Passive Acoustic Monitoring for Marine Mammals at Site C in Jacksonville, FL, February – August 2014

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Individual technical reports of other HARP deployments are available at:
http://www.navymarinespeciesmonitoring.us/reading-room/

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Abstract

A High-frequency Acoustic Recording Package (HARP; Wiggins and Hildebrand 2007) was deployed between February 2014 and August 2014 in the Jacksonville, FL, survey area at Site C in 88 m. This HARP sampled continuously at 200 kHz and recorded for 188 days between 17 February 2014 and 23 August 2014. The data were divided into three frequency bands (10 Hz – 1000 Hz, 500 Hz – 5000 Hz, and 1 kHz – 100 kHz) and scanned for marine mammal vocalizations using Long-Term Spectral Averages (LTSAs). Vocalizations of fin whales, minke whales, humpback whales, Risso's dolphins, and unidentified delphinids were detected in the data. A 5-pulse signal, previously described in the Jacksonville area, was also heard.

Methods

The February – August 2014 Jacksonville Site C HARP (Jacksonville 10C) was deployed at 30.32643^o N, 80.20493^o W on 17 February 2014 (recording started on 17 February 2014) and recovered on 23 August 2014 (recording ended on 23 August 2014). The instrument location is shown in Figure 1. Bottom depth at the deployment site was approximately 88 m. A schematic diagram of the Jacksonville 10C HARP is shown in Figure 2.

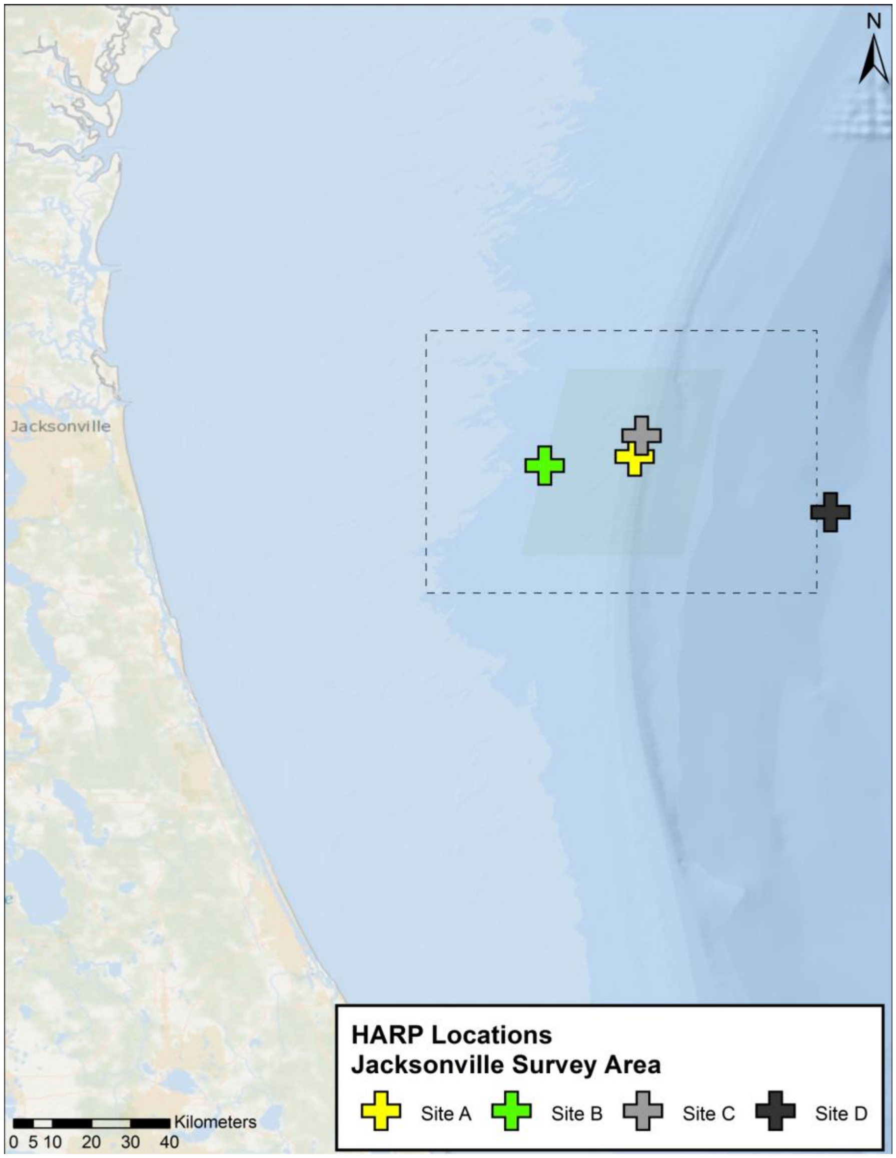

Figure 1. Location of HARP deployment sites in the Jacksonville survey area. The location of the Jacksonville 10C HARP is shown in gray.

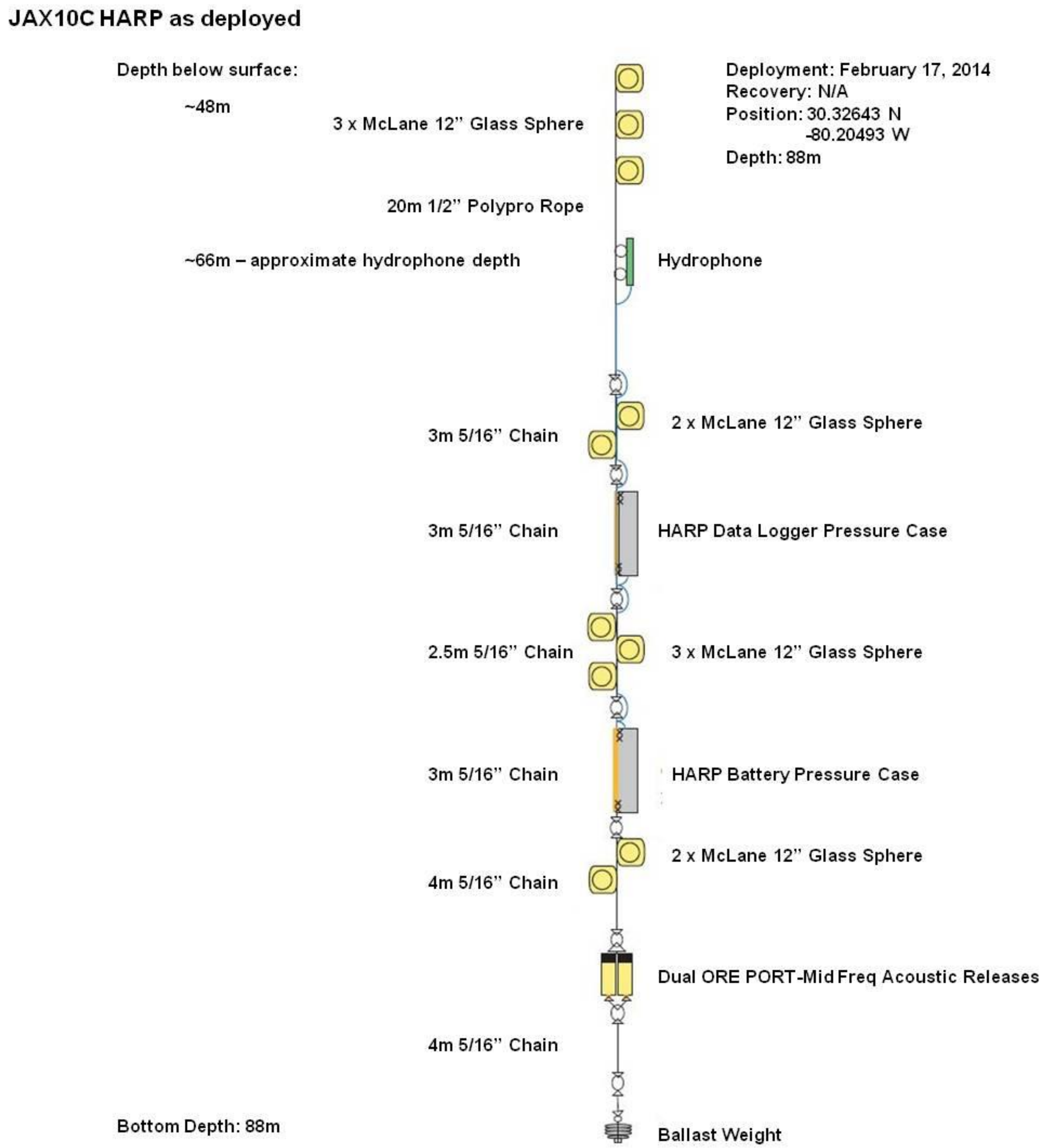

Figure 2. Schematic diagram showing details of the Jacksonville 10C HARP. Note that diagram is not drawn to scale.

Data were acquired continuously at a 200 kHz sampling rate during the Jacksonville 10C deployment. This deployment provided a total of 4488.3 hours of data over the 188 days of recording.

The following methods are a summary of Debich *et al.* (2015). Members of the Scripps Whale Acoustics Lab manually scanned the data from the Jacksonville 10C HARP deployment for marine mammal vocalizations and anthropogenic sounds (sonar, explosions, and shipping) using LTSAs. Automated computer algorithm detectors were also used to analyze the data. LTSAs were made for three frequency bands ((1) 10 – 1000 Hz, (2) 10 – 5000 Hz, and (3) 1 – 100 kHz). The resulting 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: 10-5000 Hz band), and 5 s in time and 100 Hz in frequency (for the data not decimated: 1-100 kHz). Each LTSA was analyzed for sounds of an appropriate subset of species or sources.

For effective analysis of marine mammal and anthropogenic sounds, the data were divided into three frequency bands: (1) low-frequency, between 10-300 Hz, (2) mid-frequency, between 10-5000 Hz, and (3) high-frequency, between 1-100 kHz. Each band was analyzed for the sounds of an appropriate subset of species or sources. Blue, fin, sei, Bryde's, minke, and North Atlantic right whales as well as the 5-pulse signal were classified as low-frequency; humpback whales, killer whale tonal and pulsed calls, shipping, explosions, underwater communications, and mid-frequency active sonar were classified as mid-frequency; and the remaining odontocete and sonar sounds were considered high-frequency.

Detections of most sounds were made by manually scanning LTSAs. However, detectors were used for some calls, including humpback whale calls and beaked whale echolocation signals. Humpback whale call detection effort was automated using a power-law detector (Helble *et al.* 2012). After the generalized power-law algorithm was applied, a trained analyst verified the accuracy of the detected signals. Beaked whale echolocation signals were detected using an automated method and then assigned to species by a trained analyst, as detailed in Debich *et al.* (2015). A Teager Kaiser energy detector (Roch *et al.* 2011) 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. After this, a computer-assisted manual classification step was performed where 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). Explosions were also detected automatically, using a matched filter detector described in further detail in Debich *et al.* (2015). See Debich *et al.* (2015) for a more detailed description of analysis methods. Low-frequency sounds were analyzed in hourly bins; mid- and high-frequency vocalizations were analyzed in one-minute bins. Vocalizations were assigned to species when possible.

Results

Table 1 summarizes the detected and identified marine mammal vocalizations for the Jacksonville 10C HARP deployment. Figures 3-8 show the daily occurrence patterns for the different marine mammal groups (classified to species when possible). Figure 9 shows the occurrence of mid-frequency active sonar. Underwater ambient noise during this deployment is shown in Figure 10.

Fin whale 20-Hz pulses were detected in late February (Figure 3). Minke whale pulse trains were detected in February and March (Figure 4). Humpback whales were detected in February through June, with a peak in detections in late March and slightly more calling during daytime hours (Figure 5).

