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NYSERDA Environmental Research Program Plan

Research Area 4: Marine Wind and Wildlife

Final Report

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NYSERDA Environmental Research Program Plan
Research Area 4: Marine Wind and Wildlife

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Process and Content

The overall goal of this document is to provide a platform and framework to inform future discussions and research in the field of wildlife and marine wind power in New York State. The contents of this report were derived from a multi-step stakeholder outreach process, involving input from a diverse group of federal regulators and managers, New York State regulators and managers, offshore wind developers, environmental consultants, national and New York-specific environmental nongovernmental organizations (ENGOs), and academic researchers. A smaller review committee of state and federal regulators met in August 2014 and used the input provided during previous steps, as well as their own expertise and knowledge of existing data, to determine the final prioritization of research needs. Although every effort was made to ensure the accuracy of the content, this document should not be viewed as prescriptive of any single agency's views; rather, this document is intended to describe the prioritization criteria and discussions that occurred during this meeting.

Executive Summary

This research plan was developed with input from state and federal regulators, academia, nonprofit organizations, industry, and other stakeholders. It identifies environmental information gaps and research needs for marine wind energy development offshore of New York State. Specifically, the aim of this report is to identify immediate information needs, and ensure that offshore research and monitoring efforts are orchestrated to address the data gaps of greatest need for New York State at this time.

The research needs identified in this plan were prioritized because they were judged to be best addressed at this time at the state scale, and with some involvement of state agencies, rather than being more appropriate to address at larger or smaller geographic scales (perhaps by federal agencies, private developers, or other entities) at some point in the future.. "Priorities," as used in this research plan, describes the most pressing research needs at this time, not necessarily the most important priorities for each participating entity. For example, cumulative effects have been provided a lower priority for New York at this time, but will become a higher priority as projects are developed. Similarly, baseline surveys for deep sea corals have been given a lower priority here because of the fine spatial resolution required for such surveys; this type of intensive survey may be more realistically performed by site developers at the project scale. Lower prioritization in this plan should not be construed to indicate that the research needs are not priorities to participants in this exercise; rather, research relating to these issues will become the priorities as other needs are met and the development process unfolds in New York.

Baseline data on potential wildlife exposure by season, including distribution and abundance information, was generally identified during this effort as a key gap in current understanding of offshore wildlife populations in New York. Regional-scale baseline information on animal distributions, abundance, and movements are beyond the geographic scope of individual projects, and thus may not be required of individual developers during the permitting process. However, broader-scale data can accelerate the permitting process for individual projects by providing key data to regulators and placing project-specific monitoring results in context. Prioritization of baseline studies should be informed by gap analyses for existing data, such as the data assembled as part of the Offshore Atlantic Ocean Study and subsequent efforts (by the New York Department of State and federal partners). It will also be important for New York State agencies to determine the appropriate spatial scope for such studies. Suggested research priorities include: mapping of benthic habitats and patterns of primary productivity; identifying distribution patterns of focal species such as cetaceans, sea turtles, seabirds, and commercially important fishes; examining the movements and habitat use of focal aquatic species; and assessing the relative vulnerability of avian species to offshore wind energy development in New York, to guide future research activities.

This research plan is intended to be general guidance for what is important in New York waters, and does not specifically articulate NYSERDA’s priorities, although NYSERDA may choose to support components of this plan at a future date.

1 Project Background

1.1 Goals of NYSERDA's Environmental Research Program

The New York State Energy Research and Development Authority's (NYSERDA) Environmental Research Program[1] convenes working groups of science and policy experts to identify critical gaps and research needs related to energy-related environmental impacts in New York State. The resulting research plans can be implemented by NYSERDA, as well as other New York, regional, and national organizations, to help maximize the use of limited resources to serve the needs of New York State and elsewhere. Under that goal, the Environmental Research Program is committed to developing and executing a science- and policy-based, stakeholder-driven process to identify data needs and action items for New York State marine wind and wildlife studies. Environmentally responsible development of marine wind energy will require a rigorous, thoughtful, and collaborative process for identifying action items and research needs; such a process will also encourage coordination between entities regarding ongoing and planned activities.

1.2 Project Overview

There is growing interest in developing marine wind energy in New York and elsewhere. However, it is still unclear what impacts such development could have on wildlife, including corals and other invertebrates, birds, bats, sea turtles, fish, and marine mammals. In an effort to help regulators and developers respond to permitting needs, the New York State Energy Research and Development Authority (NYSERDA) and the Biodiversity Research Institute (BRI) conducted a two-phase project. The first project phase focused on understanding site-specific information needs for the permitting process and culminated in the report "Advancing the Environmentally Responsible Development of Offshore Wind Energy in New York State: A Regulatory Review and Stakeholder Perceptions (NYSERDA 2015). The second phase built on this work, but focused on broader wildlife and marine wind energy information gaps and research needs for New York State marine waters, and culminated in this report.

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1 http://www.nyserda.ny.gov/Energy-and-the-Environment/Environmental-Research/EMEP.aspx

1.2.1 Phase 1: Defining Goals for Site Assessments

The objective for the first phase of the project was the development of the report: *Advancing the Environmentally Responsible Development of Offshore Wind Energy in New York State: A Regulatory Review and Stakeholder Perceptions* (NYSERDA 2015). This first phase was organized around five regulation-specific, stakeholder-based virtual meetings (listed species, protected birds, fisheries and fish habitats, coastal zone management, and environmental consultations) with participants from State and federal agencies, including a steering committee that provided input on participants and meeting topics (Appendix A). Two stakeholder advisory meetings were also held with developers, consultants, and representatives from environmental non-governmental organizations. Discussions focused on the identification of specific monitoring and data requirements in relevant environmental regulations. This preliminary regulatory review was a first step toward defining specific monitoring guidelines for wildlife and offshore wind energy in New York State.

1.2.2 Phase 2: Identifying Data Gaps and Research Needs

The second project phase built from input received from participants in Phase 1, as well as input received via a public survey, to develop this research plan. This plan identifies large data gaps that should be addressed to facilitate offshore wind energy development in New York (particularly issues that individual developers at project sites may not be expected to address), and prioritizes areas of future research related to marine wind energy and wildlife for New York. Priorities identified in this plan may require coordination among multiple project sites, external funding of large-scale research, or both, but the plan is focused on the specific needs and priorities of New York State. This actionable, prioritized plan identifies immediate wildlife and marine wind energy information and research needs, and serves as a first step toward filling gaps in current knowledge.

1.3 Development of the Research Plan

Phase 1 was focused primarily on site-specific information needs for regulatory and permitting processes. Participants in Phase 1 also provided input on larger-scale data gaps and research needs. These data gaps generally belonged to five categories: baseline data on animal distributions and abundance; effects research; cumulative and population-level impacts; mitigation and monitoring methods; and species vulnerability (for a detailed summary of Phase 1 input, see Appendix B). This input provided the framework for a public survey on wildlife and marine wind energy research priorities for areas offshore of New York State (Appendix C), which was sent via email to a large group of regulators, academics, developers, consultants, and other interested parties on April 29, 2014. This email included a request to forward it on to others who might be interested, and the survey was also posted on NYSERDA's website.[2]

Appendix D summarizes the responses to this survey. The responses were examined in detail in August 2014 by a group of nine experts in the field (Appendix E). Members of this review committee discussed the responses, added additional input if they felt the responses to the survey were lacking in specific areas, and determined the relative priority of the suggested research activities for New York. The compilation of responses and broad viewpoint adopted by this committee form the basis of this research plan. The aim of this research plan is to ensure that future offshore research and monitoring efforts are orchestrated to address the data gaps of greatest need for New York State.

This research plan is intended to be general guidance for what is important in New York waters, irrespective of potential funding opportunities. As a result, the Plan does not specifically articulate NYSERDA's support priorities, although NYSERDA may choose to support components of this plan at a future date.

[2] https://www.nyserda.ny.gov/Energy-Efficiency-and-Renewable-Programs/Renewables/Offshore-Wind.aspx

2 Offshore Wind Energy Development and Wildlife

Global demand for alternative energy sources, driven in large part by the threat of climate change, is driving rapid development of wind energy in many locations. The United States has over 60 gigawatts (GW) of terrestrial wind energy installed to date (AWEA 2012). There is also substantial interest in offshore wind energy development along the eastern seaboard, due in part to the region's relatively high population densities. However, the natural resources of the northwest Atlantic Ocean are also substantial, with unique communities of pelagic and forage fish and critical populations of cetaceans, nesting and migratory seabirds, shorebirds, bats, and sea turtles.

Federal and state regulations require environmental assessments for offshore wind energy project development, but these assessments are hampered by significant knowledge gaps. Few published studies exist on potential wildlife interactions with offshore wind energy development, particularly in the United States. As a result, inferences about risk to marine fish and wildlife from such development are drawn from comparison to land-based wind turbines; from European studies in marine waters, where wind energy facilities have been operational since 1991 (Breton and Moe 2009); or from other marine industries, such as offshore oil and gas development. Effects of terrestrial wind facilities are largely determined by local topography, climate, species ranges, and other factors, making physical context essential for understanding and minimizing wildlife effects. This is also likely true offshore (Mann and Teilmann 2013), although the variety of wildlife and the dynamic nature of marine habitat make prediction of wildlife effects from offshore wind energy facilities challenging. Studies at European facilities have found a range of wildlife effects, although such effects have in many cases varied between studies (Mann and Teilmann 2013).

2.1 The Need to Identify Research Priorities

Data gaps and unmet research needs are hampering the efforts of federal and state regulators to avoid or minimize—or even to understand—potential impacts to wildlife from marine wind energy development. There have been several efforts in New York and elsewhere along the Atlantic coast to identify and fill these gaps in recent years, but many unknowns remain, and substantial coordination is required to avoid duplication of effort. Explicit identification of priority research needs and data gaps by the parties involved will assist with demarcation of responsibilities and efficiencies in fulfilling research needs. As a result, such research plans not only allow for more environmentally responsible development, but also serve to accelerate development by addressing the concerns of regulators outside of permitting processes for individual development projects.

Several efforts to identify research needs have been conducted in Europe (e.g., Fox et al. 2006) and at the federal level in the United States (e.g., Musial and Ram 2010). The Bureau of Ocean Energy Management's (BOEM) Environmental Studies Program also conducts a similar needs assessment to help determine research funding priorities for each fiscal year.[3] However, such assessments are often limited to a specific taxon, or in contrast, are so broad in topical and geographic scope that more specific regional research needs may be lost. An assessment of research needs at a state or multistate geographic scale could address location-specific data gaps that may be more appropriately addressed at the regional level, but would still produce data that are relevant and applicable to multiple development projects. This research plan attempts to fill this regional-scale need for identification of research priorities for the next three to five years, and is intended to be complementary to other ongoing regional, national, and international efforts.

2.2 Offshore Wind and Wildlife in New York

The New York Department of State (DOS), in cooperation with other state and federal agencies, recently assembled a comprehensive report that provides spatial information for known or predicted locations of natural resources and ocean uses important to the State.[4] As part of the development of the Offshore Atlantic Ocean Study, four supporting reports[5] were developed by DOS' partners, including the National Oceanic and Atmospheric Administration's (NOAA) *Biogeographic Assessment of Seabirds, Deep Sea Corals and Ocean Habitats of the New York Bight* (Menza et al. 2012). Such efforts will help guide the siting of offshore renewable energy production and transmission facilities and identify important habitats that support New York's ocean industries and wildlife. Other key data sources include the Avian Compendium (O'Connell et al. 2009), OBIS-SEAMAP,[6] the BOEM website and reports,[7] and the scientific literature.

