

**Passive Acoustic Monitoring for Marine Mammals at Site A
in Onslow Bay, November 2009 – February 2010**

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Abstract

A High-frequency Acoustic Recording Package (HARP; Wiggins and Hildebrand 2007) was deployed between November 2009 and February 2010 in Onslow Bay at Site A in 171 m. This HARP sampled at 200 kHz for 5 minutes of every 15 minutes and recorded for 108 days between 8 November 2009 and 24 February 2010. 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 blue whales, fin whales, minke whales, possible sei whales, *Kogia* spp., Risso's dolphins, sperm whales, and unidentified delphinids were detected in the data.

Methods

The 2009-2010 Onslow Bay Site A HARP (Onslow Bay 04A) was deployed at 33.7873° N, 76.5241° W on 8 November 2009 (recording started on 8 November 2009) and recovered on 19 June 2010 (recording ended on 24 February 2010). The instrument location is shown in Figure 1. Bottom depth at the deployment site was approximately 171 m. A schematic diagram of the Onslow Bay 04A HARP is shown in Figure 2.

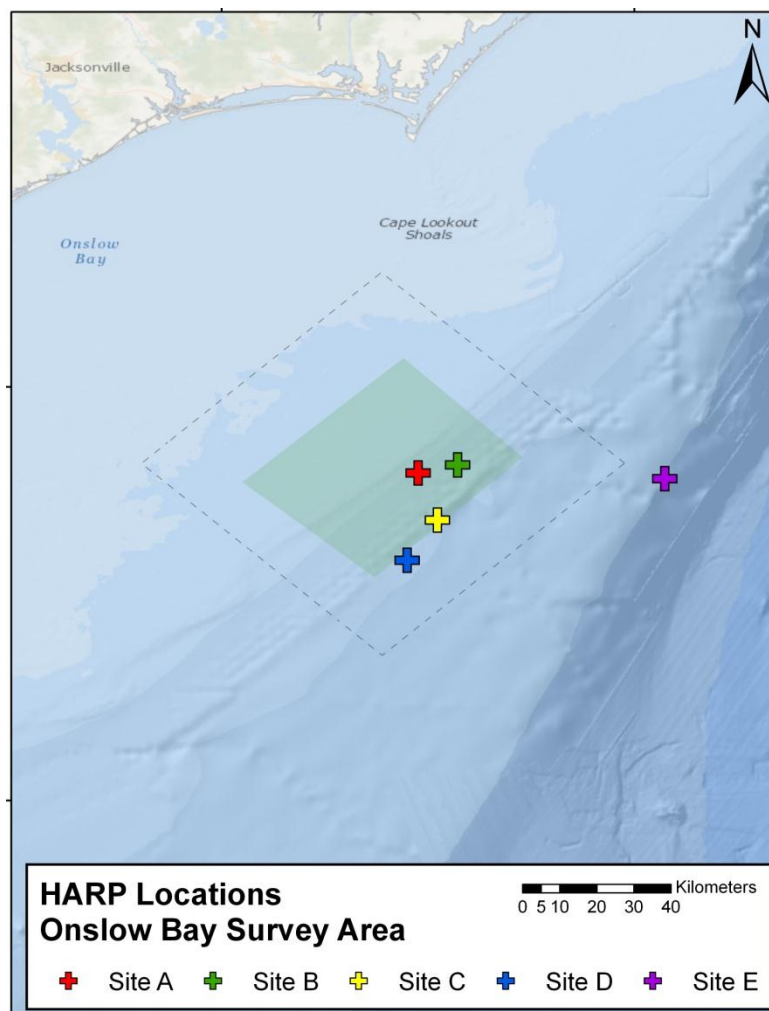


Figure 1. Location of HARP deployment sites in the Onslow Bay survey area. The location of the Onslow Bay 04A HARP is shown in red.

