

**Passive Acoustic Monitoring for Marine Mammals at Site A
in Onslow Bay, July 2010 – March 2011**

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Abstract

A High-frequency Acoustic Recording Package (HARP; Wiggins and Hildebrand 2007) was deployed between July 2010 and June 2011 in Onslow Bay at Site A in 171 m. This HARP sampled at 200 kHz for 5 minutes of every 10 minutes and recorded for 216 days between 30 July 2010 and 3 March 2011. 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, North Atlantic right whales, possible sei whales, *Kogia* spp., Risso's dolphins, sperm whales, and unidentified delphinids were detected in the data.

Methods

The 2010-2011 Onslow Bay Site A HARP (Onslow Bay 05A) was deployed at 33.79316°N , 76.51620°W on 29 July 2010 (recording started on 30 July 2010) and recovered on 10 June 2011 (recording ended on 3 March 2011). 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 05A HARP is shown in Figure 2.

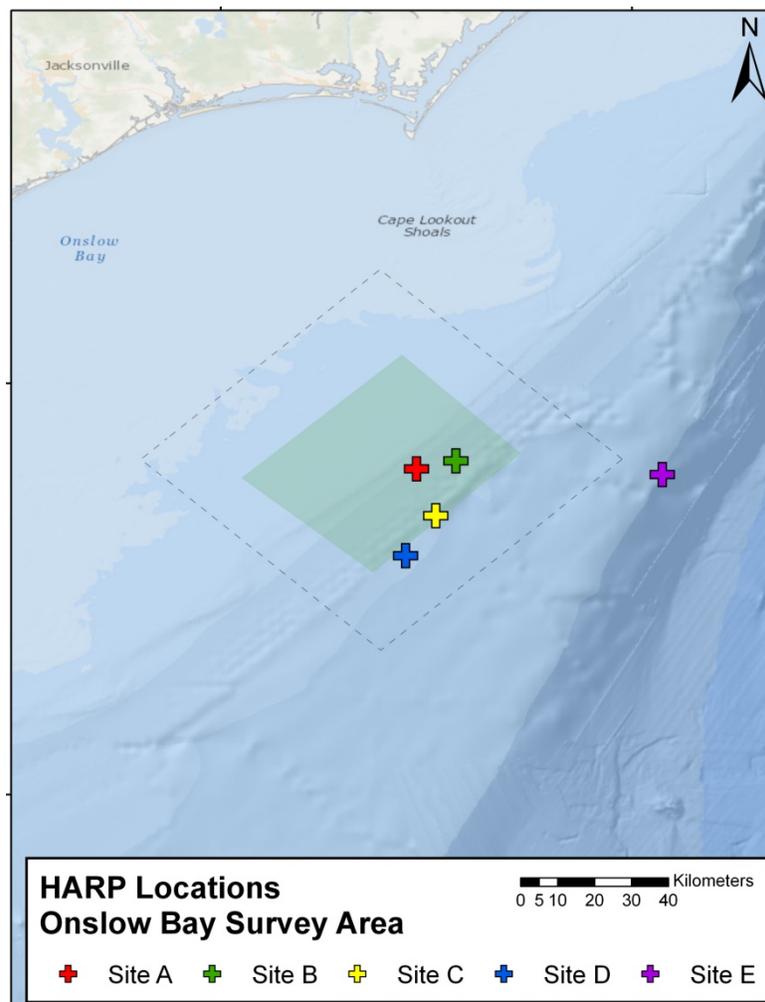


Figure 1. Location of HARP deployment sites in the Onslow Bay survey area. The location of the Onslow Bay 05A HARP is shown in red.