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3 http://www.boem.gov/Environmental-Studies-Planning/

4 http://docs.dos.ny.gov/communitieswaterfronts/ocean_docs/NYSDOS_Offshore_Atlantic_Ocean_Study.pdf

5 http://www.dos.ny.gov/opd/programs/offshoreResources/index.html

6 http://seamap.env.duke.edu/

7 http://www.boem.gov/Environmental-Studies-EnvData/

The data assembled for these studies have been collected in a variety of ways and over an extended period of time, and as such may lack the specificity required to accurately assess the current state of biological resources. Other efforts have attempted to address this gap by collecting new data for waters offshore of New York or elsewhere. Several statewide marine spatial planning efforts have been conducted near New York in recent years, including the Rhode Island Ocean Special Area Management Plan (OSAMP; McCann et al. 2010), and the New Jersey Department of Environmental Protection Baseline Studies Project (Geo-Marine, Inc. 2010). Broad-scale distribution and abundance data along the entire East Coast, including New York, are currently being collected as part of the Atlantic Marine Assessment Program for Protected Species (AMAPPS) project, which is a partnership among multiple federal agencies (NEFSC and SEFSC 2012). Though AMAPPS surveys do include New York waters, and some findings from neighboring states may have relevance for New York, it is clear that additional baseline wildlife data may be needed to improve the understanding of natural resources in state and federal waters offshore of New York and facilitate the responsible siting and permitting of offshore wind energy development.

3 Research Priorities and Recommendations

3.1 Overview

Research needs and data gaps were divided into five categories (Appendix D):

- Baseline studies – studies at a larger geographic scope than a single wind development project, aimed at obtaining information on normal wildlife distributions, abundance (or relative abundance), behaviors, habitat use, or other patterns. Baseline data are used to describe the affected environment.
- Cause/effect relationships – studies focused on understanding how impact-producing factors from wind facilities may affect wildlife, to inform the National Environmental Policy Act (NEPA) process and help identify mitigation options. Defining cause-effect relationships requires an understanding of wildlife effects and defining what adverse effects are of primary concern.
- Vulnerability – studies that attempt to prioritize species or taxa of interest according to their relative vulnerability, where vulnerability is defined as a combination of exposure to hazards posed by offshore wind energy development, behavior traits that put individuals at risk, and species' conservation status. Many species may respond to offshore wind energy development in some way; however, financial and time constraints, as well as the statistical requirements of comparing pre- and post-construction survey data (Pérez Lapeña 2011, Kinlan et al. 2012c, MacLean et al. 2013), suggest focus may need to be on species that are most vulnerable to this new type of development. Baseline data for a site can be used to narrow down the list of target species (e.g., to define exposure).
- Cumulative adverse effects – reliable approaches are needed for predicting incremental and cumulative impacts to wildlife from offshore wind energy development. This includes defining the necessary geographic and temporal scope of assessments, and considering both positive and negative implications of development.
- Methodological development and testing for monitoring and mitigation – mitigation measures should be proven to be effective in avoiding, minimizing, or compensating for adverse effects. The efficacy of these mitigation efforts at offshore wind energy projects needs to be evaluated through targeted monitoring. Additional development of monitoring approaches is also needed to effectively assess effects of offshore wind energy development on some taxa.

Baseline data on potential wildlife exposure by season (where "exposure" includes presence, distribution, and/or abundance) was generally identified as a key gap in the current understanding of offshore wildlife populations. Such regional-scale baseline information on animal distributions, abundance, and movements may not be required of individual developers, as environmental permitting processes in many cases are more focused in topical or geographic scope. Broader-scale data can be very helpful during the permitting process for individual projects, however, by placing project-specific monitoring results in context. Such data can also assist with the general siting of projects and with identifying appropriate mitigation strategies.

The review committee agreed that prioritization of baseline studies must be informed by existing data, and future work will be contingent on gap analysis of data assembled for the Offshore Atlantic Ocean Study[8] and determination of appropriate spatial scope among state agencies. Once gaps in baseline knowledge are reasonably filled, the review committee felt that the next step is to identify key species based on exposure data and species vulnerability, and carry out targeted cause-effect or mitigation studies on these priority species.

The review committee used the following key characteristics to define priority research needs:

- The estimated importance of the topic.
- The urgency of the need (e.g., in relation to the current status of development, or to allow for the fulfillment of other unmet research needs).
- The potential application (e.g., how useful the resulting data will be for siting, permitting, or detecting change between pre- and post-construction).
- The expected longevity of the resulting data (e.g., how quickly the data are expected to become "out of date" and irrelevant for future decision-making).
- Whether the review committee judged it to be appropriate that the need be addressed by the state of New York (e.g., rather than a federal agency or private developers).

Five research needs were identified as immediate priorities and six as secondary priorities. Remaining input was classified as "other potential research needs," which were judged by the review committee to be of lower immediate importance for New York State (because the data gaps are not appropriate to address at the state level, because the identified gaps require other work to be conducted first, or for other reasons). Although Tables 1-2 indicate whether research needs may require desktop studies, field studies, or a combination of the two, it should be noted that all studies will of necessity include a blend of these approaches; assessments of existing data should always inform decisions on what new data needs to be collected.

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8 http://docs.dos.ny.gov/communitieswaterfronts/ocean_docs/NYSDOS_Offshore_Atlantic_Ocean_Study.pdf

3.2 Primary Research Needs

Based upon the input received during Phases 1 and 2 of this project, additional baseline studies are clearly needed. However, a large volume of data already exists for New York waters, and this information must be compiled and examined as part of the Offshore Atlantic Ocean Study, with input from statisticians, to identify remaining priorities for future baseline surveys. Some baseline studies may be conducted in tandem (for example, aerial surveys for cetaceans could also easily collect useful data on sea turtles), while others may require a more focused study design to achieve their objectives.

Each primary research need includes information on the relevance of the data gap for policy (including regulatory and permitting processes), the research focus (a description of the proposed project), and the relation between the proposed work and other research in the region or nation. A summary of these research needs is presented in Table 1. These five primary needs were all judged to be of approximately equal importance and urgency, and thus are not presented in order of priority.

Table 1. Primary Research Needs

Needs are listed in random order. Suggested methods and length/type of study are also included, but it should be recognized that the specifics of study design may vary based on logistics, cost, or how each research need is defined.

Research Need	Potential method	Study type
Map benthic habitats in potential development areas	Benthic habitat surveys (sidescan and multibeam sonar with backscatter, plus video surveys and/or grab samples)	3-year field study
Understand movements and offshore habitat use of focal taxa in and around potential development areas	Build from existing underwater acoustic receiver network in New York - add receivers farther offshore and deploy additional tags on fish, sea turtles, or other species of interest	3 to 5-year field study
Examine the relationships between environmental processes, primary productivity, and distributions of species at upper trophic levels	Conduct GIS analysis of historical satellite imagery to identify the timing and location of areas of high primary productivity, and relate results to environmental covariate data and historical fisheries data	2 to 3-year desktop study
Examine the distributions and abundance of focal taxa in the New York Bight by season, along with the habitat or other environmental variables driving those distributions. This need was specifically identified for cetaceans, sea turtles, birds, and fish	Combine existing data with new data collection via boat surveys, aerial surveys, trawl surveys, passive acoustic monitoring (PAM), and statistical modeling	3 to 5-year field and/or desktop studies
Develop an avian vulnerability assessment for New York, to identify priority species for targeted research	Use the literature and scientific expertise to identify critical life history traits, and species with those traits that are at highest risk of exposure in New York	1-year desktop study

3.2.1 Map Benthic Habitats in Potential Development Areas

3.2.1.1 Policy Relevance

Benthic habitat data are useful for offshore wind energy development in several ways. First, they are important in and of themselves for identifying the locations of fragile or threatened species and habitats (such as deep sea corals) and commercially important species (such as scallops). Second, they can be used as proxies to try to predict the distributions of other wildlife, such as fish, marine mammals, and some bird species. Third, they are useful to developers for choosing realistic and least-impactful development locations. Multibeam sonar with backscatter can be used to survey bottom sediments and topography, which in turn can be used to predict biological assemblages for these areas (Tegowski et al. 2009, Kostylev et al. 2001). Benthic habitat mapping was identified by the review committee as a priority due to the importance and urgency of the topic, the utility of these data to help address other unmet research needs, and the expected longevity of some of the resulting data for use in decision making. For example, the locations of deep sea corals are relatively static compared to many other marine biota (Roark et al. 2009). A similar need has recently been identified as a priority in the mid-Atlantic by the Bureau of Ocean Energy Management's Environmental Studies Program (BOEM 2014).

3.2.1.2 Research Focus

The goal of this research is to identify the locations of sensitive habitats and benthic organisms, and to develop detailed distribution maps of benthic habitat types that can be used to inform predictive models for more mobile wildlife (e.g., fish, marine mammals, seabirds, etc.). A targeted 2-to 3-year field study would likely be sufficient to develop benthic habitat base maps for potential Wind Energy Areas (WEAs) or leasing areas.

Year 1 could include survey coverage of regularly spaced transects throughout the study areas, and interpolation of results between transects to develop a model of benthic habitats across the WEAs; such modeling can involve various statistical methods to determine important relationships between morphological and topographic variables and biological assemblages (Tegowski et al. 2009, Tegowski et al. 2010, Kostylev et al. 2001). The simultaneous use of a single-beam echosounder to corroborate results may also be helpful during this process (Tegowski et al. 2009). If possible, transects should overlap in width to ensure complete coverage of the study area (after Kostylev et al. 2011); if this is not financially feasible, results can be interpolated between transects.

Year 2 would involve testing this model by conducting grab samples and/or making video recordings in surveyed and interpolated areas, and analyzing the video or biological samples in the laboratory to see if the model is satisfactorily accurate at predicting the distribution of benthos and benthic habitats throughout the study area. Fine-scale patterns in sessile epibenthos or sedentary benthos, which are difficult to identify with acoustics or trawls, could also be examined via video recordings during this phase. If a higher density of transects or additional variable measurements are needed to develop the model, then additional survey work (with sonar or other equipment as needed) could be completed in Year 3.

3.2.1.3 Relationship with Other Work in the Region or Nation

Seafloor substrate mapping and model validation in the Atlantic Ocean has recently been identified as a priority by the Bureau of Ocean Energy Management Environmental Studies Program (BOEM 2014). Benthic habitat data are available for some areas of interest offshore of New York (e.g., Lathrop et al. 2006); a first step would be to assess the data available in the Offshore Atlantic Ocean Study. The Nature Conservancy (TNC) also recently completed a large-scale benthic habitat study (Weaver et al. 2013). Although the resolution of that study is too coarse to address site-specific needs for wildlife and habitat modeling, it may be useful as a starting point for model formulation. Likewise, NOAA has recently developed models to predict deep sea coral distributions[9] (Kinlan et al. in prep., Kinlan et al. 2013), and is in the process of developing similar species distribution models for infauna and epibenthic and mobile fauna in wind energy areas along the Atlantic coast. A benthic habitat mapping study in potential wind energy areas offshore of New York could be designed to help ground-truth those models.

The use of sidescan sonar requires specific restrictions on survey methodology (including vessel size and speed) that, in many cases, differ from optimal wildlife surveying methodologies. However, it will still be possible to build from this initial study design to gather additional baseline wildlife data while the boat is surveying (e.g., by hosting an avian and marine mammal observer on the boat; a marine mammal observer will likely be required under the permit from NOAA regardless).

