

3.1.3 NOAA Marine Mammal Acoustic Technical Guidance

NOAA's Marine Mammal Sound Exposure Guidance (Guidance), finalized in July 2016, allows for federal agencies and stakeholders to predict how marine mammal hearing may be affected by a project that produces underwater noise. The Guidance provides onset thresholds for permanent hearing loss known as permanent threshold shifts (PTS) and temporary hearing loss known as temporary threshold shifts (TTS) for impulsive (explosive, seismic, impact pile driving) and non-impulsive (drilling, vibratory pile driving) sources by hearing groups (low-frequency (LF), mid-frequency (MF), and high- frequency (HF) cetaceans; and phocids and otariid pinnipeds (seals). The Guidance also has a mechanism for updating the thresholds as new science becomes available and provides a spreadsheet tool for calculating cumulative sound exposure.

While the Guidance allows for all applicants to use the same thresholds when submitting the necessary documentation for permits, there is still new information needed, such as exposure duration (how long an activity occurs in a 24-hour period, number of strikes per pile/piles per day, pulse duration, repetition rate) and how the sound exposure translates to the animal (transient or resident animals, and the context of the habitat and behavior of the animals). Additional/new metrics are needed and not all values are available, which results in the use of default values (inherently conservative).

3.2 Sources of Noise

While there are many sources of noise in the marine environment, this section discusses two of the major sources of anthropogenic noise as it relates to offshore wind development, pile driving and HRG surveys.

3.2.1 Pile driving

The amount of pile driving necessary for offshore wind turbines depends on the type of structure and sub-surface conditions. Gravity foundations have no piles; therefore, require no pile driving. Monopiles have a single pile per foundation and are typically large in diameter. Tri-pod/multi-pod foundations have three to four piles per foundation. Jacket foundations have four piles per foundation, which are typically smaller in diameter than monopiles. Floating foundations have limited or no pile driving and are secured to the seafloor via drag anchors or suction anchors in the seafloor.

Pile diameter and substrate type are the most influential factors for determining pile driving noise. The diameter of a pile affects the loudness and tones produced, while substrate type affects the noise propagation. Other factors that determine the noise from pile driving include: drive depth, pile angle, hammer energy, water temperature, and water depth. Noise exposure from pile driving can cause permanent hearing loss (PTS), temporary hearing loss (TTS), stress, or behavioral effects (e.g., avoidance of an area, attraction to an area, a changing in foraging, effects on reproduction, migration effects, or effects on energetics).

Cumulative effects of pile driving exposure depend on source level (pile size), frequencies (pile size), hearing ability, duration of exposure/day (number of piles, time, and strikes/pile), number of days, time of year, and site characteristics affecting propagation. Use of a sound reduction system (SRS) can reduce cumulative exposure to pile driving sound. Table 4, below, shows pile driving cumulative PTS distances for a meteorological tower (3-8 hour cumulative exposure) with and without an SRS (calculated via NOAA's spreadsheet tool for cumulative sound exposure).

Table 3: Pile driving cumulative PTS distances for a meteorological tower, with and without the use of a sound reduction system (SRS)

As calculated with NOAA's sound exposure spreadsheet tool. Distances are calculated for a 3-8 hour exposure for a 1.4 and 2.4 meter pile, and broken into hearing groups. Use of an SRS can reduce the source level of the sound by an average of about 12 dB.

Diameter pile	Cumulative Exposure Distance for Each Hearing Group (meters)							
	LF - without SRS	LF - with SRS	MF - without SRS	MF - with SRS	HF - without SRS	HF - with SRS	Seals – without SRS	Seals – with SRS
1.4m	859 - 1,403	216-352	70-115	18-29	980-1,560	246-402	538-878	135-221

Diameter pile	Cumulative Exposure Distance for Each Hearing Group (meters)							
	LF - without SRS	LF - with SRS	MF - without SRS	MF - with SRS	HF - without SRS	HF - with SRS	Seals – without SRS	Seals – with SRS
2.4m	2,421-3,954	608-993	198-324	50-81	2,761-4,508	693-1,132	1,515-2,474	381-621

Monitoring

Because of the potential for auditory injury, pile driving requires monitoring. Protected species observers (PSO) are commonly used to detect species of interest. They use the naked eye or binoculars to estimate how far a marine mammal or protected species is from offshore wind operations. The use of these observers comes with health and safety risks due to increased crew numbers and/or increased number of vessels. However, a PSO's ability to monitor and protect protected species is limited by the number of observers and platforms of observations (i.e. boat or air).

Thermal imaging and night vision binoculars are often used for low or no light situations. Night vision works in low light, but requires a spotlight for total darkness (i.e. no moon). Therefore, the effective range and field of view of night vision is limited. Thermal imaging cameras sense heat signatures and produces high contrast images (though these can be grainy due to noise from amplification). These cameras can be used in total darkness and detect targets in warm water and cold climates. Both thermal cameras and night vision degrade in haze, especially heavy fog. Table 5 compares these two technologies. There has been recent testing of these technologies, but it is a relatively recent addition to the field and there are limited studies.

Table 4: Comparison of thermal cameras and night vision for monitoring during offshore wind development activities.

Characteristic	Thermal Camera	Night Vision
Image creation	Creates images from thermal energy (heat radiation)	Creates images by amplifying visible light, e.g. moonlight
Detection	Senses temperature difference as 0.05˚ Celsius	Detects invisible near infrared light, thus an infrared flashlight may be used to illuminate the scene

Characteristic	Thermal Camera	Night Vision
Operation in darkness	Operates in total darkness with unlimited range of visibility up to the horizon	Cannot operate in darkness; range of visibility is determined by having the right amount of visible or near- infrared light available; too much light or too little can cause whiteout or blackout respectively
Image contrast	Creates high contrast images (day and night) making it easier to detect targets	Creates low contrast images at night limited by available visible light
Field of view	Full field of view afforded by camera optics is available all of the time	Narrow beam width of infrared illuminator limits the field of view

Main themes from the panel discussion on developing BMPs for pile driving

1. *Develop a Clear Strategy:* BOEM needs to be clear about mitigating and monitoring, the mitigation measures, and the monitoring strategy. BMPs should address both mitigation and monitoring for injury and disturbance (individuals and population level); acute and broad scale impacts; short-term and long term effects; reproductive and cumulative effects.

2. *Uncertainty:* There may be some uncertainty around the data and information regarding seasonal timing of species and methods for real-time monitoring effects. The effects of offshore wind pile driving have been measured for some species (harbor porpoises and seals), but fewer studies have been conducted for large whales, sea turtles, and other species. Integrating data and platforms will be valuable for reducing uncertainty and funding projects that look at individual and vital rates will help reduce uncertainty regarding disturbance. BOEM may need to have a different approach for areas of high risk/uncertainty rather than treating all projects the same.

3. *Practicality and flexibility:* Balance must be found between reducing impacts to protected species and construction schedules. Any measures put in place need to be realistic and effective. There also needs to be some measure of flexibility for developers. There is no “one size fits all” since technology is based on unique project characteristics/specifics. It is difficult to shut down pile driving equipment. Additionally, frequent stoppages causes equipment to fatigue and the steel to be destroyed. Consideration for the lifetime of the foundation needs to be considered when designing BMPs. A cost-benefit analysis may help determine a balance.

4. *Real-time monitoring vs. seasonal timing/exclusions:* BOEM may want to consider real-time monitoring instead of relying on seasonal timing. Real-time monitoring would also help monitor for species where the seasonality is not well known or there is a high level of uncertainty. Real-time monitoring also allows for flexibility and fine-tuning. Finding a focal species for seasonal

exclusions may help tailor these seasonal exclusions (for example, the NARW). Exclusion zones should focus on areas where large whales are more persistent rather than moving through.

5. *Observers:* Depending on the observation platform (i.e., vessels or aircraft), PSOs are limited in how far they can see, and limited to observing the behavior of animals at the surface. The species' behaviors, types of monitoring technologies, and platforms from which they are deployed should be considered.

6. *Modeling:* Current data should be used to improve noise models and validate these models. Sound propagation models to assess the sound levels produced over an area may be useful to assess the likelihood of exposing protected species to certain impacts. Exposure analysis leads to risk assessment, which can then be used to decide which tools are needed.

7. *Scale:* It could be challenging to scale up and have enough information to know what the effects are going to be. Knowing the scale and potential changes of habitat use and movement of the animals will help inform monitoring practices. BOEM wants to look at larger-scale effects and explore ways to reduce impacts. This may be achieved by considering foundation choice and noise attenuation.

