Annual Report 2014: Passive Acoustic Monitoring for North Atlantic Right Whales at Cape Hatteras, NC, using Marine Autonomous Recording Units, October 2013 – December 2014

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Prepared by:

Joy Stanistreet, Sofie Van Parijs, and Andrew Read

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

Submitted by:

Virginia Beach, VA

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Marine Acoustic Recording Units. Photo courtesy of Duke University.

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Acronyms and Abbreviations

kHz	kilohertz
MARU	Marine Autonomous Recording Unit

1. Introduction

In fall 2013, Duke University and the National Oceanic and Atmospheric Administration Northeast Fisheries Science Center initiated a passive acoustic monitoring effort to detect North Atlantic right whales (*Eubalaena glacialis*) migrating past Cape Hatteras, North Carolina, during their seasonal movements to and from winter breeding grounds in Florida. The objectives of this project are to investigate the timing of right whale migration through the Mid-Atlantic region, as well as the relative distance from shore and acoustic behavior of migrating whales. This effort will help to fill a data gap in the central portion of the migratory corridor, and contribute to a broader understanding of the seasonal occurrence of right whales along the U.S. east coast. The project is ongoing, and this report details passive acoustic data collection and analysis between October 2013 and December 2014.

2. Methods

2.1 Passive Acoustic Data Collection

Passive acoustic data were collected using Marine Autonomous Recording Units (MARUs, Calupca et al. 2000, **Figure 1**). MARUs are buoyant, self-contained units consisting of an HTI-94-SSQ hydrophone mounted outside a pressurized glass sphere containing computer electronics, batteries, and hard drives, and encased in a plastic hard hat. For deployment, each MARU was attached via an acoustic release mechanism with a stainless steel burn wire to a 1.5-meter wire rope shackled to a steel anchor. While deployed, the MARU hydrophone was positioned approximately 2 meters above the sea floor. All units were programmed to record continuously at a sample rate of 2,000 hertz and a 12-bit resolution. A Sirtrack KiwiSat 202 PTT unit was attached to each MARU to provide position information via the ARGOS satellite system upon surfacing.

Figure 1. MARUs prepared for deployment.

Five MARUs were deployed in a linear configuration across the continental shelf at Cape Hatteras, North Carolina, on October 4, 2013 (**Figure 2**; **Table 1**). MARU 01-1 surfaced prior to recovery during a winter storm on February 13, 2014, activating its ARGOS satellite tracking unit. Researchers were unable to recover this unit before it was swept far offshore by the Gulf Stream. The remaining four MARUs were retrieved on February 23, 2014, and five new MARUs were deployed at the same sites (**Figure 2**; **Table 2**). MARUs 02-1 and 02-3 both surfaced during a storm on March 7, 2014. MARU 02-1 was successfully recovered, while MARU 02-3 was swept offshore. It continued to transmit its position via the ARGOS satellite system, but has not been recovered to date.

The Hatteras01 deployment in fall 2013 resulted in 142 recording days on the four recovered MARUs (October 4, 2013–February 23, 2014). The Hatteras02 deployment in spring 2014 resulted in 12 recording days on MARU 02-1 (February 23, 2014–March 7, 2014), and 104 recording days on the remaining three MARUs (February 23, 2014–June 7, 2014).

The second year of the project began in October 2014, with a deployment of five MARUs on October 6, 2014 (**Table 3**). Improvements were made to both the mooring system and the burn wire to strengthen all attachment points. However, the Cape Hatteras study area has continued to be a challenging location for moored instruments, due to the shallow depths and strong winds that frequently occur in this region during the winter. Despite the improved mooring system, another unit, MARU 03-3, surfaced during a storm on December 7, 2014. This unit is still being tracked via the ARGOS system but has not been recovered to date. The remaining four MARUs are scheduled to be retrieved in March 2015, and replaced with a new set for spring 2015.

2.2 Analysis

Data from all recovered MARUs from the Hatteras01 (fall 2013) and Hatteras02 (spring 2014) deployments have been analyzed for North Atlantic right whale up-calls. An automated low-frequency detection and classification system (Baumgartner and Mussoline 2011) was used to scan the recordings for potential right whale up-calls. This system uses a pitch-tracking algorithm to track the temporal variation in the fundamental frequency of low-frequency tonal calls, and compares the resulting pitch tracks to a reference library for classification to species and call type. An analyst viewed all automated detections, and false detections due to environmental noise, sounds from humpback whales (*Megaptera novaeangliae*), fish, etc. were removed from the analysis. The spatial and temporal occurrence of confirmed right whale up-call detections was analyzed across sites, seasons, and hours of the day.

3. Results

North Atlantic right whale up-calls were detected on 45 of 246 total recording days (17 percent of days). All detections occurred between December 4, 2013 and April 4, 2014. There was a slight peak in the number of hours per week with up-call detections in December and a higher peak in early February (**Figure 3**). