WHOI/PAM workshop: Ørsted Input for Consideration

November 21, 2019

Introduction
In direct support of our projects in development, Ørsted has contracted Bio-waves in collaboration with Tetra-Tech to conduct a review and assessment of available and in-development PAM systems and platforms for application during our projects construction and operations phases. The following memo and attached equipment spreadsheet are an output of that ongoing effort and are being provided here as a contribution to advancing the goals of the workshop. The spreadsheet is not intended to be an exhaustive list, but does serve to demonstrate viable PAM solutions are available for a range of purposes and needs.

Goals of Workshop
To develop an initial framework for creating equipment performance standards that can be used to benchmark all potential PAM systems and data standards that ensure interoperability.

Establish Goals and Priorities for PAM: A Developer View
- Monitoring for marine mammals during pile driving activities.
- Real-time monitoring for reducing ship strike risk.
- Regional/long-term monitoring of marine mammals.
- Sound field verification.

Other considerations:
- Which species are priorities (e.g. NARW)?
- What areas are priorities?
- Is localization necessary or just detection?
- Real-time versus archival (recording) modes of operation.
  - For real-time, bandwidth requirements are important to consider.
  - For archival mission, duration should be clearly defined (e.g. days vs. weeks vs. months).
- What is the area that needs to be monitored and for what frequency bands?
  - Higher frequency bands require a higher density of coverage (i.e. more devices).
  - Low-frequency bands require a lower density of coverage but are likely to be more limited by noise in the areas to be monitored.

Equipment and Performance Standards
Once the goals and priorities for PAM are clearly established, the performance standards can be addressed. These are likely to be different for different goals.

The following are some of the criteria that one might want to consider for autonomous recorders and other PAM systems:
o Frequency response
o Dynamic range
o Bit depth
o Memory/Storage capability
o Battery/mission duration
o Self-noise and noise floor (very important for high-frequency recordings)
o Impulse response (for monitoring echolocation clicks)
o Size and weight (can it be deployed/retrieved from a small vessel?)

**Validation**

Validation in the form of field tests is an important part of any evaluation of PAM systems. Ideally, the field validation should occur in the same area and season(s) where the monitoring and mitigation is to be performed. If that is not possible then a field test in an area that is similar to the location of the eventual monitoring site should be considered. Using an underwater sound source to play marine mammal and other (e.g. synthetic) signals will allow an assessment of detection and localization range for the PAM systems being validated. Note, in some areas sound “play-backs” may require a Federal research permit. Other aspects of the PAM system that can be assessed include the effects of system noise and the noise floor (especially for high-frequency bands), synchronization/timing error of recorders (for localization arrays) and the fidelity of the recorded files (e.g. the occurrence of dropouts).

**PAM Hardware table**

The PAM hardware table that was compiled by Bio-Waves ([http://biowaves.net/](http://biowaves.net/)) and Tetra Tech is intended to provide some examples of autonomous acoustic recording systems (ARS) radio-linked/telemetered acoustic buoy systems (RTBs), and autonomous surface vehicles (ASVs). The table is a work in progress and is not intended to be a comprehensive listing of all available technologies, but rather a compilation of available, mostly off-the-shelf technologies that potentially could be used for monitoring marine mammals during offshore windfarm construction and operations in the lease areas that include Ørsted projects. An emphasis was placed on regional providers for passive acoustic monitoring technologies, but due to the limited number of regional providers, others were also included. Only a select few autonomous mobile and drifting platforms (e.g. wave-gliders and sail-powered vessels) were included and most of those were referred to us by our client. Information about performance and other capabilities are provided in the table along with general deployment/retrieval requirements (e.g. small or large deployment vessels).
Bibliography of Selected Reports and Papers for WHOI Workshop


