Passive Acoustic Monitoring for Marine Mammals at Site C in Jacksonville, FL, May – June 2013

A Summary of Work Performed by Amanda J. Debich, Simone Baumann-Pickering, Ana Širović, John A. Hildebrand, Alexa L. Alldredge, Rachel S. Gottlieb, Sean T. Herbert, Sarah C. Johnson, Ally C. Rice, Jenny S. Trickey, Leah M. Varga, Sean M. Wiggins, Lynne E.W. Hodge, and Andrew Read

Marine Physical Laboratory
Scripps Institution of Oceanography
University of California San Diego
La Jolla, CA 92037

Prepared by Lynne Hodge and Andrew Read

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

Submitted to:
The Department of the Navy
Norfolk, VA

Suggested Citation:

Hodge, L. and A. Read. 2015. Passive Acoustic Monitoring for Marine Mammals at Site C in Jacksonvill, FL, May – June 2013. Technical Report. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011, Task Order CTO 0051, issued to HDR Inc., Norfolk, Virginia. Prepared 4 May 2015.

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

This project is funded by US Fleet Forces Command and managed by Naval Facilities Engineering Command Atlantic as part of the US Navy's marine species monitoring program.

Abstract

A High-frequency Acoustic Recording Package (HARP; Wiggins and Hildebrand 2007) was deployed between May 2013 and February 2014 in the Jacksonville, FL, survey area at Site C in 94 m. This HARP sampled continuously at 200 kHz and recorded for 39 days between 13 May 2013 and 20 June 2013. 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 unidentified delphinids were detected in the data.

Methods

The May – June 2013 Jacksonville Site C HARP (Jacksonville 09C) was deployed at 30.33287^{o} N, 80.20071^{o} W on 12 May 2013 (recording started on 13 May 2013) and recovered on 17 February 2014 (recording ended on 20 June 2013, earlier than expected due to a loose internal connection which caused disk skipping). The instrument location is shown in Figure 1. Bottom depth at the deployment site was approximately 94 m. A schematic diagram of the Jacksonville 09C HARP is shown in Figure 2.

