Passive Acoustic Monitoring for Marine Mammals at Site A in the Cape Hatteras Survey Area, March – April 2012

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Abstract

A High-frequency Acoustic Recording Package (HARP; Wiggins and Hildebrand 2007) was deployed between March and October 2012 in the Cape Hatteras survey area at Site A in approximately 950 m. This HARP sampled continuously at 200 kHz and recorded for 28 days between 15 March 2012 and 11 April 2012. Long-Term Spectral Averages (LTSAs) were created for two frequency bands (10 Hz – 1000 Hz and 1 kHz – 100 kHz) and scanned for marine mammal vocalizations. Calls of fin whales, minke whales, beaked whales, *Kogia* spp., Risso's dolphins, sperm whales, and unidentified delphinids were detected in the data.

I. Methods

The Hatteras 01A HARP was deployed at 35.34058^{o}N, 74.85590^{o} W on 15 March 2012 (recording started on 15 March 2012) and recovered on 9 October 2012 (recording ended on 11 April 2012). The instrument location is shown in Figure 1. Bottom depth at the deployment site was approximately 950 m. A schematic diagram of the Hatteras 01A HARP is shown in Figure 2.

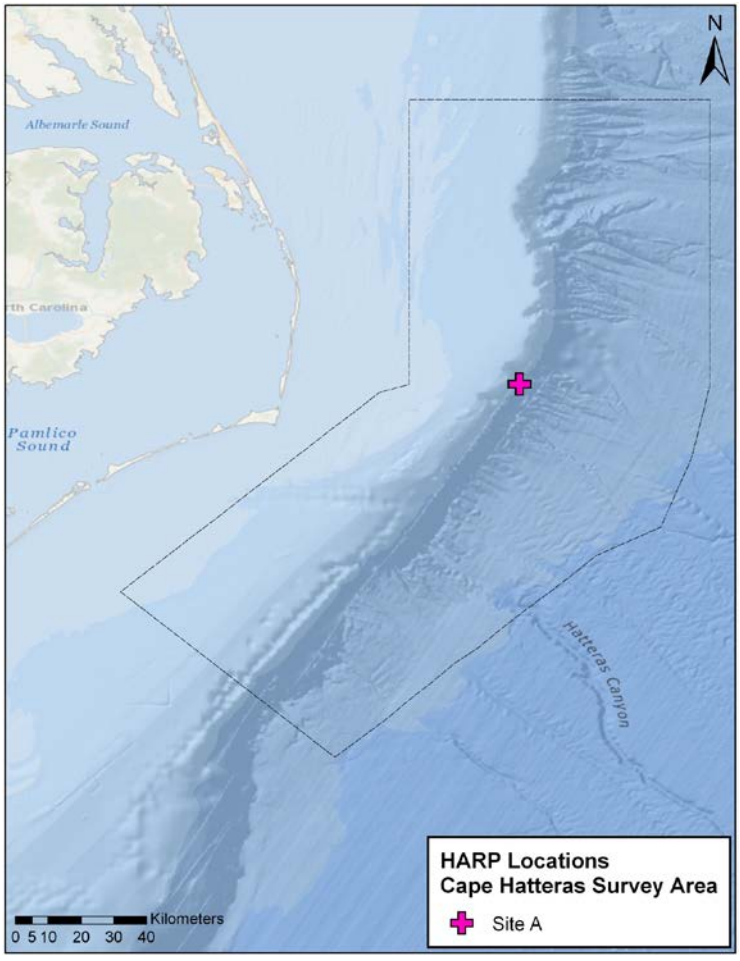

Figure 1. Location of Hatteras 01A HARP deployment site in the Cape Hatteras survey area.