8. *Constraints for developers regarding seasonality:* Weather is a big limiting factor. Developers can work in the fall or year round, but summer months are usually best. Location and how far offshore the project is also plays into seasonality.

9. *Habitat shifts:* Consider changes in habitat use by protected species. Site characterizations or assessments may need to be updated or evaluated.

10. *Species Ranges:* Consider the entire range of a population when evaluating geographic differences in impacts. For example, harbor porpoises are considered a northern species, but their geographic range is quite broad and occurs as far south as North Carolina.

11. *Effects of pile driving on sea turtles:* The effects of pile driving on the auditory abilities and behavior of sea turtles are not well understood. Uncertainty and the best available information for sea turtles and other species must be carefully considered.

3.2.2 HRG surveys and best management practices

HRG surveys are used to characterize the seafloor surface and sub-surface. Many types of equipment are used to collect geophysical information regarding archaeology, geohazards, habitat, cable routes, sediment characteristics, and unexploded ordnance. Studies to understand the sound production and propagation of these types of equipment are being conducted to better assess potential impacts. Many mitigation measures are NARW-centric; however, multiple species benefit from the protections. The current exclusion zone for HRG surveys is 200 meters.

The Naval Undersea Warfare Center (NUWC) is an expert source on underwater acoustics. BOEM and NUWC conducted a study, "Characteristics of Sounds Emitted During High Resolution Marine Geophysical Surveys," to test frequencies emitted from survey equipment during HRG surveys. The overall objective of the study is to characterize the acoustic fields radiated by marine geophysical survey systems as a first step to understanding the potential impacts to marine ecosystems. The initial phase of characterizing the frequencies and source levels is complete, and the results have been used to initially calculate PTS injury distances from source using NOAA's sound exposure spreadsheet tool. Table 6 shows the cumulative sound exposure level distances for HRG survey equipment. The field component of Phase 2 is complete and the data analysis will be completed in the spring of 2018. This analysis will tell modelers how to use this data and what models to use for assessing impacts.

Table 5: Cumulative Sound Exposure Level Distances for HRG Survey Equipment.

PTS injury distances were calculated with NOAA's sound exposure spreadsheet tool using the highest reported power level for nineteen HRG sources. Similar equipment was grouped into five categories based on similar frequency characteristics and source levels reported in Crocker and Fratantonio (2016).

HRG Category (Operating below 200 kHz)	PTS Injury Distance (meters)			
	Low Frequency Cetaceans	Mid Frequency Cetaceans	High Frequency Cetaceans	Seals (Phocids)
Boomers	9	0	2	2
Sparkers, Mini-GI gun, Bubble gun (impulsive)	26	<1	95	13
Mini-GI air gun (impulsive)	20	0	45	8
Sub-bottom profilers	2	<1	36	<1
Multi-beam echosounder (100 kHz)	0	2	430	<1

Main themes from the panel discussion panel on developing BMPs for HRG surveys

1. Uncertainty: There is a great deal of uncertainty regarding behavioral impacts. Information on species movement and behavior is uncertain and behavioral impacts to minimize, behavioral effects to mitigate, and behavior to monitor needs to be identified.

2. Practicability: Practicability is essential for the effective mitigation of potential impacts. There should be a balance on what is needed for effective mitigation and what can be practicably implemented as a BMP. Unexpected events happen which shifts a developer's schedule and BOEM should consider this.

3. Alternative monitoring plans: While no surveying at night is the default, most developers have developed an alternative monitoring plan. Evaluating these plans and PSO reports may help BOEM develop standardized mitigation measures for night operations so that developers do not have to submit alternative monitoring plans for each survey. Standardizing these requirements would help developers conduct work at night.

4. PAM: For alternative monitoring plans, BOEM has required passive acoustic monitoring (PAM) (towed) and visual monitoring (cameras, night vision, etc.). BOEM may want to consider expanding accepted PAM methods to include gliders, buoys, etc.

5. Lessons learned: The oil and gas industry has been using seismic equipment for years and lessons could be learned based on that experience. The seismic survey mitigation and monitoring strategies should be reviewed in consideration of creating alternative monitoring plan minimum requirements.

6. Vessel interactions: Vessel speed restrictions may need to be re-evaluated since vessels shorter than 65 feet could also strike a whale.

7. Species-specific mitigation: BOEM may want to consider standard exclusion zones that are protective of the most sensitive animals for the equipment proposed for use.

8. Habitat mitigation: It may be useful for mitigation to include additional metrics (e.g., modeled or food indicators) other than simple critical habitat boundaries.

9. Focused Plans: BMPs may need to be separated out into what applies to everyone and what applies to a certain area (some broad BMPs and some specific).

10. Mitigation levels: As BOEM considers a mitigation hierarchy, it may be useful to frame the BMPs into the different categories of the hierarchy.

11. Data sharing: There should be a discussion on how developers can share data. Compiled information regarding acoustical equipment performance may help find the best technology to use.

3.3 Other Effects

3.3.1 Vessel Traffic

The very nature of offshore wind development means increased vessel traffic on the seas. The types of vessels involved in offshore wind development include survey vessels, construction vessels, and service/maintenance vessels. It is important for development of offshore wind to keep in mind the navigational safety aspect of offshore wind development.

The U.S. Coast Guard (USCG) deals with standards and requirements for navigational safety at the international level. These standards include safety, security, and environmental protection (ship design, construction, equipment carriage, operations, maintenance, and certification; mariner training and certification; quality company safety management; and quality governance). These standards and regulations are set by international treaty, domestic law, government regulations and policy, industry standards, insurance requirements, and company policy. The USCG is also the federal enforcement agency at sea. The Ports and Waterways Safety Act gives the USCG the authority to control vessel movements in U.S. waters for certain situations and is intended to provide safety for mariners aboard the ships, the ships themselves, passengers, cargo, ports, and potentially affected communities, while preventing pollution.

However, none of this authority provides the USCG with the authority to restrict vessel operations, establish safety zones, regulate navigation areas, establish speed limits, or establish vessel routing measures solely for the purpose of protecting marine species. The USCG can establish a measure that protects marine species only if there is a substantial nexus between navigational safety and protection of the species. The USCG has developed the “Guidance Document for Minimizing the Risk of Ship Strikes with Cetaceans” (MEP.1/Circ.674, available here: https://www.amsa.gov.au/navigation/documents/MEPC1-Circ674.pdf) which provides guiding principles when taking action to reduce and minimize ship strikes to cetaceans.

BOEM also has jurisdiction to control vessel traffic in wind energy areas and sets vessel-strike mitigation measures. These measures include the use of protected species observers, vessel strike avoidance measures (species specific separation distances and close encounter protocols), and seasonal speed restrictions (all vessels in a DMA and vessels 65 feet or larger are restricted to 10 knots or less).

Main themes from the panel discussion on developing BMPs for vessel operations

1. 10 knot rule: Speed is a critical conservation requirement for protecting marine species. The USCG may be able to develop hotspots of concentrated shipping where the 10 knot rule could be implemented.

2. Use the Mid-Atlantic Ocean Data Portal: The tool is a product of the Mid-Atlantic Regional Council on the Ocean (MARCO) and is an online toolkit and resource center that consolidates available data and enables state, federal and local users to visualize and analyze ocean resources and human use information such as fishing grounds, recreational areas, shipping lanes, habitat areas, and energy sites, among others.

3. Geographic-specific Assessments: Gather information on species needing protection using aerial surveys, necropsies, research vessel observations, other scientific data.

4. Gather information on vessel traffic: types of vessels, traffic patterns, density. Use public meetings and con- duct outreach to shipping industry representatives, port authorities, academics, environmental groups, and research.

5. Stakeholder outreach: Outreach activities could include notices to mariners, brochures, placards, public service announcements and advisories for the offshore wind industry.

6. Educational and/or training products: Actions could include incorporating ship strike prevention into maritime academy curricula and training (and then into voyage planning), work with maritime associations, port authorities, and environmental organizations.

7. Develop technology: passive acoustics, tagging, predictive modeling, etc. Provide real-time reporting to mariners.

8. Operational measures: Operational measures for vessels could include routing and reporting, speed restrictions, and establishing areas to avoid. Also, consider offshore sailing races. Areas of concern should be prominently featured on charts and nautical publications. Nautical websites should share information.

9. Ship strike reporting: Set up a ship strike reporting program where ship strikes can be reported, stored, and retrieved. Outreach and education would need to be conducted to make companies/mariners aware of ship strike reporting programs.