Onslow Bay 05A HARP as deployed

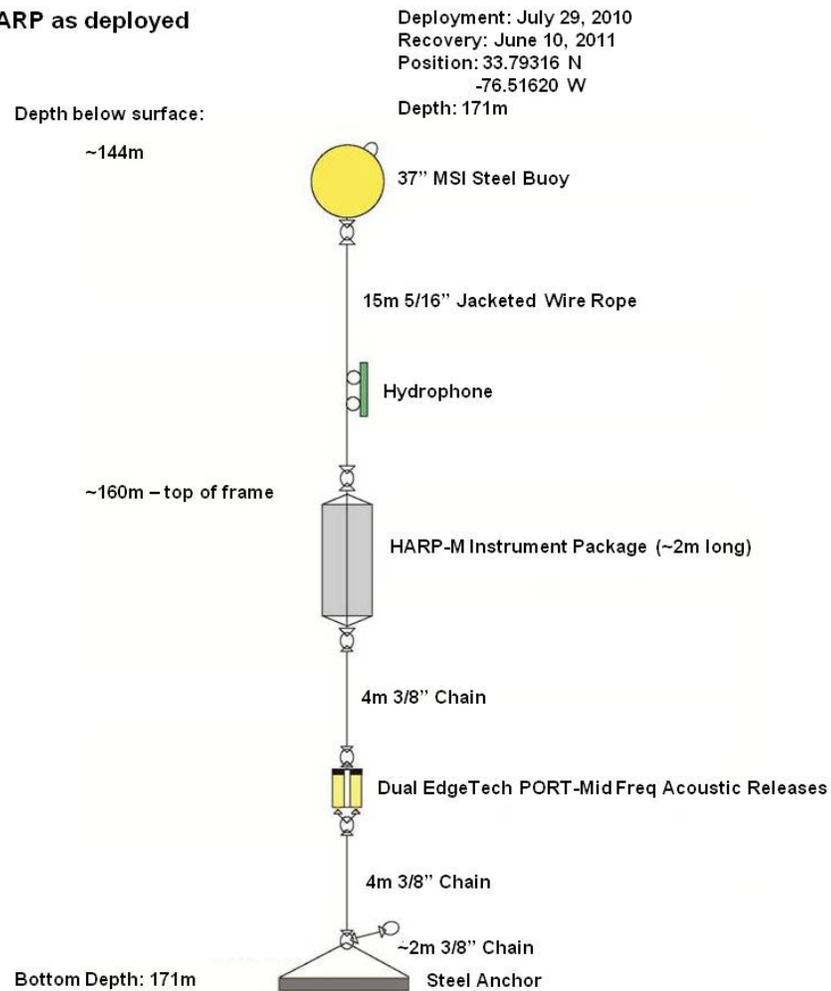


Figure 2. Schematic diagram showing details of the Onslow Bay 05A HARP. Note that diagram is not drawn to scale.

Data were acquired at a 200 kHz sampling rate for 5 minutes every 10 minutes during the Onslow Bay 05A deployment. This deployment provided a total of 2831.8 hours of data over the 217 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 (LTSA) 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). LTSA that were decimated by a factor of 100 were inspected for sounds produced by mysticetes. Non-decimated LTSA 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 05A HARP deployment. Figures 3-12 show the daily occurrence patterns for the different marine mammal groups (classified to species when possible). Figure 13 shows the occurrence of mid-frequency active sonar. Underwater ambient noise during this deployment is shown in Figure 14.

Blue whales were present primarily from September 2010 to the end January 2011 (Figure 3). Type A and B blue whale calls were detected, mainly as song but also occasionally as individual calls. Also, 26 – 27 Hz calls, which are similar to the calls produced by Antarctic blue whales, were detected between 31 July 2010 and 16 August 2010 (Figure 4).

Fin whale 20-Hz pulses were present starting as early as 19 August 2010, although most detections occurred between December 2010 – February 2011, with a minor peak in October 2010 (Figure 5). In previous deployments, fin whale calls peaked between January and March.

Minke whale pulse trains (mainly slow-down pulse trains) were detected between 12 December 2010 and the last day of the recording period, 3 March 2011 (Figure 6). Peaks in pulse train calls occurred from the end of December through the end of February, similar to the previous findings of peaks between January and March for earlier deployments.

North Atlantic right whale up-calls were detected on two days (18 October 2010 and 29 January 2011) during the 2010-2011 Site A deployment (Figure 7). Moans and variable calls were also detected on 29 January 2011. These are the first detections of North Atlantic right whales at Site A in Onslow Bay. The timing coincides with the migration of this species to and from the breeding grounds.

Downsweeps similar to those ascribed to sei whales by Baumgartner *et al.* (2008) were detected on 18 October 2010 and between 17 November 2010 and 1 March 2011 (Figure 8). Peaks in these types of calls occurred between 30 November – 1 December 2010 and 18 – 26 January 2011. The general occurrence and peaks in detections are similar to previous findings in Onslow Bay.

Three pulses, unidentified to species, with frequencies sweeping down from approximately 90 – 60 Hz were detected on 26 December 2010. These three pulses followed 10 minutes after the

detection of a single variable call (frequency range approximately between 280 – 330 Hz), also unassigned to a species.

Detected odontocete vocalizations included clicks, whistles, and burst-pulses (Figures 9-12). Most of these detections (93%) were assigned to the unidentified odontocete category (Figure 9). As found in previous winter deployments at Site A during 2007-2008 and 2009-2010, a strong pulse of longer-duration and clustered unidentified odontocete vocal events was seen during the 2010-2011 deployment starting in November and ending in January (Figure 9). *Kogia* spp. were present on only four days during the 2010-2011 Site A deployment (Figure 10), which is consistent with the sporadic occurrence found during previous deployments. Risso's dolphins were also detected throughout the deployment with a stronger nocturnal presence, again agreeing with earlier findings (Figure 11). Sperm whales were detected mainly between November and the end of February, during both day and night (Figure 12).