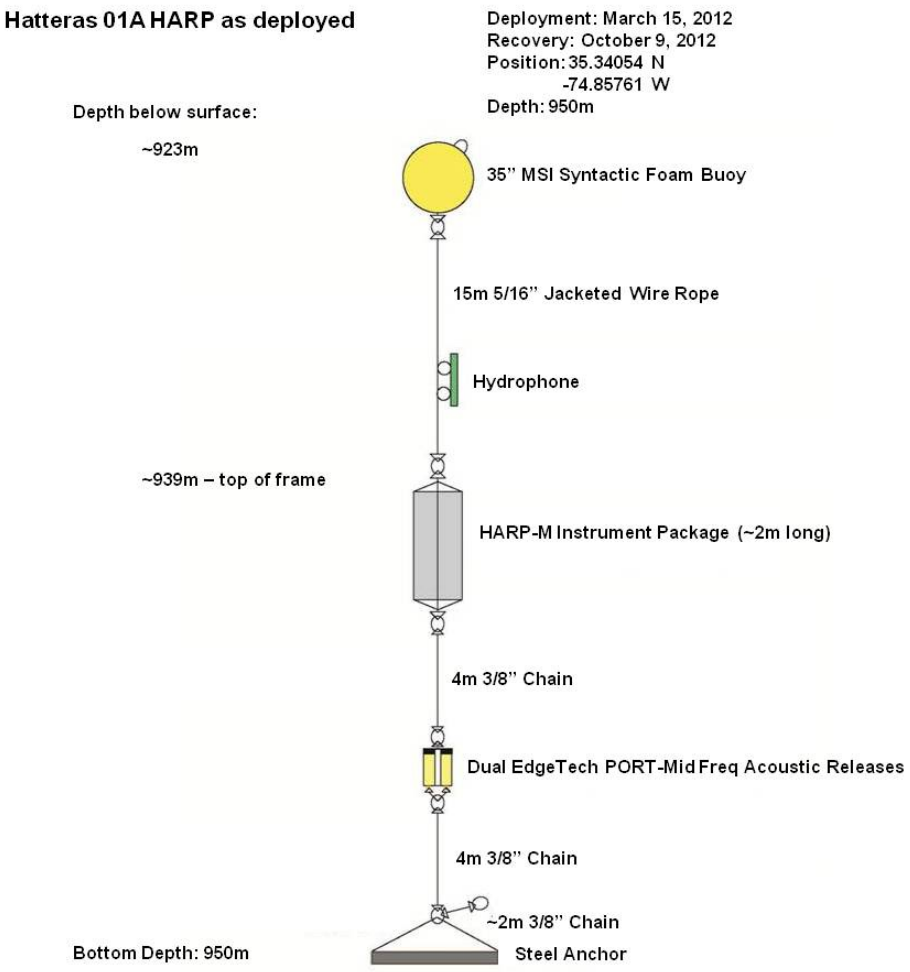

Figure 2. Schematic diagram showing details of the Cape Hatteras Site 01A HARP deployment. Note that diagram is not drawn to scale.

Data were acquired continuously at a 200 kHz sampling rate during the Hatteras 01A deployment. Data collection during this deployment was limited by an instrument malfunction, which caused recording to stop on 11 April 2012. The Hatteras 01A deployment provided a total of 636.75 hours of data over the 29 days of recording. The data collected were manually scanned for marine mammal vocalizations using the "logger" version of *Triton* (v1.81.20121030; Hildebrand Lab at Scripps Institution of Oceanography, La Jolla, CA). The effective frequency

range of the HARP (10 Hz – 100 kHz) was divided into two parts for this manual review: 10-1000 Hz and 1-100 kHz. The resulting Long-Term Spectral Averages (LTSAs) had resolutions of 5 s in time and 1 Hz in frequency (for the data decimated by a factor of 100: 10-1000 Hz band) and 5 s in time and 100 Hz in frequency (for the original data: 1-100 kHz band). LTSAs that were decimated by a factor of 100 were inspected for sounds produced by mysticetes. Non-decimated LTSAs were inspected for odontocete whistles, clicks, and burst-pulses as well as mid-frequency active sonar. The presence of vocalizations and mid-frequency active sonar was determined in one-minute bins, and vocalizations were assigned to species when possible.

