# Protocols for Baseline Studies and Monitoring for Ocean Renewable Energy

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## LONG-TERM GOALS

The overarching goal of the Environmental Protocols Framework (Framework) is to describe a clear, consistent process for regulators and industry to follow when designing environmental baseline and post-installation monitoring studies for proposed wave, tidal and offshore wind projects in the U.S, thus reducing time and uncertainty associated with project development. The project team evaluated all stressor–receptor interactions and developed a simple set of criteria to select a set of interactions that provide the most meaningful evaluation of the Framework for each technology type. Design and application of the Framework resulted in different sets of priority issues for each technology type. Case studies of ocean renewable energy projects verified the proof of concept and demonstrated the applicability of the Framework to both real and hypothetical projects. Finally, implementation of this project showed the protocols are adaptable enough to apply to different ocean renewable energy technologies, yet specific enough to be useful for a single project at a single location.

## OBJECTIVES

The Protocol Framework will:

- Establish a process for defining priority environmental interactions for wave, tidal, and offshore wind energy projects;
- Identify protocols for collecting baseline and monitoring data for wave, tidal, and offshore wind energy projects;
- Be expandable to include protocols for other offshore renewable energy resource technologies, sites, and conditions; and
- Focus on California Current LME, but also be applicable to other LMEs.

## APPROACH AND WORK PLAN

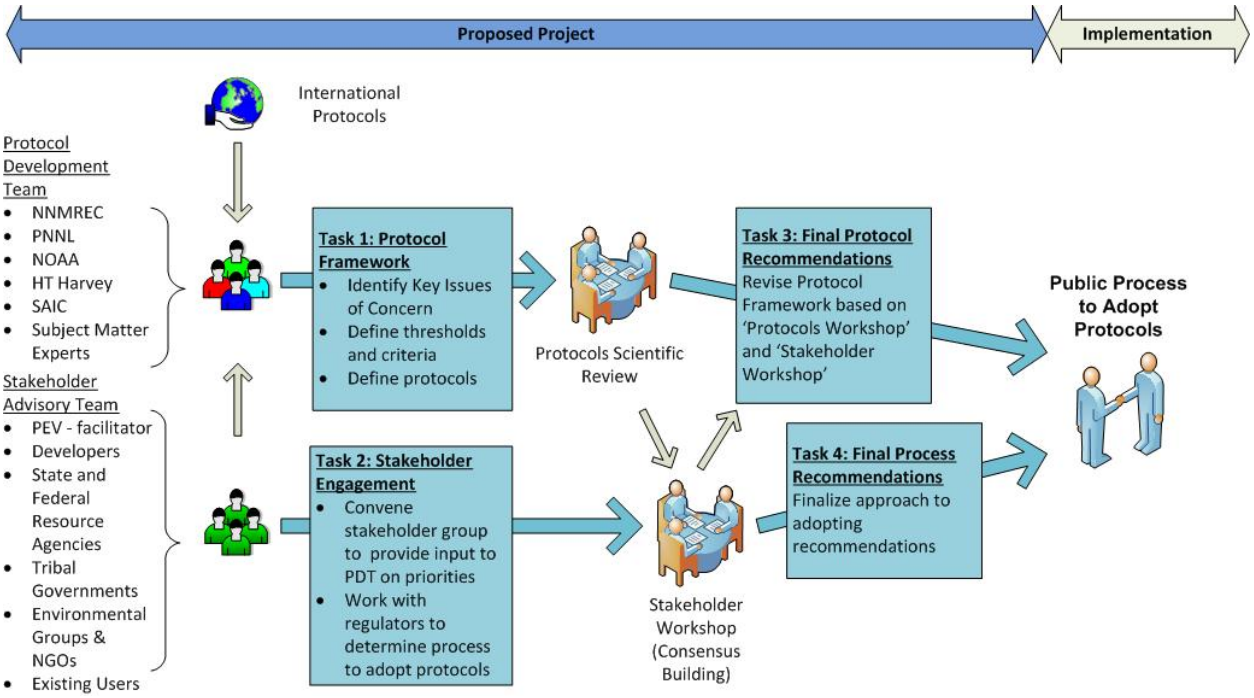
The Protocol Framework has been developed using accepted scientific practice, and considering validated models, methods, and outcomes from existing coastal and ocean assessment programs from the U.S. and abroad. The project consists of four major tasks:

**Task 1: Protocol Framework and Case Studies.** Develop a Framework to identify: 1) the key ecological and physical issues that are likely to require monitoring when renewable energy devices and arrays are installed and developed; and 2) standard assessment and monitoring protocols and metrics to address issues in an adaptive management context.