Table 1. Summary of detections of marine mammal vocalizations at Onslow Bay Site A for July 2010 – March 2011 (Onslow Bay 05A).

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)	57.35	2.02	72	33.03
Possible blue whale	26 – 27 Hz	8.17	0.29	7	3.21
Fin whale	20 Hz	93.67	3.31	65	29.82
Minke whale	pulse train (slow-down, speed-up, regular)	48.58	1.72	56	25.69
North Atlantic right whale	Up-call, moan, variable call	0.43	0.02	2	0.92
Possible sei whale	downsweep	9.95	0.35	20	9.17
Unidentified odontocete	clicks, whistles, burst-pulses	441.27	15.58	207	94.95
<i>Kogia</i> spp.	clicks	0.27	0.01	4	1.83
Risso's dolphin	clicks	12.63	0.45	19	8.72
Sperm whale	clicks	5.45	0.19	14	6.42

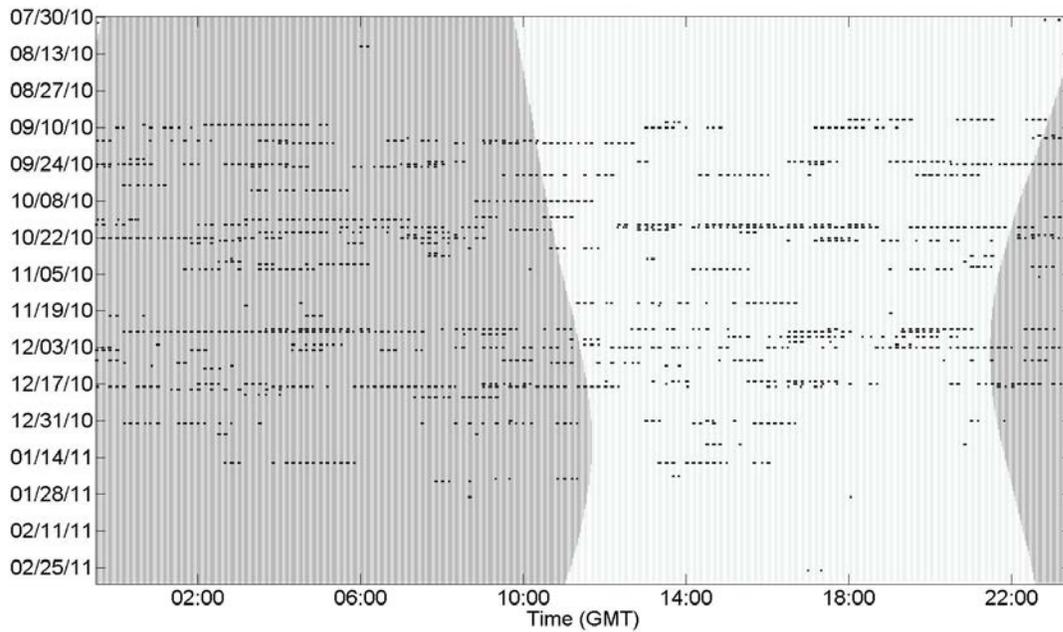


Figure 3. Blue whale Type A and B call detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