3.4 Baseline Monitoring

Baseline monitoring is important for establishing the reference condition, pre-project condition, and to be able to detect when change is due to an offshore wind project or another cause. For example, sometimes foundations provide a structure for reefs. BOEM/industry will not know about this change unless monitoring is conducted. Projects can be evaluated for environmental change by comparing pre-project environmental conditions to those after a project begins. In order to monitor for change, there are three must haves: 1) reference information, 2) known important variables to monitor, and 3) standardized monitoring and data for comparisons. Monitoring occurs throughout the whole life cycle of a project, from construction and operation to decommissioning.

Changes can be project-specific and program-specific. Monitoring can occur for the whole affected environment: species distribution, abundance, population health, critical habitat, natural stressors, migratory behavior, conservation status, prey availability, and anthropogenic stressors; chlorophyll-a; sea temperatures; and acoustic seascape. Typically, monitoring occurs to detect changes in distribution, abundance, and behavior due to:

- Avoidance of habitat/physical presence of foundations;
- Attraction of prey, protected species, and predators to structures/reef effect; or
- Acoustic environment.

Cumulative effects from multiple projects can affect migratory behavior, changes in selection/use of critical habitat, or contribute to noise in the seascape.

Monitoring can be challenging because often times the area requiring monitoring may extend well beyond the immediate project area. Baselines can vary based on geography, annual variation, and seasonal variation, and baselines can shift due to natural or other anthropogenic sources. Detecting cumulative effects from multiple projects and monitoring for additive or synergistic effects is also a challenge. Standardizing methods and data so that monitoring efforts can be compared can also be difficult. Additionally, it is often challenging to obtain the needed financial resources to carry out a long-term monitoring program.

OCSLA mandates BOEM to conduct environmental studies. Most of the data BOEM has is from BOEM-funded studies. BOEM's ESP oversees the research conducted by outside entities and seeks to have the best experts collecting information. Ongoing BOEM studies include regional data collection (Atlantic Marine Assessment Program for Protected Species, Massachusetts, Southeast Atlantic), passive acoustic monitoring (Massachusetts, Delaware, and Virginia), and RODEO. Proposed BOEM studies are focused on improving detection and data analysis of acoustic methods, addressing risk assessment of activities on whales, use of marine animals as telemetry sensors, ecosystem services approach, and development of an Atlantis Model for strategic planning and cumulative impacts.

For this workshop, BOEM was interested in the following objectives related to monitoring change:

- Understand current pre-construction baseline studies;
- Identify important issues and parameters to be monitored for change;
- Identify any regional or species-specific considerations;
- Identify any financial, logistical, and regulatory constraints; and
- Identify mechanisms for standardized data collection and management.

Methods, data, and baseline monitoring survey efforts

Baseline monitoring methods vary for the species and information researchers want to gather. Common baseline monitoring methods include aerial surveys using planes or drones; shipboard surveys using observers, trawling, and cameras; satellite tagging; and acoustic surveys.

Aerial surveys employ the use of aircraft and observers and/or imagery to indicate species presence and abundance. Aerial surveys are useful for seeing objects in the water that may not be visible from a boat and allows for a large amount of data to be collected quickly. When observers are used, planes will follow a specific flight pattern and observers will identify species and abundance. Human observers may take digital photographs that are useful to help identify individuals in a population, such as NARWs. Ultra-high resolution (HR) aerial surveys capture high resolution images which can later be analyzed via transect, grid, or other sampling methods. They can be used pre-construction, during construction, or post-construction and have fewer weather constraints than other survey methods. Because the images create a permanent record, it provides quality control and reduces human error. Additionally, data can be obtained for all offshore wildlife with no disturbance (no attraction nor repulsion). Camera systems for these surveys can produce digital stills, video, thermal, or infrared images, depending on project needs. Objects in the images can be detected manually or through automated programs to identify species, size and shape, direction, flight height, and anthropogenic data (boats, buoys, fishing, and pollution). HR surveys are currently being used in the U.S. and in Europe. The NYSERDA 2016 Digital Aerial Baseline Studies, which gathered data in the NY Bight, included HR digital video aerial surveys (data available: www.remote.normandeau.com/public_data.php).

Acoustic surveys use acoustic recordings detect the presence of marine species. This survey type is often used for marine mammals; however, fish and invertebrates can also be detected and monitored for using acoustic surveys. There are several recorder types: marine autonomous recording unit (MARU), high-frequency acoustic recording package (HARP), autonomous multichannel acoustic recorder (AMAR), gliders, soundtrap, and moored hydrophones for acoustic research underwater (HARUs). Passive acoustics provide a record of sound production that are good for large spatial scales and long term monitoring for the Atlantic. When passive acoustic data is combined with archival acoustic data, much of the Atlantic coast is covered by an acoustic record. These records can be fed into classification systems, such as the low-frequency detection and classification system, which can detect sounds and pitch tracks to identify marine mammals present. This data can be used to create maps of presence by month, ship to shore breakdown of presence to know ship strike and entanglement risk, as well as species distribution. Acoustic data is important for monitoring the acoustic seascape and assess anthropogenic and biological contributors. Acoustic data can be used for monitoring and mitigation, and can provide real time data. Recent acoustic monitoring efforts in Massachusetts and ongoing acoustic monitoring efforts in New York using a buoy have provided real or near real-time data collection. See http://dcs.whoi.edu/ for more information on these studies.

Collaborative survey efforts regarding baseline monitoring and information gathering include the Atlantic Marine Assessment Program for Protected Species (AMAPPS) and the Massachusetts Clean Energy Center Large Pelagics Study. AMAPPS is a collaborative effort of NOAA's National Marine Fisheries Service (NOAA Fisheries), USFWS, BOEM, the U.S. Navy, and others to gather information on different species using a variety of methods. The first stage of AMAPPS ran from 2010-2014, with stage two running from 2015-2019. The objectives of the study are to collect abundance and distribution data, collect tag telemetry data, estimate broad scale abundance, and develop fine scale seasonal, spatially-explicit density estimates within the ecosystem context to be used for management purposes.

Researchers studied pinniped distribution, abundance, and ecosystem by gathering data on harbor and gray seals. Maine harbor seal abundance surveys were carried out from 2011 to 2012 using aerial photographic surveys of haul out sites and capture and tagging for at-sea animals. Adult gray seals were tagged in Chatham, MA in June 2013 and tracked for 206 days to document habitat usage. At-sea and aerial observations were used to gather information on both harbor and gray seals. Aerial surveys were used to gather seabird data. Routine visual strip transect surveys were used for all bird species, and turtles and marine mammals were also recorded. Double observer teams with cameras mounted on aircraft were also used to quantify perception and availability bias to understand counting errors and misidentification of sea birds. The data gathered was used to quantify transect densities and key sites of seabird species.

Sea turtle data (distribution, abundance, and ecosystem) was gathered via satellite tagging. The tagging information was used to create density models as well as a temperature profile (sea surface temperature at turtle's depth). The study also used bottom mounted passive acoustic recorders. Hydrophones and sonobuoys were deployed to record large whales in order to estimate abundance of deep diving whales (sperm and beaked), supplement visual data, contribute to development of species-specific classifiers for other odontocetes, and integrate visual and acoustic sperm whale data for improved abundance. NOAA Fisheries used aerial surveys to target marine mammals and sea turtles and shipboard surveys to target marine mammals, sea turtles, and seabirds.

Ecosystem data was gathered via backscatter data for plankton and fish; plankton and macroplankton samples from bongo nets, video plankton recorder, and trawling; physical oceanographic characteristics from continuous flow-through surface measurements and station water column samples. Dynamic and static habitat variables collected from ocean and aerial data were used to create cetacean habitat density models, which were used to create seasonal maps and to provide information on the environmental factors related to the density of animals. Turtles (loggerhead and leatherback), whales (sperm, beaked, blue, sei, fin, humpback, and pilot), and Risso's dolphins were tagged to estimate availability bias, describe habitat usage, and describe vocalization patterns. Tagging information led to seasonality maps of density for 17 marine mammal species. NOAA will share these maps once ready, and users will be able to view data, select an area of interest, and download the data. NOAA Fisheries is interested in better understanding ecosystem interactions and learning more about where marine mammals are located so there is more understanding of change in population location.

