Building A Better Array

Developments in towed hydrophone arrays improve identification and localization of cetacean groups

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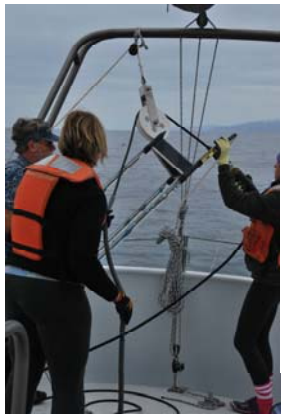
Tetrahedral Array

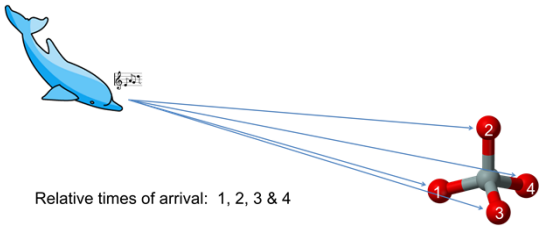
TETRAHEDRAL ARRAY

The tetrahedral consists of a 5 hydrophones potted in a solid structure to provide a tetrahedral hydrophone configuration for localization. The array is configured as a triangular box kite to minimize its cross-sectional area and hence its drag.

Deployment

The SWFSC towed tetrahedral array can be hand-deployed and retrieved from a small 10-m vessel. The current version can be towed at speeds up to 8 knots





3D Localization

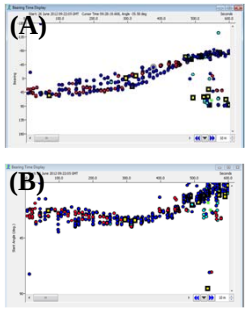
3D bearing angles can be estimated from the relative arrival times of acoustic signals at 4 or more hydrophones in a 3D spatial array such as a tetrahedron.

Publication:

Coming soon! *http://swfsc.noaa.gov*

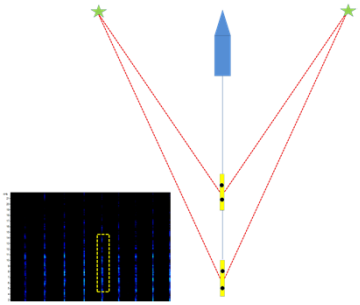
Abstract

Localization of sounds using towed hydrophone arrays from shipboard platforms typically relies on using the time-difference-of-arrival of the sound between two hydrophones to determine the conical bearing angle and the convergence of several bearing angles over time to identify a location (with a left/right ambiguity). These localization methods are successful for single animals or tight schools that are close to the surface and moving slowly relative to the vessel speed. However, these methods break down for groups that are large and spread-out, fast swimming, or when there are multiple distinct groups with overlapping calls. Likewise, the time required to obtain a location using these methods potentially violates a key requirement for line-transect surveys that the location of the initial detection occurs before the animals have responded to the vessel. Instantaneous localization using more complicated towed hydrophone array designs can eliminate these problems. A simple, robust design is needed that covers a wide range of frequencies, provides sufficient baseline to allow instantaneous localization, and is modular to allow flexibility in configurations and to allow easy replacement of broken components. Here we present two hydrophone array designs: a tetrahedral array that provides improved 3D localization of high frequency sounds and a modular linear towed array that meets these design criteria at a price that cetacean researchers can afford. Future developments will include adding the tetrahedral array as a component in the modular array design.



LOCALIZATION: TETRAHEDRAL ARRAY

The tetrahedral array can provide a 3-D localization that provides (a) lateral angle (relative to ships' track) and (b) provides a slant angle that relates to the depth of the animals. A radial plot (not shown) addresses left/right ambiguity. This array is ideal for deep-diving species such as sperm whales.



LOCALIZATION: MODULAR LINEAR ARRAY

A bearing angle to the sound can be obtained using time-difference of arrival for each pair of hydrophones on the same sound. Convergence of these two bearing angles can provide a location. With an appropriate baseline between hydrophone pairs, a *range* (provided by a location with left/right ambiguity) can be obtained using only a single vocalization.

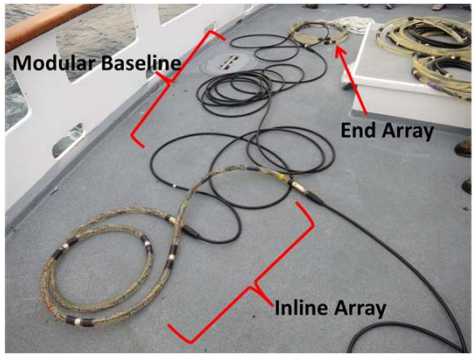
Conclusion

Development of a towed tetrahedral array provides improved detection and localization of deep-diving species such as beaked whales by addressing the left/right ambiguity and providing a slant angle (relates to depth of the sound source). Development of a modular linear array allows for measurement of an angle and range to a single sound, allowing for improved detection and localization of odontocete groups for line-transect surveys of abundance. We are currently working on a new tetrahedral design that will allow it be to integrated into the modular linear array and hope future designs will allow for instantaneous localization of a single sound to its exact position in the water column.

Acknowledgements

Funding for the modular towed array was provided by the Advanced Science and Technology Working Group (ASTWG) of the National Oceanographic and Atmospheric Administration. Funding for the tetrahedral array was provided by U.S. Navy (N-45).

Modular Linear Array



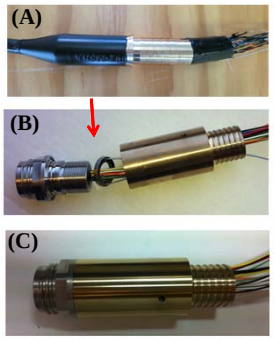
MODULAR ARRAY

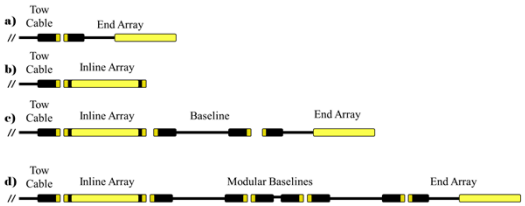
The modular linear array consists of two oil-filled arrays separated by a length of cable (referred to as the 'baseline'). The two arrays are fundamentally the same, with different terminations. All components can be connected using high quality underwater connectors (Teledyne Impulse MHDM-26).

CUSTOM ADAPTERS

The tubing for the end array is connected to a custom brass adaptor (A) that is molded to an underwater cable. The MHDM-CCR/CCP connector is molded directly to this length of cable.

The inline array consists of a length of tubing connected at either end to a custom brass adaptor that can be screwed into the MHDM-BCR connector (C). Steel cable connected to the tension disk (B) at either end provide strength for inline array.





ARRAY CONFIGURATIONS

The modular nature of this design allows for multiple array options, with different configurations providing different localization options.

Publication:

Rankin, S., J. Barlow, Y. Barkley, and R. Valtierra. 2013. A guide to constructing hydrophone arrays for Passive Acoustic Data Collection during NMFS Shipboard Cetacean Surveys. NOAA-TM-NMFS-SWFSC-511. 33p.