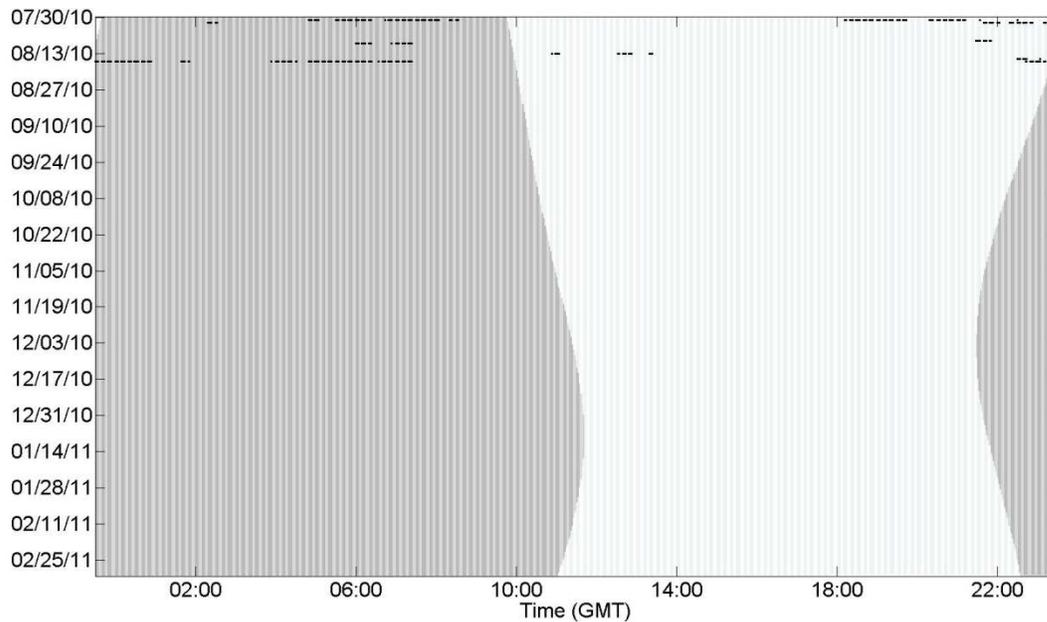


Figure 4. Detections of 26 – 27 Hz calls (black bars) likely produced by blue whales for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

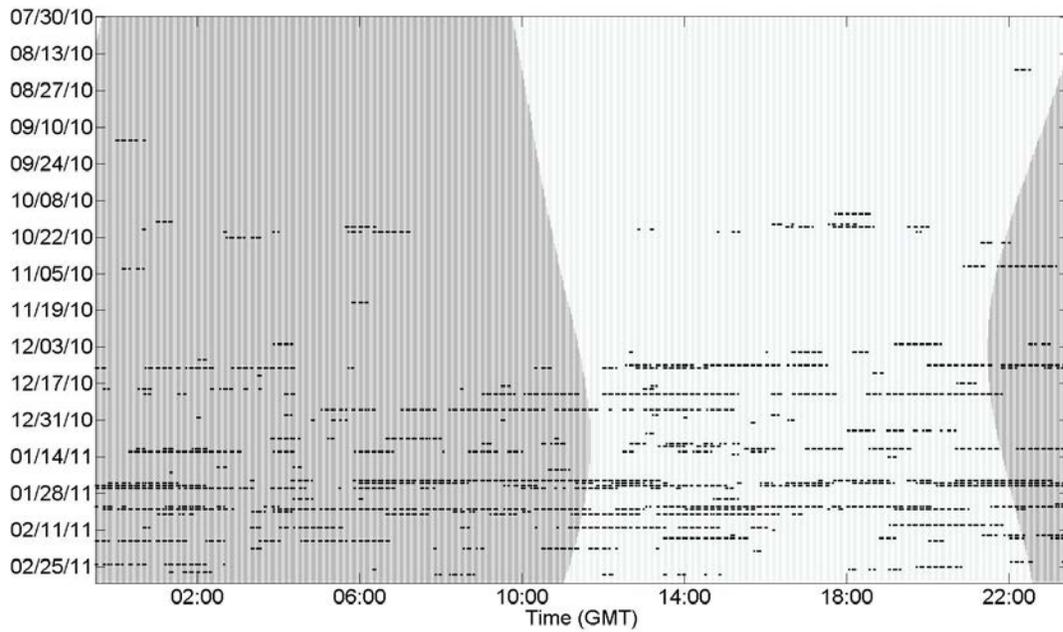


Figure 5. Fin whale 20-Hz pulse detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

