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under Contract DE-AC05-76RL01830

Environmental Effects of Offshore Wind Development

Fiscal Year 2012 Progress Report

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September 2012

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

Potential environmental effects of offshore wind (OSW) energy projects are not well understood, and regulatory agencies are required to make decisions in spite of substantial uncertainty about environmental impacts and their long-term consequences. An understanding of risks associated with interactions between OSW installations and aquatic receptors, including animals, habitats, and ecosystems, can help define key uncertainties and focus regulatory actions and scientific studies on interactions of most concern.

To examine the environmental risks associated with OSW developments in the U.S. Pacific Northwest National Laboratory (PNNL) focused on the following four priority research areas in FY 2012:

- Environmental Risk Evaluation System (ERES) - Followed project developments on the two OSW projects that PNNL screened in FY 2011 for environmental consequence: Fishermen's Energy off the coast of Atlantic City, NJ and LEEDCo. near Cleveland, OH in Lake Erie.

- *Tethys* - Developed a smart knowledge base which houses environmental research, data and information pertaining to OSW energy:

- Technical Assessment - Produced a new software to create an automated process of identifying and differentiating between flying organism such as birds and bats by using thermal imagery; and

- North Atlantic Right Whales - Developed an environmental risk management system to mitigate the impacts on North Atlantic Right Whales (NARW) during installation and piledriving stages of OSW developments.

By identifying and addressing the highest priority environmental risks for OSW devices and associated installations the ERES process assists project proponents, regulators, and stakeholders to engage in the most efficient and effective siting and permitting pathways.

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1.0 Introduction

The Pacific Northwest National Laboratory (PNNL) has been tasked by the U.S. Department of Energy (DOE) to help inform project proponents, regulators and stakeholders on the most efficient and effective means of siting and permitting OSW developments in the U.S., and to recommend the most pertinent and useful research that support these efforts. Responsible deployment of offshore wind (OSW) energy devices in the U.S. waters requires that all appropriate regulatory requirements be met and that stakeholder concerns be taken into account. The emerging U.S.-based OSW industry faces particular challenges because the regulatory pathways are not fully developed and the potential environmental effects of OSW developments are not well understood.

To begin setting regulatory and research priorities, a better understanding of the environmental risks involved with the interactions between OSW devices and environmental receptors must be attained. While OSW projects also encounter regulatory risks (the risk to OSW permitting and approvals due to regulations or their implementation) and investment risks (the risk to capital investment due to regulatory, legal, or market forces). a particular focus is on identifying and addressing environmental risks, because environmental risks can be a significant driver of both regulatory and investment risks.

In FY 2011, PNNL developed the Environmental Risk Evaluation System (ERES) to begin assessing the environmental risks associated with OSW projects in the U.S. Two case studies were chosen and examined using ERES Screening Analysis process for environmental consequence: 1) Fishermen's Energy located off the coast of Atlantic City, NJ and the Lake Erie Energy Development Corporation (LEEDCo.) in Lake Erie near Cleveland, OH. The FY 2011 ERES Screening Analysis identified priority environmental interactions between the OSW devices (stressors) and the marine environment (receptors) based on their associated biophysical and regulatory risks. Due to the lack of sufficient detailed environmental data, these risks were evaluated solely on the potential consequence of their interaction. In order to fully understand the underlying risks of these OSW stressor-receptor (S-R) interactions, knowledge of the resulting consequences as well as the probability of occurrence is required.

To continue addressing the environmental risks associated with OSW developments, and attempt to better understand and potentially mitigate the underlying risks of interactions between OSW devices and environmental receptors, PNNL continued its work on screening environmental consequence for the two case studies and pursued three additional research areas in attempt to enhance our understanding of the environmental risks associated with OSW developments. The four FY2012 activities are described below.

1.1 Environmental Risk Evaluation System (ERES)

To follow up on the FY 2011 OSW ERES process, a brief summary of the FY 11 ERES Screening Analysis and results from both case studies (Fishermen's Energy and LEEDCo.) are summarized in this report. As part of the ERES process, PNNL communicated the results of the Screening Analysis to both OSW developers. An overview of these communication efforts are provided in this report, including a

brief progress report for each of the OSW projects describing their current stage in the permitting and siting process. The FY2012 ERES activities will be highlighted in Section 2.

