Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship

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LONG-TERM GOALS

The long term goals of this project were to develop and test standardized protocols for environmental baseline studies and monitoring which will result in scientifically valid and comparable data measuring the effects of the development of offshore renewable energy. Baseline studies and monitoring protocols were developed to seamlessly integrate with a newly designed conceptual framework for cumulative environmental impact evaluation of offshore renewable energy development also produced by this project.

OBJECTIVES

The scientific and technical objectives of this project were to develop standardized protocols for baseline studies and monitoring for the potential environmental effects of offshore renewable energy projects. These protocols will enable the collection and comparison of scientifically valid and comparable data across project types and regions resulting in a better understanding of the potential effects of offshore renewable energy development. A series of decision trees were also developed to assist regulators in selecting monitoring requirements placed on project developers. A secondary objective of the project was to develop a conceptual framework and approach for cumulative environmental impact evaluation of offshore renewable energy development, as part of a larger framework for a site evaluation tool for decision makers.

APPROACH AND WORK PLAN

In separate short paragraphs, Please: 1) describe your proposed scientific and/or technical approach including data quality requirements as applicable, 2) identify the key individuals participating in this work at your own or other organizations and the roles they play and 3) describe your work plans for the upcoming year (if applicable).

1) Our approach to developing a suite of protocols involved, first, conducting a thorough literature review of: a) existing protocols used to monitor offshore renewable energy projects in Europe, and of protocols used for other types of offshore development projects both internationally and in the United States; b) monitoring protocols used in other research; c) potential environmental effects discussed in the literature. Second, we used the results of this inquiry to identify a set of monitoring objectives, and developed monitoring protocols and techniques based on these objectives according to the appropriate spatial and temporal scales. To develop the cumulative

environmental impact evaluation framework, we expanded upon an ecological valuation index we developed for the waters off Rhode Island to create a framework that can then be used in other areas and regions by layering available data sets on the distribution of natural resources and human uses offshore. We then created a user interface which allows the effects of offshore renewable energy development and other anthropogenic activities to be modeled and compiled within an area. This modeling tool allows regulators to evaluate what the cumulative effects of development may be on the resources present in a proposed project area. What is unique about this interface is that it is flexible enough to be used with a wide array of project designs by allowing regulators to adjust the model based on the specific design and installation procedures proposed for a specific project.

2) The individuals responsible for working on this project are as follows:

Management Team:
Jennifer McCann, URI Coastal Resources Center/Rhode Island Sea Grant (Program Manager)
Dr. John King, URI Graduate School of Oceanography
Dr. Peter Paton, URI, Department of Natural Resources Science
Dr. Deborah French-McCay, Applied Sciences Associates, Inc.
Dr. Malcolm Spaulding, URI, Department of Ocean Engineering

Topic Leads:
Dr. Emily Shumchenia, URI Graduate School of Oceanography - Ecological Classification and Benthic Habitats
Dr. Peter Paton and Kris Winiarski, URI, Department of Natural Resources Science - Avian Species
Dr. Sarah Smith, URI Coastal Resources Center/Rhode Island Sea Grant – Fisheries
Dr. Malia Schwartz, URI Office of Research - Sea Turtles
Dr. Robert Kenney, URI Graduate School of Oceanography – Marine Mammals
Dr. Rod Mather, URI Department of History – Cultural Resources
Michelle Carnevale, URI Coastal Resources Center/Rhode Island Sea Grant – Potential Effects of Offshore Renewable Energy

In addition, we have a large Project Advisory Committee made up of experts in the various topic areas from academia, federal and state government agencies, and industry (e.g. fishermen, and wind developers). The Project Advisory Committee extensively reviewed and commented on all products developed as a part of this undertaking.

3) This contract has ended and all products have been finished, therefore there will be no further work conducted in the upcoming year. The project team does plan on advancing the monitoring protocols developed through this project with additional future funding sources.

WORK COMPLETED

In a paragraph, please describe the actual tasks completed or technical accomplishments.