The 5-pulse signal (previously described in the JAX05A dataset) was detected throughout the deployment, with a peak in detections in July (Figure 6). Most 5-pulse signal detections occurred slightly before sunset and during nighttime hours (Figure 6). As stated in the previous report, this call is presumed to be produced by a mysticete due to its character, prevalence, and intensity.

Detected odontocete vocalizations included clicks and whistles (Figures 7-8). Most of these detections were assigned to the unidentified odontocete category (Figure 7), with clicks being divided into eight main groups based on spectral patterns (see Debich *et al.* 2015 for more details). Only one detection at the beginning of July was assigned to Risso's dolphins (Figure 8).

Table 1. Summary of detections of marine mammal vocalizations at Jacksonville Site C for February – August 2014 (Jacksonville 10C). *Analyzed in hourly bins versus one-minute bins.

Species	**Call type**	**Total duration of vocalizations (hours)**	**Percent of recording duration**	**Days with vocalizations**	**Percent of recording days**
Fin whale*	20 Hz	8	0.18	2	1.06
Minke whale*	pulse train (slow-down, speed-up, regular)	166	3.70	27	14.36
Humpback whale	song or non-song (not separated)	3.83	0.09	46	24.47
Possible mysticete*	5-pulse signal	580	12.92	82	43.62
Unidentified odontocete	clicks, whistles, burst-pulses	2210.72	49.26	186	98.94
Risso's dolphin	clicks	1	0.02	1	0.53

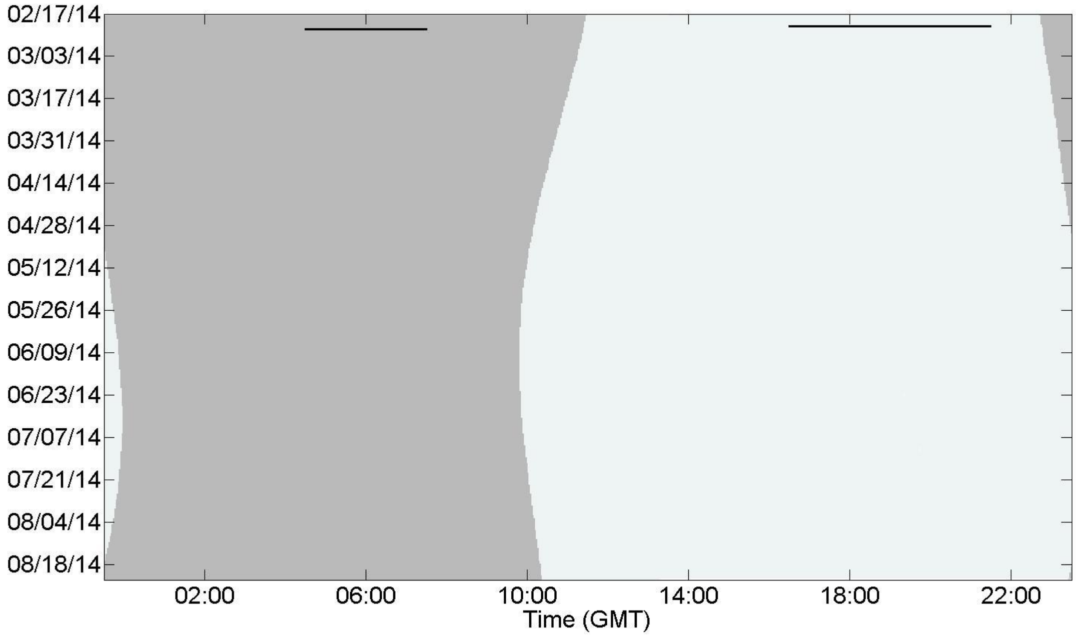

Figure 3. Fin whale 20-Hz pulse detections (black bars) in hourly bins within the Jacksonville 10C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