1.2 *Tethys*

Due to limited environmental data and overall lack of understanding on how these devices interact with and potentially affect the marine environment, PNNL was tasked by the U.S. Department of Energy to develop a knowledge management system dubbed "*Tethys*" to organize and house research, information and data on the environmental effects of offshore renewable energy. Over the course of FY 2012, PNNL researchers and developers worked toward enhancing the quantity, quality and accessibility of the OSW environmental literature and information within *Tethys*. While the limited availability of data and information has prevented researchers from modeling probability or fully analyzing the associated risks highlighted in the ERES screening analysis, *Tethys* functions as a tool to acquire and centralize the data and information required to begin analysis of the probability of S-R interactions and improve our understanding of the associated consequences. An overview of the FY2012 *Tethys* activities is discussed in Section 3.

1.3 Technical Assessment

One of the largest environmental concerns for OSW developments is the potential interaction between wind turbine blades and avian species such as birds and bats. To improve upon current monitoring and mitigation methods, in FY2012 PNNL explored the development of new automated software to differentiate among flying objects such as birds, bats, insects and debris, by using thermal imaging video equipment. By developing this software, PNNL will create an automated process for identifying thermal images of birds and bats that will provide the scientific community with a tool to process large quantities of data to support siting of wind energy projects in a time and cost efficient manner. A summary and results of the Technical Assessment are provided in Section 4.

1.4 North Atlantic Right Whales

According to the Bureau of Ocean Energy Management (BOEM) Draft Environmental Assessment of Wind Energy Areas (WEAs) on the Mid-Atlantic Outer Continental Shelf (OCS), exposure to underwater noise and vessel collision have been identified as the highest risks to North Atlantic Right Whales (NARW) during site characterization, site assessment and pile driving operations associated with OSW development. To address the environmental risks posed by the installation of OSW farms to NARWs and alleviate stringencies within the OSW permitting and siting process, PNNL began development of a risk management system that can be applied to the interaction of NARW with offshore wind areas. The NARW project is discussed in Section 5.

2.0 ERES Screening Analysis

The Environmental Risk Evaluation System (ERES) was originally developed by PNNL to address the environmental risks associated with OSW devices. ERES evaluates all possible environmental scenarios, from episodic interactions such as a collision of a vessel with a wind turbine, to chronic interaction scenarios such as toxicity due to low-level chemical releases from anti-fouling paints or coatings. Between these two extremes, intermittent events occur, such as encounters between birds and rotating blades. A key feature of understanding risk is describing the uncertainty associated with the occurrence of an episodic, intermittent, or chronic event, as well as the uncertainty of the resulting consequences. ERES can be used to assist regulators, decision-makers, and stakeholders, including the OSW industry, to assess their tolerance toward risk, set priorities for research activities, and compare the costs and benefits of OSW installation options.

