Passive Acoustic Monitoring for Marine Mammals at Site E in Onslow Bay, October 2012 – June 2013

Lynne Hodge and Andrew Read

Duke University Marine Laboratory
135 Duke Marine Lab Road
Beaufort, NC 28516

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Individual technical reports of other HARP deployments are available at:
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Abstract

A High-frequency Acoustic Recording Package (HARP; Wiggins and Hildebrand 2007) was deployed between October 2012 and August 2013 in Onslow Bay at Site E in 853 m. This HARP sampled at 200 kHz for 5 minutes of every 10 minutes and recorded for 250 days between 24 October 2012 and 30 June 2013. Long-Term Spectral Averages (LTSAs) were created for three frequency bands (10 Hz – 1000 Hz, 500 Hz – 5000 Hz, and 1 kHz – 100 kHz) and scanned for marine mammal vocalizations. Calls of blue whales, fin whales, minke whales, possible sei whales, Blainville's beaked whales, Cuvier's beaked whales, Gervais' beaked whales, *Kogia* spp., Risso's dolphins, sperm whales, and unidentified odontocetes and mysticetes were detected in the data.

Methods

The October 2012 – June 2013 Onslow Bay Site E HARP (Onslow Bay 08E) was deployed at 33.78696^{o} N, 75.92801^{o} W on 24 October 2012 (recording started on 24 October 2012) and recovered on 8 August 2013 (recording ended on 30 June 2013). The instrument location is shown in Figure 1. Bottom depth at the deployment site was approximately 853 m. A schematic diagram of the Onslow Bay 08E HARP is shown in Figure 2.

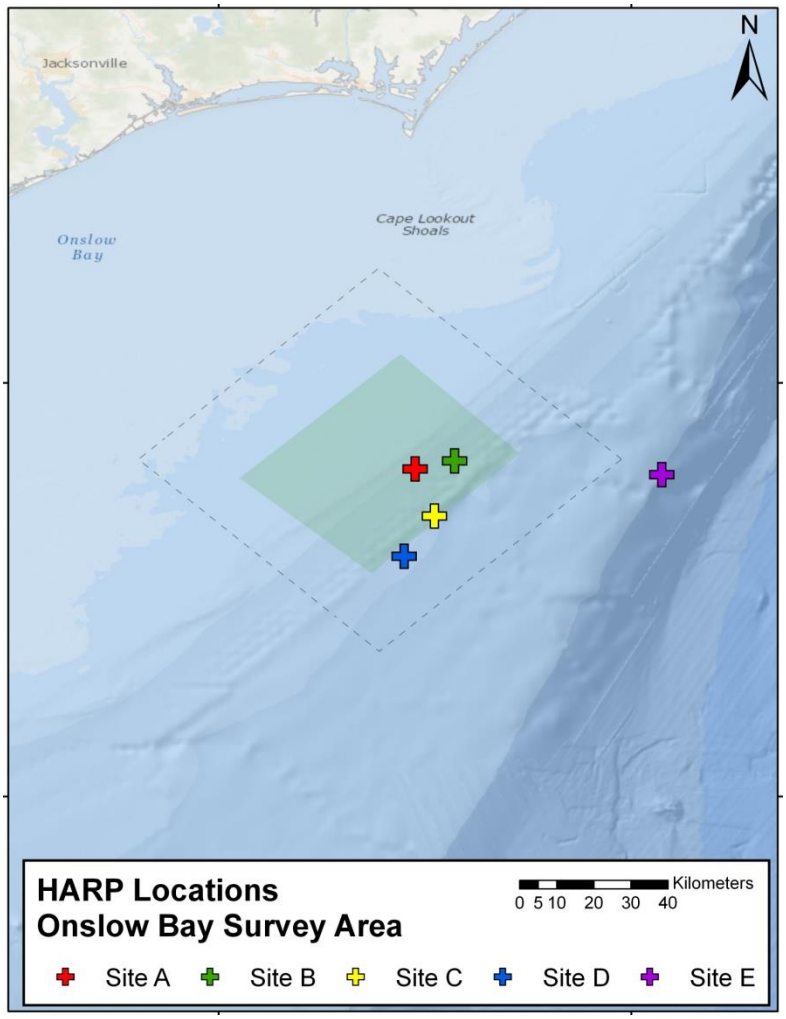

Figure 1. Location of HARP deployment sites in the Onslow Bay survey area. The location of the Onslow Bay 08E HARP is shown in purple.

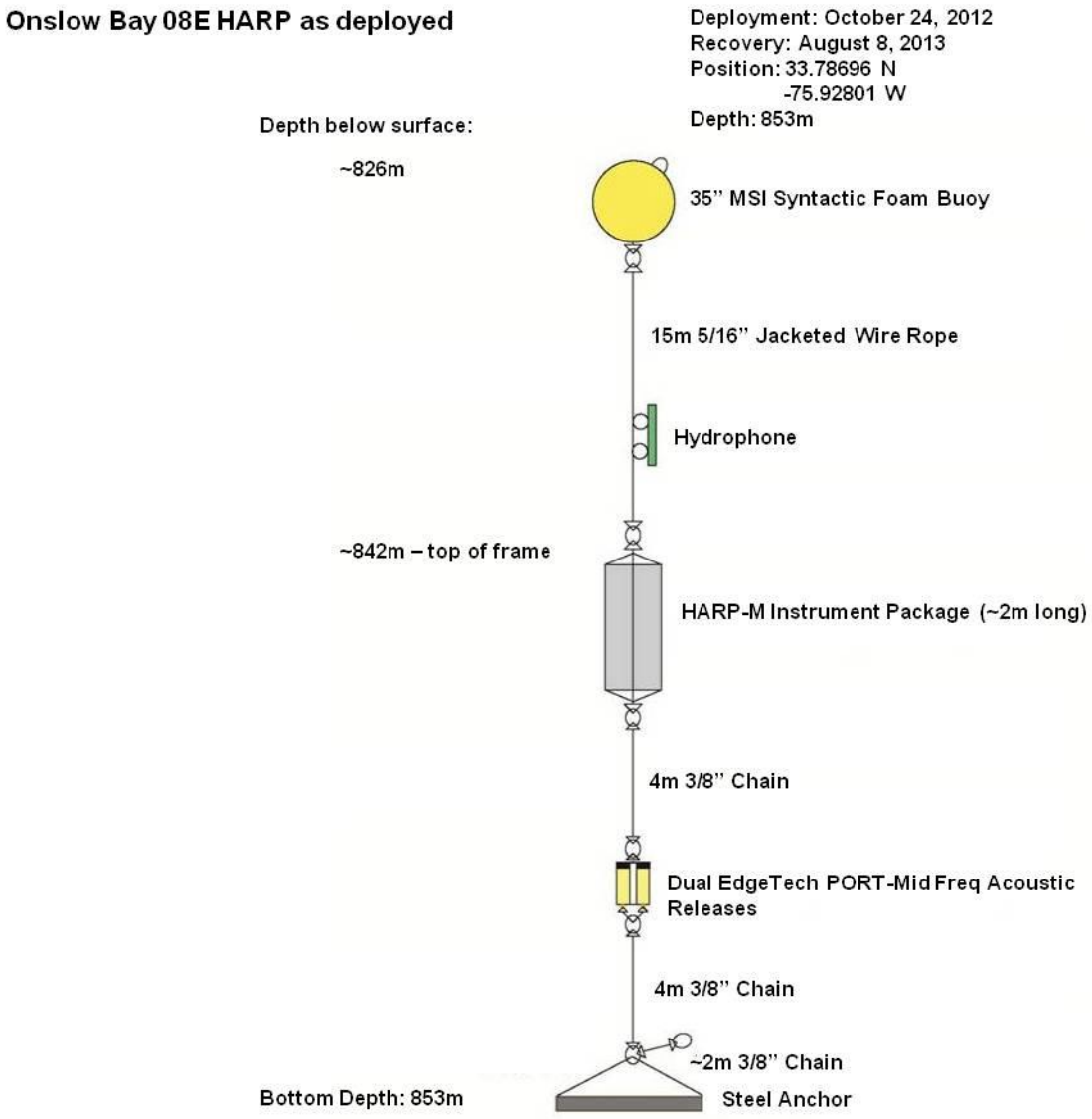

Figure 2. Schematic diagram showing details of the Onslow Bay 08E HARP. Note that diagram is not drawn to scale.