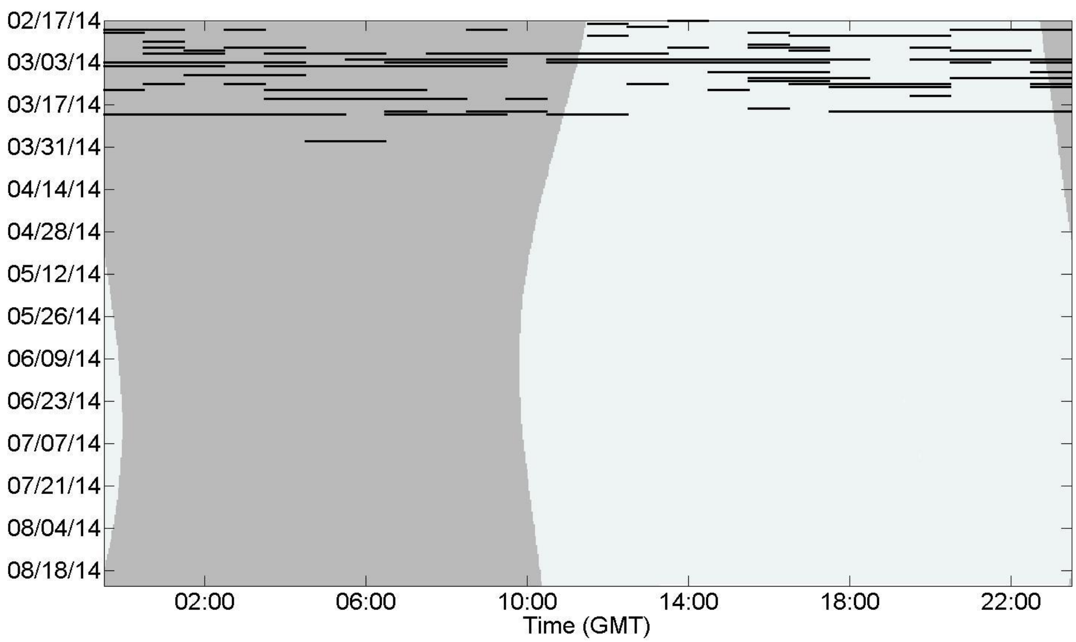

Figure 4. Minke whale pulse train detections (black bars) in hourly bins within the Jacksonville 10C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

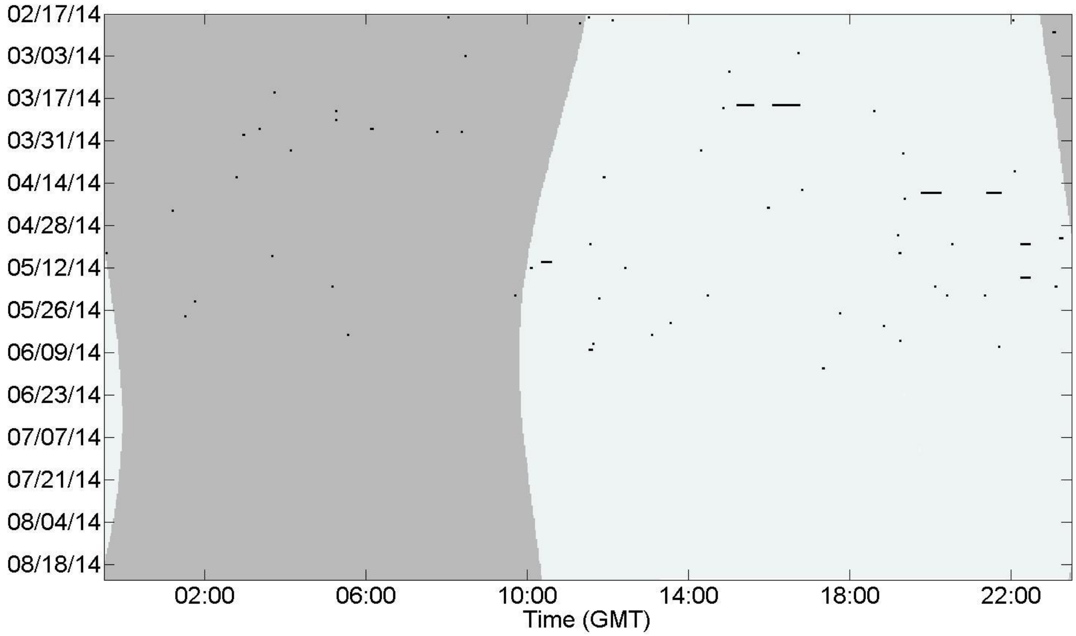

Figure 5. Humpback whale detections (black bars) in one-minute bins within the Jacksonville 10C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