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9 http://www.habitat.noaa.gov/protection/corals/deepseacorals.html, http://www.coastalscience.noaa.gov/projects/detail?key=35

3.2.2 Understand Movements and Offshore Habitat Use of Focal Taxa in and Around Potential Development Areas

3.2.2.1 Policy Relevance

Data on the individual movements of particular species were identified as a priority in relation to Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA) permitting processes, due to the expected utility of the resulting data for determining whether these species should be of concern to regulators during the permitting process at potential development sites (and if so, when). While the movements of specific individuals may vary, the resulting data in aggregate would provide key information that could be used for decision making, including siting and permitting of future projects.

Atlantic sturgeon (*Acipenser oxyrhincus*) and all species of sea turtles present in New York State waters are protected under the Endangered Species Act. As such, they will be priority species for regulators during the offshore wind environmental permitting process. More information is needed about their habitat use and movements to ensure that offshore wind energy development proceeds without causing irreparable damage to vulnerable populations. Other aquatic species of interest could also be added to the study design as needed, allowing for taxonomic flexibility to match the species priorities of state and federal regulators.

3.2.2.2 Research Focus

While there are many methods to examine animal movement patterns, the review committee specifically identified as a priority the offshore expansion of an existing underwater acoustic receiver network in New York (Frisk et al. 2012) to detect tagged fish and sea turtle movements in and around potential development areas. This network could be easily expanded to place acoustic receivers in wind energy areas or other areas of interest, and specifically examine whether Atlantic sturgeon, sea turtles, or other aquatic species of interest are using these areas. Acoustic receiver arrays are deployed year-round and maintained twice a year (including data downloading and redeployment); acoustic tags are deployed on individuals from target species and have a battery life of six years or more. The information collected by the arrays could be used to determine animals' movements and habitat use, and potentially to identify time windows for particular development activities.

3.2.2.3 Relationship with Other Work in the Region or Nation

The New York Department of Environmental Conservation (DEC) and the School of Marine and Atmospheric Science (SoMAS) at Stony Brook University have an acoustic tagging network with more than 25 gates (e.g., sets of acoustic receivers) already in place for Atlantic sturgeon, including six locations along the New York shoreline (gates have a roughly 0.25-0.5 km range of detection). Several hundred tags are currently deployed on Atlantic sturgeon in New York, and 25 tags are planned for deployment on sea turtles in 2014-2015 (Frisk et al. 2012). This network could be easily expanded to place acoustic receivers offshore in potential wind energy areas. In addition to the New York Department of Environmental Conservation's network in nearshore areas off of New York, a larger network of compatible receivers shares information for much of the Northeast and Mid-Atlantic as part of the Atlantic Cooperative Telemetry Network (ACT);[10] BOEM is currently working to expand this network offshore of Delaware, and a similar expansion in New York would provide a highly complementary dataset. This ACT network has been used to track more than 70 species of aquatic animals to date, including fish, sharks, and sea turtles.

3.2.3 Examine the Relationships Between Environmental Processes, Primary Productivity, and Distributions of Species at Higher Trophic Levels

3.2.3.1 Policy Relevance

Environmental processes, such as sea surface temperature (SST), chlorophyll *a*, and wind patterns, influence ocean productivity, and indirectly influence the distributions of species at higher trophic levels. These data can be used in taxon-specific modeling efforts of baseline distributions and relative abundance to try to predict the distributions of other wildlife, such as fish, marine mammals, and some bird species (e.g., Valavanis et al. 2004). Mapping of historical primary productivity data is a priority research need, as is the use of these data for analysis of geographic patterns of hydrodynamic variables and wildlife distributions. This prioritization will facilitate the fulfillment of other unmet research needs, as well as providing data with potential applications for siting and permitting future development projects. A more comprehensive understanding of the drivers behind primary and secondary ocean productivity could also have a long "shelf life" in terms of assisting with future decision making.

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10 http://www.theactnetwork.com/home

3.2.3.2 Research Focus

Environmental processes, such as sea surface temperature (SST), chlorophyll *a*, front locations, upwellings, oxygen content, important currents, and wind patterns, influence ocean productivity. These relationships may vary based on the species present in phytoplankton communities (Herfort et al. 2007). There are also relationships between primary productivity and distributions of animals at higher trophic levels, but the nature of these drivers is poorly understood. Geographic information system (GIS) analysis of historical satellite imagery could be conducted to identify the timing and location of high-productivity areas (e.g., with lower than average sea surface temperatures and higher than average chlorophyll concentrations, Valavanis et al. 2004) throughout marine waters offshore of New York, and relate results to historical environmental covariate and fisheries data (from NOAA[11] and other sources). Resulting maps of seasonal patterns could be used to assist with the identification of important habitat areas (e.g., Valavanis et al. 2004) and predict areas of high use in the future (e.g., Hollowed et al. 2013).

3.2.3.3 Relationship with Other Work in the Region or Nation

Similar efforts have occurred in marine ecosystems elsewhere in the world, primarily in relation to fisheries management and large whale distributions (e.g., Valavanis et al. 2004, Gill et al. 2011). Though environmental covariate data have been collected for areas along the Atlantic coast[12] (e.g., Weaver et al. 2013), these efforts have often been conducted at a large scale, and thus have been difficult to directly link to distributions of organisms at higher trophic levels for the geographic scale of interest. Recent efforts to describe seasonal patterns in environmental processes and primary productivity for the New York Bight (e.g., Kinlan et al. 2012a) are a useful first step, but these “spatial climatologies” lack the temporal detail necessary to fully develop an understanding of these conditions or their implications for higher trophic levels (Kinlan et al. 2012b).

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11 http://www.nefsc.noaa.gov/ecosys/ecology/index.html

12 Ibid.

3.2.4 Examine the Distributions and Relative Abundance of Wildlife in the New York Bight by Season, Along with the Habitat or Other Environmental Variables Driving Those Distributions

3.2.4.1 Policy Relevance

Priority species for regulators during the environmental permitting process are likely to fall into two main categories: either they are priorities due to their commercial importance, or they are species that have been accorded specific state or federal protections. For example, commercially important fisheries are a key resource of interest for NOAA and for state regulators in New York. All cetaceans are protected under the Marine Mammal Protection Act, and most are also protected under the Endangered Species Act, as are all species of sea turtles present offshore of New York State; construction and operational impacts to large whales will be a key concern for state and federal regulators. Most birds are protected under the Migratory Bird Treaty Act, and several species that occur in New York are also protected under the Endangered Species Act or the state's Environmental Conservation Law; so avoiding areas of high habitat use by seabirds, and understanding potential impacts from offshore wind energy development, are likely to be primary issues for the U.S. Fish and Wildlife Service during environmental permitting of offshore wind energy development.

In all of these cases, distribution and abundance data are critical to identifying the locations of fragile, commercially important, or threatened species and habitats. Such data can also be used to try to predict the distributions of other wildlife in some cases, and they are useful for choosing realistic and least impactful development locations. However, in part due to the rarity of some of these species, there is a paucity of data on their movements and habitat use in many areas of the United States, and this is a potentially major stumbling block for development offshore of New York.

3.2.4.2 Research Focus

Many taxonomic groups offshore of New York require a more in-depth understanding of their distributions and relative abundance by species and season, as well as the habitat or other environmental variables driving these distributions. Cetaceans, sea turtles, fish of commercial importance or conservation concern, and birds (particularly seabirds) were all identified by survey respondents as being of particular interest. An examination of the distributions and relative abundance of these target species groups by season would involve one or more 3-5 year field studies throughout the New York Bight, and would likely use a combination of existing data, boat surveys, aerial surveys, passive acoustic monitoring (PAM), and statistical modeling. Some survey approaches could serve multiple purposes, however. For example, surveys for cetaceans could also collect data on sea turtles and seabirds, and PAM systems generally record full-spectrum sound data, so these recordings could be used to examine marine mammals, fish, and ambient noise levels. A subsurface hydrophone array could also be set up to collect covariate (salinity and turbidity) data while recording, which could be used to develop predictive distribution models for multiple species groups.

Data on animal distributions and habitat use should be complemented by data on the environmental drivers of these distributions. The composition of plankton communities is an additional environmental covariate of key importance for predicting large whale distributions, for example; either gathering new or existing data and using it as a covariate (along with remotely sensed primary productivity data) should help to explain large whale distributions, and potentially help predict future changes in those distributions.

The scope of existing baseline information is highly variable between species groups of interest. In some cases, such as with seabirds and commercially harvested fishes, new data collection could potentially build from existing datasets, and be more targeted toward specific data gaps or geographic areas (for example, proposed wind energy areas (WEA)). The review committee suggested, for example, that baseline studies for birds be targeted on potential development areas and focus on ground-truthing existing distribution and relative abundance maps (Kinlan et al. 2012b). As previously mentioned, data could also be cost-effectively collected by building from existing survey efforts or vessel activity (though it should be recognized that in some cases this may hamper their utility to answer specific research questions). The planned survey activity for whales in the New York Bight beginning in 2015 (Schlesinger and Bonacci 2014) is one such opportunity

Ideal survey methods will vary by species group and survey goal. For marine mammals and birds, some combination of aerial and shipboard surveys may be the best approach (Schlesinger and Bonacci 2014); PAM is also an essential component for monitoring marine mammals, and should likewise be considered for monitoring acoustically active fish species. Sea turtles are poorly surveyed from boats, and surveys focused on obtaining sea turtle data should be conducted from the air and incorporate the use of digital survey methods (Normandeau Associates 2012, Schlesinger and Bonacci 2014, Williams et al. 2014).

Fish and environmental covariate data can be obtained from boat surveys (e.g., vessel trawl surveys, echo sounding, etc.) or passive monitoring arrays, although the use of other data sources (notably fisheries data and remote sensing data) will also be an essential component of baseline data collection and analysis.

Although ancillary observations should certainly be recorded, some of the above methods may be poorly suited to monitoring particular species or groups; a boat towing a hydrophone array, for example, might be able to simultaneously survey for whales, but will move more slowly than would normally be recommended for surveys of seabirds. It is important to clearly identify the primary goals of survey activity, and ensure that surveys are designed to meet those goals; the resulting tradeoffs in terms of ancillary data quality must simply be recognized, and minimized whenever possible.

It is unclear how many years of baseline surveys are required to provide a representative sample of the system, but it likely depends on whether survey years are representative of longer-term averages (which is generally unclear until after the fact), as well as on the taxon of interest. Three to five years is recommended in Table 1, but this range should be regarded as a general guideline rather than a hard and fast rule. It should also be noted that while the ideal result of these baseline surveys is to develop absolute abundance data and the identification of "coldspots" of low wildlife activity, relative abundance data and the identification of relative hotspots is more feasible in most cases. For rarer species, even relative abundance may not be possible, and obtaining good-quality occupancy data may be a more realistic goal (for example, for many endangered species with small populations in New York State).

3.2.4.3 Relationship with Other Work in the Region or Nation

Existing distribution data have been collected in the Avian Compendium (and analyzed by NOAA; Kinlan et al. 2012b) and in the Offshore Atlantic Ocean Study and supporting reports. Large amounts of fish data are also available (Northeast Area Monitoring and Assessment Program [NEAMAP] surveys, pelagic trawls, acoustics, etc.) All new survey efforts should build from these and any other existing data compilations to avoid duplicating efforts and to direct monitoring efforts to areas of greatest need.

DEC and other state agencies, the New York Natural Heritage Program, NOAA, and the Woods Hole Oceanographic Institute (WHOI) are conducting a marine mammal study beginning in 2015, as a supplement to existing federal survey efforts through AMAPPS. Specific study objectives and methods are outlined in a recently published report from a workshop in East Setauket in early 2014; the survey options outlined in that plan are intended to inform the development of a long-term monitoring program for New York (Schlesinger and Bonacci 2014). The study includes year-round passive acoustic monitoring (via stationary bottom-mounted recorders and autonomous mobile gliders); seasonal boat surveys; and several types of aerial surveys (including twice-annual AMAPPS surveys and bimonthly DEC-run surveys in the New York Bight). These efforts may provide a useful platform on which to "piggyback" baseline monitoring of other focal species without conducting entirely new sets of surveys; bird and sea turtle observations should be recorded during boat and aerial surveys, for example.