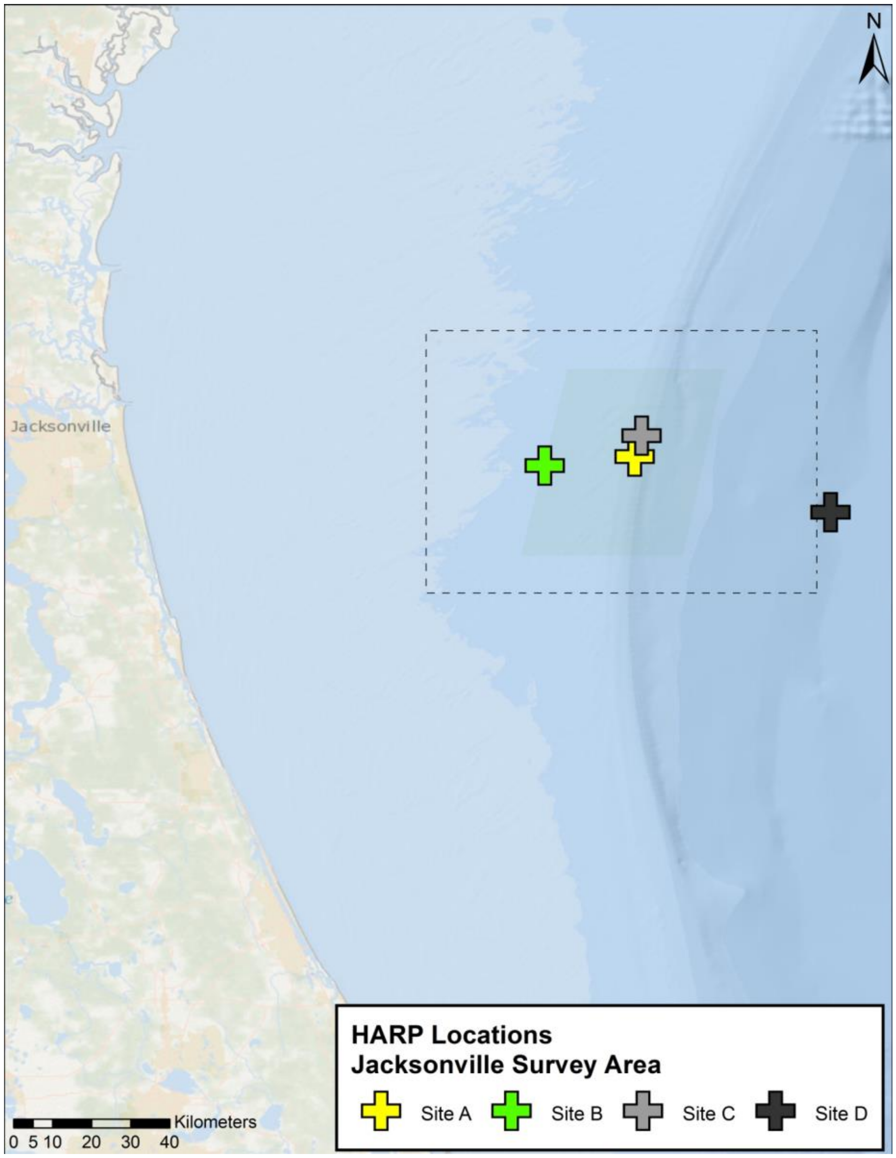

Figure 1. Location of HARP deployment sites in the Jacksonville survey area. The location of the Jacksonville 09C HARP is shown in gray.