The Massachusetts Clean Energy Center Large Pelagic Study involved field studies of whales, dolphins, and sea turtles over the course of four and a half years (2011-2015). The study used aerial surveys as well as pop-up buoys to record large whales. The data collected led to the creation of maps which showed sightings per unit effort of endangered large whales (fin, humpback, sei, sperm, and NARW), small cetacean species (dolphins, harbor porpoise, pilot whales, and unidentified small cetaceans), and turtles both seasonally and annually for all years combined. Study results indicated cetaceans are present more in the summer and spring and many sea turtles are present in the summer and fall. However, more NARW were seen in winter and in spring. Demographic data was also recorded, which allowed the project team to know when whales were on the calving ground. Minke whales were recorded inside the WEA off Massachusetts. The dual use of aerial and acoustic monitoring allowed researchers to record NARW presence even when the density declines which makes it difficult to be recorded via aerial surveys. The study also utilized hot spot (GIS) analysis which pulled out statistical high and low density areas. The winter and spring showed a density shift from east to west for the NARW. The next phase of this project (March 2017-February 2018) will use aerial and ship-board oceanographic sampling to determine why NARW are present in the winter and spring.

Other survey efforts include:

- *Ocean/Wind Power Ecological Baseline Studies* – Survey period: 2008-2009. Methods: shipboard, small boat, aerial, radar, and acoustic observations. Species: birds, fish, turtles, mammals, and shellfish. Data is available from NJ DEP.

- *Density and uncertainty maps for 26 cetacean species* – Survey period: 1992-2014. Methods: aerial and ship- board visual line transect surveys. Information available from the Mid-Atlantic Regional Council on the Ocean (MARCO), Northeast Regional Ocean Council (NROC), NOAA, and Duke websites.

- *Biodiversity Research Institute* – Survey period: 2012-2014. Methods: high resolution aerial and boat surveys, telemetry. Species: birds, mammals, turtles, and fish. Data available from BRI and Mid-Atlantic Ocean Data Portal.

- *Digital Aerial Baseline Survey of Marine Wildlife* – Products: species maps, density maps, GIS shapefiles, imagery. Survey period: 2016-2019. Species: birds, mammals, turtles, rays, sharks, fish, human activity. Methods: high-resolution aerial imagery, transects, grids. Information available on Normandeau website (https://remote.normandeau.com/nys_overview.php).

- *Fields Studies of Whales, Dolphins, and Sea Turtles for Offshore Alternative Energy Planning in Massachusetts* – Products: sightings data, density and abundance estimates, SPUE, NARW demographics. Survey period: 2011- 2015. Species: marine mammals, sea turtles, sharks. Methods: aerial surveys using observers and cameras.

- *The Real-time Opportunity for Development Environmental Observations (RODEO) approach*, led by BOEM, will be used to collect empirical data on environmental impacts as the first of the wind energy facilities are being built. This approach is currently underway and monitoring for sound during pile driving, evaluating scour from anchors and other bottom disturbing activities, conducting seafloor recovery studies, observing cable laying, and monitoring sound during operations. The study is expected to end in December 2019 and results will be used to improve analysis of environmental effects from construction and operation of wind energy developments.

- *New York Bight Monitoring* - Survey period: 2016-ongoing. Species: marine mammals and sharks. Methods: near real-time acoustic monitoring for marine mammals, ship-based surveys for marine mammals and sharks, also includes tracking studies.

Main themes from the panel discussion on developing BMPs for baseline monitoring

1. Framework for baseline monitoring: A framework that includes benefits, limitations, and what approaches work or do not work will be helpful for regulators and the communities to know what can be done in terms of baseline monitoring. Decision makers need more guidance on what tools to use and when. A comprehensive list of target species to monitor for would also be useful.

2. Detecting change: The panel discussed the types of changes that may be important to detect and the methods that should be used to detect them. Confidence intervals for abundance of some species are large and there is considerable natural variation which may make absolute changes in abundance or distribution difficult to detect without a sufficiently large sample size. There is a need to understand the prey base and if shifts are natural or cause by lease development. Looking at other characteristics, such as vital rates and baseline stress levels, may help determine changes. Consistency in the survey method may also lead to the ability to detect change. What other methods are there for collecting data other than species presence? Survey size also needs to be questioned as the spatial scale of wind farms is small compared to some surveys.

3. Data needs: 1) Experts need super fine resolution results in order to answer relevant questions related to marine species. 2) Large and small scale data are necessary. Broad scale is good to understand seasonal range and impacts to species other than marine mammals, but smaller scale studies are good for vital rates. Case studies may also be useful (harbor seals may be a good species to study). 3) Understanding inter-annual variability is vital and requires at least three years of data. Understanding this variability will help design effective mitigation. 4) Knowing absolute species abundance is not necessary, but it is important to know abundance relative to before an offshore wind installation is built and whether there is a significantly different change after the offshore wind installation is constructed. 5) There is a need for prey data from fisheries sampling and an integrated approach to surveys and sampling strategy. 6) There may be gaps in visual and acoustic data. For the Mid-Atlantic, areas used by the Navy have been heavily surveyed (mostly south), but gaps exist for areas outside of that. 7) Data integration is important and needs to be specific. There are different classifications of animals (e.g. mothers and calves will not call so as to not attract predators) and NARW spread out as they forage, so animals may be present, but not in dense numbers. Gathering specific data points and integrating data from multiple sources will help better understand what kinds of animals are present and density. 8) Comparative population studies may be helpful as would finding out what project design minimizes effects (e.g. turbine spacing). 9) Information regarding presence, absence, density, habitat, and habitat corridors is also needed.

4. Data collection and analysis: BMPs need to take into account methods of data collection. The method chosen depends on the research question. An integrated approach of methods to baseline monitoring may help provide the benefits of each method. When possible, similar methods should be used for projects investigating the same research questions.

4 Recommendations, Considerations, and Next Steps

The three-day workshop led to several main themes from the workshop panel discussions and many considerations for development of BMPs for offshore wind development in the Atlantic and protected species. Below are some specific recommendations suggested from individual experts on the panel as well as potential areas for BOEM to consider on the path forward. Although BOEM must consider all impacts, the panel recommended prioritizing species in the following order: 1) NARWs, 2) other large whales, 3) other marine mammals (small cetaceans and seals), and 4) sea turtles. This prioritization should be considered in weighing the pros and cons of mitigation strategies for different species.

Monitoring

Panelists suggested creating a research strategy to identify the most important research questions for monitoring priorities and developing simulations to inform the most important effects to be monitored. Standardizing methods for recording and reporting monitoring and data collection would also prove useful. Another recommendation was to develop guidance for PAM that provides flexibility to account for the wide distributions of animals and specifies the appropriate PAM method under the circumstances (e.g., glider, buoys, or towed).

Mitigation

Panelists noted that specific BMPs that apply to certain geographic areas or certain times of year be clearly defined and justified. A one size fits all approach may be too general to address specific habitats or seasons. One recommendation was for BOEM to develop a risk assessment that clearly explains/identifies why certain mitigations measures are or are not needed (e.g., seasonal windows). The PCoD models may be a tool to use as the risk assessment framework for determining mitigation and monitoring needed.

Cumulative impacts and secondary effects

Panelists noted the need to assess aggregate impacts to species and to focus on the larger scale effects, rather than direct effects such as auditory injury. Other effects (e.g., chronic stress, reproduction, or behavioral shifts) from sound exposure could harm individuals or the population. Another recommendation was to look at secondary effects such as increased ship strikes as a result of changing behavior patterns (e.g. a change in migratory routes that coincide with shipping routes). Panelists also recommended conducting prey-based studies to help identify potential effects.

Panelists recommended looking at cumulative impacts to determine if offshore wind development might have additive or synergistic effects with other stressors. During the NEPA process, activities that take place in the same area are listed; however, there is no analysis on the real cumulative impact of all of these impacts together. There may be future opportunities for

BOEM to consider recommendations for conducting a cumulative impact analysis for regional impacts. At this time, it is also difficult for developers to predict the future cumulative impact from individual projects because BOEM does not publish information on separate projects before plans are approved and reasonable certain to occur.

In the UK, documents are available from other offshore wind farm developers and what those developers are planning to do, which helps developers look at cumulative impacts. Panelists pointed to several studies/reports for information on cumulative impacts. The PCoD model may be useful for assessing cumulative impacts, but there are some key pieces of information (vital rates, population health parameters (stress), and energetics) that may prevent the application of PCoD models (e.g., NARWs). The National Academies of Science recently released a volume on cumulative impacts on marine mammals and may help fill some of the gaps for successful application of the PCoD model (found here: https://www.nap.edu/catalog/23479/approaches-to-understanding-the-cumulative-effects-of-stressors-on-marine-mammals). The International Whaling Commission also published a report on impacts from marine activities (found here: http://www.nmfs.noaa.gov/ia/slider_stories/2014/09/workshop_report_iwc_arctic.pdf). Germany has had a lot of success with marine spatial planning, and lessons learned from that experience may help BOEM address cumulative impacts. Collaborative studies by BOEM and NOAA Fisheries may also help understand cumulative effects.