New data could also potentially be collected by observers during benthic habitat surveys, or by observers placed on other vessels (e.g., the operations/maintenance vessels for acoustic tagging gates, PAM maintenance, etc.); while these data would be opportunistic in nature, they may have some utility for ground-truthing predictive models of avian distributions and abundance (e.g., Kinlan et al. 2012b) or providing additional observations for rare species, such as certain sea turtle and cetacean species. Other ongoing survey efforts include:

- NOAA cruises off New York to sample plankton, salinity, and temperature; these data are intended to allow for an examination of interannual variability across decades. Surveys are generally conducted four times per year, though funding limited efforts to two surveys in 2013.
- Northeast Area Monitoring and Assessment Program (NEAMAP) surveys, which are integrated fisheries surveys conducted twice a year between Massachusetts and North Carolina.
- Twice-yearly AMAPPS NOAA aerial surveys, previously mentioned, for which marine mammals and sea turtles are focal taxa.

3.2.5 Develop an Avian Vulnerability Assessment for New York to Identify Priority Species for Targeted Research

3.2.5.1 Policy Relevance

Prioritization of research needs is an important policy tool. Defining which species, areas, or topics to be most concerned about will lead to more informed decision making and improved outcomes for wildlife, since resources will be applied to the areas of greatest need. While a relatively large amount of data is available for seabirds as compared to other taxa offshore of New York, it is unclear which bird species should be of primary concern to regulators or should be considered during siting, permitting, and monitoring processes. Some species may be disproportionately impacted by offshore wind energy development in certain locations, and those species must be identified to conduct targeted research on their life history and behaviors, as well as determine options for risk prevention or mitigation. A vulnerability assessment could assist with defining species priorities and data gaps and refining the scope of future research efforts, including targeted monitoring and mitigation, and attempts to detect changes in abundance or distribution post-construction, which must be targeted and well-designed if they are to be effective (Rein et al. 2013). A similar exercise could be beneficial for other taxonomic groups as well, but is probably unrealistic at present due to a relative lack of life history data, as well as a poor understanding of the factors that might lead to species vulnerability to offshore wind energy.

3.2.5.2 Research Focus

An avian vulnerability assessment for waters offshore of New York would identify priority species for targeted research. This species list would be defined via a combination of conservation status, potential exposure, and behavior; it would likely include such species as the Roseate Tern (*Sterna dougallii*, due to its listing status), Northern Gannet (*Morus bassanus*, due to its foraging behavior), colonially nesting species that breed in New York, and species that winter in large aggregations in New York waters. This study would likely use the scientific literature, including previously published vulnerability assessments (e.g., Garthe and Huppop 2004, Furness et al. 2013, Langston 2013, Willmott et al. 2013, Goodale et al. 2014) and scientific expertise (via workshops, surveys, or other avenues) to identify critical life history traits and species with those traits that are at highest risk of exposure in New York.

Rather than a quantitative assessment of relative vulnerability to offshore wind energy development—which would be hampered by data limitations (Goodale et al. 2014)—the review committee recommended a more qualitative approach based upon the identification of critical life history traits (for example, foraging strategies) that may make species vulnerable to offshore wind energy facilities, and marrying those results with data on the presence, abundance, and distributions of avian species in New York.

3.2.5.3 Relationship with Other Work in the Region or Nation

BOEM recently published a report that attempted the first avian vulnerability assessment for offshore waters along the Atlantic coast of the United States (Willmott et al. 2013). This report was based, in part, on previous efforts to quantitatively identify vulnerable species in Europe (Furness et al. 2013, Garthe and Huppop 2004). Another recent effort in the Great Lakes region has begun to identify avian species most vulnerable to wind power development in that area (Goodale et al. 2014). Such assessments are most useful when they are specific in geographic scope, and can focus on the species of primary conservation concern for that region (and have sufficient data on species' presence and abundance for that region). A New York-specific assessment would likely build from these previous reports, as well as existing data and analyses for the New York Bight (Kinlan et al. 2012b). However, as previously noted, the review committee recommended a more qualitative approach than was pursued in some previously published vulnerability assessments, due to concerns regarding data limitations.

3.3 Secondary Research Needs

Secondary research needs (Table 2) were generally identified as such for three reasons: because they first required addressing data gaps identified as primary needs; because they were judged to be of slightly lower overall importance than primary needs; or because they were of less immediate urgency for siting or permitting projects. Offshore baseline studies of bat distributions were judged to be of less importance than those for some other wildlife, such as marine mammals and seabirds, because bat exposure to offshore development is likely to be somewhat lower. Deep-sea coral surveys were also judged to be of lesser urgency at the regional level because some surveys will be required of developers at the project level, and corals would also be detected to some extent in the benthic habitat study proposed above. Several secondary research needs were focused on environmental effects of the construction or operation of turbines, which cannot be adequately assessed until there is actually a project under construction; these needs were judged to be of slightly lower priority for New York State for this reason (though the review committee discussed the possibility of New York teaming with other organizations to address some of these research questions at project sites in neighboring states). Several other secondary needs, including examinations of cumulative impacts and life cycle impacts of different energy sources, were judged to be very important topics, but of less immediate urgency (e.g., in the next 3 years) to New York State than some of the baseline habitat and population monitoring described in the primary needs section, above. These secondary research needs were considered to be of similar importance and urgency, and as above, are listed in no particular order.

Table 2. Secondary Research Needs

Needs are listed in random order. Suggested methods and length/type of study are also included, but it should be recognized that the specifics of study design may vary based on logistics, cost, or how each research need is defined.

Research Need	Potential method	Study type
Develop approach for estimating cumulative impacts	Choose a focal species to use as a proof of concept, and develop the process for estimating cumulative impacts and population-level change. This assessment will involve a combination of literature synthesis, expert judgment, and quantitative analysis.	1-3 years
Assessment of the life cycle impacts of different energy sources	Update NYSERDA report 09-02 (NYSERDA 2009)	1-2 years
Test methods for minimizing scour and other impacts to the benthic community	Improve our understanding of circulation patterns and connectivity among benthic habitats. Test approaches to minimize disruption to these patterns and habitats, including scour protections.	3-5 years
Comprehensive study of changes to wildlife distributions in relation to operational wind energy facilities	Conduct a larger scale and longer term study around an operational wind farm than would be required of developers, in order to better understand impacts and make data available to the entire industry.	5-10 years
Baseline studies of bats in the offshore environment	Combine methodological approaches to examine flight height, potential attraction to offshore wind turbines, seasonal distributions, and relative abundance.	2-5 years
Targeted baseline surveys for deep sea corals	Conduct targeted surveys for deep-sea corals across a broad spatial scale by surveying locations that have good wind potential and that NOAA's deep-sea coral model predicts to be coral hotspots.	2 years

3.3.1 Develop Approach for Estimating Cumulative Impacts

Cumulative impacts analysis is required under NEPA, as well as under New York's State Environmental Quality Review (SEQR) process for assessing the potential impacts of development activities. Environmental impacts of most development projects, when considered singly, are likely to be minimal from a population standpoint. However, the combined impact to populations or habitats from multiple offshore wind development projects—or from multiple other types of anthropogenic impacts—is likely to be substantially greater. It is unclear for most species what cumulative impacts might entail, in part because these impacts are very difficult to estimate or measure. Despite the existence of offshore wind facilities in Europe for over 20 years, European researchers at a 2013 BOEM workshop agreed that acceptable levels of impacts—or observed levels of impacts at European facilities—remain unclear, and that a more rigorous consideration of this topic is required (Rein et al. 2013).

Several approaches were suggested among survey responses for measuring cumulative impacts and population-level change. After discussion, the review committee recommended a first step of choosing a focal species to use as a proof of concept. (It could be fluke, also known as *Paralichthys dentatus* or summer flounder, or another priority species with relatively good data that occurs in areas of interest for potential offshore wind energy development). The process of determining the appropriate spatial, temporal, and source scope of analyses and estimating cumulative impacts to this single species could then be used as a model to be replicated for other species. Methods would likely include a literature synthesis, workshop to bring together expert opinion, quantitative analysis (population viability analysis or other modeling approach), and development of a guidance document or other deliverables. This effort would build from existing literature in this area (Masden et al. 2010, Busch et al. 2013, Natural England 2014, and others), while making a significant contribution to the state of the science on this issue for the eastern United States.

3.3.2 Assessment of the Life Cycle Impacts of Different Energy Sources

All sources of energy generation have environmental impacts. An assessment of the life cycle effects of different energy sources (in particular, consideration of the pros and cons of maintaining New York's status quo for energy generation sources, including the cumulative effects of energy sources at varying use levels and consideration of climate change scenarios) is needed to make informed decisions about the combination of energy generation facilities that best meets New York's needs. Such an assessment has been conducted for vertebrates in New York (NYSERDA 2009), but has become outdated with recent changes to shipping, natural gas extraction, and other shifts in the energy landscape. Additionally, the 2009 report considers wind energy collectively, rather than splitting terrestrial from offshore wind energy development. An update to this analysis could be a powerful tool, for New York and other states in the U.S., to understand the pros and cons of different energy sources and make informed decisions. Although several related studies have recently been published (Calvert et al. 2013, Jones and Pejchar 2013), there is little in the way of comprehensive life cycle analysis available to decision makers.

3.3.3 Test Methods for Minimizing Scour and Other Impacts to the Benthic Community

Predicting and minimizing scour, sediment disturbance and resuspension, and other impacts to benthic habitats and communities around offshore wind turbine foundations are topics of concern and ongoing research (Hsin-Hung et al. 2014, Boehlert and Gill 2010, ICES 2012). Identification and rigorous scientific testing of methods for minimizing benthic community impacts from turbine installation and operation is needed, with a focus on reducing scour around turbine bases for habitat types prevalent offshore of New York. Research efforts should focus on modeling and comparison of pre- and post-construction changes in seabed morphology, turbidity, and changes in benthic communities, either in situ or at laboratory testing facilities.

European studies in this area indicate the types of changes that have been observed in benthic communities and are likely to require study in New York waters, though most studies in Europe have focused on changes in benthal and fish communities around turbines (e.g., reef effects, changes in trawling activity, etc.) rather than on changes to the substrate itself (ICES 2012). A recent study in the North Sea found substantial short-term changes to macrobenthic communities from wind facility construction, followed by a rapid (within 1 year) recovery (Coates et al. 2014); however, it is unclear how applicable these findings may be to other benthic communities (e.g., in areas with higher macrobenthic diversity and abundance). Other studies have found greater changes in benthal diversity and species assemblages on vertical turbine structures than on surrounding anti-scour boulders (e.g., Wilhelmsson and Malm 2008). Studies of scour and short-and long-term changes to benthic communities caused by other types of artificial structures in the marine environment may also be helpful resources (e.g., Manoukian et al. 2010). For New York, the first priority is to determine what benthic habitats are present in potential development areas; but of immediate secondary importance is to understand how vulnerable those habitats are to disturbance from offshore wind energy, and whether there are ways to mitigate for those effects.