Data were acquired at a 200 kHz sampling rate for 5 minutes every 10 minutes during the Onslow Bay 08E deployment. This deployment provided a total of 3436.1 hours of data over the 250 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 three parts for this manual review: 10-1000 Hz, 500-5000 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), 5 s in time and 10 Hz in frequency (for the data decimated by a factor of 20: 500-5000 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. LTSAs decimated by a factor of 20 were inspected for a new sound type, a three part 2-kHz trill, detected when looking through non-decimated data. 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. Overall analysis methods for this dataset were consistent with Onslow Bay datasets USWTR01A, 02B, 03A, 04A, 04C, 05A, and 05D except for beaked whales which is described below. Also, the third frequency band (500-5000 Hz) was added for analysis here unlike for these other datasets.

Detections of most sounds were made by manually scanning LTSAs. However, beaked whale echolocation signals were detected with an automated method and then assigned to species by a trained analyst, as detailed in Debich et al. (2014). A Teager Kaiser energy detector was used to find echolocation signals, and criteria based on peak and center frequency, duration, and sweep rate were used to discriminate between delphinid and beaked whale signals. In a second computer-assisted manual classification step, each detected event containing potential beaked

whale signals was given a species label by a trained analyst, and any remaining false detections were rejected (as in Baumann-Pickering et al. 2013).

Results

Table 1 summarizes the detected and identified marine mammal vocalizations for the Onslow Bay 08E HARP deployment. Figures 3-8 and 10-18 show the daily occurrence patterns for the different marine mammal groups (classified to species when possible). Figure 19 shows the occurrence of mid-frequency active sonar. Underwater ambient noise during this deployment is shown in Figure 20.

Blue whales were present primarily from the beginning of the recording period (October 2012) to the beginning of January 2013, with very few detections after that through mid-March (Figure 3).

Fin whale 20-Hz pulses were present from the start of the recording period until mid-March (Figure 4).

Minke whale pulse trains (mainly slow-down pulse trains) were detected mainly between mid-November 2012 and mid-April 2013 (Figure 5), but detections continued through May 2, 2013. High levels of pulse train calls occurred from December until mid-April. This agrees with findings of peaks between January and March for earlier deployments.

Downsweeps similar to those ascribed to sei whales by Baumgartner *et al.* (2008) were detected from the beginning of the recording period until February 8, 2013 (Figure 6), with peaks in occurrence in December. The general occurrence of this call type is similar to previous findings in Onslow Bay.

Short duration downsweeps (short in duration compared to possible sei whale downsweeps) were detected from December 2012 through mid-March 2013 (Figure 7). Similar short duration downsweeps were detected on two days during the Onslow Bay 04A dataset (at the end of January and beginning of February 2010) and on four days during the Onslow Bay 04C dataset (between December 2009 and February 2010).

Faint upsweeps were detected on three days in 2013 (four calls on February 6, two calls on February 10, and two calls on March 12) (Figure 8). These were similar to right whale up-calls (although shorter in duration) but could have been produced by a humpback whale(s) or other species.

One call type, a three part "2-kHz trill" (see Figure 9), that has not been described previously for North Carolina or Florida was detected on December 12, 2012 (34 times) and December 16, 2012 (three times) (Figure 10). The call was detected mainly at night (Figure 10). A majority of these calls had one or two downsweeps associated with them. Some of the downsweeps were similar to those ascribed to sei whales, some may have been shorter versions of the downsweeps ascribed to sei whales. When downsweeps occurred with this new call type, the downsweep began with, or began just prior to and then with, the first part of the sound. Some of the calls did

not seem to have any downsweeps associated with them. 2.5 kHz trills, similar to the ones detected during this deployment in Onslow Bay, were recorded on marine autonomous recording units (MARUs, Cornell Lab of Ornithology) in George's Bank between 2004-2005 with lower frequency downsweeps also associated with them (Susan Parks, personal communication). While the source of these trills is unknown at this time, it is possible that they are made by sei whales due to the association of downsweeps. Additionally, Knowlton *et al.* (1991) described sounds in the 1.5-3.5 kHz band recorded in the presence of sei whales.

Detected odontocete vocalizations included clicks, whistles, and burst-pulses (Figures 11-18). Most of these detections were assigned to the unidentified odontocete category (Figure 11). For odontocete detections that could be assigned to species, there were several click detections that were assigned to beaked whales. There were two detections in December 2012 of a click type assigned to an unidentified beaked whale species (BW38) (Figure 12). Blainville's beaked whale clicks were detected on several days during this deployment, mainly in April and May of 2013 (Figure 13). Cuvier's beaked whale clicks were also detected on several days during this deployment, although mainly in November 2012, with a few detections in January and February 2013 and a single detection in June 2013 (Figue 14). As previously found for Onslow Bay Site E, there were significantly more Gervais' beaked whale detections than any other beaked whale. While detections occurred throughout the deployment with no specific diel pattern, there were more detections from October 2012 through the end of March 2013 (Figure 15). Other detected odontocete clicks included *Kogia* spp. clicks (Figure 16), Risso's dolphin clicks (Figure 17), and sperm whale clicks (Figure 18). *Kogia* spp. clicks were present throughout the deployment, with no specific temporal pattern in occurrence (Figure 16). This deployment had the most detections

of *Kogia* spp. clicks out of any other deployment in Onslow Bay. Risso's dolphins were detected mainly from April to June 2013, with no detections from October 2012 through late February 2013 and no detections in March 2013 (Figure 17). Unlike in previous deployments in Onslow Bay, there did not seem to be a significant nocturnal click occurrence pattern. Sperm whales were detected without an apparent diel pattern throughout this deployment, with peaks in mid-December 2012 through mid-January 2013 and May through June 2013 (Figure 18).

Data Gaps

There were 50 five-minute segments of data that were not analyzed due to hard drive issues. These segments were not analyzed either because they were missing (skipped during the recording process) or the hard drive recorded the sound incorrectly. These segments were removed from the analysis effort. In addition, there were 16 days that had periods of high ambient noise levels that decreased the detection ability for low-frequency sounds. These segments were identified and removed from analysis for low-frequency sounds.

Table 1. Summary of detections of marine mammal vocalizations at Onslow Bay Site E for October 2012 – June 2013 (Onslow Bay 08E).