Onslow Bay 04A HARP as deployed

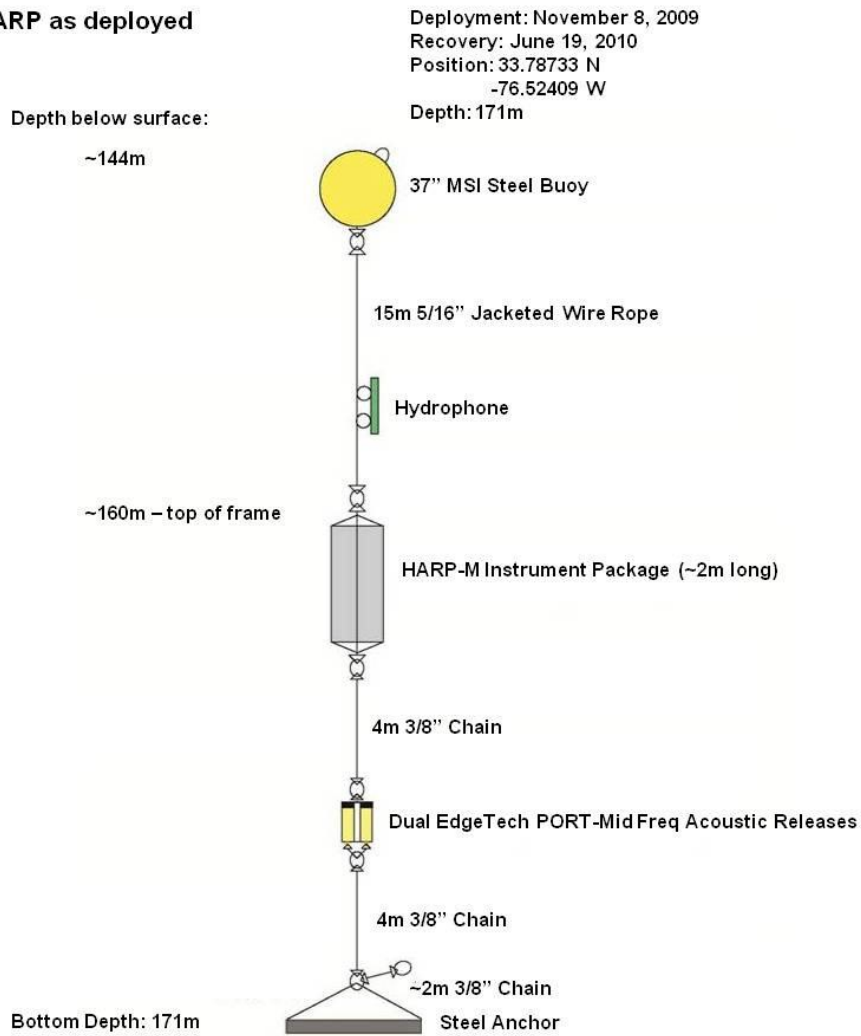


Figure 2. Schematic diagram showing details of the Onslow Bay 04A HARP. Note that diagram is not drawn to scale.

Data were acquired at a 200 kHz sampling rate for 5 minutes every 15 minutes during the Onslow Bay 04A deployment. This deployment provided a total of 942.1 hours of data over the 109 days of recording. The data collected were manually scanned for marine mammal vocalizations using *Triton* (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.

Results

Table 1 summarizes the detected and identified marine mammal vocalizations for the Onslow Bay 04A HARP deployment. Figures 3-10 show the daily occurrence patterns for the different marine mammal groups (classified to species when possible). Figure 11 shows the occurrence of mid-frequency active sonar. Underwater ambient noise during this deployment is shown in Figure 12.

Blue whale calls (mainly Type A) were present on one day in November, two days in January, and one day in February (Figure 3).

Fin whale 20-Hz pulses were present mainly starting in January and continuing until the end of the recording period (Figure 4).

Minke whale pulse trains (mainly slow-down pulse trains, but some regular and speed-up pulse trains) were detected as early as late November, but the majority of this call type occurred between mid-January and mid-February.

Downsweeps similar to those ascribed to sei whales by Baumgartner *et al.* (2008) were detected between 20 October 2009 and 10 February 2010, with a main peak in calling occurring in late December and a minor peak in late January (Figure 6).