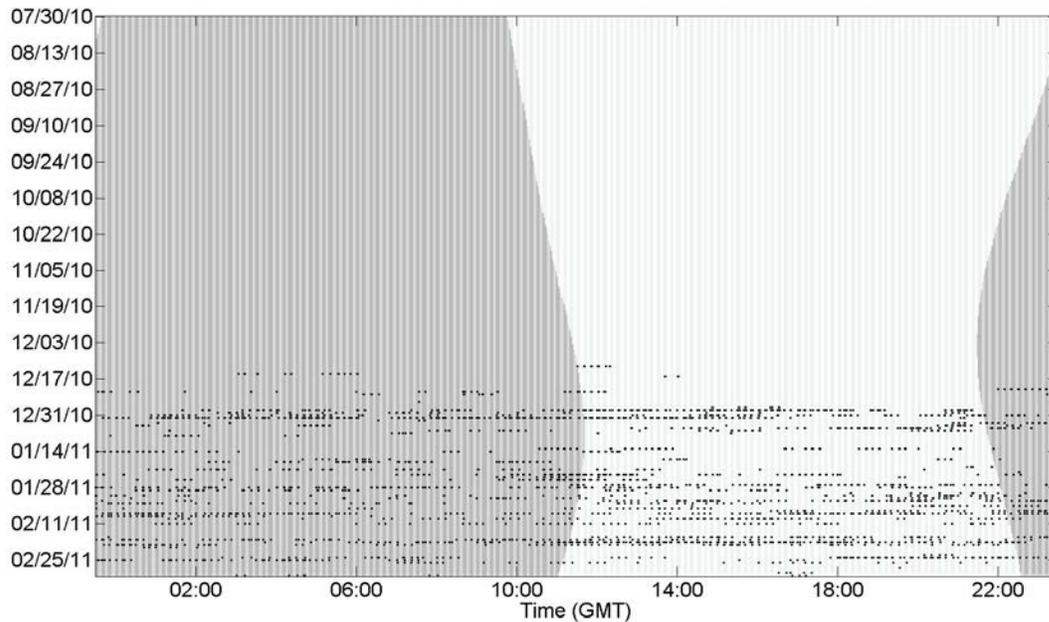


Figure 6. Minke whale detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

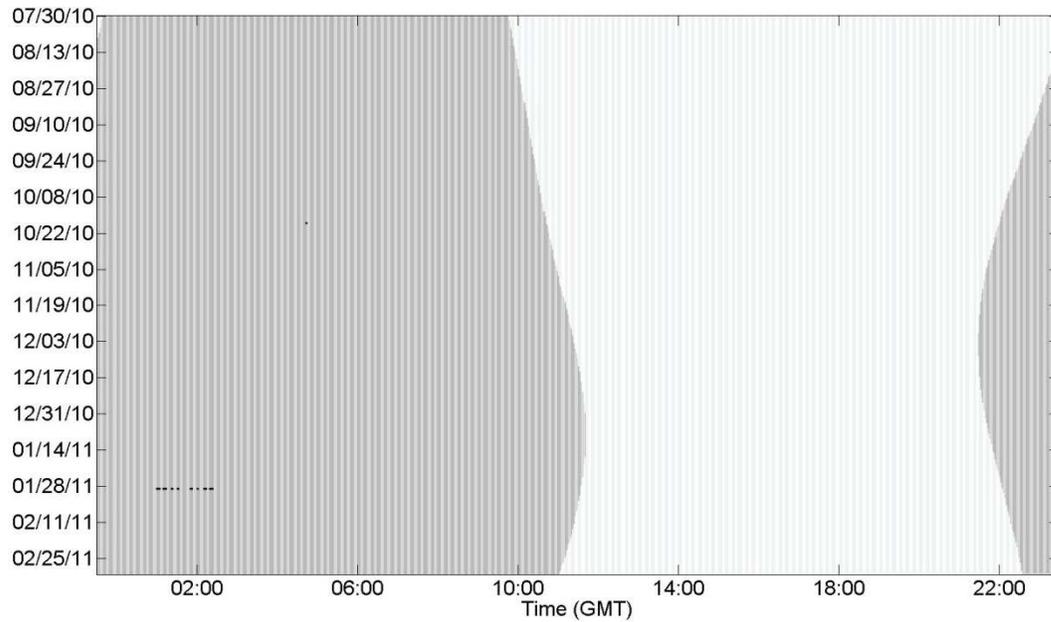


Figure 7. North Atlantic right whale detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