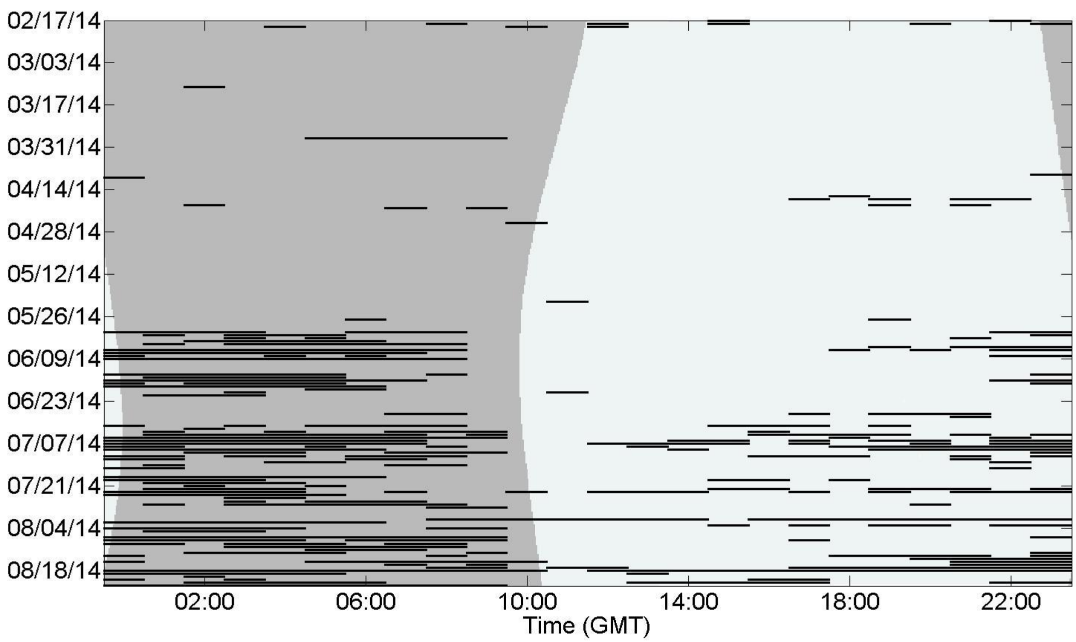

Figure 6. 5-pulse signal detections (black bars) in hourly bins within the Jacksonville 10C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