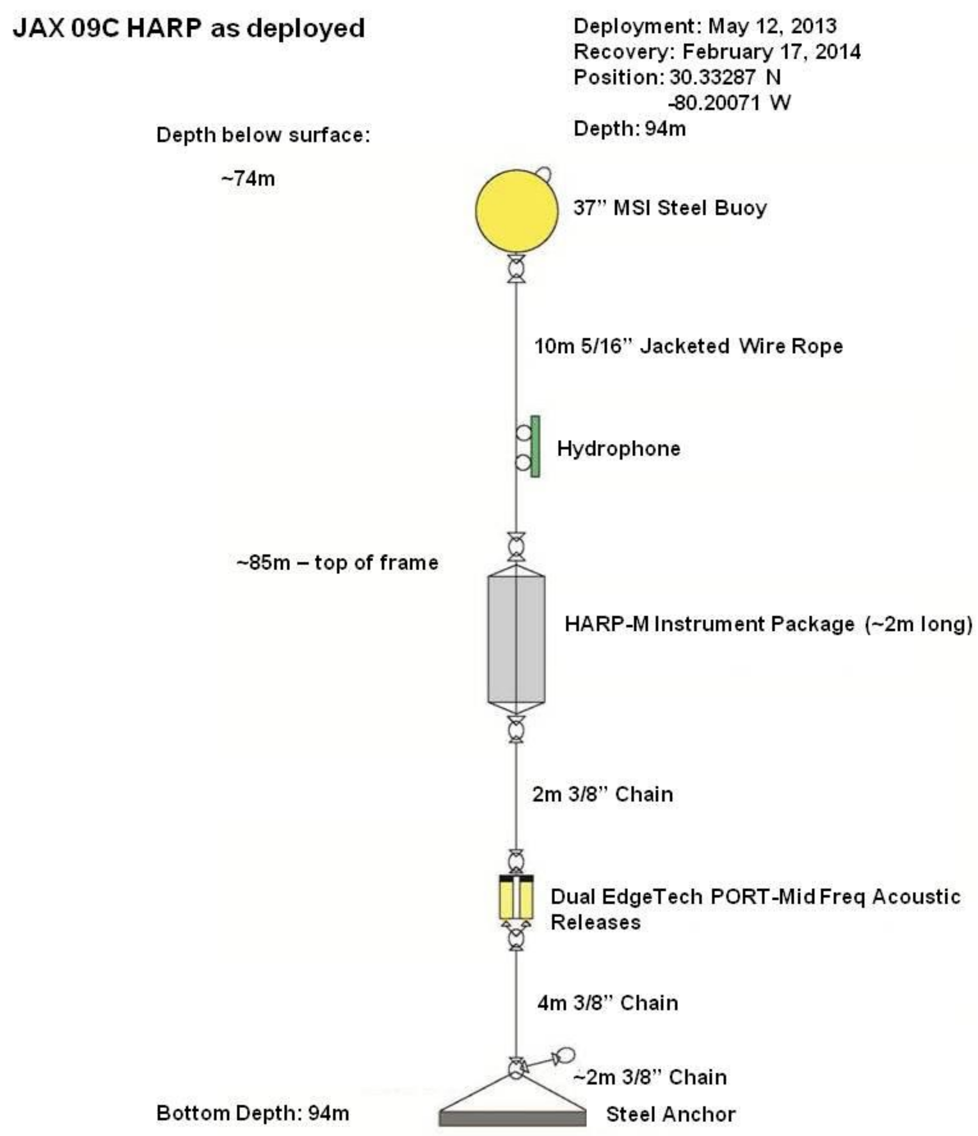

Figure 2. Schematic diagram showing details of the Jacksonville 09C HARP. Note that diagram is not drawn to scale.

Data were acquired continuously at a 200 kHz sampling rate during the Jacksonville 09C deployment. This deployment provided a total of 926.5 hours of data over the 39 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 09C 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, beaked whale echolocation signals, and delphinid clicks. 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). Also, for this particular dataset, manual detection of delphinid echolocation was difficult due to strong activity of snapping shrimp. Thus, unlike in previous datasets, to determine time periods with acoustic encounters with dolphins (based on clicks), the Teager Kaiser energy click detector was run with a threshold set high enough to yield no false detections (yet allow for an acceptable number of missed detections). 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.

The data between 23 May 2013 and 7 June 2013 appeared as if they were duty cycled due to a loose connector on the datalogger Ether/IDE card, which was discovered after the instrument was recovered. This loose connection caused disk skipping and ‘buffer wrap around’ concurrent with intense periods of strumming and full/new moon phases. Instead of continuous recording during this period, the recording times varied from 20-21 minutes on with 6-14 minutes off.

Results

Table 1 summarizes the detected and identified marine mammal vocalizations for the Jacksonville 09C HARP deployment. Figure 3 shows the daily occurrence patterns for the unidentified odontocetes, the only category of marine mammals detected in this dataset. Figure 4 shows the occurrence of mid-frequency active sonar. Underwater ambient noise during this deployment is shown in Figure 5.

Detected odontocete vocalizations included clicks and whistles (Figure 3). Clicks were divided into seven main groups based on spectral patterns (see Debich *et al.* 2015 for more details).

Table 1. Summary of detections of marine mammal vocalizations at Jacksonville Site C for May – June 2013 (Jacksonville 09C).

Species	**Call type**	**Total duration of vocalizations (hours)**	**Percent of recording duration**	**Days with vocalizations**	**Percent of recording days**
Unidentified odontocete	clicks, whistles, burst-pulses	166.55	21.47	39	100