Detected odontocete vocalizations included clicks, whistles, and burst-pulses (Figures 7-9). Most of these detections (97.6%) were assigned to the unidentified odontocete category (Figure 7). *Kogia* spp. were present on only two days during the 2009-2010 Site A deployment (Figure 8), which is consistent with the sporadic occurrence found during previous deployments. Risso's dolphins were only detected on three days during the deployment with once again a stronger nocturnal presence (Figure 9). Sperm whales were detected on seven days during the deployment, during both day and night (Figure 10).

Table 1. Summary of detections of marine mammal vocalizations at Onslow Bay Site A for November 2009 – February 2010 (Onslow Bay 04A).

Species	Call type	Total duration of vocalizations (hours)	Percent of recording duration	Days with vocalizations	Percent of recording days
Blue whale	A and B calls (mainly A)	0.27	0.03	4	3.67
Fin whale	20 Hz	79.28	8.42	36	33.03
Minke whale	pulse train (slow-down, speed-up, regular)	17.08	1.73	33	30.28
Possible sei whale	downsweep	5.50	0.56	17	15.60
Unidentified odontocete	clicks, whistles, burst-pulses	198.22	21.04	109	100
<i>Kogia</i> spp.	clicks	0.05	0.005	2	1.83
Risso's dolphin	clicks	0.57	0.06	3	2.75
Sperm whale	clicks	2.18	0.23	7	6.42

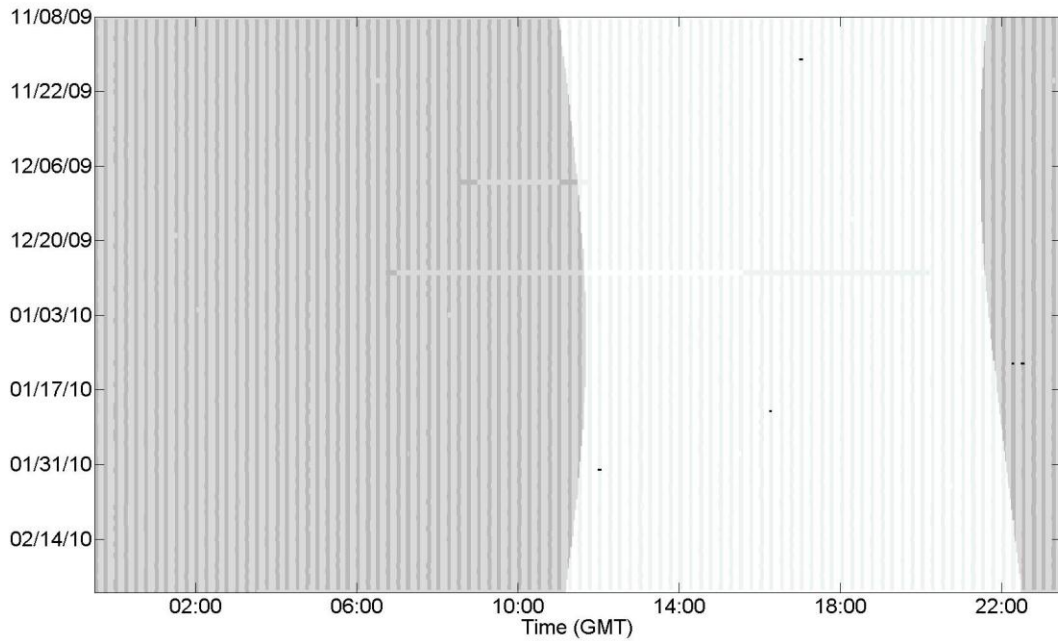


Figure 3. Blue whale Type A and B call detections (black bars) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