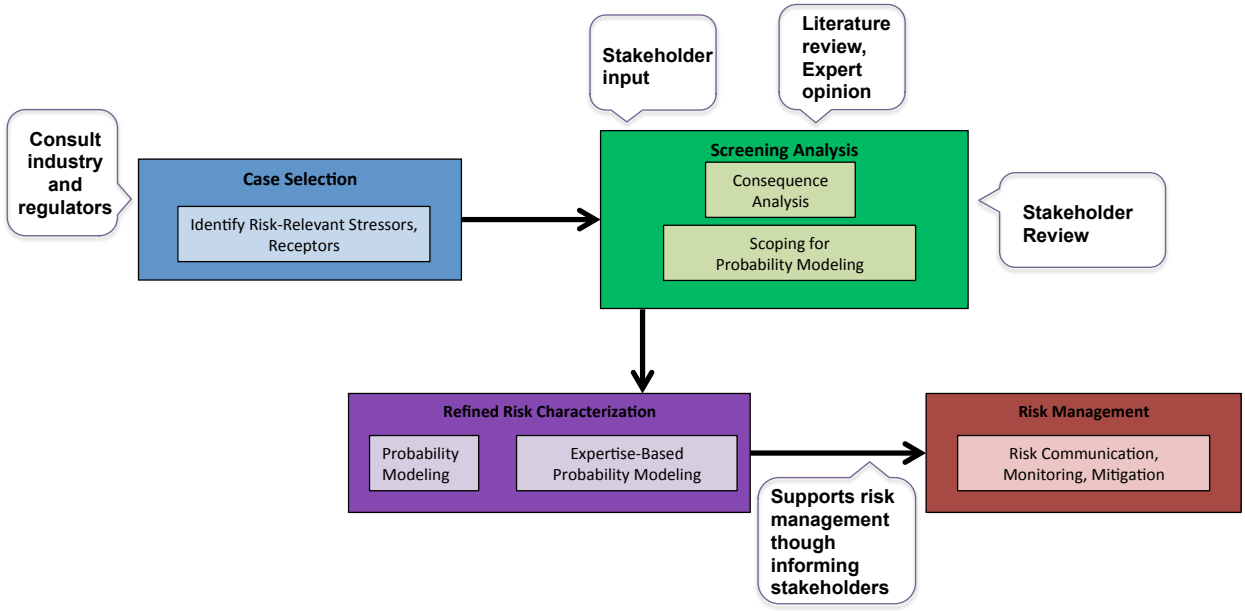

Figure 1. Risk-Informed Analytical Process

The ERES risk assessment process developed by PNNL is shown above in Figure 1. The process begins by selecting potential OSW cases to be used in the ERES process (blue box). Once these cases are chosen, all of the key environmental concerns are highlighted for each case. Two cases were chosen in FY 2011: Fishermen's Energy located off the coast of Atlantic City, New Jersey, and the Lake Erie Energy Development Corporation (LEEDCo.) in Lake Erie near Cleveland, Ohio.

During the Case Selection process (blue box), stressors from OSW installations and likely receptors were identified for each case study. In the Screening Analysis phase (green box), each case study went through a process which involved determining the potential effects for the highest priority interactions

between the stressors (OSW devices or portions of the system that may adversely affect aquatic receptors) and the chosen receptors from the case selection process (aquatic organisms, habitats, and ecosystem processes). Each stressor-receptor (S-R) interaction was then ranked using 14 biophysical risk factors (or biological imperatives) to determine the vulnerability of the receptor to the stressor. A second set of risk factors - regulatory risk factors - were also applied to the S-R pairs to create a new ranking of S-R interactions. This second ranking of S-R interactions also reflect biological risks; however, due to the regulatory stringency associated with the authorities involved with the OSW permitting and siting process, the regulatory risks were prioritized.

The outcome of the FY 2011 OSW ERES screening analysis was a two tiered lists of S-R interactions for Fishermen's Energy and LEEDCo., ranked by the regulatory and biophysical risks factors associated with each interaction. Due to the limited environmental data and lack of understanding regarding the probability of each of these interactions, the results of the Screening Analysis process were not further analyzed in the Refined Risk Characterization process of ERES (purple box in Figure 1). However, PNNL contacted each of the developers about the results of the ERES Screening Analysis in FY 2012.

The following section summarize the results of the 2011 ERES screening analysis for each case study, provides an overview of the interactions between PNNL and the OSW developers, and includes an update for each OSW project discussing their current progress and where they stand in the permitting and siting process.

2.1 Fishermen's Energy - Atlantic City, NJ

Fishermen's Energy, a community-based OSW developer and consortium formed by principals of east coast fishing companies, is developing a two-phase project consisting of two offshore wind farms off the coast of New Jersey. The first phase of the project consists of roughly 693 acres located three miles off the coast of Atlantic City, NJ. The project will consist of eight 2.5 MW turbines oriented in a linear array which is expected to produce 20 MW of energy.

2.1.1 ERES Screening Analysis, Fishermen's Energy

Due to their small population sizes and overall vulnerability to anthropogenic changes to the marine environment, those species listed as Threatened or Endangered (T&E) under the Endangered Species Act received the highest rankings of the vulnerable receptors. Marine mammals and migratory birds which are also protected under the Marine Mammal Protection Act and the Migratory Bird Treaty Act, respectively, ranked particularly high among all the listed receptors for the Fishermen's Energy project. Because of the substantial physical presence offshore wind turbines have, and the proximity this proposed project has to the shore, stressors such as *Physical Presence (dynamic or static)* and *Accidents or Disasters* were some of the highest ranked stressors. *Cables/EMF* also ranked high among the listed stressors due to the high levels of uncertainty around how these stressors may affect specific organisms in the marine environment such as elasmobranchs and other EMF-sensitive creatures.