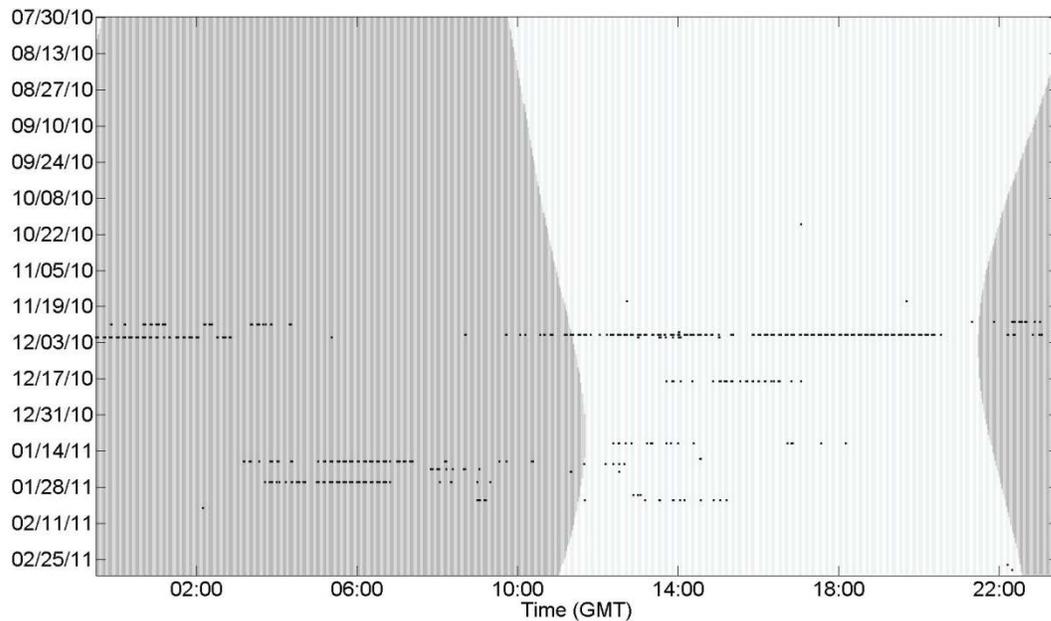


Figure 8. Downsweep detections (black bars) that may be produced by sei whales (Baumgartner *et al.* 2008) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

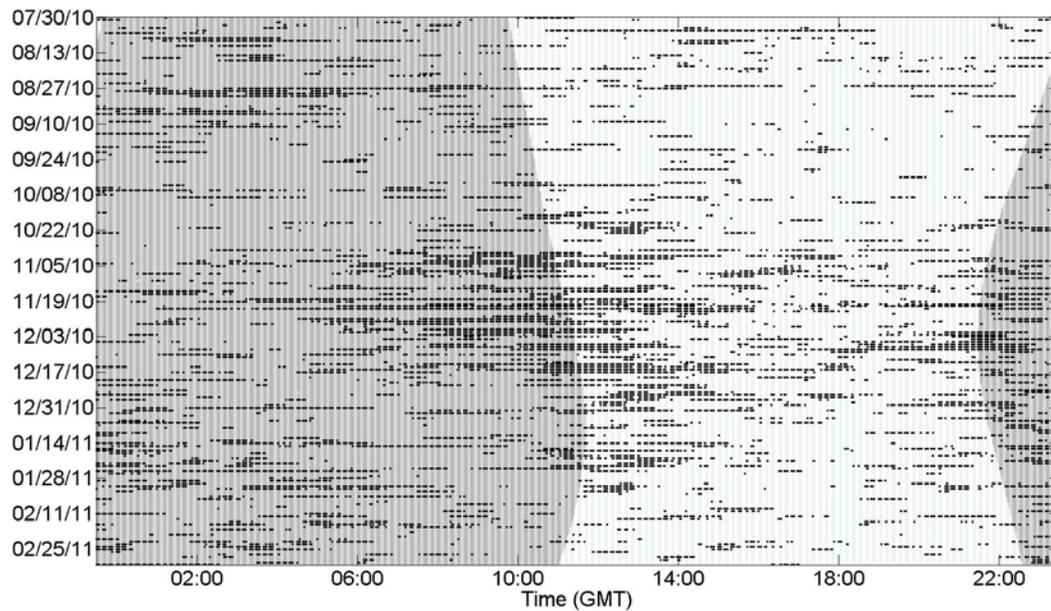


Figure 9. Unidentified odontocete vocalization detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

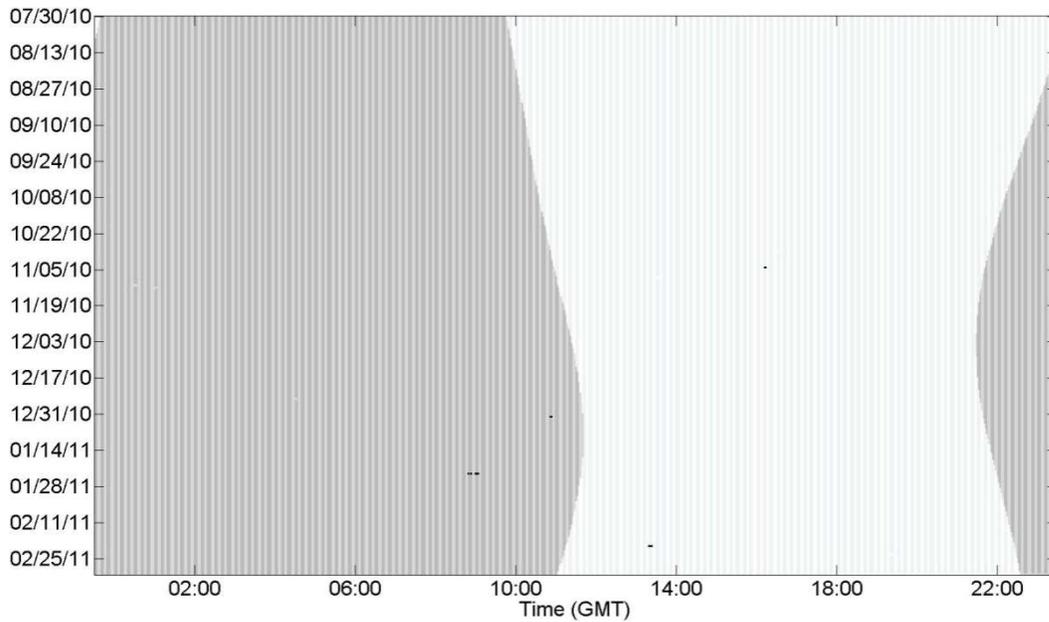


Figure 10. *Kogia* spp. click detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