During the first year, we produced three reports that served as the foundation from which standardized protocols for baseline studies and offshore renewable energy monitoring were developed. The first of these reports, entitled *Report on Monitoring the Potential Effects of Offshore Renewable Energy*, describes and categorizes the potential effects of offshore renewable energy projects based on findings in the literature. We then identified and categorized the relative severity posed by each type of impact or effect and the relative amount of scientific certainty or understanding on the particular effect. From this information we then determined which of these effects most warranted future monitoring. The second of these reports, *A Comprehensive Review and Critique: Existing U.S and International Monitoring Protocols for Offshore Renewable Energy Development and Other Marine Construction*, is a summary of existing monitoring protocols and practices used to monitor environmental effects of offshore development to benthic habitat and resources, fisheries, marine mammals, sea turtles, and avian species. The protocols summarized include those used in offshore renewable energy projects and other types of marine construction activities, both within the United States and around the world. This report provides the URI team with the framework to develop standardized monitoring protocols for offshore renewable energy projects in the United States that allow for the collection and analysis of scientifically valid and comparable data. Together, these two reports provided the basis for developing the monitoring protocols in Year 2. One additional deliverable in Year 1 was the development of the Archaeological Sensitivity Analysis along with the Cultural Landscape Approach framework, two methodologies created for finding and monitoring archaeological resources. A Siting Evaluation Model was also developed during the first year of this project to feed into the Cumulative Impact Evaluation Model that considers both ecological values and socio-economic (human) uses, and integrated various ecological data layers into an Ecological Value Model (EVM) considering multiple levels of organization and ecological categories (e.g., birds, fish, benthic ecosystem).

The second year of this project continued to build on the findings of the reports and tools generated in year 1 in order to produce a set of monitoring and data collection protocols, as well as a methodology for identifying a suite of monitoring studies that makes the most sense given the particular design of a project. To accompany the monitoring protocols, the URI team created a series of decision trees to aid regulators and other decision makers identify what monitoring should be performed based on the technology being installed, the foundation type being used, the construction methods proposed, and the operational effects associated with a particular type of offshore renewable energy device. The series of decision trees developed were not originally included in the scope of this project, however the URI team in consultation with PAC members and regulators agreed this would be a useful tool to aid in the implementation of the monitoring protocols. In addition to the creation of monitoring protocols and decision trees, in Year 2 we also finalized the Cumulative Impact Evaluation Framework and produced a software interface that allows any user to upload data layers on the natural resources or human uses for any area in the United States. Because the programming and modeling is already included in the interface created, the implementation of the Cumulative Impact Evaluation Framework is streamlined for regulators.

RESULTS

As concisely as possible, please describe meaningful scientific and/or technical results achieved in the report fiscal year. Make the significance clear. Emphasize what was learned, not what was done. This should be a short summary of significant results and conclusions. If you include figures, please include the caption in the report text and not as part of the picture or graphic. This is necessary to meet accessibility requirements.

The results of the report on the potential effects of offshore renewable energy found a number of potential effects that should be monitored in the future as part of any planned development, and for which monitoring protocols will be developed in Year 2 of the project. These potential effects are listed in Table 1, Potential effects of offshore renewable energy, categorized by species and project scale below.

Table 1. Potential effects of offshore renewable energy, categorized by species and project scale.

Benthic Habitat and Resources	
Scale 1 (Demonstration Scale)	• Scour around device • Changes in median grain size, or organic content • Turbidity during construction/decommissioning • Change in target species abundance and distribution (e.g, species of importance) • Colonization density, composition of communities on foundations
Scale 2 (Commercial Scale)	• Changes to seafloor morphology and structure (compared to pre-construction) • Changes in median grain size, or organic content • Turbidity during construction/decommissioning • Change in target species abundance and distribution (e.g, species of importance) • Change in density, diversity, dominance structure of infauna • Colonization density, composition of communities on foundations • Current speed/direction inside and outside farm
Scale 3 (Multiple Commercial Facilities in a Region)	• Changes to seafloor morphology and structure (compared to pre-construction) • Changes in median grain size, or organic content • Change in target species abundance and distribution (e.g., species of importance) • Change in density, diversity, dominance structure of infauna • Hydrodynamics inside and outside farms throughout region
Fish	
Scale 1	• Reef effects • Blade strikes (tidal power)
Scale 2	• Reef effects • Changes to abundance/distribution • Installation noise effects (for devices requiring pile driving) • Operational noise effects • EMF effects • Blade strikes / pressure gradients (tidal power)
Scale 3	• Reef effects • Changes to abundance/distribution and community composition on regional scale • Installation noise effects (for devices requiring pile driving) • Operational noise effects • EMF effects • Blade strikes / pressure gradients (tidal power)
Fisheries	
Scale 1	• Loss of access to grounds
Scale 2	• Catchability during construction • Catchability during operation • Loss of access to grounds • Changes in species distribution • Reef effects (aggregation)