Uncertainty

Panelists highlighted several areas that needed more study or contained uncertainty. 1) Piling noise and noise propagation is an area in need of more study, specifically how far sound travels, best methods for mitigating this noise, effectiveness of SRS, and determining the best technology for reducing the impact of sound. 2) Habitat use and seasonal timing also need additional study, especially for determining annual variability and seasonal timing restrictions. Gaining a better understanding and analysis of large data sets may help reduce uncertainties around seasonal differences (e.g. differences in calling rates from PAM data vs visual data). 3) Impacts, especially behavioral, and real-time monitoring effects need to be assessed. Impacts may not be limited to auditory impacts and there could be larger behavioral impacts, reproductive or physiological changes that also need to be mitigated. Further study would help reduce uncertainty around these impacts. 4) Combining survey methods will also help reduce uncertainty. For example, smaller PAM arrays are needed for fine-scale questions around lease activities, and large scale arrays are needed for broad scale questions. 5) Monitoring 50-60 kilometers around a site will help detect changes in habitat use and behavior.

Aggregate data

Panelists recommended aggregating data regarding species abundance, density, behavior, etc. Aggregating data allows for results from several methods to be combined and will help reduce uncertainty, as well as compare methodology(ies). For example, aggregating data may help compare visual vs acoustic data to see if results of these methodologies are in agreement. Additionally, aggregating data for developer tests on acoustic equipment may help identify the best performers and most useful technology for mitigation and monitoring.

Panelists also recommended breaking down the data into certain areas (e.g., off coast of New York) rather than data for all of the Atlantic. This will help assess impacts, especially for the NARW, and region specific data will help address seasonal timing questions as well as how species use certain areas during the course of the year.

Envelope approach to permitting

Panelists recommended developing the envelope approach to permitting. Currently, project permits must include specific impacts a project is likely to have on the environment. However, after the surveying is complete, results may force the developer to change their initial siting, foundation, and construction methods. This then requires developers to alter their permits, delaying the development schedule. The envelope approach would allow for a range of impacts and associated mitigation and monitoring strategies to be included in the permits, which would provide flexibility by allowing a project changes as long as the impacts were considered in the worst reasonable case analysis for the project envelope. However, obtaining stakeholder opinion regarding a project, including impacts and effectiveness/appropriateness of monitoring and mitigation strategies, is difficult to obtain without specific information on a proposed project. Developers should identify worse-case scenarios in a project envelope that will be analyzed under NEPA.

The 10 knot rule

Panelists agreed that reducing ship speed helps reduce vessel strikes and concurred that the 10 knot rule (ships over 65 feet had to reduce speed to 10 knots or less in a seasonal DMA) was a good BMP. One developer noted that adhering to this rule was not onerous. Another recommendation was to consider expanding the rule to include vessels under 65 feet since collisions could still occur with smaller vessels. Another suggestion was for the USCG to develop hotspot maps for marine areas with concentrated levels of shipping traffic.

Minimum requirements for night surveying

Panelists recommended BOEM may want to look at the alternative monitoring plans submitted by developers and develop minimum/standard requirements for night surveying (e.g., what technology to use and how far observers need to be able to see). Standardizing these procedures would allow for developers to continue operations without having to submit the same alternative plan with each project. Initial recommendations for inclusion in the standards included requiring visibility to be good enough so that observers can see a NARW or harbor porpoise at 500 meters, observers to be able to cover a 180 degree arc on the horizon, and fog/rain restrictions. PAM should be considered to supplement for all visual surveys.

Compensatory Mitigation

Panelists recommended further discussion on compensatory mitigation to identify the types of measures that could be required. Traditionally, a positive action is put in place to compensate for the negative outcomes of another. For example, potential negative impacts of offshore wind construction could be offset by reducing more severe negative effects cause by another sector (e.g. entanglement from fishing). Compensating in the ocean is challenging because there are not the same resources/institutions in the ocean as there are for land. BOEM can only compensate for activities under its control, which limits the range of acceptable compensatory mitigation measures. Currently, developers can implement voluntary compensatory mitigation measures to benefit the conservation of large whales, but no measures are required.

Next Steps

The collaborative nature and expertise of presenters and panelists produced a lot of important information and feedback. BOEM will use the considerations and recommendations put forth by the panelists to help guide developing BMPs and guidance documents related to offshore wind. BOEM also recognized that many ideas for environmental studies stemmed from the workshop. As development of BMPs progresses, BOEM will share any guidance or concepts with stakeholders developed as a result of the workshop.

Appendix A: Workshop Agenda

Day 1: Tuesday, March 7

8:00-8:30 am	*Check-in*	
8:30-9:15 am	**I. Background and Welcome**	
	• Welcome and Opening Remarks o Introductions	*Walter Cruickshank, Ph.D., BOEM Acting Director* *Abby Arnold, Kearns & West (K&W)*
	• **Science, Regulatory Requirements, and Stakeholder Coordination**	*Tamara Arzt, BOEM*
	• **Workshop and Role of Panel** o Best Management Practices o Role of the Panel o Review of Agenda and Ground rules	*Kyle Baker, BOEM* *K&W*
9:15-10:35 am	**II. Perspectives on Protected Species and Offshore Wind Development**	
9:15-9:30 am	• **BOEM Offshore Wind Leasing Process and Workshop Goals** *(presentation followed by Panel Q&A)* o Lease area locations o Lease and plan review stages o Survey instruments for lessees o NEPA o Role of BMPs in these processes	*Michelle Morin, BOEM*
9:30-9:45 am	• Industry Perspectives on Offshore Wind Development and Protected Species. • **An overview of workshop goals and considerations from the industry perspective***(presentation followed by Panel Q&A)*	*Rachel Pachter, Vineyard Wind Presenting for the American Wind Energy Association*
9:45-10:00 am	• NGO Perspectives on Conservation Priorities for Protected Species*(presentation followed by Panel Q&A)* • **An overview of perspectives and workshop goals from national environmental organizations.**	*Catherine Bowes, NWF, Michael Jasny, NRDC, and Howard Rosenbaum, Wildlife Conservation Society*
10:00-10:15 am	• Scientific/Academic Perspectives *(presentation followed by Panel Q&A)* • ***An overview of academic perspectives on offshore wind development.***	*Jason Roberts, Duke University*
10:15-10:35 am	• **NMFS Endangered Species Act**	*Julie Crocker, NOAA Fisheries*

	Consultations *(presentation followed by Panel Q&A)* o NMFS ESA requirements and timelines o Incidental Take Statement requirements o Existing/future consultations pertaining to Construction and Operations Plans and General Activities Plans	
10:35-10:45 am	***Break***	
10:45-11:05 am	**II. Perspectives on Protected Species and Offshore Wind Development** *(continued)*	
10:45-11:05 am	• NOAA Fisheries Remarks • **NMFS Marine Mammal Protection Act (MMPA) Compliance***(presentation followed by Panel Q&A)* o MMPA Incidental Take Authorization Requirements and timelines o Information requirements	*NOAA Fisheries Leadership* *Jordan Carduner, NOAA Fisheries*
11:05-12:30 pm	**III. Identifying Effects to Protected Species**	
11:05-11:10 am 11:10-11:20 am	• **Purpose and Goals** • **Protected Species and Critical Habitat in Atlantic Wind Energy Areas – An overview of Species, Habitat, and Conservation Goals** • *(presentation followed by Panel Q&A)*	*Kyle Baker, BOEM* *Allison Hernandez, NOAA Fisheries*
11:20-11:35 am	• **Activities Associated with Offshore Wind Development (general plan-envelope concept)** • *(presentation followed by Panel Q&A)* o Overview of general activities, surveys, turbine bases, cables, vessel ops, and trends in turbine height and number	*Aileen Kenney, Deepwater Wind*
11:35-12:30 pm	**IV. Lessons Learned from Offshore Wind in the UK – a conservation agency perspective** *(presentation followed by Panel Q&A)* • Mitigation and monitoring strategies in the UK • Lessons learned • Panel Discussion	*Sónia Mendes,* *Joint Nature Conservation Committee*
12:30-1:30 pm	***Break for Lunch***	
1:30-2:15 pm	**V. Introduction to an Effects Framework** *(presentation followed by Panel Q&A)* • Introduction to Effects Matrix	*Facilitated by K&W*