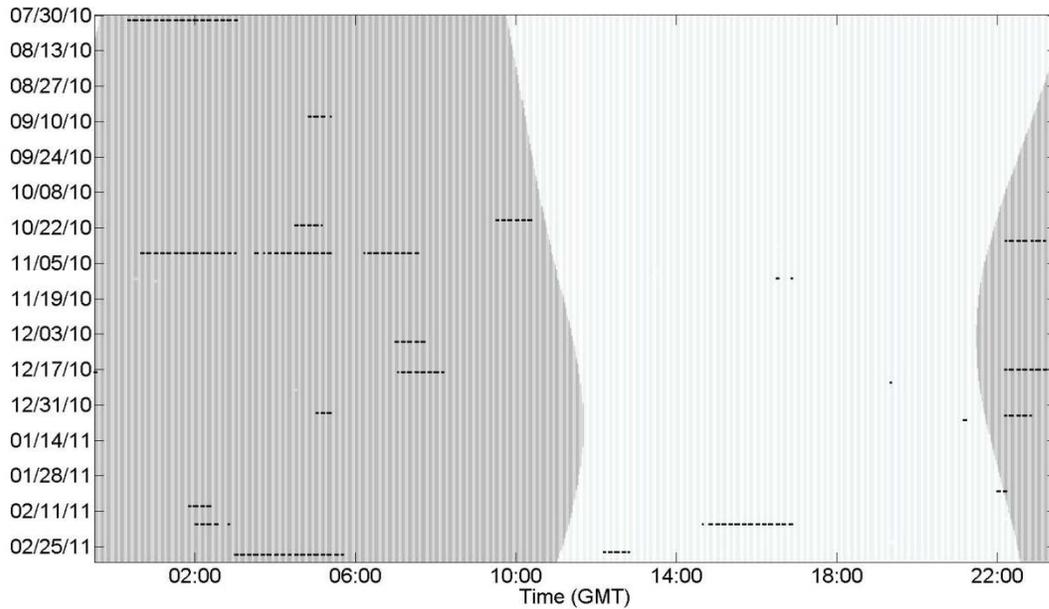


Figure 11. Risso's dolphin click detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

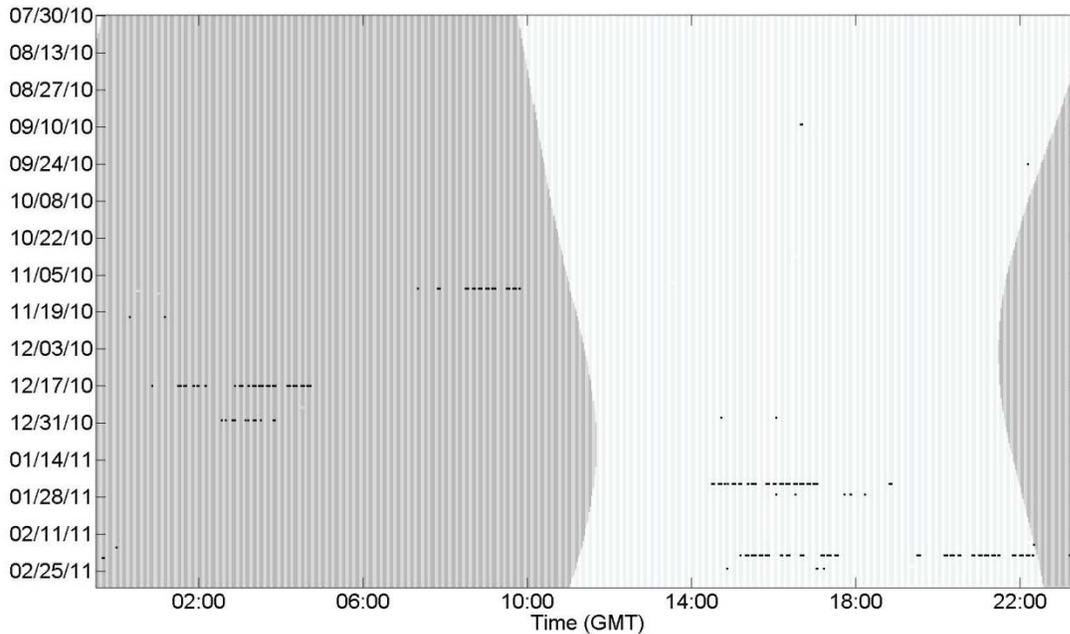


Figure 12. Sperm whale click detections (black bars) for the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