**Task 2: Stakeholder Engagement.** Engage stakeholders to: 1) establish a stakeholder advisory team; 2) establish priorities for protocol development; 3) review Protocol Framework and protocols; and 4) develop a process for future adoption of Protocol Framework and representative protocols.

**Task 3: Final Protocol Recommendations.** Synthesize feedback from subject matter experts and stakeholder to produce final Protocol Framework.

**Task 4: Final Process Recommendations.** Use stakeholder engagement to produce final process recommendations for future adoption of protocols utilizing the Protocol Framework.



## WORK COMPLETED

The Protocol Development Team has gathered existing information and applied accepted scientific practices in the completion of the following:

- Defined and executed a process for defining high priority issues for protocol development for wave, tidal and offshore wind energy. The process has been documented so that it may be replicated by others and the information, references, and results of the Protocol Development Team's efforts are captured in a draft report.
- Researched and defined the thresholds and criteria relevant to siting, construction, and operation of wave, tidal and offshore wind energy projects. The information has been documented and referenced in a draft report.
- Defined a Protocol Framework process for evaluating the baseline and monitoring study protocols required for wave, tidal and offshore wind energy projects. Developed 14 case studies to illustrate and validate the Protocol Framework process.
- Engaged with subject matter experts on key issues associated with the Protocol Framework.
- Drafted a comprehensive project report that summarizes the Protocol Framework, the case studies, and the process for defining high priority issues.
- Submitted final report to BOEM.

## RESULTS

The Protocols Framework (Framework) uses a step-wise approach to identify monitoring protocols for developing wave, tidal and offshore wind ocean renewable energy projects in the U.S. and aboard. (The use of the term environmental in the context of this report refers specifically to natural resources and ecological issues, not to human resources or socioeconomic or cultural issues.) Common protocols will provide clarity and consistency in study requirements, which presently differ substantially between projects and regions. The specific objectives of the Framework project to are to:

- Identify and prioritize potential environmental issues to be monitored;
- Develop a screening tool (the protocols framework) for renewable ocean energy projects that can be used to identify baseline and effects information and protocols needed to collect that information;
- Address environmental thresholds, both scientific and regulatory, and related criteria in the framework;
- Screen the environmental issues and design the protocols framework, focusing on the California Current Large Marine Ecosystem (LME) and with intended portability to other LMEs;
- Obtain and consider information on emerging environmental monitoring protocols for ocean renewable energy development from Europe;
- Verify the proof of concept for the framework through case studies of wave, offshore wind and tidal projects on the U.S. West Coast;
- Vet the resulting products and process with a broad stakeholder group representing industry, regulators, scientists, environmental nongovernmental organizations, and industry; and

- Provide process recommendations for the possible adoption of this work into the state and federal regulatory processes to allow for consistency.

The protocols framework may be used to identify protocols that are applicable to a specific project and areas where additional protocol development is likely needed. The protocols framework may serve as a point of departure for discussions between ocean energy industry proponents and regulatory agencies.

This analysis is designed to provide guidance to the ocean energy industry and regulatory agencies as it relates to project development, focusing limited resources on those issues most critical to commercial development. It is important to note that nothing in this paper is intended to prescribe baseline information and monitoring needs or protocols for any specific ocean energy project. All references to ocean renewable energy projects and case studies in this report are hypothetical in nature. The companies referenced in this paper were not involved in developing content, analysis, or conclusions. The project information presented in this report is based on the project team's summary of existing public information available at the time of its drafting, and is not endorsed by any company to be representative of any current or planned project.

## PRIORITIES FOR PROTOCOLS DEVELOPMENT

The Framework project is based on setting priorities for environmental issues that are likely to be the focus of ocean energy monitoring needs. The interaction of stressors (those parts of an ocean energy technology and/or project that may cause stress on the marine environment) and receptors (marine plants or animals, habitats, or ecosystem processes) is used to describe the environmental issues of concern.

### Approach to Setting Priorities

The study team identified eight generic environmental stressors (e.g., noise) across 18 generic environmental receptors (e.g., resident fish) for a total of 144 possible stressor–receptor interactions. These interactions were screened by separate sub teams for wave, offshore wind, and tidal energy, and from three different perspectives—scientific expert opinion, regulatory requirements, and stakeholder opinion—resulting in a total of 1,296 possible integrated rankings. Each interaction was ranked as high, medium, low, or no interaction. The rankings for each perspective were integrated and scored based on a set of objective criteria, as described in the report.