2.1.2 Communicating with Fishermen's Energy

During FY2011 and again in FY2012, the FY2011 OSW ERES report was sent to contacts from Fishermen's Energy for review and comments. A response was received several weeks later confirming the have received the report, but no comments were attached. Several other attempts were made to discuss the ERES process with Fishermen's Energy, however no responses or comments regarding the ERES process have been received to date.

2.1.3 Current Progress

As of mid-July, 2012, Fishermen's Energy received its final construction permit from the U.S. Army Corps of Engineers for an individual permit under the Clean Water Act. Fishermen's Energy was originally planning to install five 5 MW wind turbines produced by the Chinese manufacturer XEMC; However, based on concerns surrounding XEMC's technology and financial resources, Fishermen's Energy is considering installing 6 smaller 3.6 MW wind turbines produced by Siemens. While a final decision has yet to be made, Fishermen's Energy needs approval from the New Jersey's Board of Public Utilities for their pricing plan for offshore renewable energy credits. Fishermen's first attempt was recently rejected by the state due to the company's failure to demonstrate the environmental and financial benefits to New Jersey residents and electricity customers. Pending the state's Board of Public Utilities approval, Fishermen's Energy aspires to begin construction in 2013 and have six fully functioning turbines operating by 2014.

2.2 Lake Erie Energy Development Corporation (LEEDCo) – Cleveland, OH

Lake Erie Energy Development Corporation (LEEDCo), a nonprofit economic development corporation, is developing an offshore wind pilot project in Lake Erie 7 miles northwest of Cleveland, Ohio. This project will consist of five to seven 4.1-MW turbines, with a total rated capacity of 20–30 MW of energy.

2.2.1 ERES Screening Analysis, LEEDCo

Similar to Fishermen's Energy, all T&E species received priority over the other non-protected receptors. However, because the LEEDCo project is located in Lake Erie, no marine mammals or reptiles were listed as vulnerable receptors. This allowed T&E birds and fish to be ranked as the most important ranking receptors, particularly T&E migratory birds, which are protected under the Endangered Species Act as well as the Migratory Bird Treaty Act. T&E bats were also ranked very high due their presence around Lake Erie and their ability to fly great distances over the lake. *Physical Presence (dynamic or static)* and *Accidents/Disasters* again ranked the highest among the listed stressors for the LEEDCo project due to the substantial size of the wind turbines and their proximity to shore. *Cables/EMF* did not rank as highly as it did for Fishermen's Energy due to the limited presence of EMF-sensitive organisms.

2.2.2 Communicating with LEEDCo

A summary of the FY2011 OSW ERES report was sent to LEEDCo. LEEDCo responded with enthusiasm and was eager to learn more about the ERES process and inform PNNL on LEEDCo's goals and progress on their OSW project. After several discussions on the ERES results associated with the LEEDCo project, LEEDCo came to the conclusion that the ERES report should be presented to Ohio state environmental agencies involved in the permitting and siting process for the project. This presentation has been delayed while a Power Purchase Agreement (PPA) is being discussed between LEEDCo and their primary utility partner. PNNL continues to communicate with LEEDCo and maintain an ongoing relationship with the offshore wind developer.

2.2.3 Current Progress

In 2011, LEEDCO obtained a lease option from the Ohio Department of Natural Resources, giving LEEDCo exclusive rights to their proposed development site. To expedite the leasing process, four counties along Lake Erie's shorelines have agreed to share the annual revenue they may receive each year ensuring a collaborative approach to developing offshore wind in the Great Lakes. Originally planning to use GE's 4.1 MW turbines, LEEDCo decided to switch to a smaller, more efficient turbine in order to cut construction costs and produce electricity at a better price. LEEDCo is currently working with Siemens to install between five and nine 3.0 MW direct-drive turbines in Lake Erie. The LEEDCo project is getting closer to its deployment stage, but it has yet to obtain a PPA favorable enough to proceed with development.