Scale 3	• Catchability during construction • Catchability during operation • Loss of access to grounds • Changes in species distribution • Reef effects (aggregation)
Avian	
Scale 1	• Vessel strikes causing chemical spill • Displacement/ attraction • Barrier effects – effects on foraging, roosting, migratory movements • Collision mortality
Scale 2	• Vessel strikes causing chemical spill • Displacement/ attraction • Barrier effects – effects on foraging, roosting, migratory movements • Collision mortality
Scale 3	• Vessel strikes causing chemical spill • Displacement/ attraction • Barrier effects – effects on foraging, roosting, migratory movements • Collision mortality
Marine Mammals and Sea Turtles	
Scale 1	• Vessel strikes • Noise generated during all stages of development • Disturbance or injury during all stages of development • Changes in distribution or migratory routes
Scale 2	• Vessel strikes • Noise generated during all stages of development • Disturbance or injury during all stages of development • Changes in distribution or migratory routes
Scale 3	• Vessel strikes • Noise generated during all stages of development • Disturbance or injury during all stages of development • Changes in distribution or migratory routes • Changes in life history and demographics

Overall, the literature review of existing monitoring protocols conducted in Year 1 found that, while many types of monitoring protocols exist and are currently employed, there are few standards for monitoring within any of these subject areas. While there is considerably more documentation of offshore wind energy projects than marine hydrokinetic projects, because there have been many more offshore wind energy projects developed within the last decade, monitoring data for any offshore renewable energy project are sparse. Within Europe, despite the proliferation of offshore wind facilities, most monitoring for effects does not follow any recognized standard, and there is little consistency in the data collected at each site. Existing monitoring practices are also inconsistent between countries. Within the United States, most other offshore development industries, including the offshore oil and gas industry, do not have standardized protocols for monitoring the effects of these activities. Many other potential effects of offshore activities, such as the effects of noise, or the disturbance caused by the installation of a device, appear to be monitored inconsistently if at all.

The results of the third product from Year 1 are, first, a two-tier approach to geophysical survey, instrumentation and survey resolution for identifying cultural and archaeological resources present within a survey area, and second, the outline of a Cultural Landscape Approach for identifying and evaluating the potential effects of ocean renewable energy siting on marine cultural heritage resources. In addition, this report provides the framework and a case study for the use of Archaeological

Sensitivity Analysis, a method for analyzing the likelihood of finding marine cultural heritage resources within a given area.

The second year results of this project included a set of monitoring protocols to address the effects identified in Table 1, decision trees to help regulators select which of these monitoring protocols to require of developers, and the completion of a cumulative impact evaluation framework and tool to aid regulators in assessing the overall impacts of offshore development projects. Table 2 lists all the monitoring protocols developed. What was learned during the completion of these tasks was that in order for monitoring protocols and a cumulative impact evaluation framework to be useful to decision makers, we needed to provide guidance in their implementation. As a result, the URI team produced decision trees to assist regulators in selecting which protocols made the most sense given the particular nature of a proposed project, as well as a tool which would allow regulators to simply upload relevant data layers to the cumulative impact evaluation model rather than build the framework themselves. Furthermore, through the use of test cases examining the effectiveness of the decision trees created, the URI team in discussion with federal and state regulators learned that while the relative impacts posed by demonstration scale offshore renewable energy projects would likely be minor, monitoring at this scale would be incredibly valuable in furthering our understanding of the effect of offshore renewable energy. Regulators should view these pilot projects as an opportunity to monitor the particular effects that are of greatest concern to the local stakeholders or resource managers.