3.3.4 Comprehensive Study of Changes to Wildlife Distributions in Relation to Operational Wind Energy Facilities

At a 2013 BOEM workshop, European researchers agreed that one of the key considerations for assessing wildlife impacts from offshore wind is to identify research questions ahead of time, and to design site specific pre-construction studies to appropriately compare with post-construction assessments, including the monitoring of a large enough area around the project footprint to detect and understand changes through time (Rein et al. 2013). One of the early offshore wind facilities in Europe (Nysted in Denmark) used this approach in a collaborative setting (Petersen et al. 2006), and as a result made substantial contributions to the state of our knowledge on avian responses to offshore wind farms. Many projects have included less involved pre- and post-construction monitoring programs, however, and as a result have produced little data to forward the state of the industry as a whole. Other reviews of European development have also emphasized the importance of identifying clear objectives and hypotheses, and conducting targeted monitoring on specific taxa of interest in order to test these hypotheses (e.g., MMO 2014). Developers will be collecting post-construction data at facilities, but a more comprehensive analysis of changes to wildlife distributions in relation to operational offshore wind energy facilities (both attraction and displacement), including at least three years of post-construction data to monitor for lag effects in behavioral changes post-construction, would provide context to allow for a better understanding of adverse effects and be more broadly useful for assessing and understanding the potential impacts of future projects.

3.3.5 Baseline Studies Of Bats in the Offshore Environment

Historic observations of bats in the marine environment have occurred up to 1,500 km from shore, with an average distance in one recent review of 104 km (Hatch et al. 2013). Given that these observations were almost all incidental, the relative frequency of occurrence at great distances from land suggests that bats may migrate farther offshore and more often than has been widely acknowledged (Hatch et al. 2013). This is particularly true of the tree-roosting bat species, which are most widely observed offshore and are also the species most at risk from collisions with terrestrial wind turbines in the eastern U.S. (Arnett et al. 2008, Hatch et al. 2013, Pelletier et al. 2013). Baseline studies of bats in the offshore environment, including behavior (e.g., flight height, potential attraction to offshore wind turbines, etc.), seasonal distributions, and relative abundance, are needed to assess the potential risk to bats from offshore wind energy development. Such studies will require a combination of methodological approaches, given the challenges with studying migratory bat populations in the offshore environment; passive acoustics, telemetry, and digital aerial surveys have all proven to be of some utility in recent years (Taylor et al. 2011, Hatch et al. 2013, Pelletier et al. 2013).

3.3.6 Targeted Baseline Surveys for Deep-Sea Corals

Deep sea or cold water corals can occur at all water depths, either solitarily or in large reefs, and provide valuable habitat for many other marine species. They are also particularly vulnerable to disturbance due to their fragility and slow growth rates (Packer and Dorfman 2012). Data on coral distributions in New York is incomplete and the quality of existing data is poorly understood, making it difficult to preserve these areas from anthropogenic stressors, including offshore wind energy development (Packer and Dorfman 2012). Though there have been some recent efforts to develop predictive models of deep sea coral distributions (Leverette and Metaxas 2005, Davies and Guinotte 2011, Kinlan et al. 2013, Kinlan et al. in prep.), additional survey effort is needed to understand their distributions and avoid adverse impacts to these vulnerable habitats in the New York Bight (Packer and Dorfman 2012).

NOAA is conducting a three-year (2013-2015), regional investigation into deep-sea coral distribution, biology, and ecology, and has developed a deep-sea coral predictive model (using biogeographic and sediment profiles). A cost-effective approach to surveying for corals would be to conduct baseline research (using submersibles, towed cameras, or other approaches) in areas offshore of New York that are predicted coral hotspots with good wind potential. This approach would allow for surveys across a broad spatial scale, but target surveys towardareas of primary interest. It may be desirable to integrate this approach with the benthic habitat mapping proposal identified as a primary research need.

3.4 Other Potential Research Needs

Remaining input on research needs and data gaps was judged by the review committee to be of lower immediate importance for New York State than items in previous sections. This lower ranking was assigned because the review committee did not feel these needs were appropriate to address at the state level; because the identified gaps required other work to be conducted first; or for other reasons. More detail about some of these suggested research needs may be found in Appendix D.

Needs that require other studies to be conducted first. This category included such proposals as the study of seabird behaviors offshore, and whether there are certain areas that might pose particular development risks given these patterns. Such a study would require a combination of methods, potentially including radar, passive acoustics, satellite telemetry, NanoTags, compilation of historical and current survey data, etc., but more importantly would require the identification of focal species for research, because it is not going to be feasible to fulfill this need for all bird species. Once focal species have been identified, however (see Section 3.2.5), maps of predicted high/low habitat use by species, and a better understanding of how they are using various locations (e.g., for foraging, roosting, breeding, migrating, staging, etc.), would be helpful for siting future development projects and for permitting processes. Likewise, a proposal to study collision risk to birds and bats from offshore wind energy development will require additional technological developments before it can be conducted satisfactorily.

Needs that are the primary responsibility of offshore wind energy developers. This category included studies that are most appropriately performed at the individual project scale, including analysis of noise reduction and attenuation technologies and methods, in situ collection of noise data, and the determination of contaminants in sediments at proposed development areas that could potentially re-enter the benthic ecosystem during construction and maintenance activities.

Needs that are the primary responsibility of federal regulatory agencies (not appropriate to address at the state level). This includes the determination of effective and practicable monitoring and mitigation approaches, which in many cases is the primary purview of BOEM and other federal regulatory agencies.

Needs identified by survey respondents that are not priorities at the current time. This last category included several proposals that the review committee judged to be low priorities for research. For example, there have been some concerns about electromagnetic fields (EMF) from renewable energy subsea cables and their effects on electromagnetic-sensitive elasmobranchs, fish, sea turtles, or invertebrates. These cables will be buried and shielded, however, and given existing data, EMF is not expected to cause substantial impacts (though BOEM is currently funding a lobster EMF study in Long Island Sound to address these concerns). Studies of bird flight heights were judged to be of lower importance because species-specific flight heights are generally only possible to observe during daylight and in reasonably good weather conditions, and it is unclear whether flight heights during these conditions are useful data for predicting collision risk; while flight height behavioral data should be collected by the developer as part of pre- and post-construction surveys at development site, this did not seem to be a larger research need at this time. And finally, a review was suggested of the types of monitoring data and modeling studies that have been required at existing or proposed projects for offshore wind, cables, and pipelines. However, the review committee felt that a synthesis of previous data and findings is probably of limited utility at this time, as regulators are still on a steep learning curve in terms of determining the types of monitoring and studies they should be asking offshore wind energy developers to conduct.

4 Conclusions

Current research priorities include mapping of benthic habitats and organisms and patterns of primary productivity, and identifying distribution patterns of focal species such as cetaceans, sea turtles, seabirds, and commercially important fishes. Movements and habitat use of focal aquatic species, and the assessment of relative vulnerability of avian species offshore of New York to identify focal species and guide future research activities, are also research priorities for the State.

Baseline data on potential wildlife exposure by season, including distribution and abundance data, was generally identified as a key gap in the current understanding of offshore wildlife populations in New York. Regional-scale baseline information on animal distributions, relative abundance, and movements is generally beyond the scope of project permitting, and thus is not required of individual developers. Broad-scale data can accelerate the permitting process for individual projects, however, by providing key data to regulators and placing project-specific monitoring results in context. Such data can also assist with siting projects and identifying appropriate mitigation strategies. Prioritization of baseline studies must be informed by existing data, and future work should be contingent on gap analysis of data assembled for the Offshore Atlantic Ocean Study[13] and following determination of appropriate spatial scope among State agencies. More existing data is available (in compiled and usable formats) for some species and habitats than others, and these considerations should play a role in the decision to undertake new monitoring or survey efforts. A broader geographic scope for baseline surveys provides more flexibility and applicability of resulting data, but also increases the expense. A potential compromise for many baseline research needs may be to conduct finer resolution surveys within specific areas of interest (such as potential wind energy

In part, baseline data on potential wildlife exposure is currently considered to be a key weakness in understanding vulnerability because exposure is more easily measured and understood with current knowledge and research frameworks than cause-effect relationships, the factors that contribute to species-level vulnerability, or cumulative impacts. Exposure is also highly relevant given the nascent stage of offshore wind energy development in New York at present. However, while it is always easy to say, "We need more data," it is essential to consider how data will actually be used. Research goals should be practical and applied, and research should feed directly into clearly identified management endpoints (for purposes of siting, permitting, or detecting change between pre- and post-construction).

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13 http://docs.dos.ny.gov/communitieswaterfronts/ocean_docs/NYSDOS_Offshore_Atlantic_Ocean_Study.pdf

This research plan is intended as a reference guide and framework for research in New York waters and the vicinity. Although the hope for this plan is that it will be of general reference use for developers, regulators, and other stakeholders, NYSERDA may also choose to use this research plan as a basis for future requests for proposals (RFPs), and will work within this framework with topic-specific experts to develop them.

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Appendix A: Project Steering Committee

In addition to a NYSERDA project manager and BRI project leads, the committee for the first phase of the project was comprised of 10 federal and New York State regulators and personnel with expertise in the legal framework and science around offshore wind and wildlife. Participating agencies were:

- New York Department of State (DOS).
- New York Department of Environmental Conservation (DEC).
- New York Attorney General's Office (NYAG).
- New York State Energy Research and Development Authority (NYSERDA).
- U.S. Fish and Wildlife Service (FWS).
- National Oceanic and Atmospheric Administration (NOAA).
- Bureau of Ocean Energy Management (BOEM).
- Biodiversity Research Institute (BRI).

Appendix B: Summary of Phase 1 Input on Potential Critical Data Gaps and Research Needs

Phase 1 of the New York Wildlife and Marine Wind Energy project was focused primarily on site-specific information needs for regulatory and permitting processes. Participants in this phase of the project also provided input on larger-scale data gaps and research needs. These data gaps generally belonged to five categories: baseline data on animal distributions and abundance; effects research; cumulative and population-level impacts; mitigation and monitoring methods; and species vulnerability.

B.1 Baseline Data on Animal Distributions

Substantial gaps exist in baseline resource data in and around wind development areas along the East Coast of the U.S., and so much variability over the ocean that understanding where and why animals are concentrated through time and space is exceedingly difficult. A desire was expressed for "an encyclopedia of baseline information" to use as a foundation for collection of site-specific data in leasing areas; this kind of baseline data is available for some locations along the East Coast but not others. The general categories of baseline needs are listed below.

1. General baseline data needs to describe the affected environment:
    a) Species presence/absence data (may be the only available information for rare species; also can be used to help pick the handful of species to focus on for site-specific monitoring).
    b) Multiyear, multiseason distribution and abundance data (or relative abundance data) on a regional scale for focal species (particularly migratory listed species and fish stocks). Where are they and when?
    c) Identify biological hot and cold spots (and why animals are there).
    d) Seasonal behavioral data (Do they vocalize? What are their normal functions or behaviors when they are in the survey area? Are they rafting, staging, feeding, molting, migrating?)
    e) What are their local-scale or regional-scale movements?
    f) Compare historical data with new data, collected the same way, to determine utility of older data for describing current distributions?
    g) Where are important breeding, foraging, wintering, or staging areas for listed species?
    h) Where are seabird colony and foraging sites?
    i) Regional scale movement data for wide ranging or migratory species (will help with ESA and MMPA needs, including cumulative impacts).
    j) Presence/absence, migration and offshore movement data for bats and shorebirds

2. Habitats and prey distributions:
   a) Where are the important habitat use areas—not officially designated as critical habitat, but important areas for foraging, aggregations, or migration?
   b) What are the critical environmental covariates for predicting habitat use? Are there environmental covariates or oceanographic features that could be used to predict aggregation of animals or predict migratory pathways (for example, changes in the jet stream?) Could these data on habitat, prey base, sea surface temperature, water chemistry, turbidity, etc. be used as a proxy for wildlife data?