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)	30.73	0.92	71	28.4
Fin whale	20 Hz	127.28	3.80	120	48
Minke	pulse train	751.08	21.88	184	73.6

whale	(slow-down, speed-up, regular)				
Possible sei whale	downsweep	6.95	0.21	33	13.2
Unidentified mysticete	short duration downsweep	5.67	0.17	40	16
Unidentified mysticete	upsweep	0.1	0.003	3	1.2
Unidentified animal	2-kHz trill	0.62	0.02	2	0.8
Unidentified odontocete	clicks, whistles, burst-pulses	1072.83	31.26	250	100
Unidentified beaked whale (BW38)	clicks	0.07	0.002	2	0.8
Blainville's beaked whale	clicks	1.38	0.04	12	4.8
Cuvier's beaked whale	clicks	1.78	0.05	16	6.4
Gervais' beaked whale	clicks	233.38	6.80	240	96
Kogia spp.	clicks	22.75	0.66	158	63.2
Risso's dolphin	clicks	12.2	0.36	24	9.6
Sperm whale	clicks	171.85	5.01	133	53.2

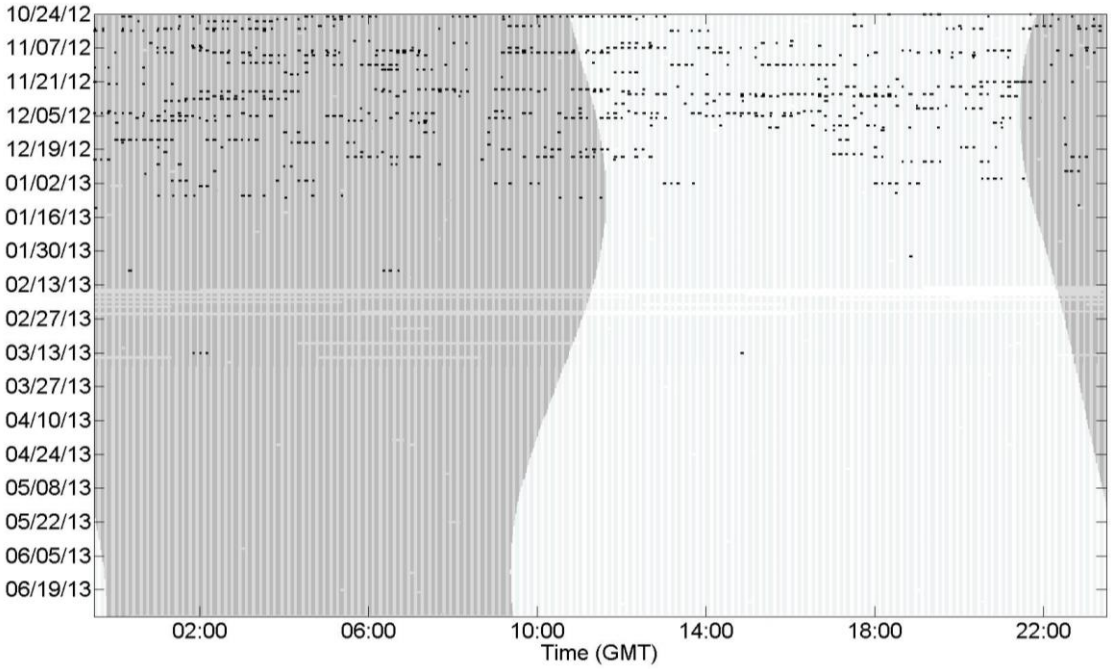

Figure 3. Blue whale Type A and B call detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

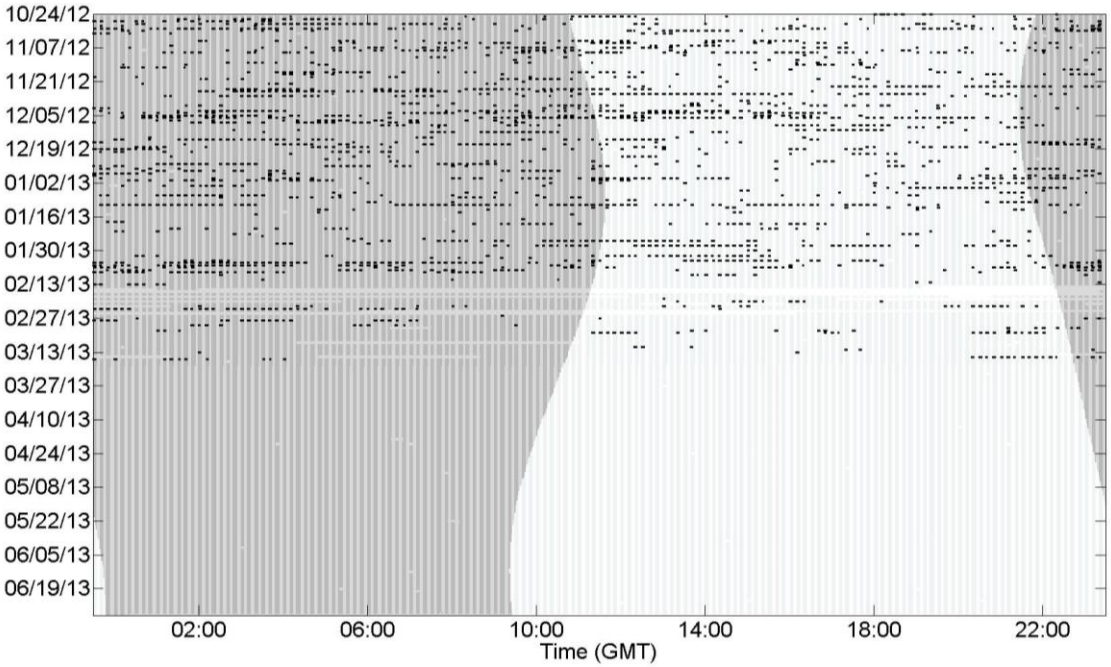

Figure 4. Fin whale 20-Hz pulse detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