II. Results

Table 1 summarizes the detected and identified marine mammal vocalizations for the Hatteras 01A deployment. Figures 3-9 show the daily occurrence patterns for the different marine mammal groups (classified to species when possible). Figure 10 shows the occurrence of mid-frequency active sonar. Underwater ambient noise during this deployment is shown in Figure 11.

Mysticete vocalizations detected during the deployment consisted of fin whale 20 Hz pulses and minke whale pulse trains. No blue, sei, humpback, or North Atlantic right whale vocalizations were identified. Fin whales were present in approximately half the recording days (Figure 3), based on occurrence of visibly distinct 20 Hz pulses. However, this represents a minimum estimate of fin whale vocal activity, since increased energy in the 20 Hz band was often observed, likely due to distant calling fin whales. Periods of increased energy without distinct pulses were not included in the fin whale occurrence summary and figures, but are reflected by a

peak in ambient noise at 20 Hz (Figure 10). Minke whale pulse trains, including speed-up, slow-down, and regular type pulse trains, were present in all recording days except for 11 April 2012 (Figure 4). Slow-down pulse trains occurred most frequently.

Detected odontocete vocalizations included clicks, whistles, and burst-pulses (Figures 5-9). Most of these detections were assigned to the unidentified odontocete category. These vocalizations were present nearly continuously throughout the deployment, and consisted of overlapping detections of multiple groups and species (Figure 5). Clicks produced by Kogia spp. were detected once during the deployment, on 27 March 2012 (Figure 6). Sperm whales were present throughout the deployment, with detections on all but two days (10 -11 April 2012) (Figure 7). Risso's dolphins were detected twice, on 16 March 2012 and 30 March 2012 (Figure 8). There were eleven detections of beaked whale clicks on separate days throughout the deployment (Figure 9), summarized in Table 2. Using custom *Matlab* scripts, spectral characteristics of clicks from these vocal events were measured and compared with known beaked whale species templates. Each vocal event was tentatively identified as either *Mesoplodon europaeus* (8 events) or *Ziphius cavirostris* (3 events).

Table 1. Summary of detections of marine mammal vocalizations at Hatteras Site A for March – April 2012.

Species	**Call type**	**Total duration of vocalizations (hours)**	**Percent of recording duration**	**Days with vocalizations**	**Percent of recording days**
Fin whale	20 Hz	45.13	7.09	14	50.00
Minke whale	pulse train (slow-down, speed-up, regular)	51.5	8.10	27	96.43
Unidentified odontocete	clicks/whistles/ burst-pulses	491.57	77.20	28	100
Kogia spp.	clicks	0.1	0.02	1	3.57
Sperm whale	clicks	65.27	10.25	26	92.86
Risso's dolphins	clicks	2.47	0.39	2	7.14
Beaked whale spp.	clicks	1.77	0.28	11	39.29

Table 2. Summary of detected beaked whale click events, including duration of each event and tentative species identification based on spectral characteristics of clicks.

Date & Time (GMT)	**Duration (h:min)**	**Tentative species ID**
3/15/12 19:04	00:08	*M. europaeus*
3/18/12 17:38	00:04	*M. europaeus*
3/20/12 18:34	00:12	*M. europaeus*
3/21/12 18:45	00:18	*M. europaeus*
3/25/12 07:09	00:06	*M. europaeus*
3/27/12 09:57	00:11	*Z. cavirostris*
3/28/12 15:45	00:05	*M. europaeus*
3/30/12 11:06	00:06	*M. europaeus*
4/5/12 03:25	00:06	*Z. cavirostris*
4/6/12 08:00	00:08	*Z. cavirostris*
4/11/12 00:46	00:11	*M. europaeus*