	• What are activities and effects to marine mammals, sea turtles, and habitat (e.g., injury, avoidance, duration of impact)? • Can we assign a relative priority level for each impact? (What are the criteria we use to set priorities?)	
2:15-3:45 pm	**VI. Mitigation and Monitoring of Underwater Noise**	
2:15-2:30 pm	• **Introduction to Noise from Offshore Wind Activities** • Panel discussion on effects of underwater noise (matrix) • Key issues for mitigation and monitoring regarding underwater noise	*Desray Reeb, BOEM* *Facilitated by K&W*
2:30-3:00 pm	• **NOAA Marine Mammal Acoustic Technical Guidance***(presentation followed by Panel Q&A)* o NOAA sound exposure criteria summary o Example cumulative exposure distance calculation and applications to BMP development	*Amy Scholik-Schlomer, NOAA Fisheries*
3:00-3:20 pm 3:20-3:45 pm	• High-Resolution Geophysical (HRG) Surveys • *(presentation followed by Panel Q&A)* • Introduction • **Sound Source Characterization Studies** • **Review of BOEM's Existing HRG Requirements based on New Sound Source Information** *(presentation followed by Panel Q&A)* • Exclusion Zones • Protected Species Observers • Sound Source Verification • Nighttime surveys and alternative monitoring plans	*Desray Reeb, BOEM* *Stanley Labak, BOEM* *Desray Reeb, BOEM*
3:45-4:00 pm	**VII. Participant Comment on all meeting topics** (participants should register in advance if they wish to comment)	*Facilitated by K&W*
4:00-4:15 pm	***Networking Break***	
4:15-5:15 pm	**VIII. Panel Discussion on HRG Surveys and**	*Facilitated by K&W*

	Best Management Practices	
5:15-5:30	**Wrap up and Adjourn**	*Facilitated by K&W*

Day 2: Wednesday, March 8

8:00-8:30 am	*Check-in*	
	IX. Welcome	
8:30-8:45 am	• Day 1 Recap and Overview of Day 2	*Facilitated by K&W*
8:45-12:30 pm	**X. Pile Driving**	
8:45-8:50	• **Introduction**	*Kyle Baker, BOEM*
8:50-9:05 am	• **Monitoring Results from Block Island Wind Farm** *(presentation followed by Panel Q&A)*	*David Zeddies, JASCO Applied Sciences*
9:05-9:50 am	• **Germany Requirements for Pile Driving** *(presentation followed by Panel Q&A)* • Requirements in Germany • Mitigation and monitoring results • Lessons Learned	*Eva Philipp, Vattenfall*
9:50-10:05 am	• Questions from the Audience on Pile Driving	*Facilitated by K&W*
10:05-10:35 am	• Panel Discussion on Pile Driving	*Facilitated by K&W*
10:35-10:45 am	***Break***	
10:45-12:30 pm	• Panel Discussion on Pile Driving (continued) o Noise Levels and Exclusion Zones o Survey Platforms (Visual and Acoustic) o Nighttime Construction o Sound Source Monitoring	*Facilitated by K&W*
12:30-1:30 pm	***Break for Lunch*** *Optional Lunchtime Presentation on Thermal Imaging and Round the Clock Visual Monitoring*	*Bernard Padovani, Seiche*
1:30-2:30 pm	**X. Pile Driving** (continued)	
1:30-2:25 pm	f. Panel Discussion on Pile Driving (continued) • Seasonal Considerations • Data Collection and Reporting	*Facilitated by K&W*
2:25-2:55 pm	**XI. Participant Comment on all meeting topics** (participants should register in advance if they wish to comment)	*Facilitated by K&W*
2:55-3:35 pm	**XII. Baseline Monitoring**	
2:55-3:00 pm	• **Introduction and Goals**	*Kyle Baker, BOEM*
3:00-3:10 pm	b. Baseline Assessments Management *(presentation followed by Panel Q&A)* o Role of BOEM's Environmental Studies Program o **BOEM's 2016 Science Forum Summary**	*Mary Boatman, BOEM*

3:10-3:20 pm	• **Orientation to Baseline Marine Wildlife and Habitat Data for Offshore Energy Siting and Operations** *(presentation followed by Panel Q&A)* • Types of data collected • Broad-scale and fine-scale • Future work funded	*Jay Odell, The Nature Conservancy*
3:20-3:35 pm	• **Atlantic Marine Assessment Program for Protected Species***(presentation followed by Panel Q&A)*	*Debra Palka, NMFS*
3:35-3:45 pm	***Networking Break***	
3:45-5:15 pm	**XII. Baseline Monitoring** (continued)	
3:45-4:00 pm	• **Atlantic Passive Acoustic Monitoring of Soundscapes** *(presentation followed by Panel Q&A)* • Discuss broad scale and fine scale capabilities of the PAM effort currently underway	*Sofie Van Parijs, NOAA Fisheries*
4:00-4:15 pm	• **Massachusetts Clean Energy Center Large Pelagics Surveys** *(presentation followed by Panel Q&A)* • *Fine-scale survey efforts*	*Scott Kraus, New England Aquarium*
4:15-4:30 pm	• **Ultra High Resolution Aerial Surveys in the Atlantic** *(presentation followed by Panel Q&A)* • Broad and fine-scale surveys	*Christian Newman, APEM*
4:30-5:15 pm	h. Panel Discussion on Baseline Monitoring o Distribution and abundance o Reef Effect, Habitat Use, and Migration o Monitoring parameters	*Facilitated by K&W*
5:15-5:30 pm	**Wrap up and Adjourn**	*Facilitated by K&W*

Day 3: Thursday, March 9

8:00-8:30 am	*Check-in*	
	XIII. Welcome	
8:30-8:45 am	1. Day 2 Recap and Overview of Day 3	*Facilitated by K&W*
8:45-10:15 am	**XIV. BMPs for Baseline Monitoring**	
8:45-10:15 am	1. Panel Discussion on Monitoring for changes in Baseline Conditions 2. What parameters should be monitored during wind farm operation? 3. Visual Surveys 4. Passive Acoustic Surveys 5. Habitat Parameters	*Panelists/BOEM* *Facilitated by K&W*
10:15-10:30 am	**XV. Vessel Traffic**	
10:15-10:30 am	1. **Introduction** 2. **Vessel Lanes and Strike Risk in Wind Energy Areas** *(presentation followed by Panel Q&A)* 3. Existing port traffic 4. Location of offshore wind energy areas	*Desray Reeb, BOEM* *Douglas Simpson, USCG District V CIV*
10:30-10:45 am	***Break***	*Facilitated by K&W*
10:45-12:00 pm	**XV. Vessel Traffic** (continued) 1. Panel Discussion: Vessel Strike Risk 2. Risk 3. Seasonal speed reduction 4. Monitoring	*Facilitated by K&W*
12:00-12:30 pm	**XVI. Participant Comment on all meeting topics** (participants should register in advance if they wish to comment)	*Facilitated by K&W*
12:30-1:30 pm	***Break for Lunch***	
1:30-3:15 pm	**XVII. Panelist Discussion on BMPs** 1. Refine BMPs discussed for mitigation, monitoring, reporting, data management 2. Identify areas of uncertainty 3. Panel Members Provide Their Independent Recommendations	*Facilitated by K&W*
3:15-3:30 pm	**Wrap Up and Adjourn**	*K&W*

Appendix B: Panelist and Presenter Bios

Tamara Arzt is an Environmental Protection Specialist and the ESA Lead for the Division of Environmental Assessment within the Office of Environmental Programs at BOEM. Ms. Arzt has been with BOEM since 2011where her work has focused mainly on policy, procedural and legal aspects of ESA Section 7 Consultations across BOEM regions related to oil and gas activities, MMPA issues, and NEPA. Prior to joining BOEM, she worked for the Bureau of Land Management in DC and Colorado on issues in the terrestrial environment.

Dr. Helen Bailey is a Research Associate Professor at the University of Maryland Center for Environmental Science. Helen has published over 40 journal articles, specializing in marine mammal and sea turtle ecology. She has studied the environmental impacts of offshore wind turbines in Scotland and currently leads a project on passive acoustic monitoring of marine mammals in the Maryland Wind Energy Area.

Kyle Baker is a Marine Biologist for the Bureau of Ocean Energy Management's Office of Renewable Energy Programs. Kyle works on environmental studies and assessments of sea turtles and marine mammals in Atlantic wind energy areas. Prior to joining BOEM, Kyle worked at NOAA with endangered species and marine mammals for 15 years. He has worked on population impacts from ocean noise, oil spills, and has been a leader in the development of mitigation and monitoring strategies.

