Developing standardized methods for passive acoustic data collection during NMFS shipboard cetacean surveys

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Goals

Southwest Fisheries Science Center has been conducting shipboard towed hydrophone array surveys since 2000, and we have been designing and building our own acoustic equipment since 2002. As additional Science Centers increase their usage of this technology at sea, we are finding that it is difficult to obtain functioning equipment with the time and resources typically provided prior to a given survey. Unfortunately, much of our required equipment for passive acoustic data collection cannot be purchased 'off the shelf', and there are few resources for constructing, troubleshooting, and repairing equipment.

The primary goals of this workshop were to (1) develop a modular hardware/software system to be used by all NMFS science centers during shipboard cetacean surveys and (2) host a workshop to build these systems. By standardizing our methods and equipment, we can provide flexible solutions to equipment repair and modifications as well as the opportunity to loan/borrow equipment from other Science Centers as need arises.

Likewise, standardization of methods will allow us to more easily compare results across ocean basins. We expect that the single input of funding and effort will ultimately save tremendous resources, while providing the opportunity to collect a greater quantity of high-quality data that can be directly compared between survey efforts and projects.

Priorities

The three priorities/tasks include 1) Development of standard hardware and software methods for passive acoustic data collection, 2) Host a hands-on hardware workshop, and 3) Complete a workshop report.

Approach and work completed

The first task was related to the design of standard hardware and software methods, including a towed hydrophone array design with modular components. We worked with Robert Valtierra (Boston University) to develop an in-line hydrophone array as one component that could work in tandem with an end array component to provide improved localization capabilities (Fig. 1). A prototype of this in-line array was developed and briefly tested to ensure that it could withstand the tensions applied while being towed at sea. Design of the end array had been tested over the previous four years and modifications included changes to the inline hydrophone pre-amplifiers to improve stability and increase gain, as well as changes to the adapter to allow for a seawater ground to decrease system noise. The equipment purchased and constructed during this workshop would allow scientists to customize their array configurations (Fig. 1; options are shown in a-d) based on research needs.

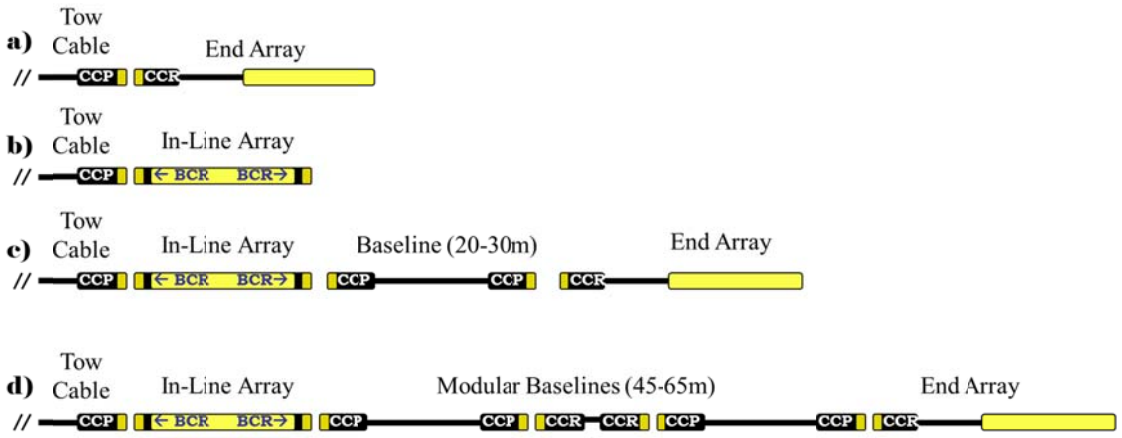

Figure 1. Schematic of array configurations (and connector types) designs.

Modifications to Pamguard, a customizable software system for recording, detecting, classifying and localizing marine mammal vocalizations during field surveys, are currently underway. Work to date includes the incorporation of a simple database to allow storage of metadata, gear and software configurations, and real-time detection information. This initial database has been provided for beta testing and incorporation of necessary improvements to move the software into full field use. We expect this next round of improvements to be completed for the spring beta release of Pamguard. Delays

in initiating these modifications were due to complexities in awarding the contract for modifications.

The second task was to host a workshop to build these towed array systems. This workshop was held 29 October – 8 November, 2012 at Southwest Fisheries Science Center (Fig. 2) which was attended by 10 researchers from six science centers, with additional assistance from local graduate students and volunteers.

The final task of this project is the development of written methods outlining the procedures used to build these towed hydrophone arrays. This manuscript is currently in draft form, and will be submitted as a NOAA Technical Memorandum when complete.

Figure 2. NMFS Passive Acoustic Monitoring Hardware Workshop was held at Southwest Fisheries Science Center from 29 October through 8 November.

Results

A total of 12 hydrophone arrays, consisting of 6 inline arrays and 6 end arrays, were constructed during the workshop (one set for each science center). These arrays were tested during two days of sea trials, and all components of all hydrophone arrays were found to be functional (Figure 3). This high rate of success was due, at least in part, to the focused dedication and group working environment that the workshop provided.