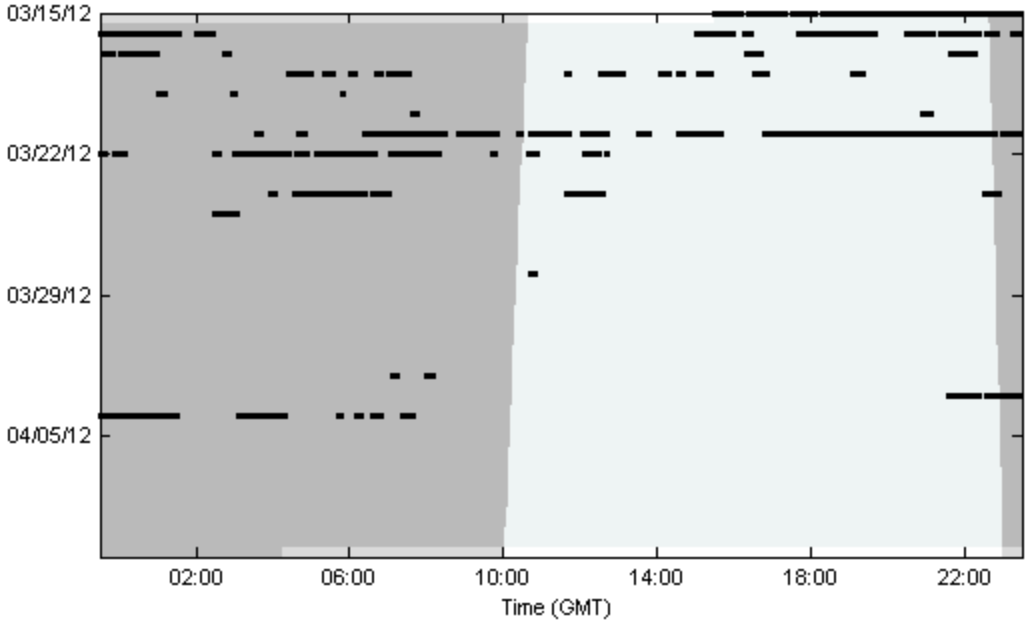

Figure 3. Fin whale 20 Hz pulse detections (black bars) for the Hatteras 01A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

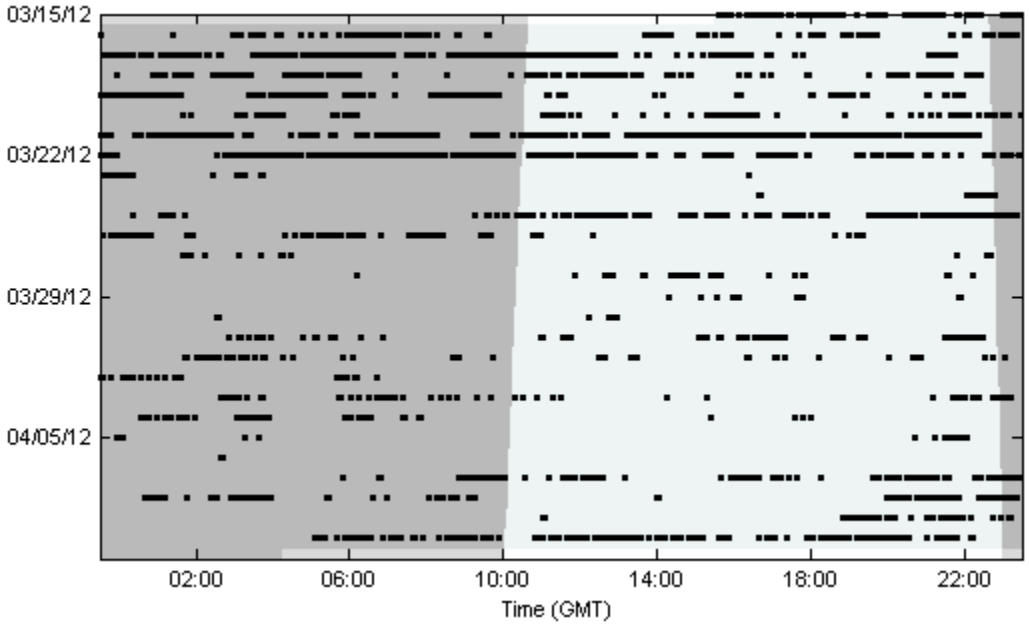

Figure 4. Minke whale pulse train detections (black bars) for the Hatteras 01A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