### Priorities from Different Perspectives

The primary input from the scientific expert opinion was derived from recent West Coast workshops on environmental effects of wave and tidal energy, and from European and Cape Wind project development experience for offshore wind. The regulatory rankings were highly influenced by species and habitats accorded special status under state and federal regulatory authorities such as the Endangered Species Act of 1973 (ESA). Stakeholder rankings reflected the interests and mandates of the individuals responding.

Overall, high levels of uncertainty about an interaction tended to increase the ranking to a higher priority. When conflicting rankings were accorded to a stressor–receptor interaction, the scientific expert opinion was given the greatest weight. Minor nuances in the scoring are explained in the

text. Of the 144 possible stressor–receptor interactions, the number of integrated priorities ranked medium or high totaled 41 for wave energy, 29 for tidal energy, and 32 for offshore wind energy. The greater number of high-priority interactions for wave energy reflects the diversity of wave energy conversion technologies now being developed and the uncertainty associated with the related environmental stressors.

**Priorities for Monitoring and Protocol Development**

Across technologies, the environmental stressor with the largest number of high- and medium-priority rankings was the presence of static devices, reflecting the variety of new interactions that could occur when new structures are introduced in open waters. Moving devices had more interactions for wave and tidal energy, whereas moving devices for offshore wind energy would be likely to interact only with bats and birds. Noise, vibration, and electromagnetic fields (EMF) were important across all three of the energy technologies, due largely to the uncertainty of effects associated with these stressors. Across the three energy technologies, the environmental receptors with high-and medium-priority rankings tend to favor groups with special regulatory status, including resident and migratory fishes, birds, and marine mammals.

## THE PROTOCOLS FRAMEWORK TOOL

The Environmental Protocols Framework tool, shown in Fig. 1, is a nine-step screening process designed to screen renewable energy technologies and environmental site characteristics to identify needed baseline and effects information and applicable monitoring protocols. The framework tool will assist in determining the protocols needed for industry to carry out environmental studies.

Step 1 is a description of the technology to be used and the site where it is to be deployed. A description of the technology is necessary to identify the stressors that will be introduced into the ocean environment; greater detail of the technology will allow more specificity of the potential environmental stressors. Similarly, identifying the receptors that may be affected by an ocean energy development will help determine potential environmental effects. The receptors may include biological resources expected to be present at the site, such as individuals or populations, communities, habitats, or ecological processes, or physical attributes and dominant processes at the site, including ocean currents, seabed slope, and bottom sediment type. Specific information about the potential development site also allows for assessment of the physical attributes and dominant processes at the site.

Steps 2 through 5 focus the potential scope of environmental interactions to identify specific information needs. The remaining steps identify the information needed to establish baseline conditions (Step 6), the information needed to measure the effects of a stressor on a receptor (Step 7), and the protocols to collect that baseline (Step 8) and effects (Step 9) information, respectively. Although the framework is conceptually and visually simple, it can provide project-specific output (s).