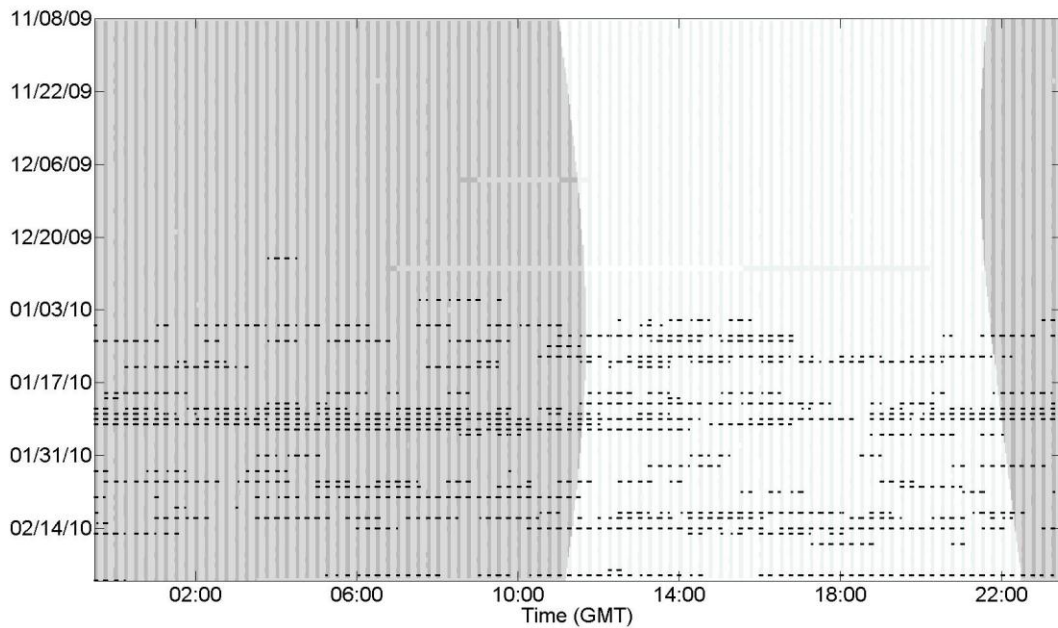


Figure 4. Fin whale 20-Hz pulse detections (black bars) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

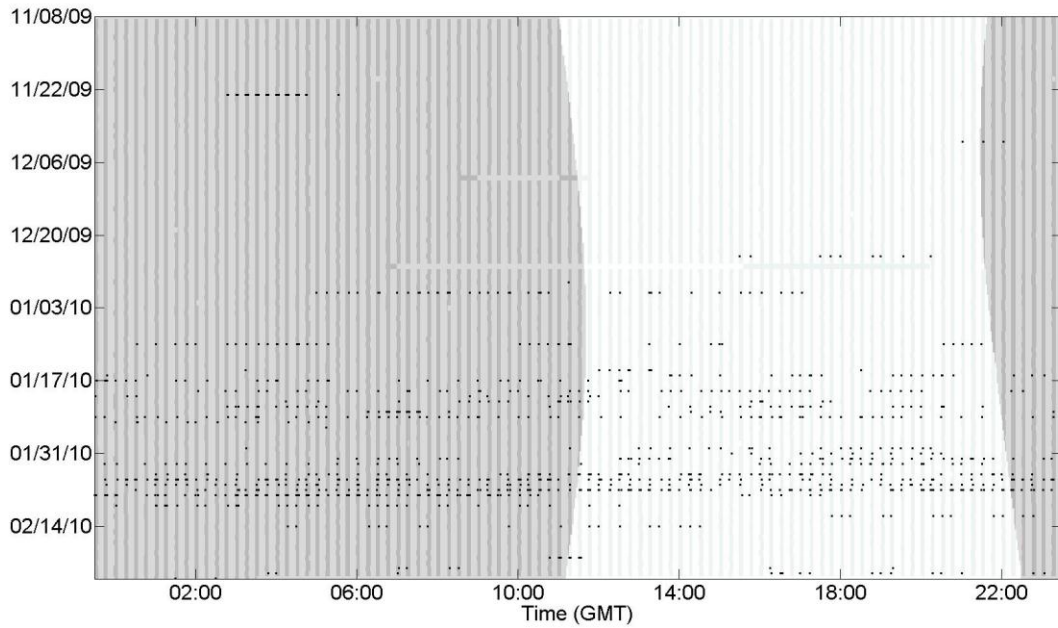


Figure 5. Minke whale detections (black bars) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