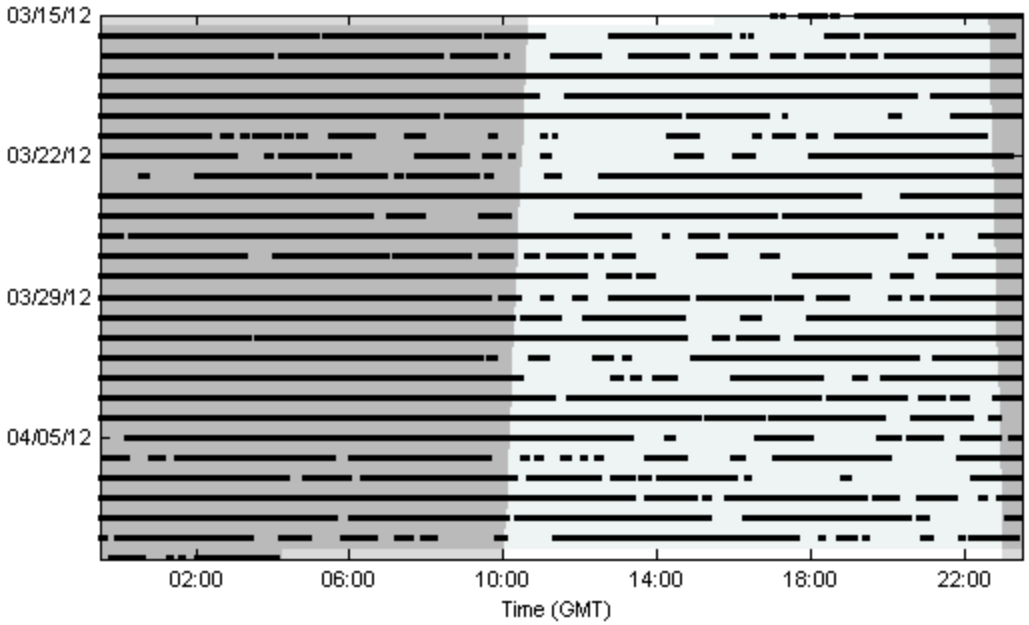

Figure 5. Unidentified odontocete vocalization detections (black bars) for the Hatteras 01A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

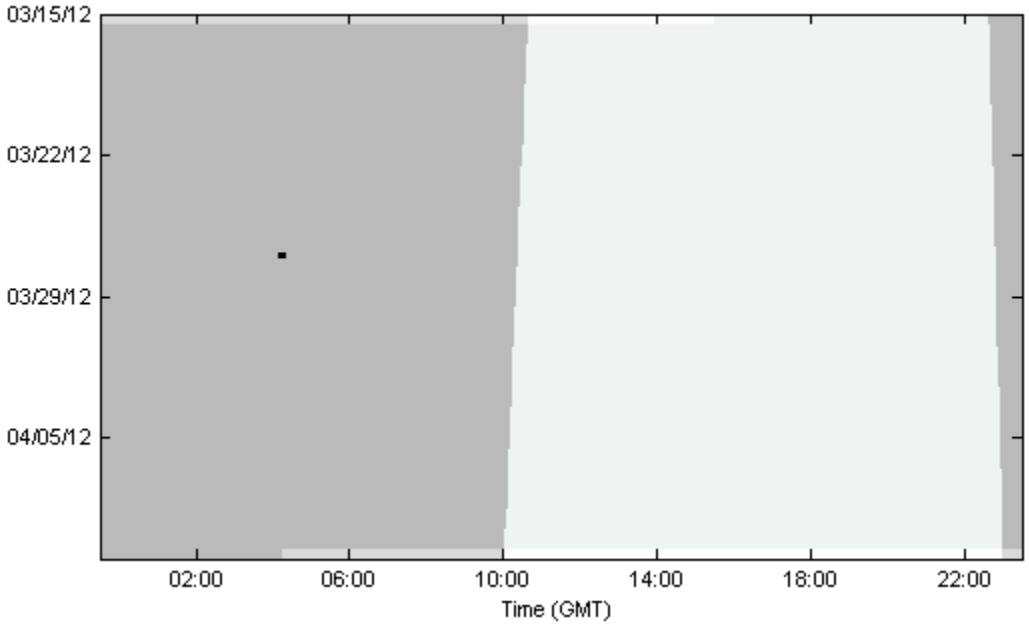

Figure 6. *Kogia* spp. click detections (black bars) for the Hatteras 01A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