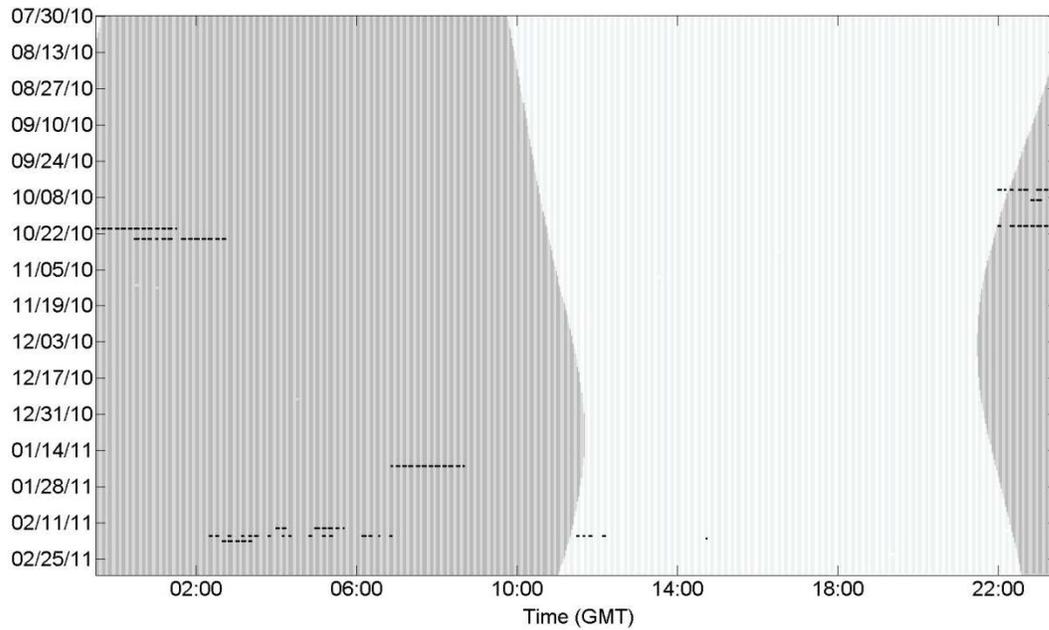


Figure 13. Mid-frequency active sonar (black bars) detected during the 2010-2011 Site A deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (<http://aa.usno.navy.mil>). Lighter shading indicates recording/analysis effort.

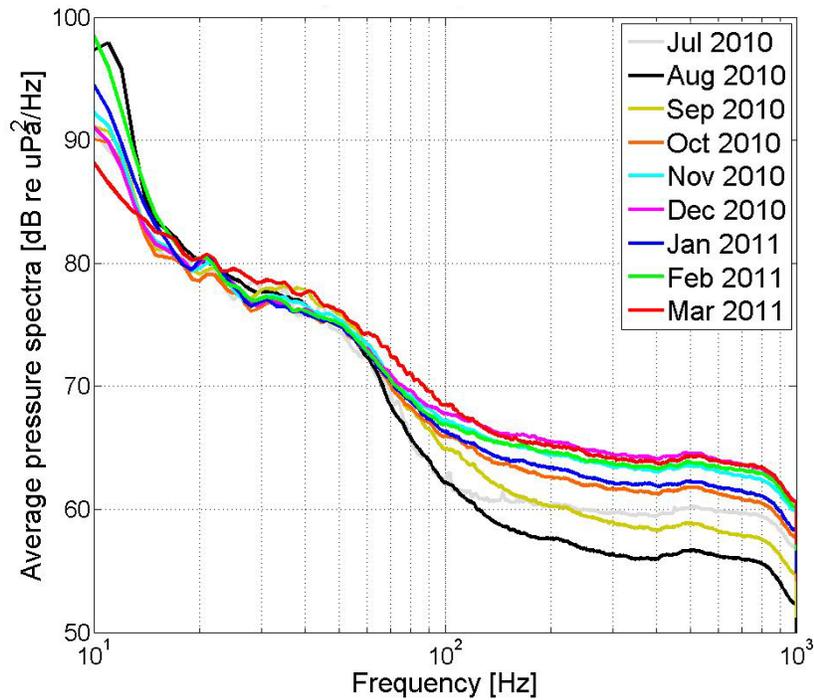


Figure 14. Monthly averages of ambient noise at Onslow Bay Site A for July 2010 – March 2011.

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.