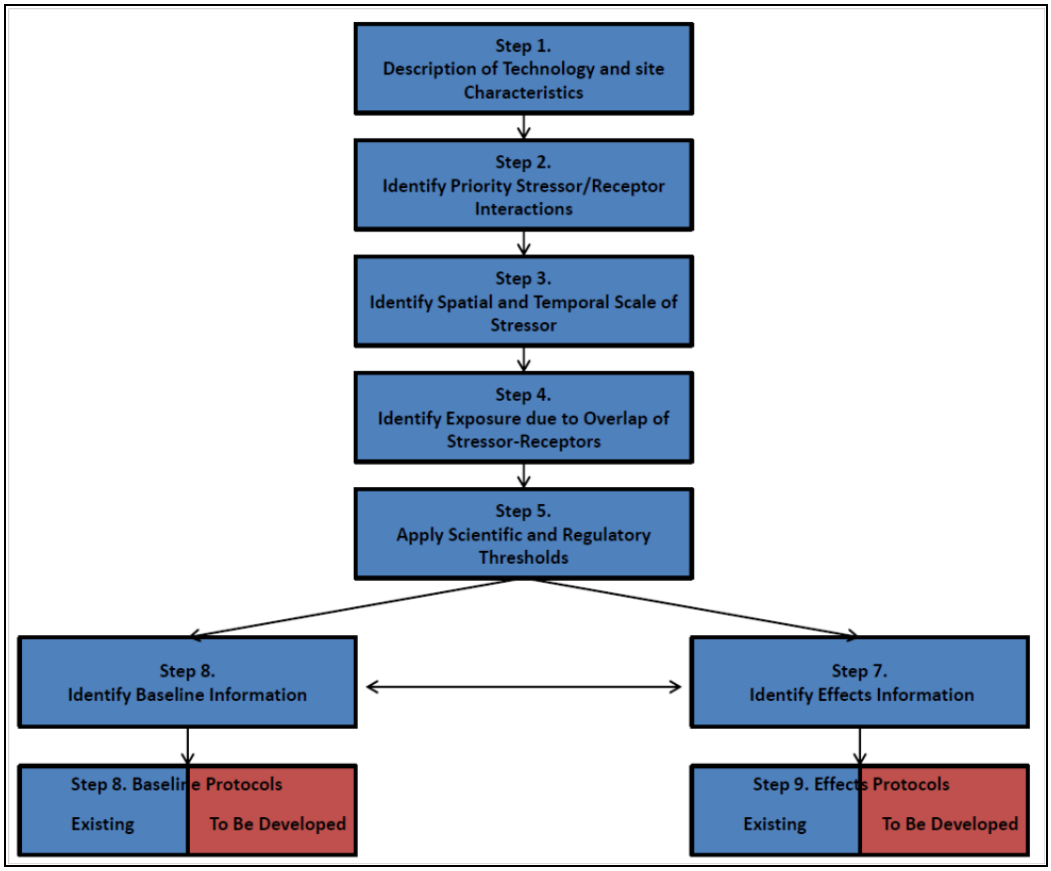



Fig. 1. The ocean renewable energy Protocols Framework, described step-by-step.

## CONCLUSIONS

The development and application of the *Framework* resulted in three major conclusions.

### 1) Identification of Priorities for Monitoring Potential Environmental Effects

The first conclusion concerns the identification of priorities for monitoring potential environmental effects. Design and application of the framework resulted in a priorities list for each type of ocean energy technology (wave, tidal, and offshore wind), based on the consideration of the interaction of environmental stressors and receptors by scientific subject matter experts, regulatory requirements, and stakeholder opinion. The study team believes, and the subject matter experts agree, that the priorities identified include the environmental interactions that will most likely require baseline and/or effects monitoring for the siting and permitting or licensing of actual projects. However, the setting of priorities among these issues may change, depending on the specific technology and location, with the acquisition of new or more accurate data on environmental effects or with changes in regulatory status, such as the listing or delisting of species or habitats that are provided special protections. The information derived from applying the protocols framework can help to inform future projects and will begin to provide a useful record of investigating and resolving environmental issues associated with ocean energy development.

### 2) Applicability of the Protocols Framework Tool

The second major conclusion concerns the applicability of the framework tool. The case studies have verified the proof of concept and demonstrated the utility of the framework for hypothetical and actual projects. Given increasing specificity about the environmental stressors accompanying a given technology, and the deployment of that technology at a specific site, the framework can successfully screen many potential environmental issues to identify those that require substantial monitoring and specific baseline or effects protocols. Further, the general applicability of the priorities for protocols development, the case studies, the team reviews of European protocols, and the subject matter expert reviews suggest that this framework should be portable across ocean renewable energy projects sited in the United States. However, the ability of the screening tool to deliver specifically applicable protocols or information needs depends on the specificity of the information available about the technology and its stressor characteristics at the project site.

### 3) Adaptability of Protocols

The third major conclusion of this study concerns the adaptability of protocols that are portable across differing technologies but are still specific enough to be useful at a single site. The marine environment is highly variable across time and space, which results in high variability in organism densities across days or months and across mesoscale distances (i.e., kilometers to tens of kilometers), and strong variability in physical conditions that can affect deployment of sampling technologies. Such variability is likely to determine the sampling density required to demonstrate a given level of change. A user of the framework can expect to fine-tune or adapt a selected protocol to the existing conditions at his/her project site.

## IMPACT AND APPLICATIONS

### Economic Development

The Protocol Framework will increase the efficiency for both project developers and regulatory agencies in siting, analyzing and permitting ocean renewable energy projects.

### Quality of Life

It is anticipated that the Protocol Framework will improve the site selection and evaluation process for new wave, tidal and offshore wind energy projects. The Protocol Framework provides a scientifically supported method of evaluation and captures current information which, if used by developers and regulators, could reduce potential effects associated with ocean energy projects.

## TRANSITIONS

The material developed under this project is has been released for use by others. http://www.oceanrenewableenergy.com/content/environmental-study-protocols-framework

## RELATED PROJECTS

There are no closely related projects within Pacific Energy Ventures at this time. However, the University of Rhode Island is conducting similar research under the NOPP program regarding environmental protocols.