As seen with the Fishermen's Energy case study, the PPA is particularly important for any offshore renewable energy project because it not only ensures the energy produced will be purchased, but it is also one of the primary avenues for these developers to attract investors and acquire financial assistance LEEDCo anticipates the 27 MW offshore wind project to be fully functioning by early 2015.

3.0 *Tethys*

This section highlights *Tethys* project activities from FY 2012 relating to OSW. Note this report is a brief summary of the year's activities; the full report can be found on the *Tethys* website at: http://mhk.pnnl.gov/wiki/index.php/Tethys_Home.

3.1 Summary of *Tethys*

The marine and hydrokinetic (MHK) environmental Impacts Knowledge Management System, dubbed "*Tethys*" after the mythical Greek titaness of the seas, is being developed by the Pacific Northwest National Laboratory (PNNL) to support the U.S. Department of Energy's Wind and Water Power Program. Functioning as a smart database, *Tethys* enables its users to identify key words or terms to help gather, organize and make available information and data pertaining to the environmental effects of MHK and OSW energy development. Originally created to provide only MHK-related information and data, *Tethys* has progressed to include both OSW and MHK information, creating a more comprehensive site to appeal to a broader community. By providing and categorizing relevant publications within a simple and searchable database, *Tethys* acts as a dissemination channel for information and data which can be utilized by regulators, project developers, and researchers to minimize the environmental risks associated with offshore renewable energy developments and to accelerate the permitting process.

The primary objective for FY2012 was to enhance the reliability and accessibility of the *Tethys* knowledge base, and to continue expanding the knowledge base through the addition of documents, datasets, modeling scenarios, and other information types pertaining to the environmental effects of offshore renewable energy. Metrics and associated goals were created as a part of an overall measurement plan for *Tethys*, enabling PNNL researchers and *Tethys* users to evaluate the site's effectiveness and overall usability.

3.2 Results of *Tethys*

Tethys activities over FY 2012 can be categorized into three separate actions: 1) site development; 2) data curation and partnerships; and 3) site maintenance and management. Each of these actions is discussed in more detail below.

3.2.1 Site Development

Site development focused on creating and extending the *Tethys* technical infrastructure to ensure that it functions effectively and that new features are added in a timely and cost-effective manner. Site development was a major focus of the *Tethys* task in FY2012. Highlights include:

- The MHK and OSW databases were combined into one comprehensive knowledge base. Prior to 2011, the MHK and OSW databases were separate knowledge bases containing separate information. Merging the data promotes sharing of information between stakeholders for these two renewable energy types and enhances the searchability of *Tethys*.

- Several enhancements were made to improve the user experience and increase the scalability of Tethys as our data collection grows. Improved handling of search results and a new indexing program were implemented, significantly decreasing the page-loading times.
- The *Tethys* map viewer was upgraded to allow association of any type of document or report with a specific location or project site data. Originally, site associations were limited primarily to the MHK projects extracted from the FERC docket.
- The knowledge base was reorganized to streamline data entries and maintain uniformity amongst all media types. This enabled properties such as the Technology Type to be a label for many different media types, thus enhancing the search capabilities of the site.
- "Support" pages such as a *Tethys* blog, FAQs, contacts, recent news, and definition pages for stressors, receptors, and technology types were created, and an explanation of *Tethys* was added to educate and direct users to the appropriate information.

3.2.2 Data Curation and Partnerships

Data curation, which includes properly vetting, classifying, abstracting and indexing documents, is a critical aspect of maintaining the *Tethys* knowledge base. Information housed in *Tethys* must be current and new research and information must be incorporated as they become available. Partnerships with agencies and other stakeholders can be invaluable resources to review and attain content and throughout FY2012, *Tethys* focused on fostering data curation and partnership activities. The Tethys content team, led by Luke Hanna and assisted by Pacific Energy Ventures (PEV), added approximately 400 new knowledge base entries in FY 2012, greatly exceeding the goal of adding an average of 40 documents each quarter. As of September 1, 2012, *Tethys* contained approximately 600 entries in the *Tethys* knowledge base with approximately 260 of those entries being associated with a specific geographic location and viewable via the map viewer.