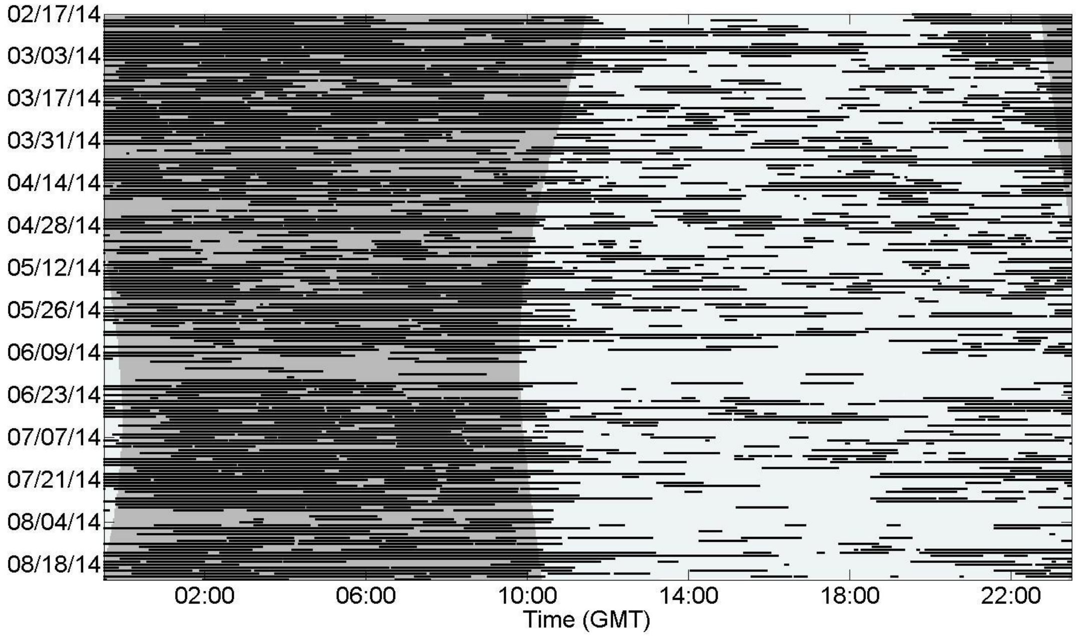

Figure 7. Unidentified odontocete click and whistle detections (black bars) in one-minute bins within the Jacksonville 10C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

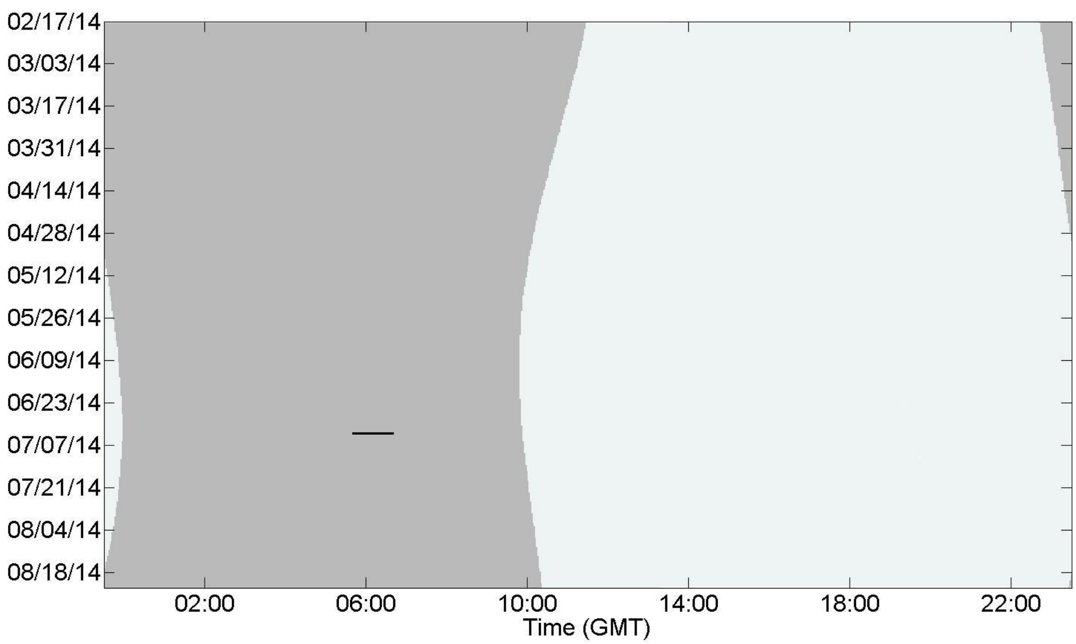

Figure 8. Risso's dolphin click detections (black bars) in one-minute bins within the Jacksonville 10C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