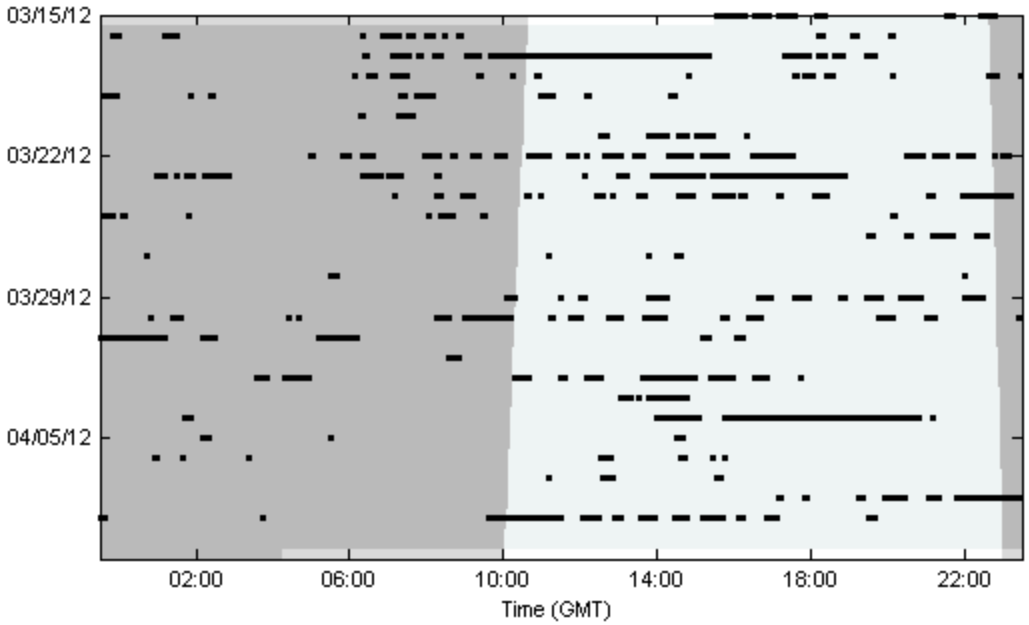

Figure 7. Sperm whale click detections (black bars) for the Hatteras 01A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