Jen Banks is the Environmental Permitting Specialist for US Wind. Jen leads permitting efforts for the Maryland Offshore Wind Energy Project – managing agency relationships, securing permits and overseeing environmental consultant activities. Previously, Jen worked at SEWC and AWEA. Jen holds a B.S. in Environmental Technology from NCSU and a Master of City and Regional Planning degree from Clemson University.

Dr. Mary C. Boatman is the Science Coordinator for the Bureau of Ocean Energy Management's Office of Renewable Energy Programs. Mary has worked at BOEM at both the regional office in New Orleans and in the Headquarters office in Herndon, Virginia on both offshore oil and gas and renewable energy issues. Her area of expertise is Chemical Oceanography, but she has worked in a multi-disciplinary capacity for many years through the Environmental Studies Program at BOEM

Catherine Bowes is the Senior Manager for Climate and Energy at the National Wildlife Federation. Catherine leads the organization's Campaign for Offshore Wind Power, which is focused on promoting responsibly developed offshore wind as an essential strategy for achieving a clean energy future. She holds a B.A in Political Science from Washington University in St. Louis and a Master's in Environmental Policy from Bard College.

Jordan Carduner is a Fishery Biologist for NOAA Fisheries' Office of Protected Resources, Permits and Conservation Division. Jordan evaluates applications for incidental take authorization under the Marine Mammal Protection Act. He has also worked on ESA section 7 consultations and served on the U.S. delegation to the International Whaling Commission. Jordan earned a Masters in Environmental Management from Duke University where he participated in a study of the underwater soundscape in the proposed Cape Wind project area.

Vicki Cornish is an Energy Policy Analyst for the U.S. Marine Mammal Commission. The Marine Mammal Commission is an independent federal agency of the U.S. Government, located in Bethesda, MD. Ms. Cornish focuses on the effects of offshore oil and gas and renewable energy activities on marine mammals and their environment, as well as the enhancement of policies and programs to better understand and minimize those effects.

Julie Crocker is the Endangered Species Coordinator for Protected Resources Division of NOAA Fisheries' Greater Atlantic Regional Fisheries Office. Julie oversees programs for the recovery of Endangered Species Act listed Atlantic salmon, Atlantic sturgeon and shortnose sturgeon as well as supervising staff that carry out ESA section 7 consultations on energy projects.

Deborah Epperson is a Protected Species Biologist for the Department of the Interior's Bureau of Safety and Environmental Enforcement. Deborah has worked on protected species issued associated with energy development since 2003. This includes the Protected Species Observer program associated with seismic surveys in the Gulf of Mexico as well as Endangered Species Act and Marine Mammal Protection Act consultations. In her current position, she monitors compliance and provides enforcement for BOEM and BSEE required protected species mitigation.

Pernille Hermansen is the Permitting Project Manager for DONG Energy Wind Power AS. Pernille is leading on DONG Energy's US offshore wind farm project with responsibility for the permitting including environmental assessment as well as stakeholder engagement. Pernille has extensive experience of permitting and environmental topics in relation to development, construction and operation of commercial scale offshore wind farms in Europe.

Allison Hernandez is an Endangered Species Act section 7 consultation biologist for NOAA Fisheries. Allison joined NOAA in 2016 and conducts consultations for wind and conventional energy programs. She has a diverse background with over 17 years as a biologist with expertise in protected species ecology; having achieved most of that time in federal Service at BOEM, U.S. Fish and Wildlife Service, and the National Park Service in several locations including Guam.

Michael Jasny is the Director of the Marine Mammal Protection Project for the National Resources Defense Council. Michael is an expert in the law and policy of ocean noise pollution, among other issues affecting marine mammals, and has worked domestically and internationally for more than a decade through high-profile litigation, lobbying, science- based policy development, and public advocacy to improve regulation of this emergent problem.

Aileen Kenney is the Vice President of Permitting and Environmental Affairs for Deepwater Wind. Aileen is responsible for overseeing the environmental assessment, permitting, and key stakeholder outreach. Aileen successfully permitted the Block Island Wind Farm. Aileen was instrumental in developing measures to protect the endangered North Atlantic Right Whale. Her environmental stewardship has helped make Deepwater Wind a leader in responsible offshore wind development.

Dr. Scott Kraus is the Vice President for the Anderson Cabot Center for Ocean Life and Senior Advisor at the New England Aquarium. Scott, a research scientist at the New England Aquarium since 1980, has published over 110 papers on marine mammals, bluefin tuna, fisheries, and bycatch. He is an expert on North Atlantic right whales and aerial surveys, and serves on the faculty at the University of Massachusetts.

Stan Labak is a Marine Acoustician for the Department of the Interior's Bureau of Ocean Energy Management, Office of Environmental Programs, Division of Environmental Sciences. Stan has worked on the development and testing of acoustic systems for over 30 years. For the last 15 years that work has included modeling and analysis of anthropogenic noise on marine animals. He is a former submariner and a retired Naval Reservist. He currently works on projects involving acoustics for BOEM's Oil & Gas, Renewable or Marine Mineral Programs.

Dr. Sónia Mendes is the Senior Marine Mammal specialist in the offshore industries advice team at the Joint Nature Conservation Committee. JNCC is a statutory advisor to government in the United Kingdom. Sónia has a marine biology background and has, for the past 10 years, worked at the interface between science, policy and regulation to advise on risk assessment, mitigation and monitoring of the effects of offshore industries on marine mammals.

Michelle Morin is the Chief of the Environment Branch for Renewable Energy in the Bureau of Ocean Energy Management. During Michelle's 21 years with the bureau, she coordinated dozens of environmental impact statements and assessments for BOEM's oil and gas and renewable energy programs. Currently, Michelle manages an interdisciplinary team responsible for environmental assessments, consultations, and studies related to renewable energy leasing and development on the Atlantic OCS.

Kara Nave (facilitator). Kara Nave is an Associate at Kearns & West in the marine and energy practices. She joined the firm in 2015 with experience in policy research related to smart growth, land conservation, and energy issues. Kara also has a strong background in federal energy policies and program administration.

Christian Newman is President of APEM Inc. an aerial remote sensing and geomatics company with 20 years of experience developing innovative wildlife monitoring technology. He oversaw the BOEM's first project to use high resolution digital aerial methods for offshore wildlife in the United States. He is APEM's project director for the largest offshore digital wildlife survey in the world occurring off of Long Island, New York.

Jay Odell leads The Nature Conservancy's Mid-Atlantic Marine Program, developing science and policy in service of ocean conservation solutions. Jay has worked as fisheries biologist and marine ecologist since 1988. For the past several years this work has included spatial data development, coleading the Mid-Atlantic Ocean Data Portal Team and serving as a strategic advisor to the Mid-Atlantic Regional Planning Body.

Dr. Debra Lynn Palka is a Research Fishery Biologist with NOAA Fisheries' Northeast Fisheries Science Center. Debi received her Master's in bio-statistics from University of North Carolina 1986. PhD in Biological Oceanography from Scripps Institution of Oceanography 1993. She currently estimates abundance and bycatch for marine mammals in the US North Atlantic, assist take reduction teams, study marine mammals' habitat, and work with the International Whaling Commission's Scientific Committee.

Dr. Sofie Van Parijs is a Fishery Biologist for NOAA Fisheries' Northeast Fisheries Science Center. Sofie leads the passive acoustic research program at the Northeast Fisheries Science Center in Woods Hole. She has worked from the poles to the Tropics for over 20 years. Currently her focus is on using acoustics to improve long term monitoring of marine mammals and fish as well as ocean noise.

Dr. Eva Philipp is the Environmental Lead for Offshore and Onshore Wind Projects for Vattenfall. Eva runs the Environmental strategy department in the Business Area Wind at Vattenfall. She is a marine biologist and worked > 10 years in science before joining Vattenfall Wind in 2012. Her theoretical and practical Offshore Wind experience covers all environmental topics from development to construction and generation.

Rachel Pachter is the Vice President of Permitting Affairs with Vineyard Wind. She has fifteen years of experience in US offshore wind development. She directed and finalized the permitting for the first fully permitted offshore wind farm in federal waters of the United States. Rachel has represented environmental and regulatory concerns in all aspects of project development including contracting and financing, and lead numerous stakeholder outreach efforts. Rachel has managed extensive offshore site investigation work including reconnaissance and design level geophysical and geotechnical surveys and cutting edge avian surveys. Rachel is overseeing the permitting of the BOEM Lease area acquired in January 2015 by OffshoreMW, now called Vineyard Wind.