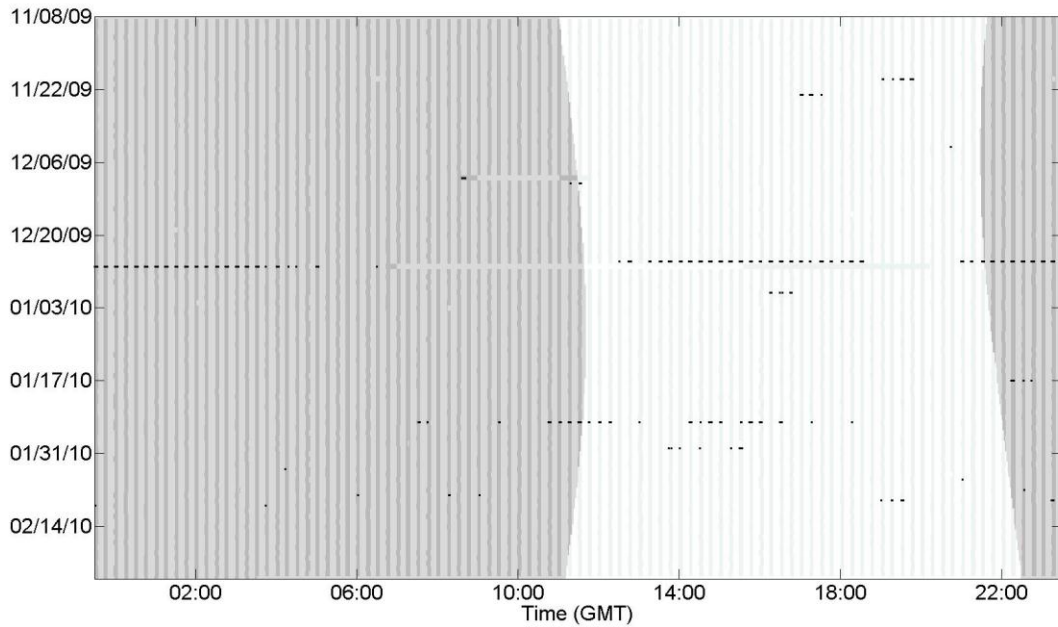


Figure 6. Downsweep detections (black bars) that may be produced by sei whales (Baumgartner *et al.* 2008) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

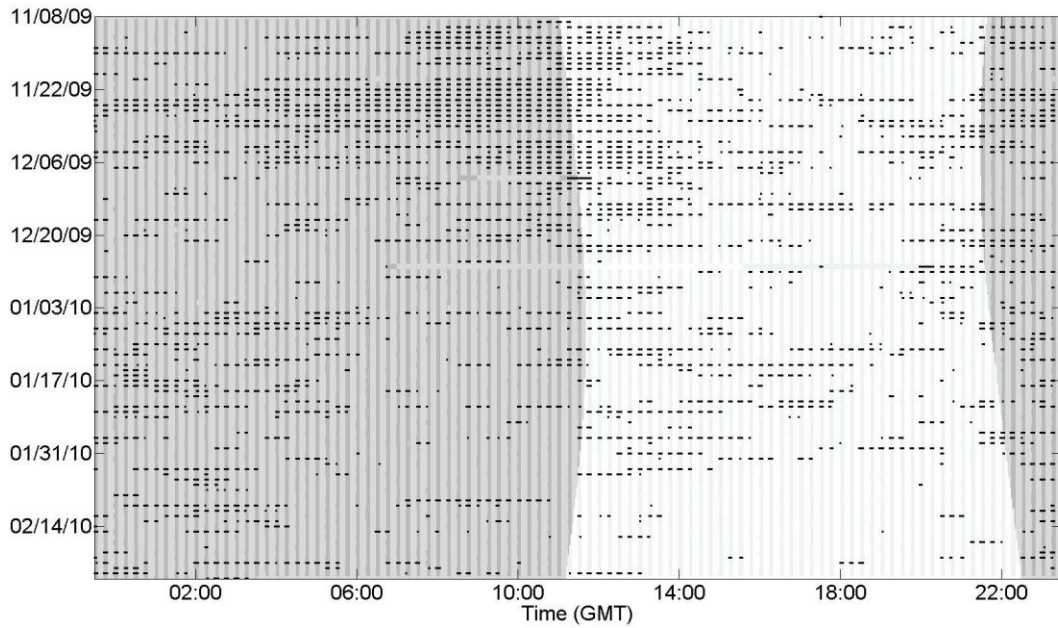


Figure 7. Unidentified odontocete vocalization detections (black bars) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