Table 2 List of Monitoring Protocols Developed

Benthic Resources and Habitat
Protocol 1. Scour and/or deposition
Protocol 2. Changes in benthic community composition
Protocol 3. Increase in hard bottom habitat
Protocol 4. Changes in hydrodynamics
Fisheries Resources and Fishing Activity
Protocol 1a. Trawl surveys
Protocol 1b. Ventless trap surveys
Protocol 2. Monitoring for project-scale changes
Protocol 3. Reef and aggregation effects
Protocol 4. Blade strikes
Protocol 5. Spatial use of fishing activity
Avian Species
Protocol 1. Ship-based visual surveys
Protocol 2. Aerial surveys using human observers
Protocol 3. Aerial surveys using high definition videography
Protocol 4. Aerial surveys using digital still photography
Protocol 5. Radar surveys
Protocol 6. Visual surveys of flight ecology
Protocol 7. Flight call surveys
Protocol 8. Systems to remotely assess collision risk
Protocol 9. Sonar and video technology
Protocol 10. Using radio telemetry to assess movements
Protocol 11. Using satellite telemetry to assess movements

Protocol 12. Using GPS tracking to assess movements
Marine Mammals and Sea Turtles
Protocol 1. Visual surveys
Protocol 2. Passive acoustic monitoring
Protocol 3. Marine mammal observers
Protocol 4. Stranding response networks
Protocol 5. Tagging
Protocol 6. Underwater photography
Protocol 7. SCUBA surveys
Protocol 8. ROV surveys

IMPACT AND APPLICATIONS

Quality of Life

In a few sentences, what is the potential future impact on Quality of Life, e.g., public and ecosystem health, coastal resource management?

The results of this project thus far have been to identify those potential effects of offshore renewable energy that are likely to be most significant and that warrant further study, as well as to identify methodologies by which these effects can be monitored. The potential future impact of this study on ecosystem health and coastal resource management is to provide for standardized and better monitoring of these effects, so that they can be better detected and understood, as well as providing data that can be comparable across regions. This will result in offshore renewable energy development projects that can better account for these effects in the siting and development processes to reduce or mitigate potential environmental effects to our coastal ecosystems. Standardized and scientifically sound monitoring protocols will also allow for a more efficient permitting process, resulting in more renewable energy sources providing for the energy needs of the United States.

TRANSITIONS

Quality of Life

In a few sentences, please describe the transitions related to Quality of Life, e.g., public and ecosystem health, coastal resource management.

The results of this project are being used to design a monitoring plan for the eventual development of a small-scale wind farm projected to be constructed in Rhode Island state waters in 2014.

RELATED PROJECTS

Please identify closely related projects and briefly describe the nature of each relationship. (Include web links as appropriate/available).

At present, the URI Coastal Resources Center, including many members of the NOPP project team, are involved in an effort to implement the Rhode Island Ocean Special Area Management Plan, or Ocean

SAMP, a marine spatial plan created for Rhode Island's offshore waters, with the goal, among others of siting an offshore wind farm. The Ocean SAMP implementation project includes collecting baseline data within an offshore area identified as the Area of Mutual Interest for wind energy development between Rhode Island and Massachusetts. The protocols being developed by this NOPP project complement this data collection endeavor, and the data collected are feeding into testing these protocols.

Additionally, the protocols being developed by the NOPP will use a common language and format compatible with NOAA's Coastal and Marine Ecological Classification System (CMECS). Using a unified classification scheme can focus data collection, streamline data interpretation and integration, and produce data layers in a format useful for calculation of the Ecological Value Index (EVI). The NOAA CMECS group and NatureServe are partners in this work.

PUBLICATIONS

Shumchenia, E., Smith, S., McCann, J., Carnevale, M., Fugate, G., Kenney, R., King, J., Paton, P., Schwartz, M., Spaulding, M., Winiarski, K., (in press). An adaptive framework for selecting environmental monitoring protocols to support ocean renewable energy development, in: Azzellino, A., Conley, D., Vicinanza, D., Kofoed, J. (Eds.), Marine renewable energies: Perspectives and implications for marine ecosystems, *Scientific World Journal*.