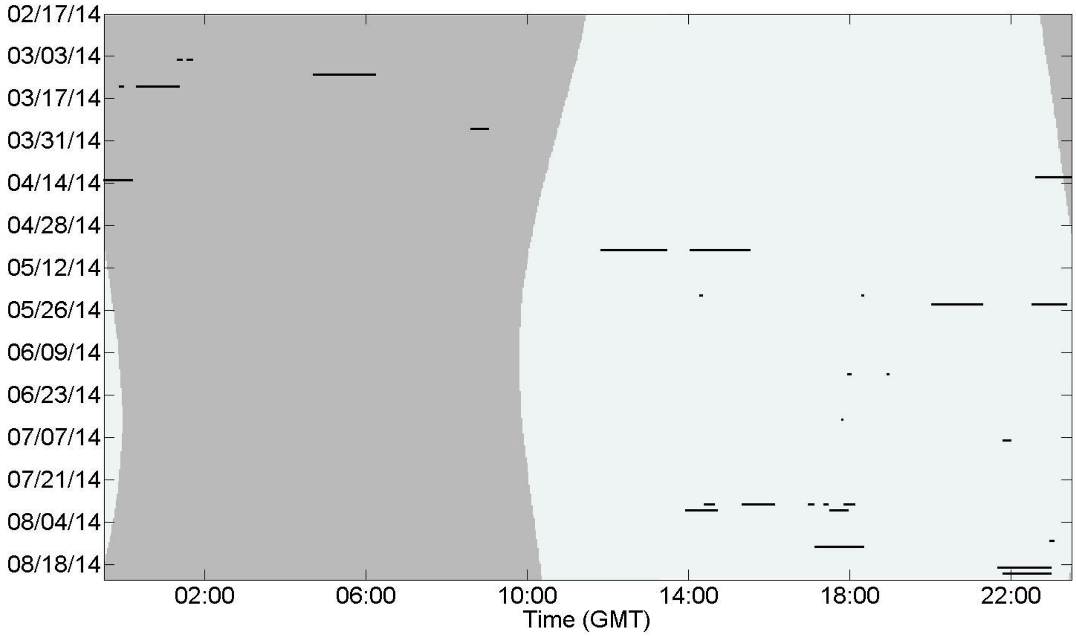

Figure 9. Mid-frequency active sonar (black bars) detected during the Jacksonville 10C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

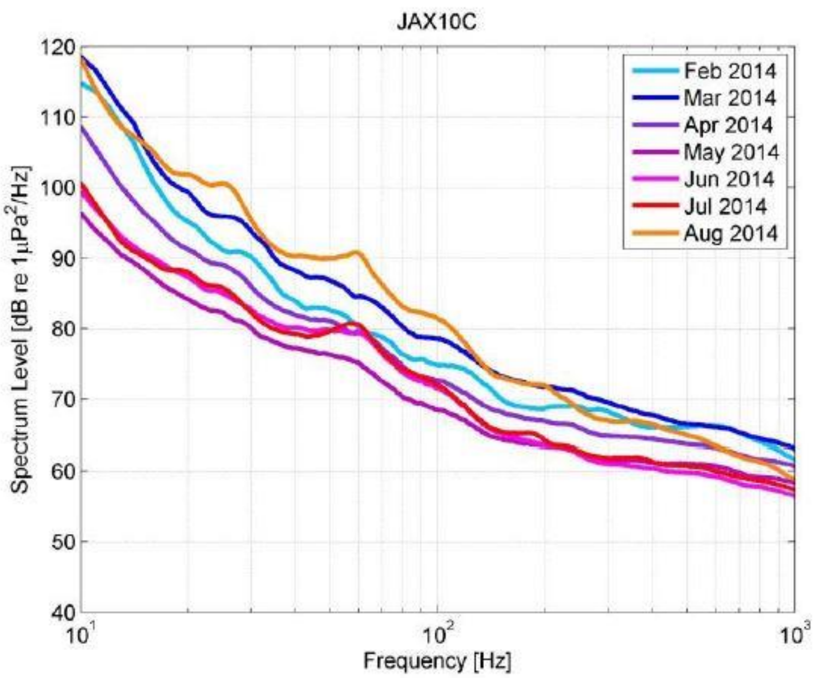

Figure 10. Monthly averages of ambient noise at Jacksonville, FL, Site C for February – August 2014. Figure from Appendix 6 of Wiggins 2015.

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