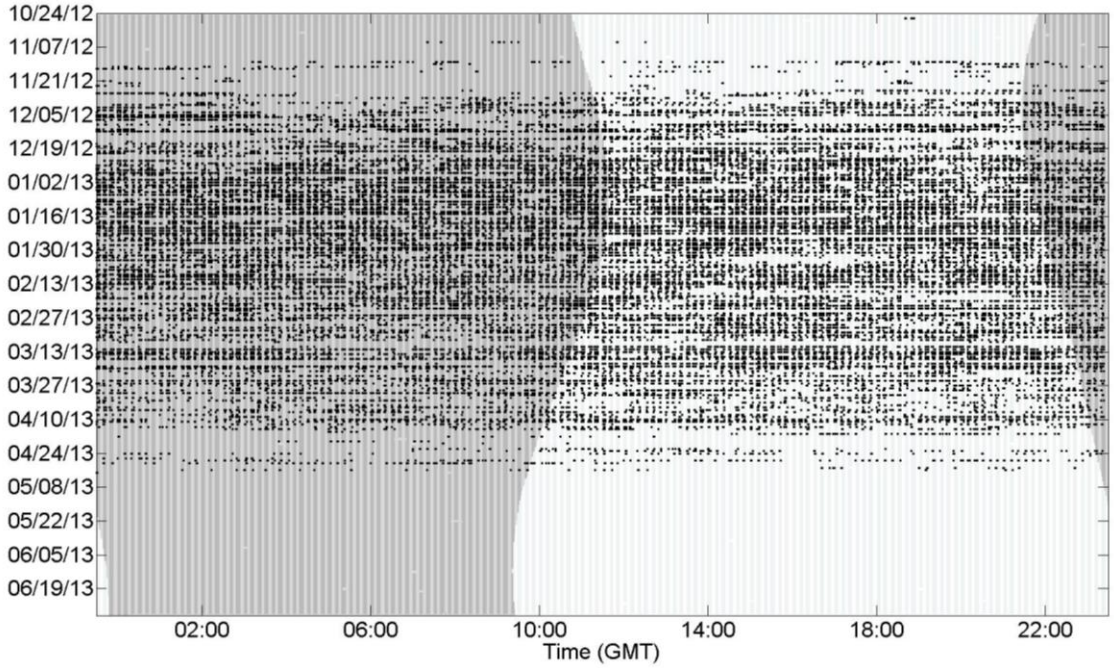

Figure 5. Minke whale detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

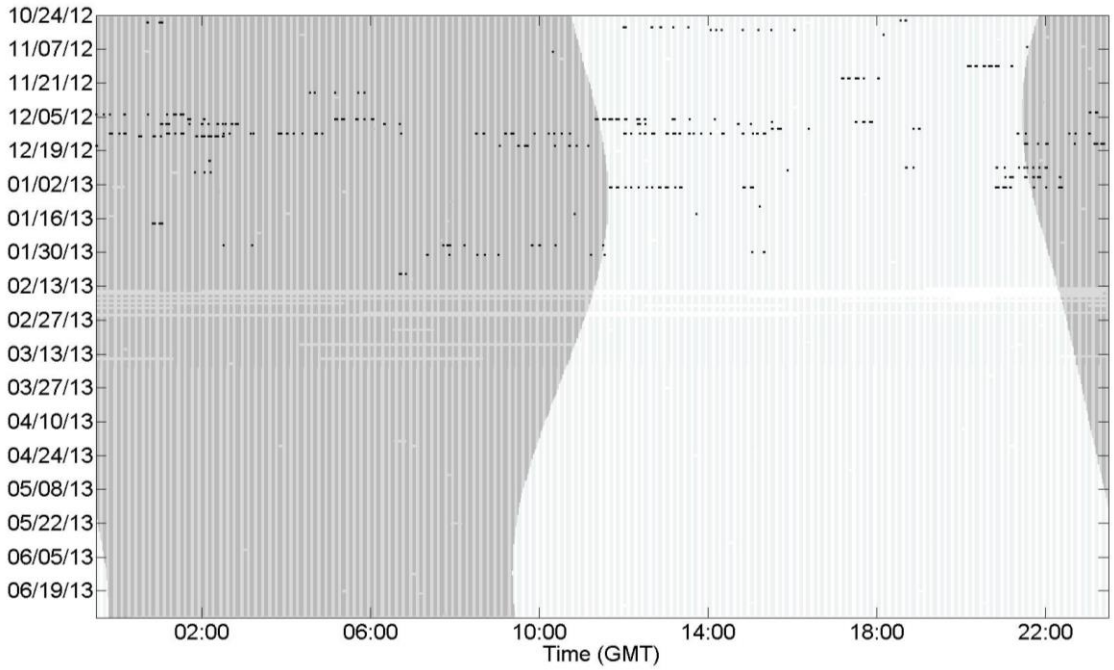

Figure 6. Downsweep detections (black bars) that may be produced by sei whales (Baumgartner *et al.* 2008) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

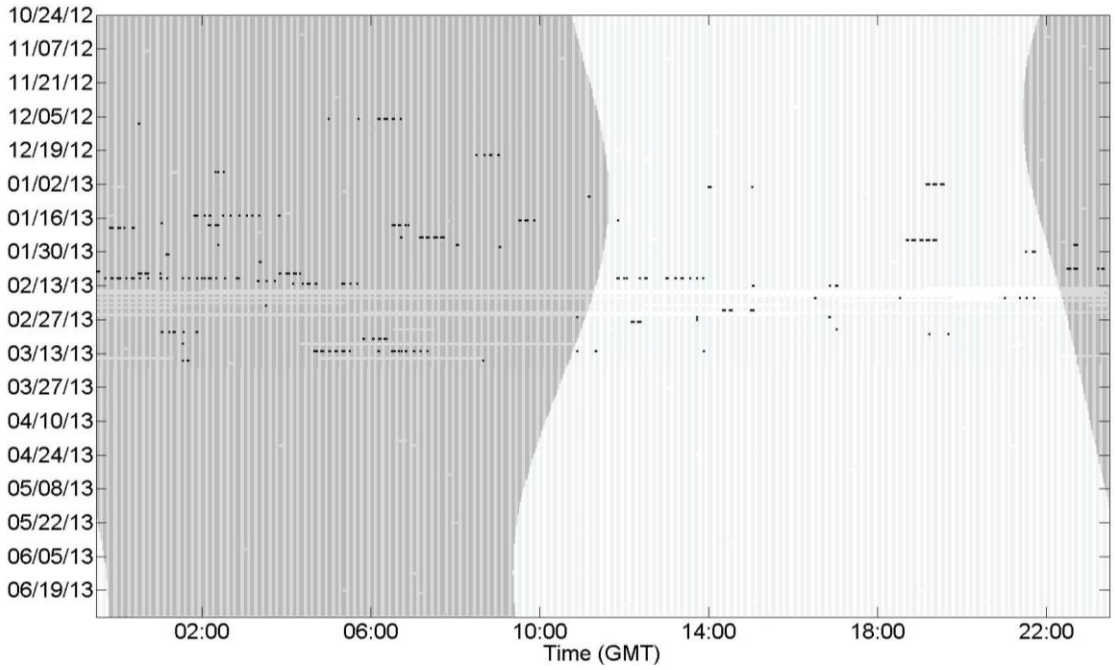

Figure 7. Short downsweep detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