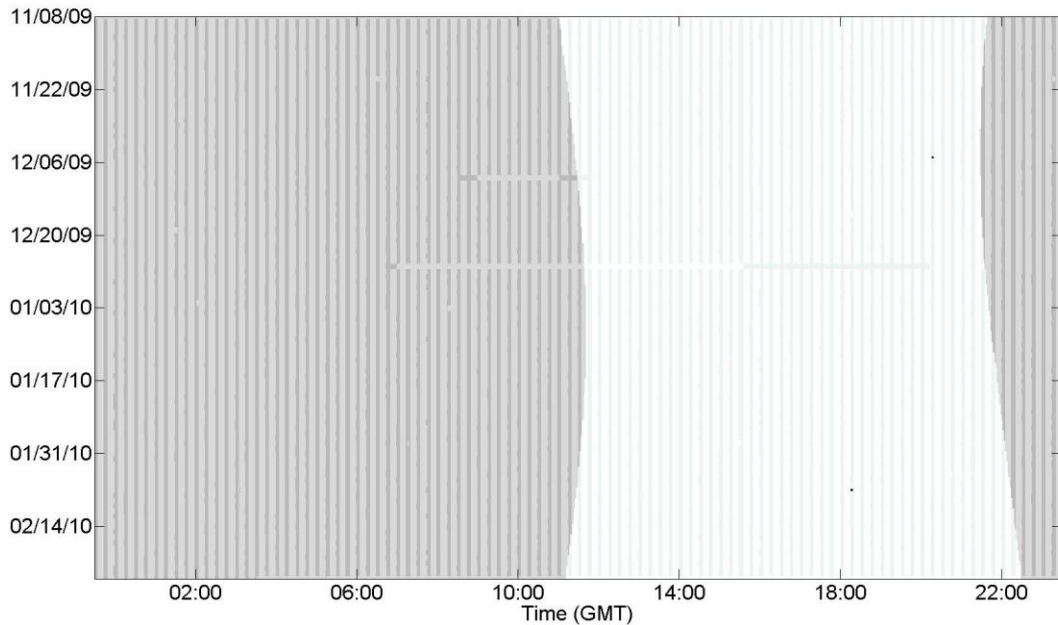


Figure 8. *Kogia* spp. click detections (black bars) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