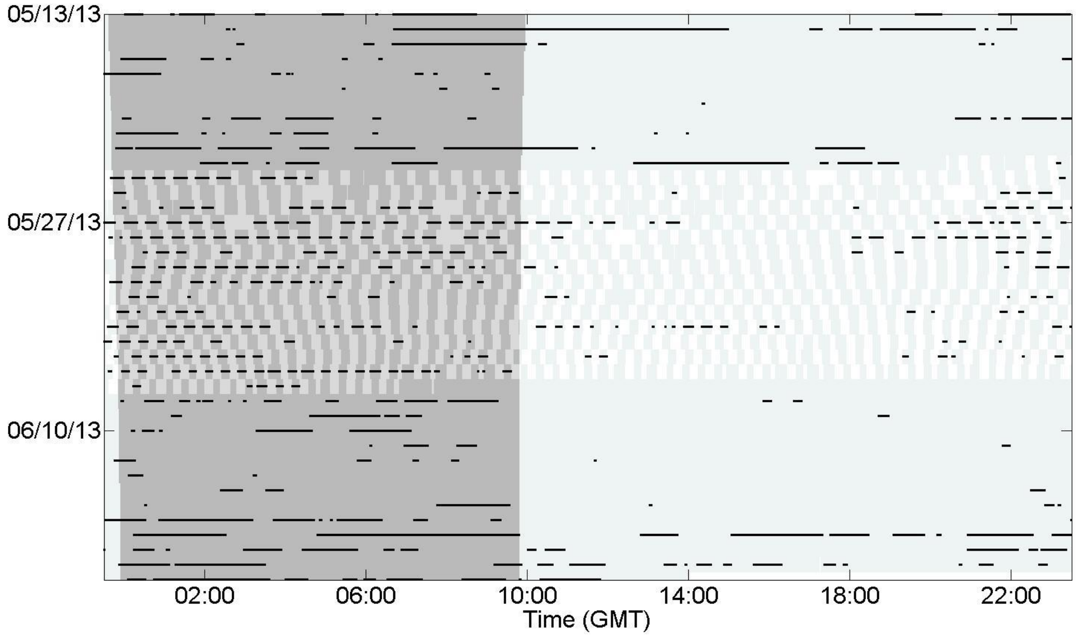

Figure 3. Unidentified odontocete click and whistle detections (black bars) in one-minute bins for the Jacksonville 09C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

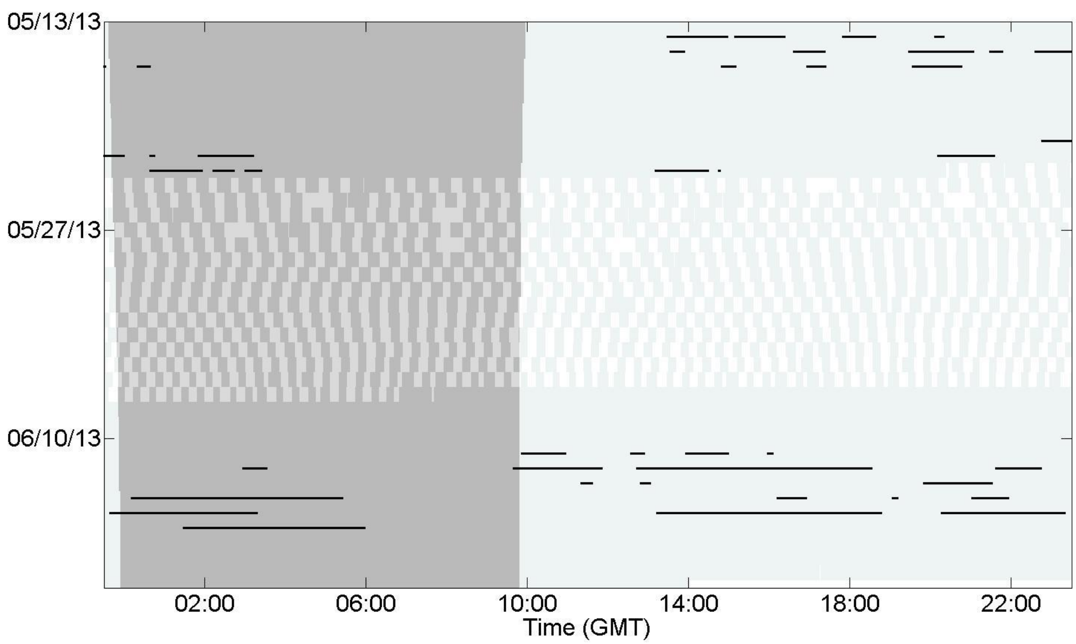

Figure 4. Mid-frequency active sonar (black bars) detected during the Jacksonville 09C deployment. Dark gray shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil). Lighter shading indicates recording/analysis effort.

