Passive acoustic monitoring for beaked whales and other cetaceans off Cape Hatteras, North Carolina

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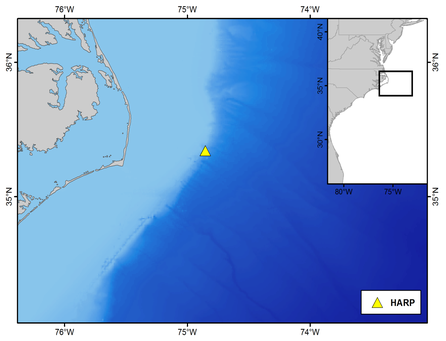


Fig 1. Map of Cape Hatteras passive acoustic monitoring site

Introduction

The continental shelf break and slope off Cape Hatteras, North Carolina, USA supports one of the most diverse cetacean faunal assemblages in the western North Atlantic. Ongoing aerial and vessel-based surveys are characterizing the distribution and density of cetaceans in this region, but these surveys are limited by weather, daylight, and cryptic animal behavior. Passive acoustic monitoring contributes valuable information on patterns of occurrence, acoustic behavior, and foraging ecology, particularly for deep-diving odontocetes such as sperm whales (*Physeter macrocephalus*) and beaked whales (*Ziphius* and *Mesoplodon* spp.). As part of a long-term monitoring program (see McLellan *et al*. poster), we began collecting continuous acoustic recordings in this region in spring 2012, using a bottom-mounted High-frequency Acoustic Recording Package (HARP) deployed on the shelf slope (Fig. 1). These recordings provide a long-term dataset to examine temporal trends in species occurrence and acoustic activity at various time scales. Here, we present results from preliminary analysis of acoustic detections within the first two datasets, with a focus on sperm whales and beaked whales in the second dataset.

Data Collection

- High-frequency Acoustic Recording Package (HARP)
- Deployed on shelf slope at 950 m depth (Fig. 1)
- 200 kHz sample rate (0.01 – 100 kHz bandwidth)
- Continuous recordings

Table 1. HARP recording effort at Cape Hatteras

Deployment	Deployment Date	Retrieval Date	Recording Duration
1	15 Mar 2012	9 Oct 2012	28 days*
2	9 Oct 2012	29 May 2013	215 days**
3	29 May 2013	future	---

*Short recording duration due to instrument malfunction
** 187 days analyzed due to recording issues later in the dataset

Methods

- Vocal events visually identified using long-term spectral averages (LTSAs) (Fig. 2) generated in *Triton* software
- Diel and seasonal trends examined (Figs. 3, 5, 6)
- Spectral characteristics of beaked whale frequency-modulated pulses measured and compared to known species templates (Fig. 4)

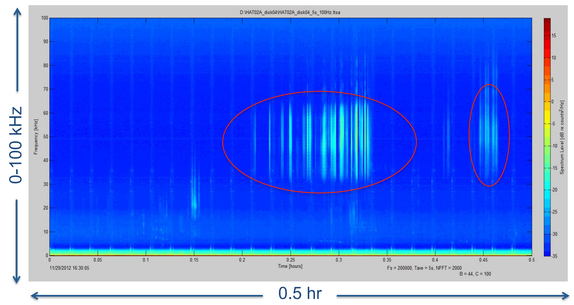
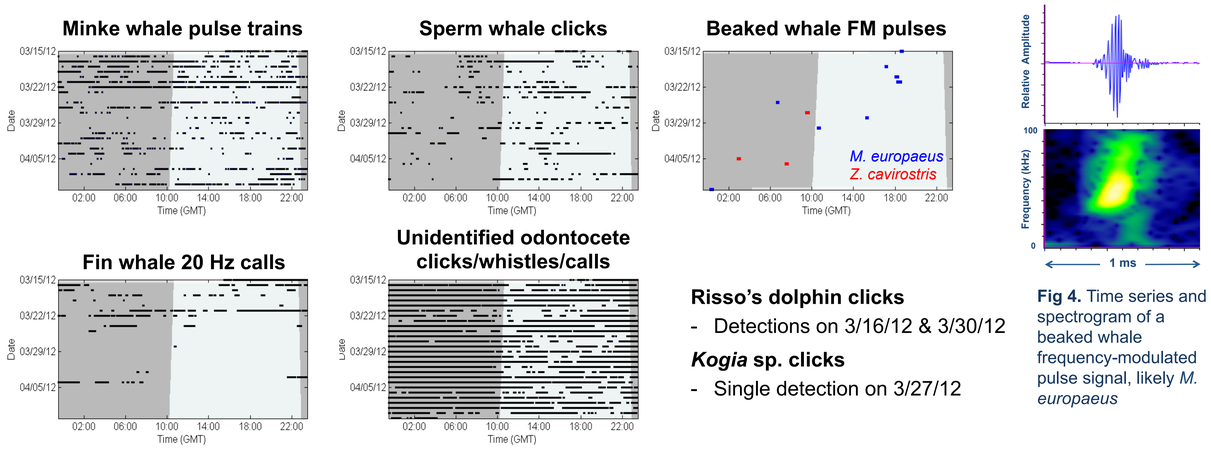


