Sights and Sounds in the Sky: Integrated Acoustic-Visual Aerial Monitoring of Marine Mammal Behaviors Using Sonobuoys and Visual Methods

Conference Paper · January 2013

7 authors, including:

David Steckler
Entiat River
6 PUBLICATIONS **0** CITATIONS
SEE PROFILE

Mari Ann Smultea
Smultea Environmental Sciences, Preston, WA USA
101 PUBLICATIONS **712** CITATIONS
SEE PROFILE

Sights and Sounds in the Sky:

Integrated Acoustic-Visual Aerial Monitoring of Marine Mammal Behaviors Using Sonobuoys and Visual Methods

Tom Norris[1], David Steckler[2], Mari Smultea[3], Bernd Würsig[4], Talia Dominelli[1], Cory Hom-Weaver[1], Cathy Bacon[3,5]

[1]Bio-Waves Inc., 144 West D. St., Encinitas, California, 92024; [2]Entiat River Technologies, P.O. Box 256, Preston, WA 98050; [3]Smultea Environmental Sciences (SES), P.O. Box 256, Preston, WA 98050;
[4]Marine Mammal Research Program, Texas A&M University at Galveston, Pelican Island, Galveston, TX 77553; [5]HDR Inc., 9449 Balboa Avenue, Suite 210, San Diego, CA 92123

Correspondences: thomas.f.norris@bio-waves.net

Dr. Bernd Würsig, Mari Smultea, and Tom Norris

BACKGROUND

- Behaviors of marine mammals are poorly understood.
- Aerial behavioral studies of cetaceans have been conducted for the Navy in Southern California bight for the past 3 years.
- In 2012 we were funded to integrate sonobuoy monitoring with visual monitoring of marine mammal behaviors.
- This pilot study was conducted to collect and analyze visual *and* acoustic data on marine mammal behaviors with an empasis on *real-time* data-processing and display.

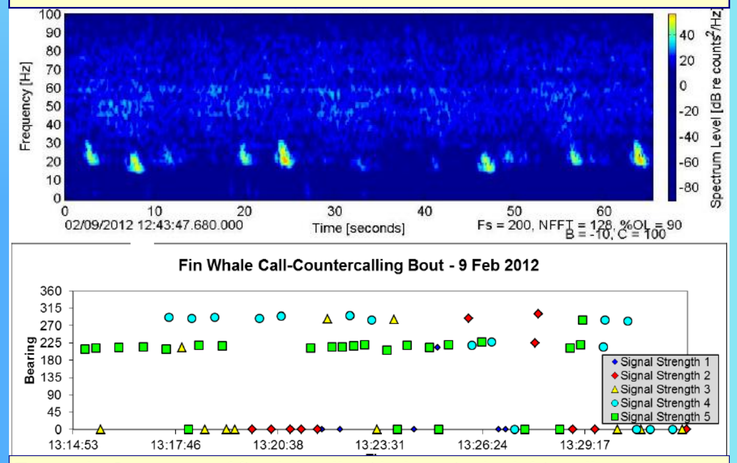
GOALS

- To integrate real-time visual and acoustic data collection and post-analysis of marine mammal behaviors.
- To obtain new information about acoustic behaviors in relation to surface behaviors, conspecifics, and anthropogenic activities.
- To refine sonobuoy array data processing methods to better localize sounds produced by animals and human sources.

METHODS

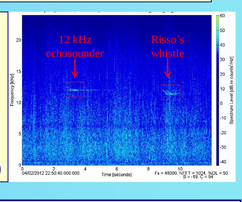
- Sonobuoys were deployed near focal groups of animals.
- Focal groups were simultaneously observed visually.
- Real-time monitoring and recordings of sonobuoys conducted.
- DiFAR based methods used to directional-ize and (in some cases) localize low frequency sounds from animals.
- Data were post-processed to obtain more bearings, detailed acoustic behaviors, and other information.

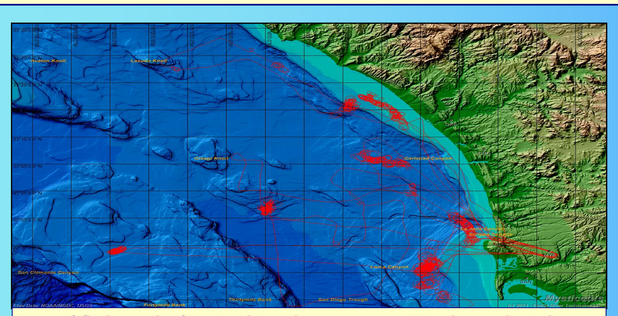
RESULTS



Top panel – Spectrogram of fin whale calls with alternating loud, faint calls.
Bottom panel – Bearing and time series of a call sequence indicating counter calling.