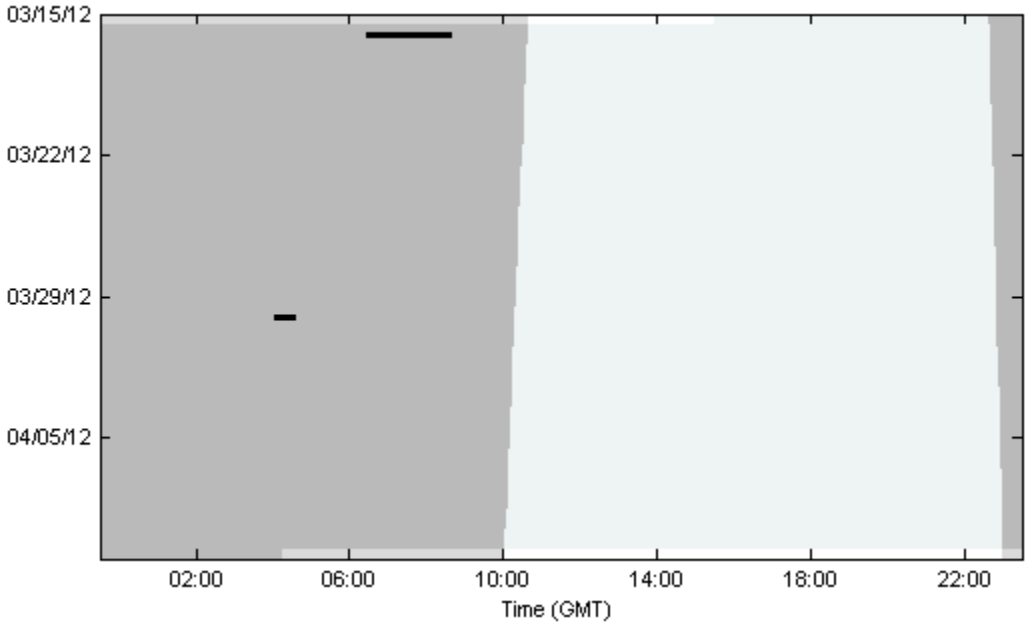

Figure 8. Risso's dolphin click detections (black bars) for the Hatteras 01A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

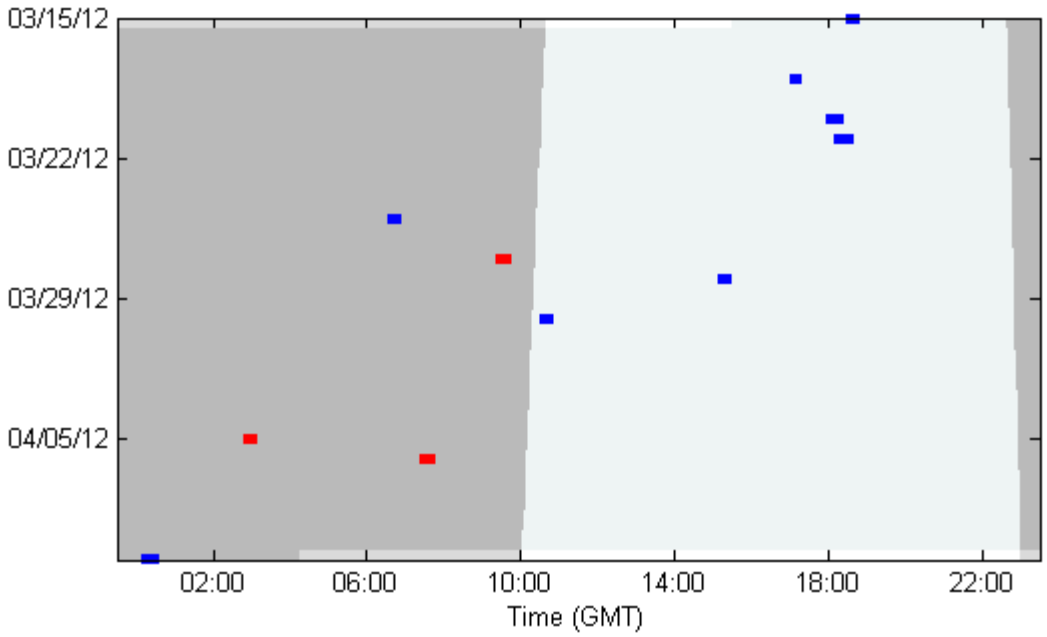

Figure 9. Beaked whale click detections for the Hatteras 01A deployment. Colors indicate tentative species identification: *M. europaeus* (blue) and *Z. cavirostris* (red). Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