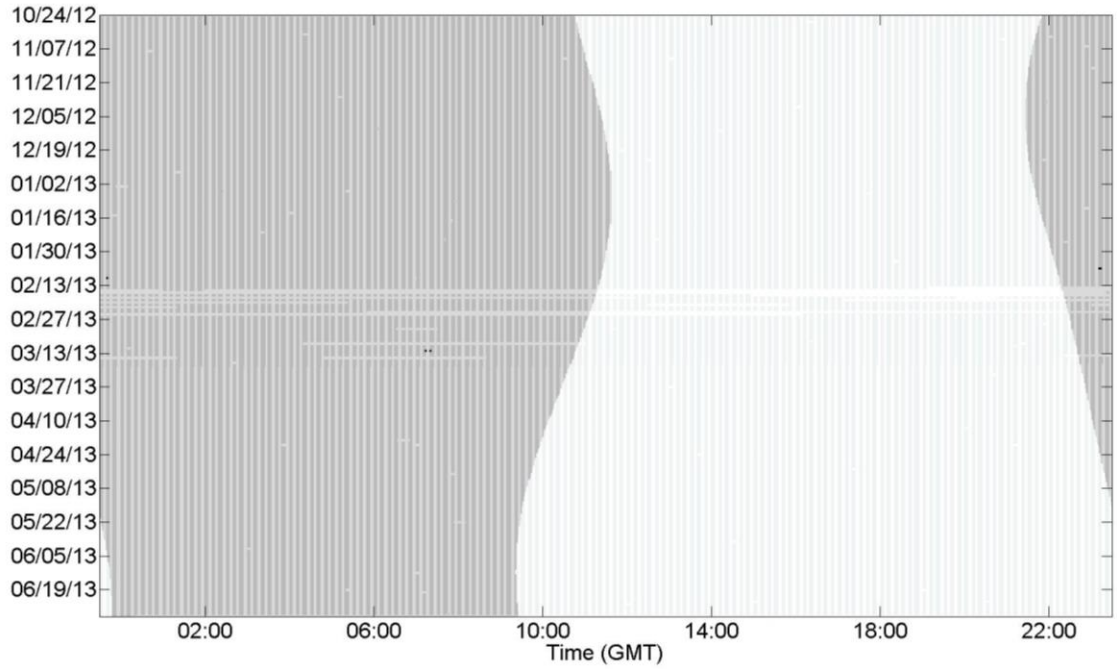

Figure 8. Upsweep detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

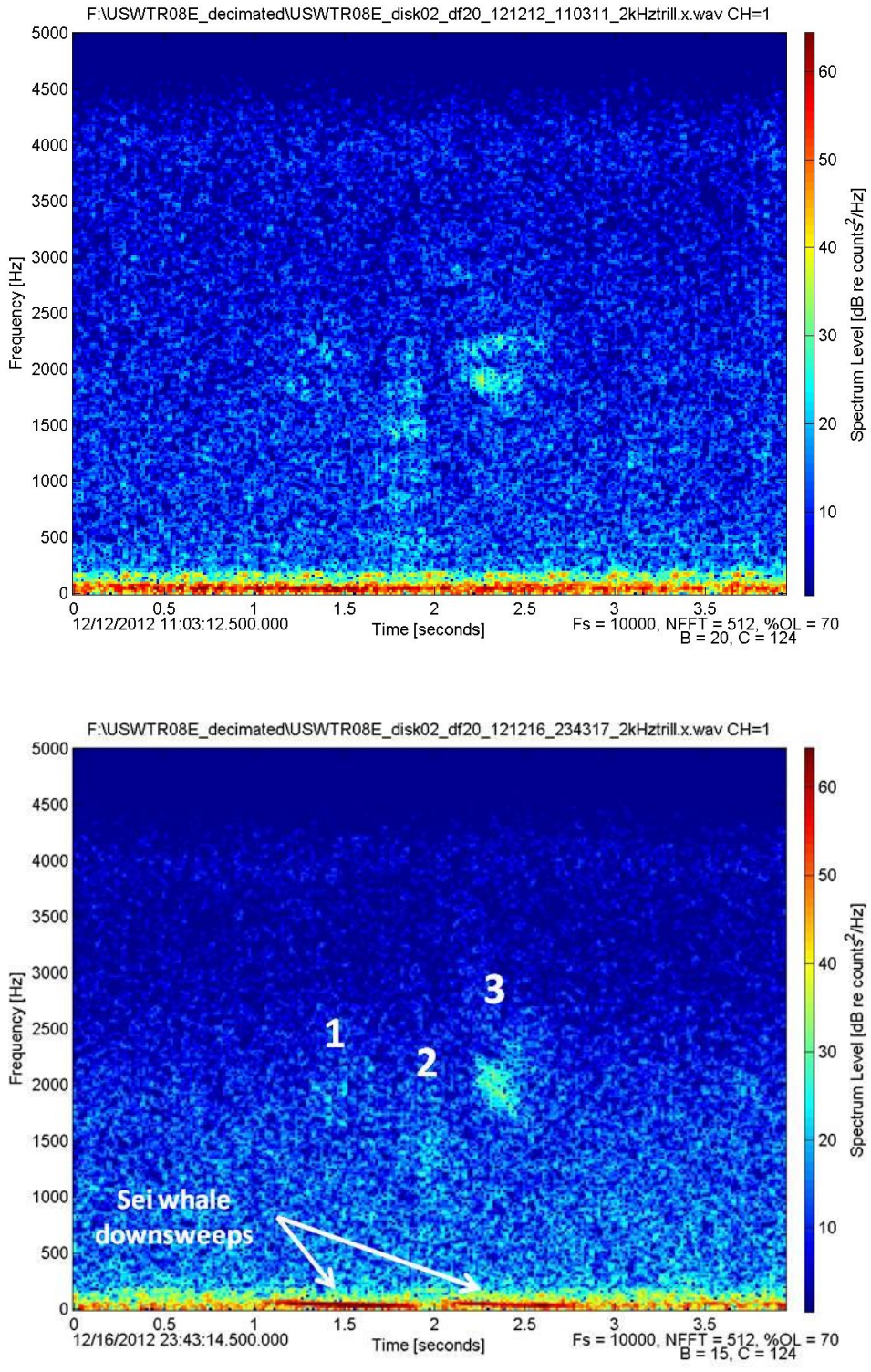

Figure 9. Spectrograms of the three part "2-kHz trill" recorded at Onslow Bay Site E on December 12, 2012 (top) and December 16, 2012 (bottom). The three parts to the call are labeled in the bottom figure as are sei whale downsweeps associated with the call.

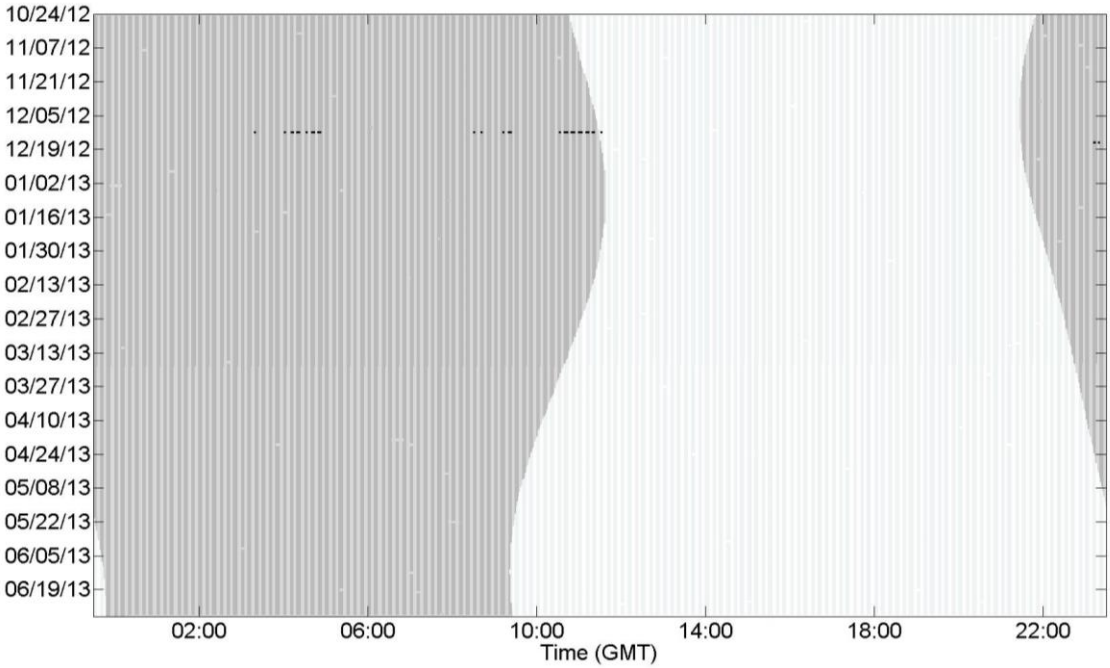

Figure 10. 2-kHz trill detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

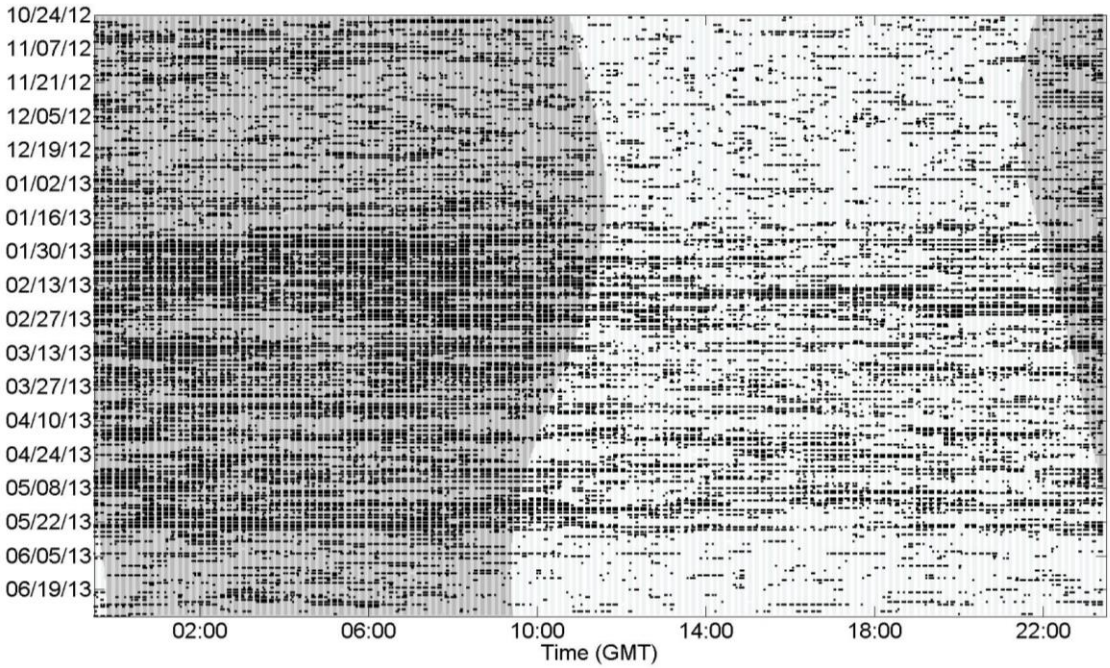

Figure 11. Unidentified odontocete vocalization detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