Fig 2. Long-term spectral average (LTSA) showing beaked whale echolocation signals (circled in red).

Results: March – April 2013



Risso's dolphin clicks
- Detections on 3/16/12 & 3/30/12

***Kogia* sp. clicks**
- Single detection on 3/27/12

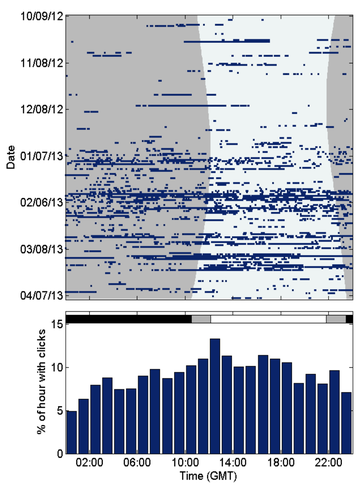
Fig 4. Time series and spectrogram of a beaked whale frequency-modulated pulse signal, likely *M. europaeus*

Fig. 3. Temporal occurrence of cetacean vocal events detected in the first HARP deployment at Cape Hatteras, between 15 March 2012 and 11 April 2012. Gray shading indicates periods of darkness.

Summary

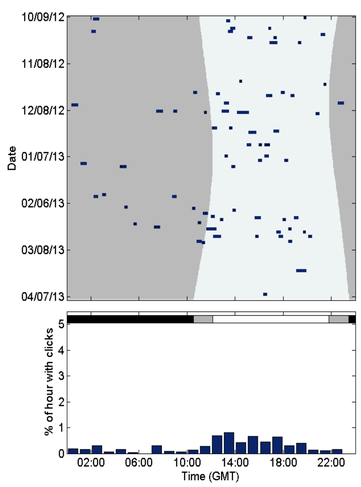
We analyzed HARP recordings from March/April 2012 for all cetacean species, and identified acoustic detections from two baleen whale and five odontocete species. Additionally, we detected nearly continuous vocalizations from unidentified odontocetes, likely including pilot whales, bottlenose dolphins, and other delphinid species, which we are presently unable to acoustically classify to species. We analyzed HARP recordings from October 2012 to April 2013 specifically for sperm whale and beaked whale occurrence. We found no significant diel pattern in sperm whale clicks, in contrast to the nocturnal trend previously observed at other sites off the southeast U.S. coast. We detected frequency-modulated pulses from at least two beaked whale species (*Z. cavirostris* and *M. europaeus*), and will further analyze these signals to identify all pulse types.

Results: October 2012 – April 2013



Sperm whale click detections:
- 126 days (67%)
- 402 hours (9%)

Fig 5. Temporal occurrence of sperm whale click events throughout the second HARP deployment by date (top) and time of day (bottom). Gray shading indicates periods of darkness on upper plot; black bar indicates darkness on the lower plot.



Beaked whale FM pulse detections:
- 45 days (24%)
- 12 hours (0.3%)

Fig 6. Temporal occurrence of beaked whale FM pulse events throughout the second HARP deployment by date (top) and time of day (bottom). Gray shading indicates periods of darkness on upper plot; black bar indicates hours of darkness on lower plot.

Future Work

- Characterize beaked whale signal types recorded on HARP; identify species where possible by comparing spectral and temporal characteristics to known signal types
- Compare HARP detections with aerial and vessel survey data for beaked whales and sperm whales; examine seasonal trends in occurrence
- Collect opportunistic recordings of beaked whales and sperm whales using a towed hydrophone array to gain further insight into foraging behavior
- Estimate HARP detection range using sound propagation modeling and transmission loss experiments

Acknowledgements

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