3.2.3 Site Maintenance and Management

To ensure the operational success of *Tethys*, the *Tethys* team is continuously improving the functionality of *Tethys* where opportunities present themselves, insuring that the site is kept current with security and software code updates as required. The *Tethys* team has implemented an issue tracking system that allows client and user community requests, as well as system upgrade tasks, to be tracked and assigned to individuals within the team.

Key FY2012 maintenance and management activities included:

- To assess the functionality, content, and practicality of *Tethys* to other professionals in the offshore renewable energy community, several researchers in the offshore renewable energy community were asked to peer review the *Tethys* knowledge base. Comments and suggestions from the review were incorporated into a revision of *Tethys*.
- An assessment plan was prepared and approved by WWPP that delineates key performance metrics and a process for using them to monitor and improve *Tethys*. Unfortunately, our ability to collect web metrics was compromised during the final quarter of FY2012 due to technical issues stemming from PNNL's web security system. While these issues have been resolved moving

forward into FY2013, FY2012 data are limited to the overall site traffic and top rated documents/features. The data should be considered provisional, and will be updated in Q1 FY13 following the first quarter of fully responsive data.

- Highlights of the FY2012 web site data include:
    - From June 20 – Sept 19, 2012 *Tethys* averaged 19,485 hits per day. This figure includes internal (PNNL/DOE) users and search engine hits so should be taken as an optimistic estimate of site activity.
    - A more reasonable estimate can be derived from looking at download activity on technical documents indexed in *Tethys*. These documents are rarely accessed by PNNL users for maintenance purposes, and accessed relatively infrequently by users who are not seeking the data they contain. From these data we find:
        - The most downloaded document is the Fundy Ocean Research Center for Energy's Environmental Effects Monitoring report, downloaded more than 6,800 times (an average of more than 68 downloads per day over observation period).
        - 12 reports were downloaded 1,000 or more times during the observation period.
        - More than 100 documents indexed in *Tethys'* knowledge base were downloaded 200 or more times during the 100-day observation period.
    - Modifications to the way in which *Tethys* use logs are generated were implemented that allow much greater resolution of user patterns, including an analysis of average number of pages downloaded per user, distribution of countries from which downloads originate, and search terms that are being used to find Tethys documents. These data will be reflected in quarterly reporting from Tethys starting at the conclusion of Q1 FY2013.

4.0 Technical Assessment

The Summary of PNNL's FY 2012 Technical Assessment is provided below. The full report can be found in the PNNL report 21911 (Duberstein et al. 2012).

4.1 Summary of Technical Assessment

The primary method used to assess the environmental risk of offshore wind energy developments to flying fauna (birds and bats) is to use marine radar to enumerate birds and bats that fly through the rotor-swept zone (Svedlow 2011, Davenport 2010, d'Entremont 2010, Johnson 2010). Information currently provided by radar include the number of targets passing through the radar beam in a set amount of time, distance from the target to the radar device, and trajectory or travel path. However, radar data alone do not allow researchers to effectively differentiate between targets of interest (e.g., birds and bats) and other flying objects (e.g., insects). Inclusion of these false bird/bat detections skews risk calculations.

One method successfully used to differentiate birds, bats, and insects is the simultaneous deployment of a thermal-imaging camera with radar (Zehnder et al. 2006; Gauthreaux and Livingston 2006). However, the manual methods that are required to process the thermal imagery data are time consuming and costly. To address this issue, PNNL developed algorithms and software in FY 2012 to automate processing and classification of thermal image data to distinguish birds, bats, and insects.

4.2 Results of Technical Assessment

During FY2012, PNNL created an annotated digital thermal library by recording six hours of bird video at multiple locations near the PNNL Marine Science Lab (MSL) at Sequim, WA. These thermal digital videos were fed to a image processing algorithm developed by PNNL through an internally-funded project to provide proof-of-concept that target tracks could be identified and that numerical data describing those tracks could be extracted from digital video. By evaluating track attributes such as intensity, object size, rate of travel across the camera view, and track sinuosity, researchers were able to begin to define attributes that would be useful in automated classification. Although several factors complicated the automated identification, enumeration and classification of bird and bat tracks, the development of these thermal image processing techniques enable researchers to proof large volumes of data critical to siting wind energy projects in a time and cost efficient manner.