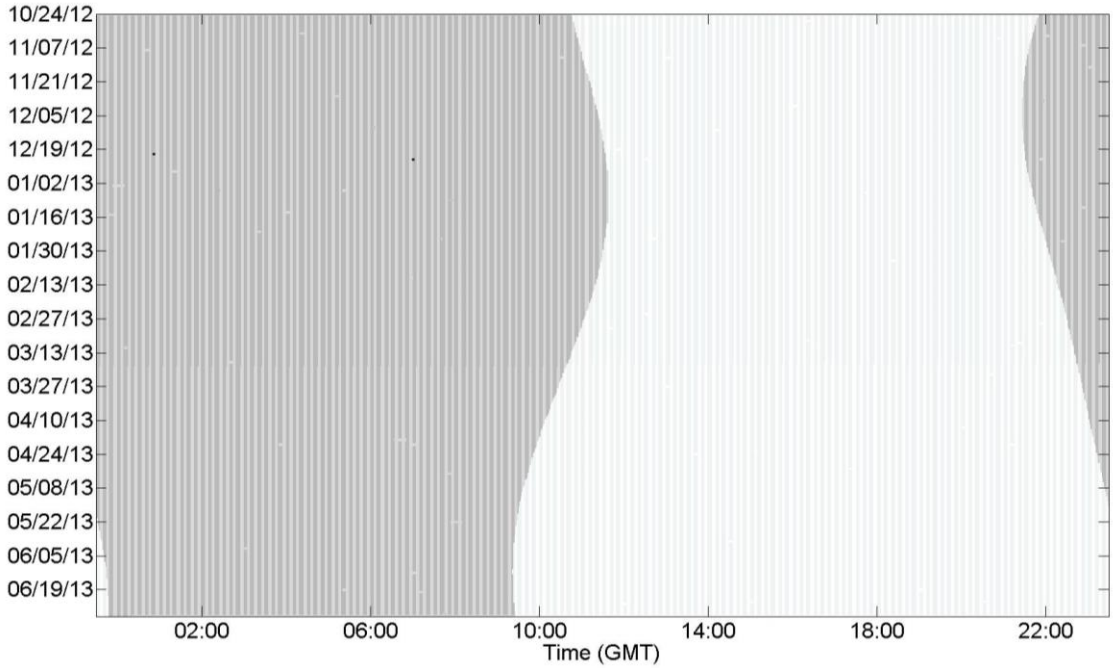

Figure 12. Unidentified beaked whale (BW38) click detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

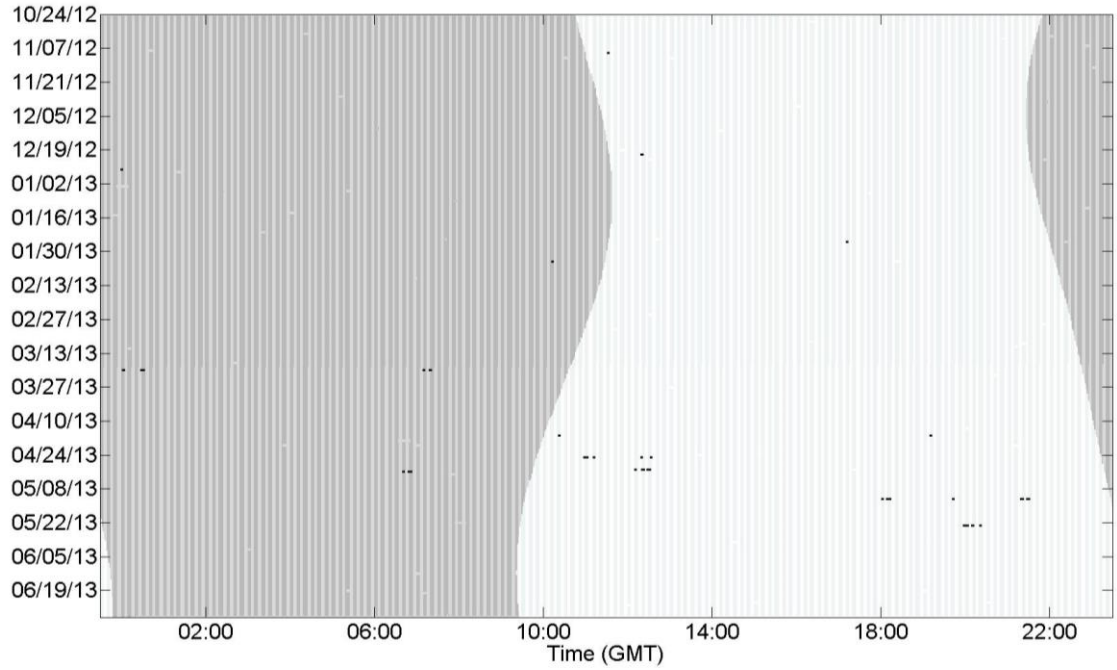

Figure 13. Blainville's beaked whale click detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

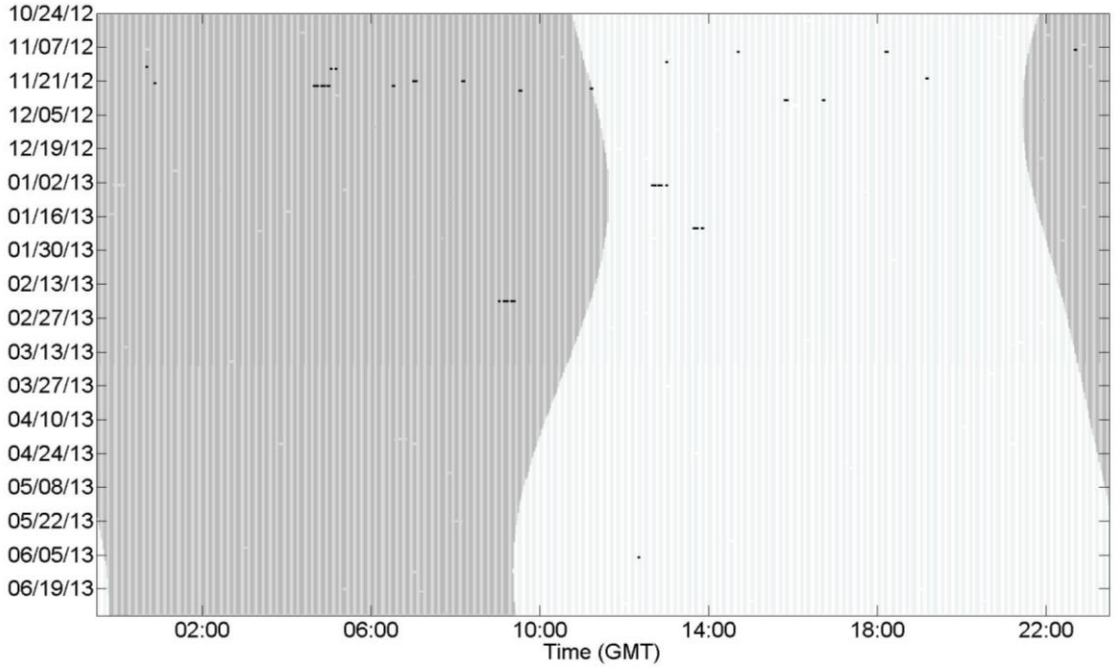

Figure 14. Cuvier's beaked whale click detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