B.2 Effects Research

There is a need to understand more about wildlife effects and define what adverse effects we are most concerned about, to inform the NEPA process. There is a need to identify cause-effect relationships and understand how impact-producing factors from wind facilities may affect wildlife. Specific needs may include:

1. Effects to marine mammals and sea turtles from ship strikes and marine debris
2. Collision impacts on seabirds and bats during operations
3. How are marine mammals and sea turtles affected by underwater noise from construction and operation of wind turbine generators (WTGs)? Need more data on what noise sea turtles can perceive.
4. Are there special considerations for hatchling turtles (lighting, etc)?
5. Offshore wind is a technology that combines a "known base" installation process (similar to oil rigs and meteorological monitoring stations)—assess effects at these sites?
   a) Reef effects and habitat conversion: What is the strength of reef effects, and do reef effects actually improve overall habitat quality for some taxa, or just aggregate animals that would be in an area anyway?
   b) Benthic community impacts during construction and operations.
6. How are sea turtles and other wildlife affected by electromagnetic fields (EMF) generated by undersea cables? (Assess existing cables for other types of development?)
7. Field verification data for acoustic sound sources – assess noise emission levels for equipment to be used in survey collection, wind farm construction, etc.
8. Understand cause/effect relations specifically related to avoidance behaviors and response to habitat change.

B.3 Cumulative and Population-Level Impacts

Reliable approaches are needed for predicting incremental and cumulative impacts. Particular needs in this area may include:

1. Careful assessment of both the positive and negative aspects of maintaining the status quo (e.g., a comprehensive calculation of increased carbon emissions and effects on the physical environment and natural resources, human health, and environmental justice and socioeconomic costs). Need to look at impacts of global climate change on oceans and put localized impacts from development in context. Also consider ocean dumping, active military operations, ongoing fishing, and shipping activities.
2. The temporal, spatial, or topical scope of cumulative impacts assessment that should be considered during NEPA assessments for offshore wind energy.
3. How do existing anthropogenic activities in the oceans affect the marine life in the U.S. Atlantic? Need studies for cumulative impacts assessment and assessment of relative impacts of different types of development:
    a) What else is impacting focal species, locally, regionally, or globally, and how will offshore wind development contribute to those cumulative effects? (ocean dumping, active military operations, fishing, shipping, boating, etc.).
    b) Need baseline noise data.
4. Would be desirable to obtain population estimates for whole stocks or species. Need to develop cost-effective strategies for estimating breeding population changes.

B.4 Mitigation and Monitoring Methods

Mitigation measures must be developed that are proven to be effective in avoiding, minimizing, or compensating for adverse effects. The efficacy of these mitigation efforts need to be evaluated through monitoring.

1. Carefully craft and learn how to apply appropriate and effective mitigation measures:
    a) Testing of avoidance devices (anti-perching devices, color schemes, lighting, etc) on offshore structures and evaluating how these devices discourage birds from perching on WTGs.
    b) Direct impact reduction measures: Efforts to reduce sound; acoustic deterrent devices; slow ship speeds to ensure no ship strikes; night-time lighting; bubble curtains and coffer dams.
    c) There is a possibility that curtailment might be useful for a few nights a year (foggy nights in fall, when there wouldn't be any wind anyway) — can be cheaper than other mitigation options in some cases, but more info is needed.

2. Further develop monitoring methods:

   a) Major monitoring technology gap related to bird and bat collision (e.g., post-construction studies to determine actual effects of development). Need to develop better, less expensive, more effective remote camera technology or other technologies (radar) to detect collisions and get reliable annual counts and species identifications.
   b) Acoustic monitoring of offshore structures to detect birds in the project area post-construction.
   c) Testing thermal and motion sensor cameras to assess bird use of the project area post-construction.
   d) What is the best scale for surveys? Could do a nested study to look at amount of area in addition to project site that is needed to determine impacts.
   e) Post-construction monitoring at offshore projects will be very difficult, and novel methods of monitoring turbines in operation will need to be developed and tested before accurate estimates of direct impacts to birds and bats can be made.
   f) Need to develop better remote camera technology or other technologies (radar) to get reliable annual counts and species identifications.

3. How can marine mammal/sea turtles best be detected and take minimized during site assessment and construction activities?

   a) Species Observers have been shown to not be particularly effective– e.g., hard to spot a whale given that it is actually there. Examine passive acoustics with real time shutdown? Combination of approaches?
   b) Need to determine the proper buffer area around activities (e.g., "harassment zone" where animal in that area would shut down activities) – species- and site-dependent?
   c) Modeling stressors can help determine the size of the monitoring zone. For example, modeling on sounds from pile driving should be used to determine the extent of the survey area. "Acoustic propagation and marine mammal exposure modeling may be required. Passive acoustic monitoring (using hydrophones) could be helpful data to have."

B.5 Species Vulnerability

Many species may respond to offshore wind energy development in some way. However, financial and time constraints, as well as the statistical requirements of comparing pre- and post-construction survey data, suggest that the focus may need to be on species that are most vulnerable to this new type of development.

1. Which species or taxa are most vulnerable to impact-producing factors?
2. Identify a single handful of bird species to monitor, and know exactly what post-construction studies need to be answered by having pre-construction data for comparison. Choose based on vulnerability, umbrella species, species of conservation concern, etc.
3. We need to focus on those traits species exhibit – foraging, rafting, etc. and look for ways to mitigate "high-risk" behaviors. It's the behavior that's vulnerable, not the specific species.
4. Need to understand flight behaviors. What are the physical environmental conditions? Wind speeds, wind direction, sea surface temperature, sea state, chlorophyll?

Appendix C: Survey to Identify Research Needs

Input requested on research needs:
Wildlife and marine wind energy research priorities for areas offshore of New York State

Sent out April 29, 2014
Response date: June 3, 2014
Please respond to: survey@briloon.org

Background
In order to prioritize research efforts in New York State, the New York State Energy Research and Development Authority (NYSERDA) requests assistance in identifying data gaps and research needs relating to wildlife and marine wind energy projects. Responses will be used as the basis for a New York State Marine Wind/Wildlife Environmental Research Plan. This is the second phase of a project that is designed to determine the goals for environmental assessments and identify information gaps (for more information visit: www.nyserda.ny.gov/BusinessAreas/Energy-Efficiency-and-Renewable-Programs/Renewables/Offshore-Wind/Marine-Wind-Energy-Project.aspx).
During Phase I of the project, we received preliminary input from a team of state and federal regulators and stakeholders on data gaps and research priorities to inform the regulatory process. A summary of this initial input is included on Page 3 below.

Instructions
Please identify and prioritize the most pressing research needs (in the next 3-5 years) relating to wildlife and wind energy development for marine state and federal waters offshore of New York. For each priority (see example on next page), list:

- Priority ranking (if you are submitting multiple responses)
- Topic (regional-scale baseline studies; effects research; cumulative and population-level impacts; monitoring and mitigation methods; species vulnerability; or other)
- Specific research question (specify species or taxa of interest)
- Practical timeline
- Potential methods (highlight if methodological deficiencies hamper our ability to answer the research question)
- Expected deliverable or product
- Justification of need

Each response should be limited to no more than one page, but you can submit as many responses as desired. Responses must follow the format described above in order to receive full consideration. Please focus on New York's oceanic coast, rather than the Great Lakes. Thank you for your input!

Send responses via email to survey@briloon.org by 06/03/14
For questions or more information about the project please contact:
Wing Goodale or Kate Williams, Biodiversity Research Institute
wing_goodale@briloon.org or kate.williams@briloon.org, 207-839-7600 ext. 219/108
Greg Lampman
New York State Energy Research and Development Authority
ggl@nyserda.ny.gov, 518-862-1090 ext. 3372

<u>Example</u>

(Note: this example is provided to demonstrate the preferred format of responses. It is not intended to suggest that the topic described in the example is a priority.)

1. *<u>Priority ranking:</u>* 1

   <u>Topic:</u> Baseline Studies

   <u>Research question</u> (1-2 sentences):
   How are marine mammals, particularly baleen whales, distributed in waters offshore of New York State, and how do those distributions change seasonally?

   <u>Timeline:</u> Three years.

   <u>Potential methods (1-3 sentences):</u>
   1) Two years of monthly boat surveys in state and federal waters offshore of New York;
   2) Statistical modeling to examine correlations between resulting marine mammal observation data and environmental covariates;
   3) Use of these correlative relationships to predict seasonal densities of marine mammals.

   <u>Deliverable (1 sentence):</u>
   Predictive maps of marine mammal distributions by species and season.

   <u>Justification of need (2-5 sentences):</u>
   Marine mammals are priority species under the Endangered Species Act and Marine Mammal Protection Act. Site-specific surveys of marine mammals (in relatively small geographic areas) are unlikely to provide the number of detections of marine mammals necessary to develop predictive models. Most marine mammal survey data for the east coast of the U.S. is thirty years out of date, and will not provide sufficient baseline coverage to site offshore wind projects in low-use areas or provide adequate context for site-specific surveys conducted by developers.

Potential Critical Data Gaps and Research Needs

(as identified during Phase 1 of the New York Wildlife and Marine Wind Energy Project)

Baseline data on animal distributions: Understanding where and why animals are concentrated in time and space can be difficult, and there are substantial gaps in baseline resource data along the east coast of the U.S. Baseline information collected at a state, multi-state, or continental scale can be used as a foundation for collection of site-specific data in leasing areas. Baseline studies should identify:

- Focal species or species groups,
- Types of data that are needed (and feasible to obtain; e.g., presence/absence vs. density or abundance data; behaviors; local- or regional-scale movements),
- Locations of critical habitat use areas, or
- Environmental covariates associated with animal distributions.

Wind turbine effects research: There is a need to identify cause-effect relationships and understand how impact-producing factors from wind facilities may affect wildlife. A better understanding is required of:

- Potential offshore wind energy hazards (impact-producing factors) that may affect wildlife (example: propagation and attenuation of underwater sounds from pile driving),
- Corresponding wildlife responses (example: cetacean displacement), and
- Direct and indirect effects on birds and bats.

Cumulative impacts: Reliable and consistent approaches are needed to predict incremental and cumulative impacts to wildlife. Particular needs in this area may include:

- Defining the topical, spatial and temporal boundaries of cumulative adverse effects assessments for offshore wind energy development, and
- Determining the relative impacts of offshore wind energy development in the context of other anthropogenic stressors (e.g., ocean acidification, fisheries bycatch).

Monitoring and mitigation methods: Mitigation measures must be effective in avoiding, minimizing, or compensating for adverse effects. Specifically, we must identify:

- Existing methods that can be used to avoid, minimize, or compensate for adverse effects of offshore wind on wildlife, and
- Methodological developments that are needed to effectively detect and monitor the cause/effect relationships between impact-producing factors and wildlife effects.

Species vulnerability: Financial and time constraints, as well as the statistical requirements for effective comparison of pre- and post-construction data, suggest that we may need to focus on certain species or taxa that are most vulnerable to offshore wind energy development. This requires determination of:

- The life history, behavioral attributes, or environmental conditions that make individuals from certain species particularly vulnerable to impact-producing factors from offshore wind energy development, and
- Effective approaches for determining whether these individual impacts may have population-level consequences.

Appendix D: Summary of Responses to the Project Survey

BRI broadly distributed a survey titled, “Input requested on research needs: wildlife and marine wind energy research priorities for areas offshore of New York State” in April 2014. The goal of the survey was to gather input on data gaps and research needs related to wildlife and offshore wind energy in New York. In total, 16 responses were received, from federal and state agencies, universities, and nongovernmental organizations, that described 34 specific research needs.

