BOEMRE ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Headquarters

Planning Area: Pacific

Title: Evaluating acoustic technologies to monitor aquatic organisms at renewable energy sites (AT-10-x15)

Total Cost: $746,617 ($196,617 BOEMRE, $450,000 DOE, $100,000 NOAA)

Period of Performance: FY 2010-2012

Conducting Organization: University of Washington

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Description:

Background: Characterizing and monitoring biological and physical environments is an integral component of marine renewable energy site development. Prior to installation of any devices, potential energy resources must be quantified and baseline environmental conditions measured. Once devices are installed, device performance and potential environmental impacts must be monitored. All marine hydrokinetic projects in operation or currently being permitted include comprehensive monitoring plans (e.g. Ocean Power Technologies 2010, Fundy Ocean Centre for Research 2009, Snohomish PUD 2009). While technologies to monitor the physical environment around marine renewable energy projects are well-established, techniques to comprehensively monitor animals that may interact with pilot devices or commercial arrays are less developed. Limited and variable monitoring procedures can be found in the aquatic species monitoring plans proposed in the above references.

Before biological monitoring can be implemented and standardized, it is imperative to quantify the composition and distributions of aquatic organisms associated with renewable energy sites.

The label "nekton" will be used to include all macroinvertebrates and pelagic (i.e. in water column) fish species that are capable of moving independent of fluid motions. Without baseline measurements of nektonic species, suitability of sites and potential or realized impacts of device deployment and operation can not be known. The characterization of nekton at marine energy sites can also be used to design the type and number of monitoring instruments needed; and protocols to adequately monitor trajectories of animals toward devices and changes in the composition and density distributions of resident or migratory species. Ultimately, understanding the composition and spatiotemporal variation of nekton is needed to design and implement a warning system when high densities of small organisms may be entrained in devices, endangered or threatened species occur within safety radii established around devices, or a large animal is at risk of colliding with a device.

Dynamic flows at energy sites require robust technologies that can monitor large ranges over wide apertures. High velocities at sites, such as the 3.5 m/s observed in northern Admiralty Inlet
(Gooch et al, 2009), may increase water turbidity and reduce optical ranges. As optical transmissions lose energy at rates that are three orders of magnitude faster than sound (i.e. 30 m optic range compared to 30 km acoustic for two-thirds energy loss), acoustics sensors have the capability of providing high-resolution data over long ranges. Acoustic technologies are commonly used to map, size, count, and identify pelagic fish and large invertebrate species in all aquatic environments. With the ability to continuously sample the entire water column over short (<1 second) time periods, acoustics provides a comprehensive snapshot of nekton that is not possible using direct sampling technologies such as nets or pumps. Acoustic technologies send short (e.g. 0.2 - 1.0 msec), repetitive (e.g. 3 pulses s-1) pulses of high frequency sound (e.g. 12 - 420 kHz) in a conical beam. With each acoustic pulse, the entire water column is sampled at resolutions of one meter or less. When the sound wave encounters a density different from water (e.g. fish or large invertebrate), energy is reflected and then received at the transducer. This echo is used to derive quantitative measures of target locations, sizes, and densities. Acoustic technologies can be deployed at fixed locations to monitor sites over time, or in mobile surveys along transects to construct continuous, detailed maps of target densities and sizes. The challenge to identify species is met by combing acoustic measurements with direct sampling technologies such as nets. New developments using multiple acoustic frequencies combined with biological knowledge increases the ability to remotely identify acoustic targets.

This project will evaluate the use of acoustic technologies to characterize and monitor nekton at a proposed renewable energy site in northern Admiralty Inlet, Puget Sound, Washington. This is the site selected by Snohomish Public Utility District for the deployment of up to two OpenHydro hydrokinetic turbines. Three classes of acoustic instruments – echosounder, multibeam sonar, and acoustic camera will be used to detect, categorize, and enumerate pelagic fish, invertebrate, and marine mammal species at the site. Data from stationary instrument deployments will be compared to data from a mobile acoustic and midwater trawling survey to determine how well each technology captures spatiotemporal variation in nekon density distributions. Results of the design, deployment, retrieval, and analysis of data from these three instrument classes will be used to formulate recommendations for instrument choice, configuration, and the characterization and monitoring of pelagic nekton at any potential or commercial renewable energy site.

Objective: The specific objectives are to:

1. Collect stationary data using echosounders, multibeam sonar, and an acoustic camera at the proposed Admiralty Head hydrokinetic site;

2. Perform a mobile acoustic and midwater trawling survey to characterize macroinvertebrate, fish, and marine mammal spacio-temporal distributions at the study site;

3. Compare and contrast stationary instrument and mobile acoustic survey data;

4. Evaluate abilities and weaknesses of each instrument type; and

5. Provide recommendations for deployment and data acquisition procedures at pilot and commercial scale tidal and wave energy projects.

Methods:
This project is comprised of four phases:

1. Planning and Mobilization, which includes adapting and mounting three acoustic instruments and power supplies on frames, designing a mobile survey (echosounder and midwater trawl) to characterize nekton density distribution variability, and designing the sampling duty cycles to identify locations for acoustic packages;

2. Instrumentation deployment, which includes deploying the acoustic packages and conducting mobile surveys;

3. Data analysis, which includes processing of all acoustic data using a common software, computing species-specific densities using all acoustic data in common spatial and temporal bins, and comparing stationary to mobile acoustic data; and

4. Evaluation of the ability of representative instruments to detect categorize, and enumerate aquatic species, compare density distributions measured by stationary instruments to those measured during mobile surveys, and recommending the use of acoustic packages, in conjunction with other monitoring to establish the environmental baseline and monitor for environmental effects of renewable energy project developments.

Importance to BOEMRE: The National Environmental Policy Act (NEPA), as well as the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA), requires Federal agencies to evaluate and mitigate the impacts of their activities, or those they oversee, on protected species. Detailed assessments of species abundances are a critical component of accomplishing these mandates. Particularly under the MMPA, it is essential to have both accurate and precise estimates of population size for a given management unit or population stock. For risk assessment and mitigation of impacts, it is necessary to have information on the seasonal and inter-annual variability in distribution at smaller spatial scales to estimate the potential for mortality or other impacts on protected species due to localized activities (e.g., energy exploration).

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Final Report Due: September 30, 2012

Publications:

Affiliated WWW Sites:

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