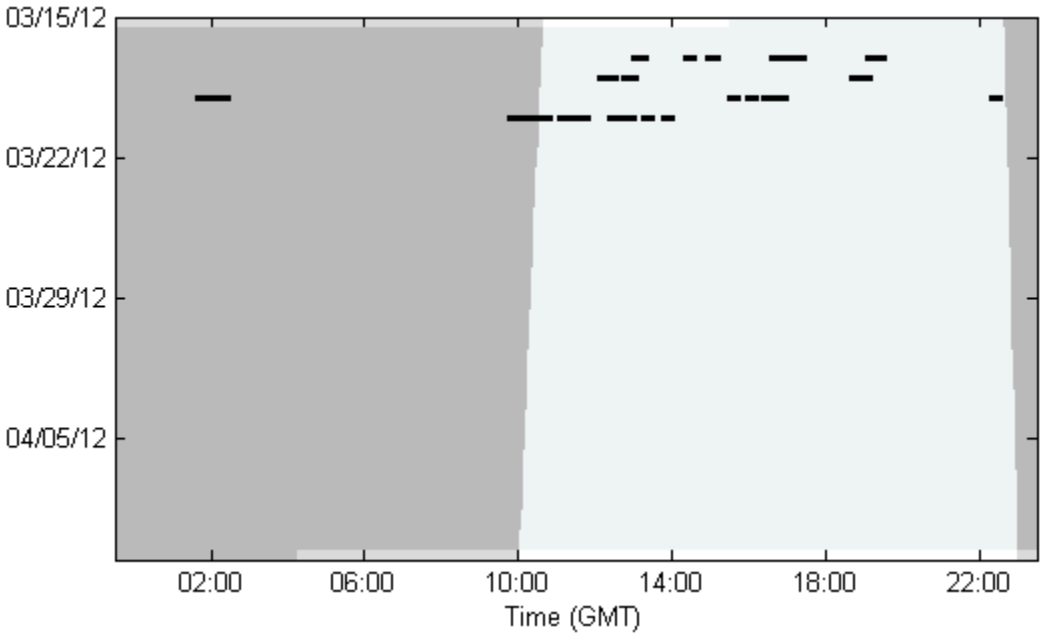

Figure 10. Mid-frequency active sonar (black bars) detected during the Hatteras 01A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

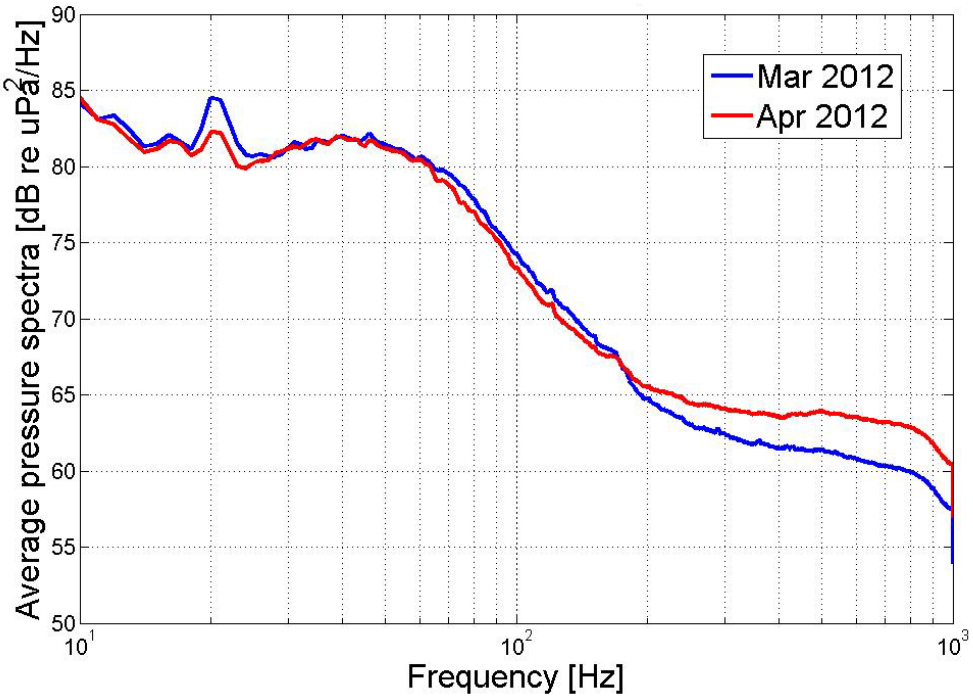

Figure 11. Monthly averages of ambient noise at Cape Hatteras Site A for March – April 2012.

References

Wiggins, S.M. and J.A. Hildebrand. 2007. High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring. In: *International Symposium on Underwater Technology 2007 and International Workshop on Scientific Use of Submarine Cables & Related Technologies 2007*: 551-557. Tokyo, Japan: Institute of Electrical and Electronics Engineers.