Left figure is an aerial picture of a Risso's dolphin group recorded with calibrated omni-directional sonobiouy. Right figure shows a spectrogram with possible mimicry of a depth sounder signal (1st signal)





Map of flight tracks for visual/sonobuoy surveys. Circular tracks indicate focal follows of animals or groups with sonobuoy deployments.

SONOBUOYS AND DIFAR

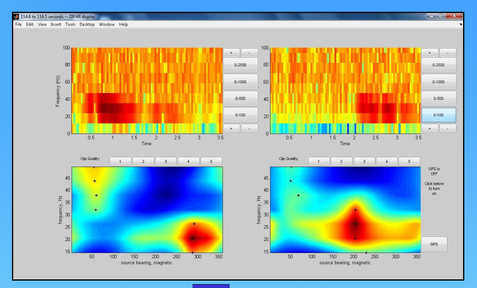
What are Sonobuoys?

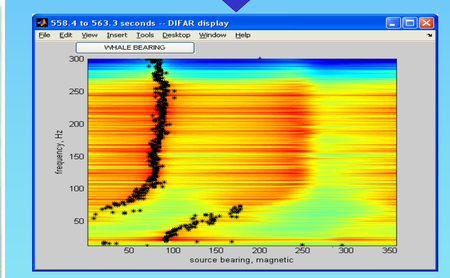
- Radio-linked hydrophones that transmit an audio signal via radio-waves to a receiver at a remote location .
- Sonobuoy model '53F' has 3 'modes' of deployment: 1) Calibrated omni-directional; 2) shallow; 3) DIFAR

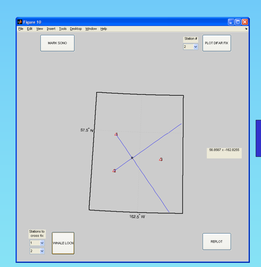
WHAT IS DIFAR?

- **Di**rectional **F**requency **a**nd **R**anging (a sonobuoy mode).
- Uses a directional sensor and a compass to determine the direction that the sounds are coming from.
- Limited to frequencies < 2 kHz (DIFAR mode only)
- The DIFAR signal is coded in a 'carrier' signal which must be 'de-modulated' to obtain the bearing.
- The demodulated DIFAR signal provides information about the time, frequency, and bearing of the sources and can be plotted (see figures to right →)

DIFAR PROCESSING





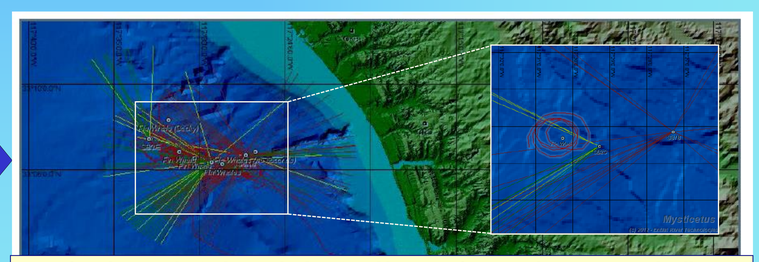


Dismantled sonobuoy. Red bag inflates upon deployment. Electronics package is attached to bag. Silver orb contains DIFAR/hydrophone sensors. White discs used to dampen 'strumming'.

Screen shots from Difar processing program. Panel (A) is an example of 2 channel spectrogram with 'difar-gram' windows below. Panel (B) is a 'Difar-gram' - sound frequency plotted on vertical axis, bearing to source on horizontal axis. Panel (C) is a plot of the intersection of the two sonobuoy bearings which is then plotted on a map (Mysticetus).

WHAT DID WE LEARN ?

- Most species vocalize, but some (e.g. gray whales) are less vocal, or do not vocalize at levels that are easy to detect.
- Fin whales called frequently during northward migration.
- Counter-calling occurred between widely separated groups.
- Acoustic-visual integration is difficult because animals at surface do not call and the focal animals are not the only ones calling.



Map of airplane tracks (red irregular lines) and bearings from sonobuoys to animal calls. Color of line indicates relative strength of signal/confidence of bearing (green/yellow = high confidence; red = low confidence). Notice that the large number of bearings makes interpreting the locations confusing. This was remedied by applying a time filter (inset at right) during post processing to restrict the time window of bearings plotted. Visually confirmed whale location is small dot inside circular tracks. (Mysticetus -SB Beta Version)

Acknowledgements: Work funded by US Navy (Chip Johnson - COMPACFLT and Jessica Bredvik NAVFAC-Southwest Division) via HDR. Aspen Helicopters and their top-notch pilots. DIFA code originally developed by Mark McDonald (Whale Acosutics) and modified by Catherine Berchok (NMML) and Mike Oswald (Bio-Waves). Real-time mapping, behavioral observation recording and DIFAR bearing display provided by the Mysticetus Observation System developed by Dave Steckler (Entiat River Technologies). Shannon Coates assisted with data management in the field.