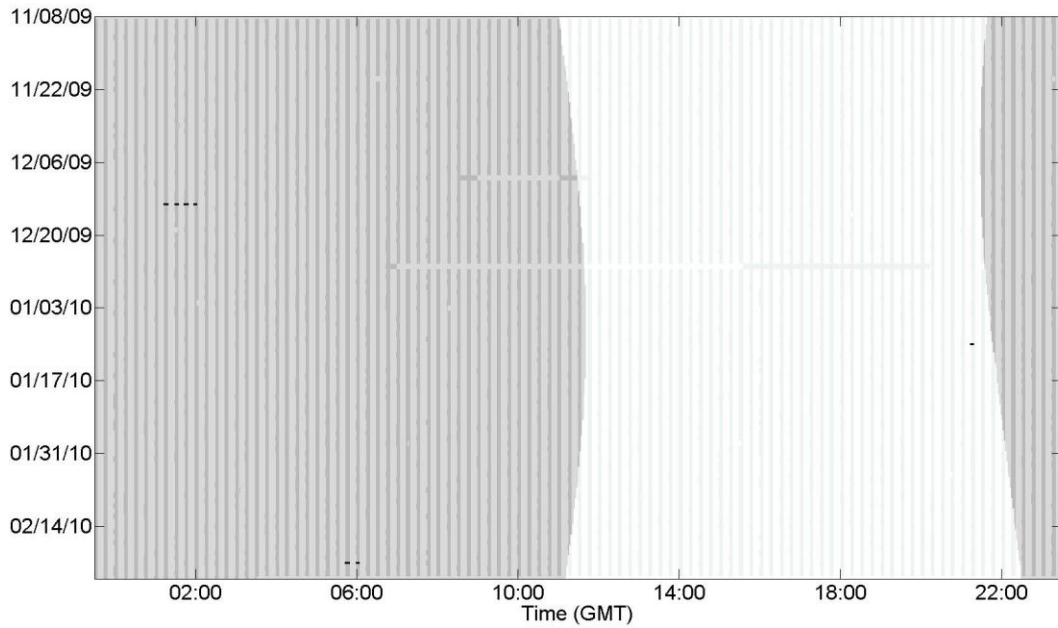


Figure 9. Risso's dolphin click detections (black bars) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

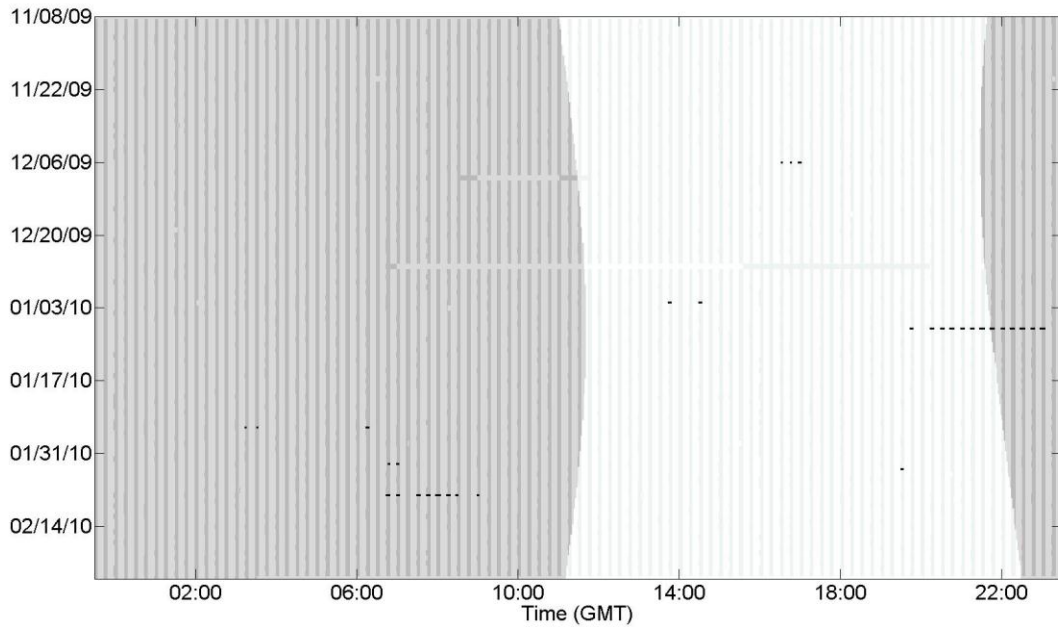


Figure 10. Sperm whale click detections (black bars) for the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