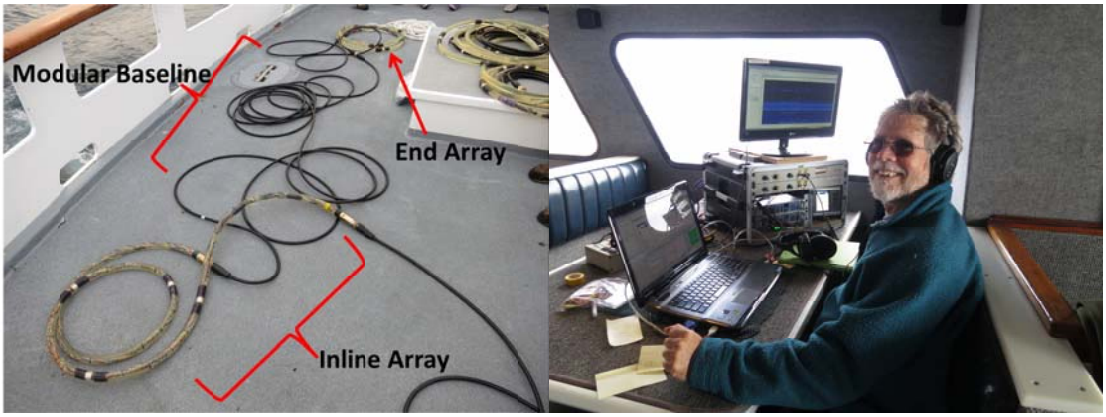

Figure 3. Inline array, modular baseline, and end array in series during sea trial. Rack-mounted recording equipment shows successful audio recording of array in the water.

One benefit of combining hardware construction on this scale was associated with a cost savings for bulk purchases. This, combined with a decrease in expected cost of the inline array design, allowed for project funding to be applied to construction of both hydrophone arrays using ASTWG funding (initially it was expected that each science center would provide matching funds for the hydrophone array construction). All science centers now have a complete set of towed hydrophones, regardless of their ability to provide matching funds.

Impacts / Applications

The development of a standardized modular hardware and software system for shipboard acoustic surveys of cetaceans provides several layers of benefits for NMFS. The system designed should provide improved detection and localization capabilities. Likewise, by standardizing hardware, it allows for more direct comparison of data collected from the different regions. Each science center now has a set of equipment that has been tested, and this equipment can be borrowed should problems occur at sea. This workshop has provided marine mammal acousticians at each of the science center with the skills needed to build and repair hydrophone arrays, from building the internal electronics, including custom preamplifiers and calibrated depth sensors, laying out and connecting hydrophone elements with appropriate spacing for research needs, and creating the robust external packaging to sustain the equipment for months at sea. Future application of these acquired skills and the ability to share standardized equipment between centers will minimize downtime in data collection at sea due to broken equipment which, along with the quality of the developed hardware, will improve both the quality and the quantity of data collected.

Transitions

During this workshop we were able to build the critical hardware components necessary to run a successful shipboard acoustic survey of cetaceans, namely, the towed hydrophone array. Partial funds were provided to purchase some of the components for the rack-mounted hardware system, and necessary modifications were discussed. We expect to finalize discussion of configuration of this hardware system during a conference call in January 2013.

Initial plans included calibrating the hydrophones in the acoustic test tank at the new Southwest Fisheries Science Center in La Jolla, CA; however, the building schedule has been delayed we were unable to take advantage of this opportunity. We hope that when the facility becomes available, we will be able to calibrate some (or all) of the equipment built during this workshop.

The rack-mounted recording system consists primarily of components that can be purchased 'off the shelf'. Development of a streamlined 12v power supply (to reduce electrical noise) and modification of components to allow for 12v power usage were discussed.

The Pamguard software program provides a versatile interface that works reasonably well for our data collection needs. Software modifications to make it more appropriate for our needs were provided by this grant. We expect to test these modifications after they have been applied to the upcoming beta release. Once these modifications are in place, there will be a need to develop a standardized method for data collection and analysis using Pamguard.

A complete report in the form of a NOAA Technical Memorandum will provide the methods for constructing the towed hydrophone array system developed during this project. This manuscript is currently in draft form, and will be completed in the near future.

An important benefit of this workshop was to bring together colleagues from the science centers. The success of this workshop has motivated us to identify additional areas in which we might be able to combine limited resources and standardize methods across the six science centers.

Related Projects

A project funded by ASTWG may directly benefit from the hardware and software provided by this grant. The project "Development of an automated system for acoustic identification of odontocetes in the California Current and the Hawaiian Islands" includes testing of the automated detectors using Pamguard software. It is expected that the software modifications provided by this project will allow for improved application of these detectors. Also, testing of these detectors during shipboard surveys, should sea time become available, will use the hardware developed during this workshop. Funds for the sea trial were provided by NOAA's National Cooperative Research Working Group. We were able to combine our sea trial with testing of drifting autonomous acoustic recorders to maximize resource use.

Publications
This work has not resulted in any publications to date, but we do expect to publish a NOAA Report in early 2013.

Expenditures
All funds provided by this grant have been applied towards completion of this project. A summary of expenditures is given in Table 1. The complete list of all individual expenditures is extremely lengthy, but can be provided upon request. Unexpected costs associated with contract overheads were offset by using Cooperative Research Program funds.

Table 1. Summary of estimated and actual expenditures.

	Estimated Cost	Actual Expenditures
Assistant	$9,891.00	$14,638.00
Software	$18,000.00	$18,540.00
Travel	$14,100.00	$14,100.00
Hardware + Supplies	$90,480.00	$91,193.00
Vessel Charter	$6,000.00	$0.00
	$138,471.00	$138,471.00