5.0 Monitoring and Mitigation Alternatives for Protection of North Atlantic Right Whales During Offshore Wind Farm Installation

PNNL's North Atlantic Right Whale (NARW) project is summarized in Section 5. The full report can be found in the PNNL report XXX (PNNL xxx).

5.1 Summary of North Atlantic Right Whales Project

According to the BOEM Draft Environmental Assessment of Wind Energy Areas (WEAs) on the Mid-Atlantic Outer Continental Shelf (OCS), exposure to underwater sound and vessel collision have been identified as the highest risks to the North Atlantic Right Whale (NARW) during site characterization, site assessment, and pile driving operations of OSW development on the Mid-Atlantic OCS. While NARW may only be present in WEAs during certain months of the year, they are listed under the Endangered Species Act and are therefore of great concern to regulators and OSW developers, particularly during the installation and maintenance stages of an OSW project on the OCS.

Ensuring the safety of NARWs during offshore wind turbine installation will require real time monitoring of the whales and mitigation measures when they are found in the vicinity of the installation operations, particularly those associated with pile driving. Installing wind turbines on the OCS will require that large diameter steel shell piles are driven into the seabed, an operation that can extend for several days, depending on the number of foundations, and can produce a substantial source of underwater sound that may place animals at risk. Specialized equipment is needed, such as hammers, purpose-built vessels, and a trained crew to operate them. Mobilization, operation and demobilization of this gear is very expensive; these expenses continue throughout the deployment period whether they are idled by inclement weather or other delays such as the presence of NARW.

The purpose of monitoring actions around pile driving operations is to detect the presence of marine mammals and inform necessary mitigation actions, which may include a number of actions including cessation of pile driving. At present, the most commonly required monitoring for marine mammals around pile driving operations is by ship-based marine mammal observers (MMO). Mitigation measures for pile driving in NARW areas[1] establish an exclusion zone 7 km in radius (covering 154 km²) around the sound source such that pile-driving operations must cease when marine mammals are observed within the zone. Observational monitoring protocols consist of one observer located near the sound source and a second observer on a moving vessel operating at a radial distance of 4 to 5 km from the sound source. Pile driving operations are commonly disallowed when conditions do not permit visual monitoring.

The purpose of this project is to begin to manage the potential risk to North Atlantic Right Whales (NARW) from the development of offshore wind farms in the Atlantic, and to develop a system of risk management that is portable to other offshore wind development areas where other marine animals may be of concern from offshore wind installation. This report examines the feasibility of using both MMO and passive acoustic monitoring (PAM) to monitor during pile driving activities, and how active acoustic

[1] 75 Code of Federal Regulations 140:42698-42708

techniques may be utilized. Various combinations of MMO and PAM monitoring techniques were evaluated, including extensions of monitoring technologies and mitigation plans that are currently integrated into OSW construction activities. The outcome of these efforts will be to allow the extension of pile driving operations into the night and during daytime periods when visual monitoring for NARW is not effective. By extension, many of the monitoring and mitigation strategies discussed will be transferable to offshore wind installation operations in other regions, in conjunction with other marine mammal species.

5.2 Results of North Atlantic Right Whale Project

PNNL researchers contacted OSW developers and consultants to gain their perspectives on the effect that regulatory protections for NARW might have on development in the Atlantic. Feedback from the developers and consultants indicated that there is concern about the uncertainty surrounding regulations protecting NARWs at present, and how those rules may change in the future. Generally, the offshore wind developers are concerned with the possibility of lengthy windows when pile driving is prohibited, particularly as that relates to the availability of weather windows needed to complete construction. Respondents felt that industry would consider the use of PAM; however, they mentioned that they understand its limitations and would not want to rely totally on PAM. Respondents indicated that the use of PAM and MMOs should be standardized so that the costs of environmental compliance may be understood and accounted for early in the feasibility process.