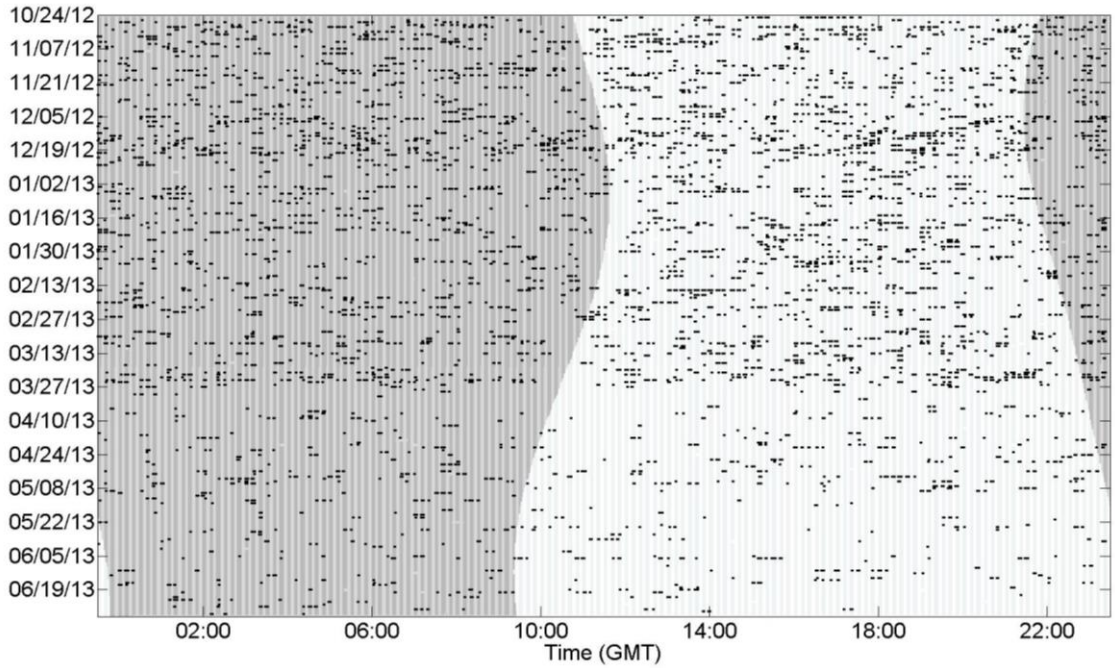

Figure 15. Gervais' beaked whale click detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

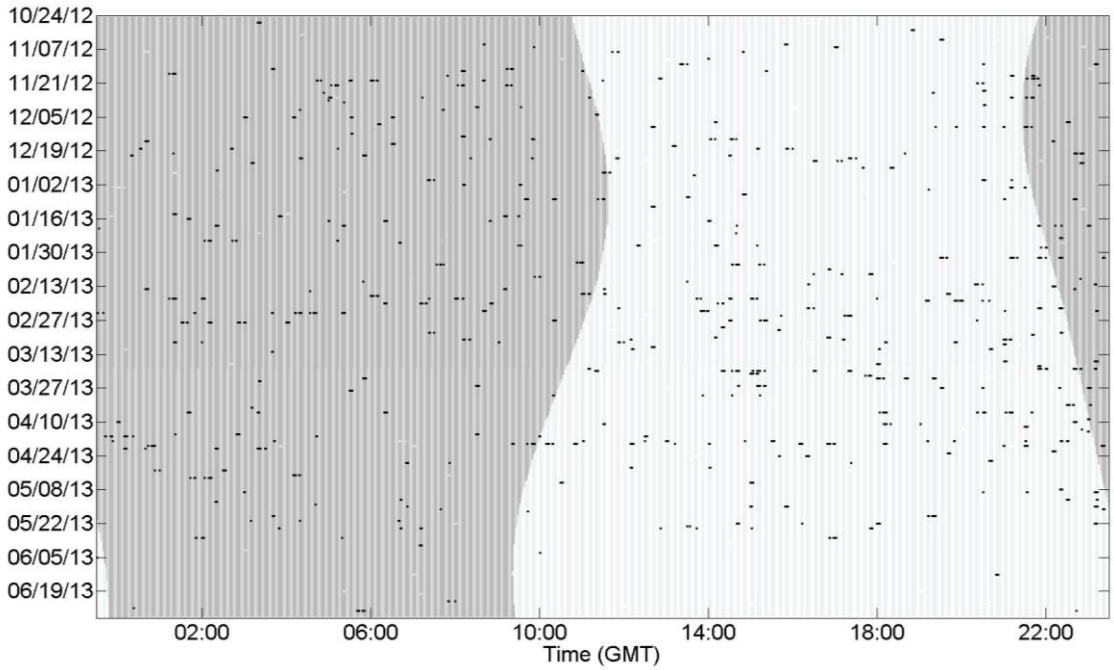

Figure 16. *Kogia* spp. click detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

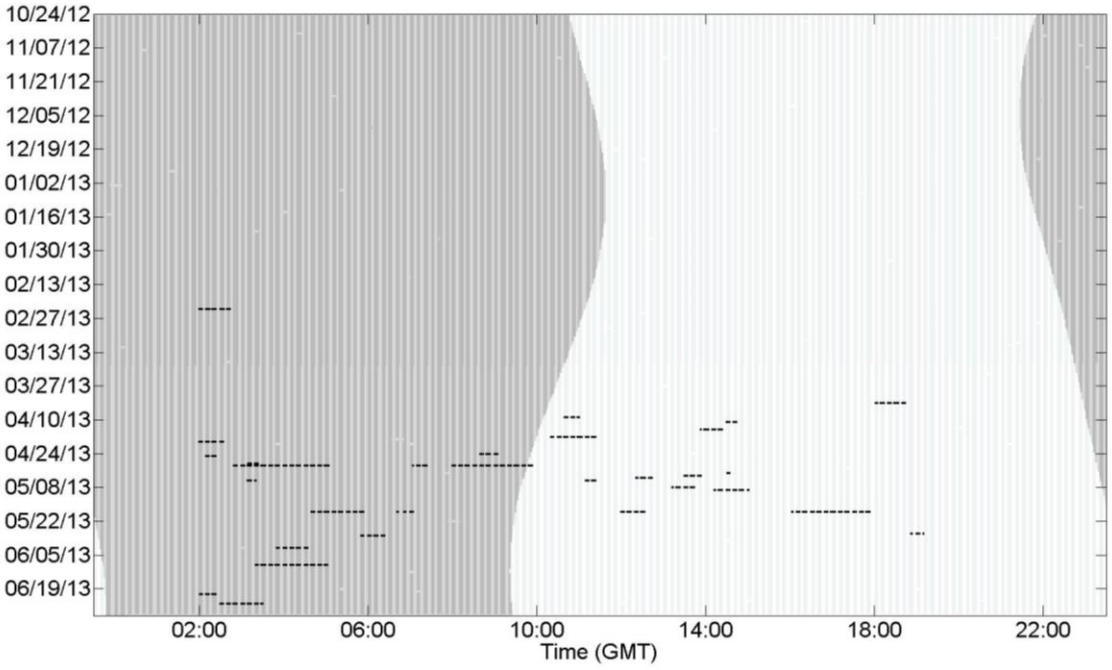

Figure 17. Risso's dolphin click detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