Desray Reeb is a Marine Biologist for the Department of the Interior's Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Desray did her Ph.D. and post-doctoral work mainly focusing her research on issues related to right whales. However, she has worked on various aspects related to multiple marine mammal species throughout her career. She spent much of her career as a field biologist and brought her research and mitigation experience to BOEM's Renewable Energy Program in 2013.

Jason Roberts is a Research Associate at Duke University's Marine Geospatial Ecology Laboratory. Jason is a marine ecologist and software engineer interested in the habitats and movements of marine animals, methods for modeling species distributions, the application of remote sensing to marine ecology problems, and techniques for minimizing human impacts on ocean life while facilitating sustainable use of ocean resources.

Dr. Howard Rosenbaum is a Senior Conservation Scientist and Director of the Wildlife Conservation Society's Ocean Giants Program. Howard is a Senior Scientist at the American Museum of Natural History and core faculty member at Columbia University, a member of the United States Delegation to the International Whaling Commission, the IUCN Cetacean Specialist Group and Important Marine Mammal Area Task Force, and holds the Conservation Seat for SBNMS Advisory Council.

Amy Scholik-Schlomer is the Protected Resources Acoustics Coordinator for NOAA Fisheries. Amy has been the technical lead for acoustic issues within the Office of Protected Resources in NOAA Fisheries for over a decade. She has been an author on several publications/reports, as well as presented at numerous national/international conferences, on the issue of underwater noise and marine protected species.

Douglas Simpson is with District 5 of the United States Coast Guard.

Nancy Sopko is the Director of Offshore Wind & federal Legislative Affairs at the American Wind Energy Association. As such, Nancy is staff liaison to the association's offshore wind committee, works with the administration on permitting, regulatory, and other priorities, lobbies Congress on policies that are helpful to the industry, and liaises with the environmental community on marine wildlife issues

David Zeddies is a senior scientist and engineer for Jasco Applied Sciences. David received a BS in Mechanical Engineering from the University of Illinois at Urbana-Champaign (1990) and a PhD in Neuroscience from Northwestern University (2001). He was a Post-doctoral Associate at the Parmly Hearing Institute at Loyola University of Chicago from 2001 to 2003 and a Research Associate in the lab of Arthur Popper at the University of Maryland from 2004 to 2008.

Abby Arnold (facilitator). Abby S. Arnold is a Principal at Kearns & West, and concurrently the Executive Director of the American Wind Wildlife Institute, nonprofit science based organization. AWWI is a collaboration among the wind industry and conservation/science organizations committed to developing wind power while minimizing impacts to wildlife. Abby has been a practicing mediator for nearly 30 years and specializes in energy resources and wildlife conservation.

Appendix C: List of Attendees

Joseph Abe, MD Department of Natural Resources	Breanna Evans, Gardline
Andrea Ahrens, Stantec	Bryan Faehner, National Park Service
Tamara Arzt, Bureau of Ocean Energy Management	Pasha Feinberg, Defenders of Wildlife
Justin Bailey, Alpine	Evica Felins, NOAA Sea Grant
Helen Bailey, University of Maryland Center for Environmental Science	Stephanie Fiori, Bureau of Ocean Energy Management
Kyle Baker, Bureau of Ocean Energy Management	John Fisher, VA Department of Environmental Quality
Jen Banks, U.S. Wind	Kimberly Fitzgibbons, Atkins
Joel Bell, U.S. Navy	Kellie Foster-Taylor, NOAA Fisheries
James Bennett, Bureau of Ocean Energy Management	Bernd Geels, Marine Conservation Institute
Ingrid Biedron, Oceana	Howard Goldstein, NOAA Fisheries
Mary Boatman, Bureau of Ocean Energy Management	Katie Guttenplan, Ecology and Environment
Catherine Bowes, National Wildlife Federation	Anne Hawkins, Fisheries Survival Fund
Tiffini Brookens, Marine Mammal Commission	Andrea Heckman, Bureau of Ocean Energy Management
Liz Burdock, Business Network for Offshore Wind	Pernilla Hermansen, Orsted
Jordan Carduner, NOAA Fisheries	Allison Hernandez, NOAA Fisheries
Heidi Cocca, EPI Group	Brian Hooker, Bureau of Ocean Energy Management
Paul Crissy, U.S. Coast Guard	Brian Hopper, NOAA Fisheries
Walter Cruickshank, Bureau of Ocean Energy Management	Michael Jasny, Natural Resources Defense Council
Vicki Cornish, Marine Mammal Commission	Kit Kennedy, Natural Resources Defense Council
Jordan Creed, Bureau of Safety and Environmental Enforcement	Aileen Kenney, Deepwater Wind
Julie Crocker, NOAA Fisheries	Francine Kershaw, Natural Resources Defense Council
John Crowther, Stantec	Scott Kraus, New England Aquarium
Marc d'Entremont, LGL Limited	Marcus Kwasek, Alpine
Jeff Deem	Stan Labak, Bureau of Ocean Energy Management
Glen Degnitz, Bureau of Safety and Environmental Enforcement	Ben Laws, NOAA Fisheries
Sam Denes, JASCO	Rebecca Lent, Marine Mammal Commission
Dorothy Deutschmann, Bureau of Ocean Energy Management	Lisa Lierheimer, NOAA Fisheries
Thomas Douglas, NAVSEA	Emily Lindow, Bureau of Ocean Energy Management
Jennifer Draher, Bureau of Ocean Energy Management	Carl Lobue, The Nature Conservancy
Deborah Epperson, Bureau of Safety and Environmental Enforcement	Steven Lohrenz, Dartmouth University
Magnus Eriksen, Statoil	Caren Madsen, Consultant
	Timothy McCune, Bureau of Ocean Energy Management
	Eoin McGregor, NIRAS
	Sonia Mendes, Joint Nature Conservation Committee

Jill Meyer, CSS	Chris Scraba, U.S. Coast Guard
Todd Mitchell, Fugro	Greg Silber, NOAA Fisheries
Annette Moore, Bureau of Ocean Energy Management	Douglas Simpson, U.S. Coast Guard
Katie Morgan, Ocean Conservancy	Mari Smultea, Smultea Sciences
Michelle Morin, Bureau of Ocean Energy Management	Maura Smyth, Gardline
Kara Nave, Kearns and West	Erica Staaterman, Bureau of Ocean Energy Management
Barbara Neale, SC Department of Health and Environmental Control	David Steckler, Mysticetus
Pamela Neubert, Stantec	Jessica Stromberg, Bureau of Ocean Energy Management
Christian Newman, APEM	Tyler Studds, Massachusetts Clean Energy Center
Jeffrey Nield, CH2M	Todd Sumner, Law Office of Todd Sumner
Jay Odell, The Nature Conservancy	Brendan Talwar, Marine Mammal Commission
Rafael Olivieri, Caird Sextant	Erin Trager, Bureau of Ocean Energy Management
Jant Foley Orosz	Amy Trice, Ocean Conservancy
Rachel Pachter, Vineyard Wind	Sofie van Parijs, NOAA Fisheries
Bernarrd Padovani, Seiche	Kristjan Varnik, TetraTech
Debra Palka, NOAA Fisheries	Stephen Viada Continental Shelf Associates
Eric Patterson, NOAA Fisheries	Lauren Wahl, AIS
Ann Pembroke, Normandeau	Erica Wales, Kearns and West
Douglas Perkins, EON	Sierra Weaver, Southern Environmental Law Center
Eva Philipp, Vattenfall	Amy Whitt, Azura
John Pierson, Navy	Meghan Winands Araiza, Bureau of Ocean Energy Management
Danbiel Pisegna	David Zeddies, JASCO
Bonnie Ram	
Desray Reeb, Bureau of Ocean Energy Management	
Meghan Rickard, NYS Department of Environmental Conservation	
Danielle Rious, NOAA Fisheries	
Jason Roberts, Duke University	
Matthew Robertson, Vineyard Wind	
Julia Robinson Willmott, Normandeau	
Howard Rosenbaum, Wildlife Conservation Society	
Kathryn Roy, AIS	
Emily Runnells, NYS Department of Environmental Conservation	
Greg Sanders, Bureau of Ocean Energy Management	
Amy Scholik-Schlomer, NOAA Fisheries	

Department of the Interior (DOI)

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management (BOEM)

The mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program

The mission of the Environmental Studies Program is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM's Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).