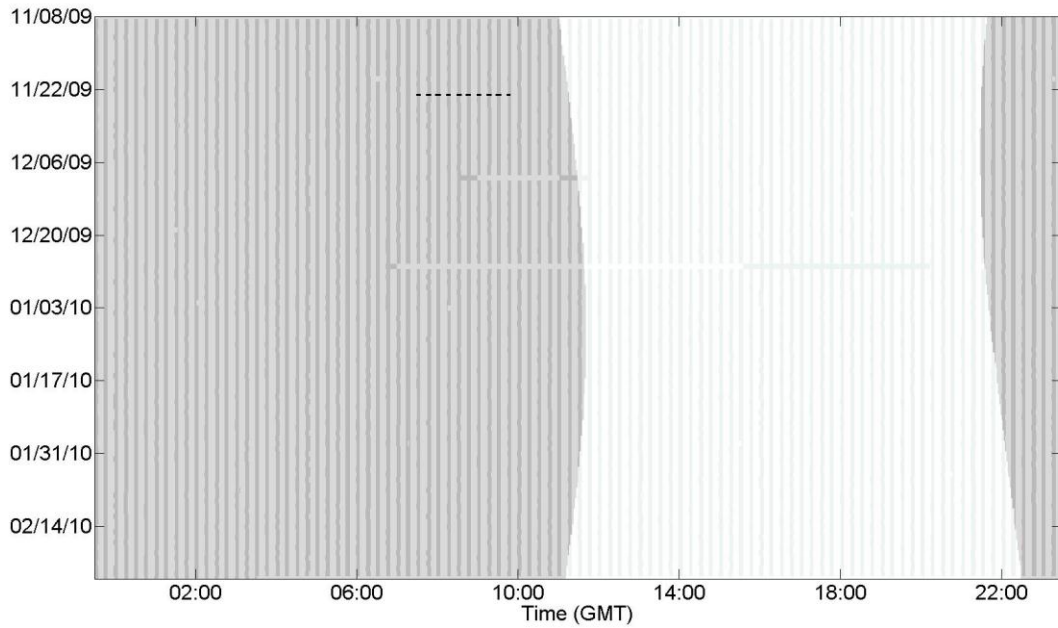


Figure 11. Mid-frequency active sonar (black bars) detected during the Onslow Bay 04A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

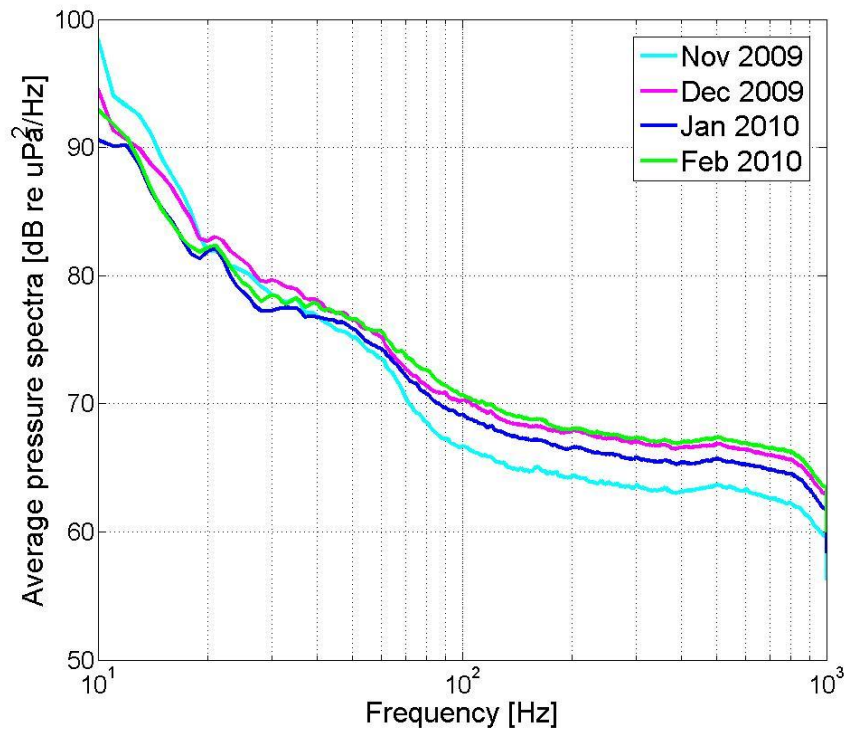


Figure 12. Monthly averages of ambient noise at Onslow Bay Site A for November 2009 – February 2010.

References

Baumgartner, M.F., S.M. Van Parijs, F.W. Wenzel, C.J. Tremblay, H.C. Esch, and A.M. Warde. 2008. Low frequency vocalizations attributed to sei whales (*Balaenoptera borealis*). *Journal of Acoustical Society of America* **124**: 1339-1349.

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.