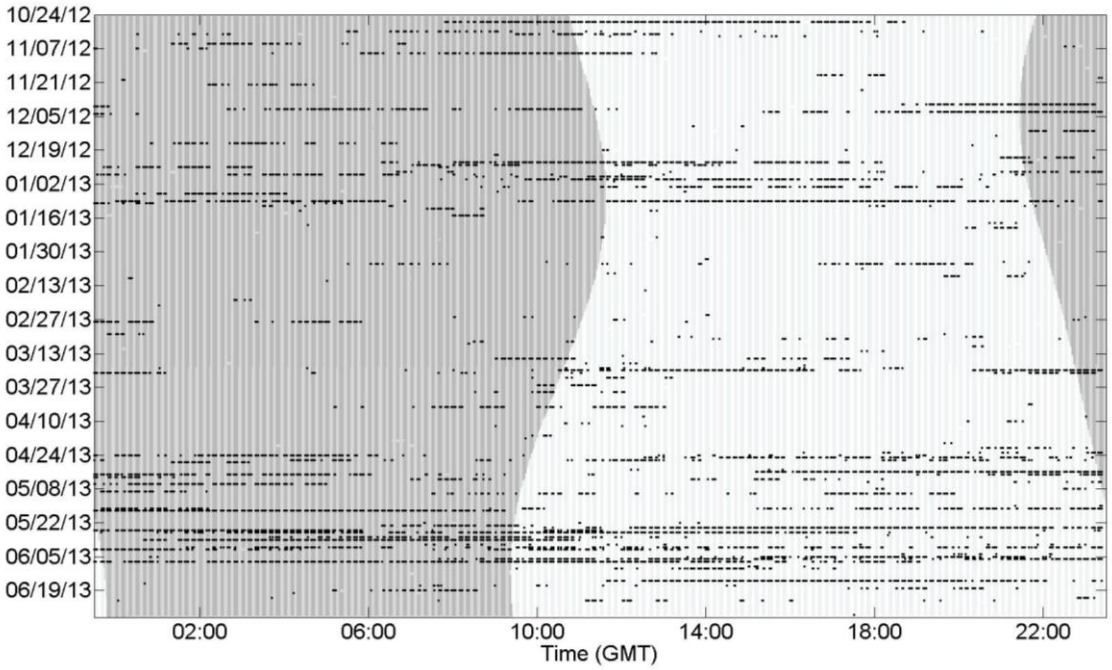

Figure 18. Sperm whale click detections (black bars) within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

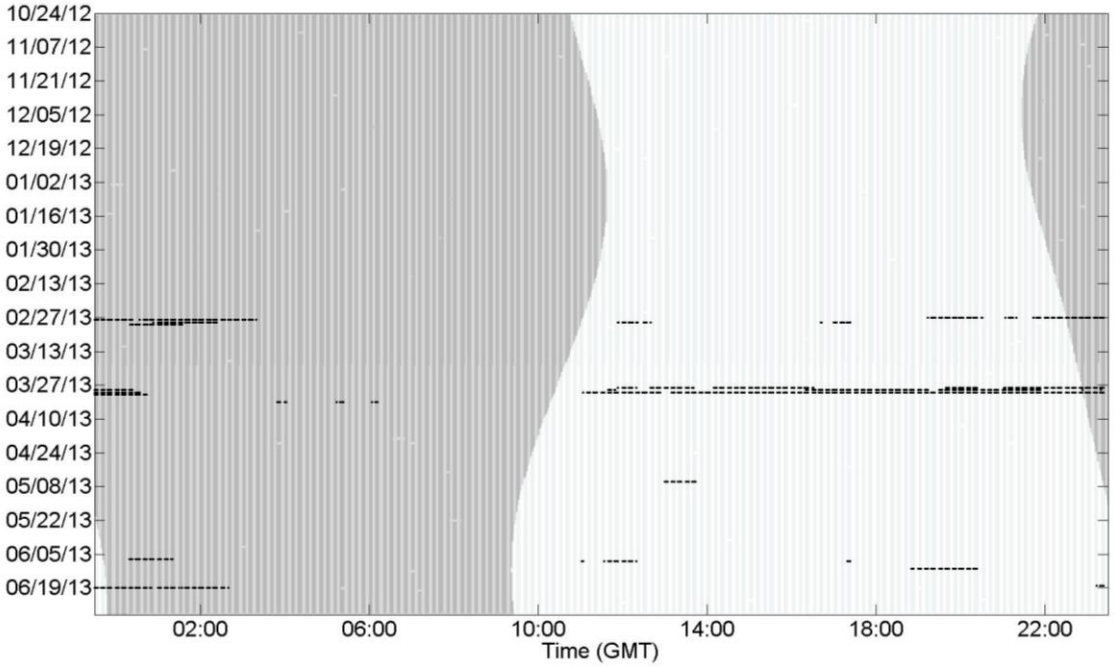

Figure 19. Mid-frequency active sonar (black bars) detected within the October 2012 – June 2013 Site E deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

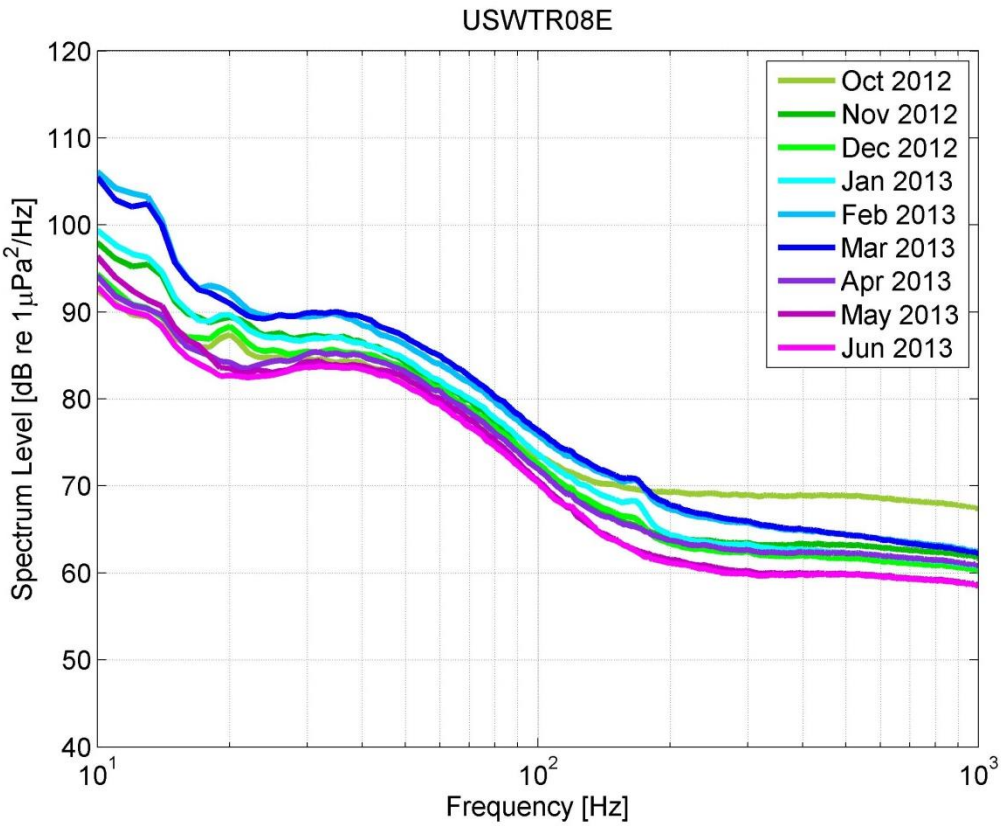

Figure 20. Monthly averages of ambient noise at Onslow Bay Site E for October 2012 – June 2013.

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