The bulk of responses (68%) focused on the need for regional baseline survey work to determine the temporal and spatial patterns of wildlife distributions in New York waters. These responses were centered primarily on information needs for benthic habitat, fish, marine mammals, and birds, with one response each for bats and sea turtles. Responses also focused on the need to understand the relationships between hazards (e.g., impact-producing factors) and effects (18%); species vulnerability (6%); cumulative adverse effects (6%); and monitoring and mitigation (3%; Table D-1).

Table D-1. Distribution of Survey Responses

Row Labels	Baseline Studies	Effects Research	Species Vulnerability	Cumulativ e Effects	Monitoring & Mitigation	Grand Total
General	5	1		1	1	8
Marine mammals	4	1	1			6
Benthic habitat and benthos	3	1	1	1		6
Fish and sea turtles	4	2				6
Aerofauna	7	1				8
Grand Total	23	6	2	2	1	34

Baseline studies research suggestions were focused broadly around needing to better understand the temporal and spatial abundance and distribution patterns of wildlife, and how those patterns correlate with environmental covariates. The most commonly suggested methods for these baseline studies were three years of boat and/or aerial surveys. The end products of this research, as outlined in the survey responses, would include raw data to be uploaded into databases, reports/peer-reviewed papers, GIS maps, and models.

Cause and effect studies were suggested for several taxonomic groups, but generally focused on the direct or indirect effects of specific impact-producing factors (e.g., sounds from pile driving) to wildlife. Suggested research around species vulnerability and cumulative adverse effects were focused on the need to better understand wildlife behavior, population dynamics, and the adverse effects other anthropogenic stressors (Table D-2).

Table D-2. Summary of Responses

Category	Taxon	Question	Timeline	Method	Deliverable
Baseline	General	What is the current baseline for habitat, wildlife, and noise?	3-5 years	Boat/aerial surveys, acoustics	Baseline estimates of wildlife abundance and habitat maps
	Benthic habitat & benthos	How are benthic animals distributed, and what contaminants are in sediments?	3 years	Sonar, grab samples, faunal sampling	Predictive maps
	Fish/ sea turtles	How are fish/sea turtles distributed and how are these patterns related to environmental covariates?	2-3 years	Boat/aerial surveys, acoustic tags, GIS analysis	Data, reports, maps of seasonal abundance
	Marine mammals	How are marine mammals distributed by season?	3-5 years	Existing data, boat surveys, acoustics	Data, reports, maps of seasonal abundance
	Aerofauna	What is the seasonal abundance of bat/birds?	2-5 years	Boat/aerial survey, radar, acoustics, individual tracking	Data, reports, maps, models of seasonal abundance
Cause/ Effect	General	How can construction noise be minimized?	1-2 years	Analyze existing methods, and conduct in situ monitoring	Evaluation of minimization technologies
	Benthic habitat & benthos	How is sediment disturbed?	4 years	Pre/post-construction surveys	Report
	Fish/ sea turtles	Does EMF affect fish?	2-3 years	Track fish around DC subsea cables, lab studies	Report
	Marine mammals	How are marine mammals affected by sound?	3 years	Field studies and modeling	Coupled circulation-acoustics model
	Aerofauna	How to birds respond to wind turbines?	1 pre-, 2 post-construction	Boat surveys	Guidance document

TableD-2 continued

Species Vulnerability	How vulnerable is marine life?	1-3 years	Existing data synthesis, behavior studies, population modeling	Report, maps
Cumulative Effects	How do other stressors effect populations?	2 years	Assess existing stressors, modeling	Literature synthesis, tools to estimate large-scale effects
Monitoring/ Mitigation	What mitigation and monitoring methods are effective?	2 years	Review of existing measures	Report

D.1 Summary of Responses: Baseline Studies

D.1.1 Baseline: General (5 responses)

D.1.1.1 Questions

- What is the abundance/distribution of wildlife in offshore waters of New York State in relation to the wind resource?
- Can we generate accurate and spatially explicit predictive habitat models of these species using bathymetric/ocean satellite data?
- What monitoring data and modeling studies have been required at existing or proposed projects for offshore wind, cables and pipelines?
- What are historic and present-day ambient noise levels, and present-day shipping noise levels, within the New York Bight?

D.1.1.2 Timeline

- 3-5 years (1-2 years for analysis of existing monitoring, and noise study)

D.1.1.3 Methods

- Use marine buoy technology to acquire detailed wind data using LiDAR and wildlife presence/absence with acoustic technology.
- Conduct an integrated synoptic boat survey (using DISTANCE modeling) consisting of trawling, benthic grab sampling and daytime wildlife monitoring over the entire area of development interest.
- Conduct aerial line transect surveys and statistical analyses to develop relationships with wildlife abundance and oceanographic variables.
- Collect acoustic data from hydrophones situated in representative locations within New York Bight, including both within and outside the shipping lanes.

D.1.1.4 Deliverables

- Baseline estimates with seasonal abundance trends and maps of biodiversity of fish, benthic species, birds and marine mammals and analysis of environmental factors with wind speed data up to 500 m from the ocean surface.
- Predictive spatial habitat models to identify hotspots for marine megafauna in offshore waters, and ecopath trophic model that can be used to simulate future ecosystem state under various scenarios.
- Synthesis of previously collected data/findings, plus a research gap analysis.
- Estimates of historic and present-day ambient noise levels and maps of cumulative shipping noise levels, within the New York Bight.

D.1.1.5 Need

- There is little data on the abundance/distribution of wildlife in New York marine environment, and wind energy activity will have local/regional impacts to the marine ecosystem. Informed marine wind development decisions will be impossible to make without an understanding of the availability of wind resources and abundance of marine animals.

D.1.2 Baseline: Benthic Habitat and Animals (3 responses)

D.1.2.1 Questions

- How are benthic animals distributed in waters offshore of New York State, and how do those distributions change with depth, distance from shore, and bottom type?
  - What kinds of bottom habitats are present in the New York Wind Energy Area (WEA) and what role do sediment types and topography play in defining those habitats and supporting demersal fisheries resources, (e.g. sea scallops, summer flounder, skates, black sea bass, scup)?
  - How do sediment bedforms and associated habitat communities (amphipod beds, etc.) change from year to year with storms and fishing activities?
- What kind of contaminants are in the sediments and what is their potential for re-mobilization during construction and maintenance activities and entering into the benthic system supporting sea scallops, summer flounder, skates, black sea bass, and scup?

D.1.2.2 Timeline

- 3 years

D.1.2.3 Methods

- Multibeam and sides can sonar
- Grab samples
- Benthic faunal sampling survey

D.1.2.4 Deliverables

- Predictive maps of marine benthic communities, terrain, sediment, and sediment contaminants

D.1.2.5 Need

- There has not been benthic sampling in New York since 1990, and previous work in other WEAs has shown that habitats for demersal fish can be extremely patchy. These patchy areas are vulnerable to disturbance from offshore wind energy development, and play a significant role in supporting fisheries species. Standard mapping (e.g., 3 arc second or ~90M grids) used in contour charts often cannot detect these hard bottom outcrops, gravel beds, and sand waves. Baseline surveys are critical to ensure that siting of offshore wind energy development and other lease activities take into consideration these habitats.

D.1.3 Baseline: Fish and Sea Turtles (4 responses)

D.1.3.1 Questions

- How are fish, sea turtles, and mobile invertebrate animals distributed and use habitat in waters offshore of New York State during winter and summer, and how do those distributions change with season, depth, distance from shore, bottom type, and temperature?
- How do environmental processes such as sea surface temperature (SST), chlorophyll a, and wind patterns influence ocean productivity such as the timing of spring algal blooms and seasonal forage fish availability?
- How does the location of primary productivity influence distribution of predator species?

D.1.3.2 Timeline

- 2-3 years

D.1.3.3 Methods

- Tag fish with acoustic tags, which are detected with acoustic telemetry receivers
- Sea turtles: Aerial and shipboard surveys, tagging
- GIS analysis of historical satellite imagery of SST, chl a, wind data to ID timing and location of spring alga blooms; relate results to historic fisheries data to determine good/poor productivity years.

D.1.3.4 Deliverables

- Data on of fish use of habitats over multiple years
- Report/maps of abundance and distribution of sea turtles
- GIS maps of seasonal patterns and commercial fishing pressure to identify important habitat areas.

D.1.3.5 Need

- The impacts of wind energy to mobile marine species is unknown; however, it could alter species behavior and serve as an attractant/repellant. Periodic sampling is important to determine if some species use particular areas exclusively year round, or periodically, as well as during important times in their life history (such as spawning); or if these areas are just used as a migratory pathway.
- Help predict in future years how environmental processes may influence the presence and distribution of predators such as piscivorous seabirds, cetaceans, or pinnipeds. These patterns will directly influence placement of wind turbines in the marine environment.
- Few estimates of sea turtle population abundance exist in any region and New York's sea turtle relative abundance and seasonal distribution maps for the offshore area rely primarily on survey sitings data conducted in 1978–1982 for southern New England waters by the University of Rhode Island's Cetacean and Turtle Assessment Program.

D.1.4 Baseline: Marine Mammals (4 responses)

D.1.4.1 Questions

- How are marine mammals, particularly baleen whales and harbor porpoises, distributed in waters offshore of New York State (i.e., New York Bight), and how do those distributions change seasonally?
  - What locations (relative to the shelf break) and seasons show the acoustic detection rates of marine mammal vocalizations?
  - What areas are of highest value for marine mammals, and how is this habitat used?
  - Does the New York Bight contain any resident marine mammal populations, and what is the abundance and distribution of these populations?
  - How is the right whale migration distributed within the New York Bight as a function of distance from shore?
  - What is the density and habitat use of harbor porpoises within areas proposed for wind development?

D.1.4.2 Timeline

- 3-5 years

D.1.4.3 Methods

- Synthesis of existing data, including AMAPPS
- 2+ years of monthly boat surveys
- 1-3 years of passive acoustic data collection
- Statistical models of survey data and environmental covariates

D.1.4.4 Deliverables

- Report/peer-review publication of densities and distributions including predictive maps of marine mammal distributions by species and season.
- Continuous acoustic monitoring of marine mammal species to quantify habitat use by species, distance to shelf break, and season.
- Data products, such as location and time of observation to be entered in web-based data portal, such as CetMap (http://cetsound.noaa.gov/cetacean.html) or OBIS-SEAMAP (http://seamap.env.duke.edu/)

D.1.4.5 Need

- Since Cornell's short-term study in 2007, there have been no comprehensive surveys of the occurrence
  and seasonality of marine mammals in New York.
- Baseline data on marine mammal/sea turtle abundance are necessary to determine effects to marine life from offshore wind energy development.
- The acoustic impacts of offshore construction (e.g., that is required for the development of wind energy) on marine mammals are not well understood, but likely vary considerably by species. Acoustic methods have several advantages over visual surveys, particularly in that they allow continuous observations and also allow observations to be made at night and during inclement weather.

D.1.5 Baseline: Aerofauna (Birds and Bats; 7 responses)

D.1.5.1 Questions

- What is the frequency and spatial and seasonal distribution/abundance of bat/bird activity offshore of New York State?
    - How does near shore compare to offshore particularly for seabirds?
    - At what height are they flying?
- How are sea ducks distributed throughout the winter in offshore waters of New York State; what particular habitats are they using, and are there certain areas where offshore energy projects would pose threats to sea ducks?
- For individuals of a given target species, what are the patterns of movement in offshore waters of New York, what habitats are they primarily using, and what is the risk associated with certain wind farm locations given the bird's pattern of movements and habitat use.