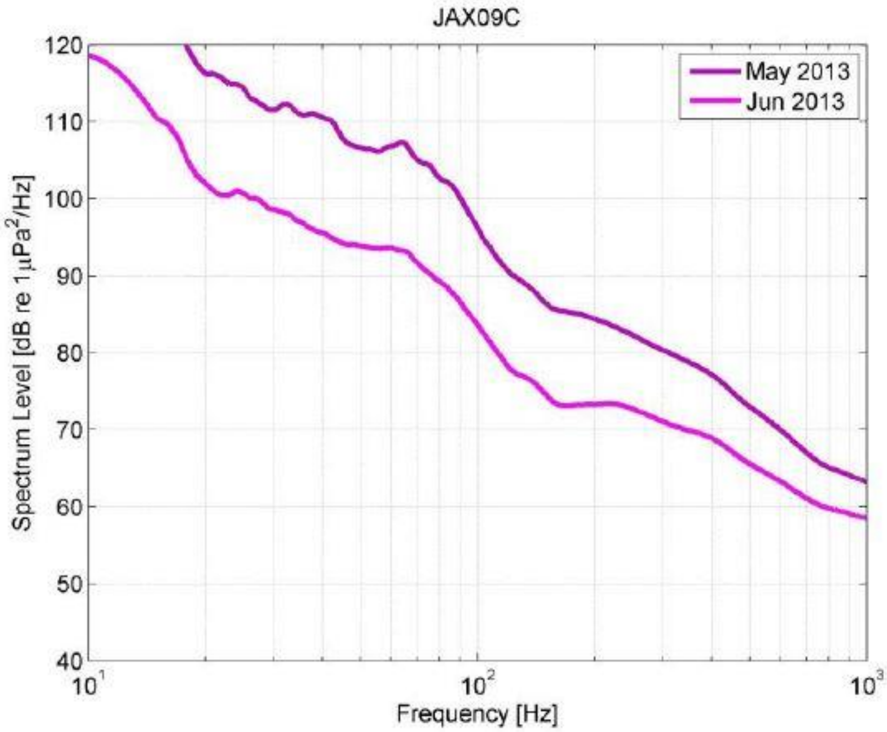

Figure 5. Monthly averages of ambient noise at Jacksonville, FL, Site C for May – June 2013. Figure from Appendix 6 of Wiggins 2015.

References

Baumann-Pickering, S., M.A. McDonald, A.E. Simonis, A. Solsona Berga, K.P.B. Merkins, E.M. Oleson, M.A. Roch, S.M. Wiggins, S. Rankin, T.M. Yack, and J.A. Hildebrand. 2013. Species-specific beaked whale echolocation signals. *Journal of the Acoustical Society of America* **134**: 2293-2301.

Debich, A.J., S. Baumann-Pickering, A. Širović, J.A. Hildebrand, A.L. Alldredge, R.S. Gottlieb, S.T. Herbert, S.C. Johnson, A.C. Rice, J.S. Trickey, L.M. Varga, S.M. Wiggins, L.E.W. Hodge, and A.J. Read. 2015. Passive acoustic monitoring for marine mammals in the Jacksonville Range Complex May 2013 – August 2014. Final Report, Marine Physical Laboratory Technical Memorandum #555.

Roch, M.A., H. Klinch, S. Baumann-Pickering, D.K. Mellinger, S. Qui, M.S. Soldevilla, and J.A. Hildebrand. 2011. Classificaiton of echolocation clicks from odontocetes in the Southern California Bight. *Journal of the Acoustical Society of America* **129**: 467-475.

Wiggins, S.M. 2015. Low-frequency ambient noise offshore of North Carolina and Florida 2007-2014. Final Report. Marine Physical Laboratory Technical Memorandum 556. April 2015. Submitted to Naval Facilities Engineering Command (NAVFAC) Atlantic, Norfolk, Virginia, under Contract No. N62470-10-D-3011- Task Order Number 051 issued to HDR, Inc.

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.