In conjunction with the feedback received from the OSW developers and consultants regarding NARWs on the OCS, PNNL reviewed current methods, trends and overall efficiency of utilizing MMO, PAM, active acoustics and a combination of these monitoring approaches in attempt to increase the effectiveness of marine mammal monitoring and migration. Because the large-scale construction of offshore wind farms will require monitoring for marine mammals at times when the effectiveness of visual observations is limited, and the economic viability of offshore wind farms depends in large part on the costs of their construction, PNNL suggests four steps to effectively design monitoring and mitigation components that will help facilitate the permitting of wind farms. These four steps are:

1. Integrate monitoring and mitigation planning into the overall construction planning for offshore wind farm installations;

2. Identify the scope of monitoring to be conducted and the appropriate mix of visual, acoustic and other monitoring modalities;

3. Evaluate the likelihood that marine mammals of interest will occur in a construction site, and the most likely behavior they will exhibit while at the site; and

4. Create an integrated monitoring and mitigation plan that will bring together information about construction schedules and times that can be extended through the application of appropriate monitoring techniques; capabilities of visual, acoustic, and other marine mammal monitoring modalities, and the likely occurrence of NARWs in the construction zone.

6.0 Discussion/Conclusion

The screening analysis for risk associated with developing OSW projects can be separated into three categories: environmental risk, regulatory risk, and investment risk. Environmental risk can be described as the risk that the technology poses to living organisms, and the physical and chemical processes that support living systems. Regulatory risk is the risk to OSW permitting and approvals due to regulations or their implementation. Investment risk is the risk to capital investment due to regulatory, legal, or market forces. The ERES process was created to address environmental risk because environmental risk also drives regulatory and investment risk. The ERES offshore wind energy case studies illustrate the value of assessing environmental risk to reduce both regulatory and investment risks.

By determining the highest-priority risks for stressors from OSW devices and associated installations with vulnerable receptors in the marine and freshwater environment, the ERES screening process assists project proponents, regulators, and stakeholders to engage in the most efficient and effective siting and permitting pathways.

The analyses reported here show that the insight gained into potential interactions between OSW energy turbines and the natural environment supports the acceleration of OSW developments in U.S. waters. However, it is also clear that the information gaps are still present. PNNL will build upon the studies completed in FY 2012 and undertake the additional projects and analyses outlined below in FY 2013:

1. *OSW Risk Assessment and Marine Planning* – Federal, state, and regional governing bodies have been established throughout the U.S. to create comprehensive spatial management plans for the jurisdictional waters. To ensure that the development of OSW projects are factored into the process on the U.S. west coast, PNNL staff will engage with designated task forces and governing bodies responsible for marine spatial planning to reduce regulatory risk and procedural barriers for the OSW industry. A case study will be presented in FY 2013 discussing the integration of OSW project opportunities into federal, state, and regional-level marine spatial plans in the Pacific region.

2. *Tethys* – The *Tethys* knowledge base system houses and organizes data, information, and research pertaining to the environmental effects of OSW information. FY 2012 showed that *Tethys* serves as an accessible dissemination channel for information and research about stressor/receptor interactions, and serves as a collaborative site for OSW researchers, developers and regulators. The system will be enhanced in FY 2013, enabling users to more-easily navigate through the system to view data from various project sites and research studies. An updated reference collection plan will be completed pertaining to the environmental effects of OSW developments.

3. *Technical Assessment*—The goal of the technical assessment is to develop software solutions to automate identification and counting of birds and bats in the vicinity of OSW farm using infrared (IR) video. In FY 2013, PNNL will continue development of an infrared video software tool. Specifically, a decision tree that will allow scientifically defensible methods to identify recorded objects including both birds and bats will be developed and bundled with data processing algorithms to produce the software tool.

4. *North Atlantic Right Whales*—Exposure to underwater sound has been identified as one of the highest risks to North Atlantic Right Whales (NARW) during site characterization, site assessment, and pile driving operations for OSW project developments on the Mid-Atlantic outer-continental shelf. PNNL staff will continue work begun in FY 2012 to specify systems to more accurately detect, localize and range NARW using a mix of methodologies including marine mammal observers, passive acoustics, and active acoustics; estimate the acoustic output from a range of pile driving protocols used for OSW installation, and test the integration of monitoring and mitigation methods into the work flow for installation of wind turbines offshore.

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