D.1.5.2 Timeline

- 2-5 years (3-years pre-construction, 3-years post-construction)

D.1.5.3 Methods

- Radar, infrared thermal imaging, acoustic monitoring, analysis of historical data, nano-tag telemetry,
- 2-3 years of monthly boat/aerial surveys
- 1-2 years of individual satellite telemetry tracking (loons, seaducks)
- Modeling of environmental covariates

D.1.5.4 Deliverables

- Narrative/map-based report as well as a web-based geospatial database detailing the seasonal abundance, distribution, and frequency of occurrence of various migratory and non-migratory bird/bat species offshore of New York
- Modeling software (habitat utilization models, density surface models) utilizing observational and environmental covariate data to develop predictive maps of marine bird distributions by species and season.
- Maps of the predicted high/medium/low-use areas for each target species along with the proposed location(s) of offshore wind farms.

D.1.5.5 Need

- Existing data are helpful in suggesting occupancy of certain species at certain times, but do not provide insight into how long the species are at particular locations or how they are moving through the area.
- Long Island contains 29 designated Important Bird Areas many along the South Shore, with diverse vegetation communities.
- Offshore wind is of particular concern because many of the areas ideal for offshore wind development coincide with areas used by sea ducks. Potential impacts on marine birds are one of the major conservation concerns for offshore wind development, thus assessing habitat use and risk for key target species is critical.

D.2 Summary of Responses: Cause/Effect Relationships

D.2.1 Cause/Effect: General (1 response)

D.2.1.1 Questions

- Which technologies and methods are likely to be most effective in reducing and attenuating turbine construction noise in areas proposed for wind development offshore New York?

D.2.1.2 Timeline

- Several days of field effort, preceded and followed by analytical work

D.2.1.3 Methods

- Analysis of existing noise reduction/attenuation technologies and methods, and applying the in situ data and propagation modeling to the local conditions of areas proposed for wind development offshore, to estimate relative effectiveness and cost.

D.2.1.4 Deliverable

- Estimates of noise reduction/attenuation (and cost) from various available measures; in situ data on noise reduction/attenuation for certain measures; noise propagation maps for turbine installation with and without such measures.

D.2.1.5 Need

- Noise reduction and attenuation has emerged as one of the leading approaches to mitigating turbine installation noise.

D.2.2 Cause/Effect: Benthic Habitat and Animals (1 response)

D.2.2.1 Question

- What are the magnitude and extent of impacts from sediment disturbance/resuspension (during construction) and sediment scouring (during operation) on downdrift sediment and benthic environments?

D.2.2.2 Timeline

- 4 years

D.2.2.3 Methods

- Pre-installation bathymetric, sediment chemistry, and benthic surveys; post-installation bathymetric, sediment chemistry, and benthic surveys immediately after installation, at one year, and again at 3 years post-installation during the same season as the pre-installation surveys.

D.2.2.4 Deliverable

- A report which provides the analytical results and compares pre- and post-installation chemical concentrations in surficial sediments, documents changes in seabed morphology, and describes any alterations in benthic communities downdrift of the turbines and underwater cables.

D.2.2.5 Need

- Pre- and post-installation studies that evaluate the magnitude and extent of sediment disturbance impacts on the marine system will provide regulators with the tools necessary to ensure that this oft-forgotten aspect of turbine installations is considered in future environmental reviews of wind projects.

D.2.3 Cause/Effect: Fish, Sea Turtles (2 responses)

D.2.3.1 Question

- Do electromagnetic sensitive fish (e.g. skates, eel) and invertebrate species (lobster) respond to electromagnetic fields (EMF) generated by the subsea cables from renewable energy sites?

D.2.3.2 Timeline

- 2-3 years

D.2.3.3 Methods

- Utilize high-resolution acoustic telemetry arrays (i.e. positioning array) that continually track the spatial and temporal movements of individually tagged species around DC subsea cables; animals will be tagged and monitored at different seasons within the positioning array.
- Laboratory analysis, field study of existing energized and non-energized cables, and other methods designed in consultation with experts

D.2.3.4 Deliverable

- Movements, orientation, and spatial distributions of the acoustically tagged fish and invertebrate species will be quantified and analyzed with respect to the EMF generated by the subsea cable within and between different seasons to evaluate their responses.
- Report detailing the impact of electromagnetic fields produced by DC cables on fishes (particularly elasmobranchs, such as sharks, skates, and rays, and Atlantic sturgeon) and sea turtles, including recommendations for mitigation methods.

D.2.3.5 Need

- High-resolution field studies such as an acoustic positioning array located around DC cable systems are needed to properly evaluate the responses of sensitive marine species.

D.2.4 Cause/Effect: Marine Mammals (1 response)

D.2.4.1 Question

- How do sounds propagate in the coastal environment and how will this impact marine mammals?

D.2.4.2 Timeline

- 3 years

D.2.4.3 Methods

- Modeling to evaluate potential impacts on marine mammals should include variability in coastal ocean stratification due to coastal plumes and upwelling

D.2.4.4. Deliverable

- A coupled circulation-acoustics model that predicts acoustic fields caused by offshore wind power construction/operations under variable density fields.

D.2.4.5 Need

- To fully understand whether and how marine mammals may be affected by sound from offshore wind,
  we need to use modeling to study various design/operation/siting scenarios and their potential impacts
  on marine mammals under variable coastal water conditions.

D.2.5 Cause/Effect: Aerofauna (1 response)

D.2.5.1 Questions

- Do offshore wind turbines form an attractive hazard (e.g., "The Reef Effect")?
- How do the structures and boat activity affect foraging birds like terns, gulls, shearwaters, etc.?
- Are there seasonal differences in which bird species are feeding near the structures?

D.2.5.2 Timeline

- 1 year pre-construction/2 years post-construction

D.2.5.3 Methods

- Using party boats to determine the height at which birds circle above the water line during feeding events.

D.2.5.4 Deliverable

- Development of a guidance document on average species altitude during feeding events.

D.2.5.5 Need

- Knowledge of the average height at which birds are foraging would allow for better determination on turbine height placement, hopefully leading to minimizing the potential for birds to be impacted by the turbine blades.

D.2.6 Summary of Responses: Vulnerability (2 responses)

D.2.6.1 Questions

- How vulnerable are marine mammals/sea turtles to the wind energy?
- What are the key marine species life history and behaviors?

D.2.6.2 Timeline

- 1-3 years

D.2.6.3 Methods

- Research and data synthesis on what is known about marine animal behavior and hearing; empirical data collection on marine animal behavior and the application of the data into a predictive model; and monitor the actual impacts of activities and compare with predictive model results.
- Monitor individuals of key marine species across years so that annual survival and productivity can be effectively estimated. Satellite telemetry can be useful for known fate survival analyses in the non-breeding season and movement studies. Population modeling either via individual-based models and/or matrix modeling would be used to estimate population growth rates and then quantify the sensitivity of such rates to changes in life history parameters.

D.2.6.4 Deliverables

- Report on the predictive impacts of various wind energy activities on marine life with follow-on ground-truthing research collecting data on the actual impacts.
- Report describing the life history of key marine species in the area of interest as well estimates of population growth and the sensitivity of population growth to changes in demographic parameters.

D.2.6.5 Need

- To date European research on marine/mammals and wind has focused on one or two species. While there has been extensive research conducted in Europe on the effects of their wind energy operations on marine mammals, these usually only refer to one or two species as compared to the large variety of marine mammal species found in the U.S. Atlantic, and their corresponding varied levels of conservation. Therefore, there is a need for data to enable the prediction of possible effects to marine mammals, particularly for large whales.
- It is difficult to predict the vulnerability of species to changes at their breeding or to their survival rates without understanding their basic life history. Current species vulnerability analyses make assumptions about the life history traits of species often with little or no data particularly in the region of interest. In addition to making inaccurate vulnerability predicts this prevents a population-based understanding of
how negative effects of wind development (e.g., collision mortality or reduced productivity) affect long-term population viability.

D.2.7 Summary of Responses: Cumulative Adverse Effects (2 responses)

D.2.7.1 Questions

- What are the incremental contributors to anthropogenic effects on marine life and what are their cumulative impacts?
- How does turbine placement, spatial configuration and density affecting breeding, wintering and migrating wildlife populations in the marine environment?

D.2.7.2 Timeline

- 2 years

D.2.7.3 Methods

- Research on the activities in New York State and adjacent waters (such as Environmental Impact Statements and working with shipping and fishing industries)
- Acoustic and marine mammal exposure modeling of multiple activities
- Using a spatially explicit modeling framework (via individual-based models and population models) we can test the effects of wind energy build-out scenarios on key species likely to be affected by such development (e.g., Red-throated Loons).

D.2.7.4 Deliverable

- A literature and data synthesis of the various activities that happen in and near New York State waters including predictive modeling of marine mammal behavior to the various activities.
- A tool to estimate the effect of wind power development on a large-scale that will give an estimate of the cumulative effects of various wind power development scenarios. Such a tool could be modified and updated over time as more data are acquired and our understanding of marine development risks increases.

D.2.7.5 Need

- Understanding the cumulative impacts of anthropogenic activities on marine mammals and sea turtles is a difficult task. However, with the understanding that shipping activity is regularly increasing, and in anticipation of the possibility of the oil and gas industry starting to conduct geological and geophysical surveys just south of New York state waters, these increased activities greatly shift the potential stressors on marine life, and may change the cumulative impacts as they are today.
- While cumulative effects have been identified as an issue, little thought has been put toward means to limit such effects on marine animal populations. Spatial models will make our predictions and assumptions about cumulative effects clear, but also allow for the testing of particular build out scenarios that give marine resources planners clear development alternatives to weigh.

D.2.8 Summary of Responses: Monitoring and Mitigation (1 response)

D.2.8.1 Question

- A mitigation and monitoring (both for mitigation implementation and long term monitoring) plan is necessary before requesting permits under the MMPA for wind energy activities. It is important to determine ahead of time what mitigation and monitoring measures will be both effective and practicable.

D.2.8.2 Timeline

- 2 years.

D.2.8.3 Methods

- A review of existing monitoring and mitigation measures can be compiled:
- These measures should be examined for:
  - What they are protecting
  - Effectiveness
  - Feasibility of employing specific mitigation methods during proposed activities
- A team of experts can create the monitoring and mitigation plan for these activities

D.2.8.4 Deliverable

- A report or plan for monitoring and mitigation as well as a long term monitoring plan.

D.2.8.5 Need

- Marine mammals are priority species under the Endangered Species Act and Marine Mammal Protection Act. Many forms of monitoring and mitigation measures exist but it is important to determine the suite of measures that will be most suited to proposed activities. Questions to be addressed must include: the need for night time operations; Operational timeline vs. protected species migratory timeline; What acoustic sources will be used and will they be within the hearing ranges of any protected species?; What are the capabilities of the boats or ships to be used for all proposed activities (site surveys and construction)—will there be space for protected species observers (visual) or passive acoustic monitors? Is the ship capable of deploying a passive acoustic monitoring system? A long term monitoring plan would help to determine/define any possible effects as a result of the proposed activities.

Appendix E: Participants in Review Committee Meeting

Experts in the field of offshore wind and wildlife issues met in August 2014 to review input received via the survey to identify research needs (Appendix C) and begin development of this Research Plan. In addition to a project lead from NYSERDA (Gregory Lampman) and two moderators from BRI (Wing Goodale and Kate Williams), this group was comprised of six federal and New York state regulators with expertise in the science around offshore wind and wildlife. The following agencies were represented:

- New York Department of State (DOS).
- New York Department of Environmental Conservation (DEC).
- U.S. Fish and Wildlife Service (FWS).
- National Oceanic and Atmospheric Administration (NOAA).
- Bureau of Ocean Energy Management (BOEM).

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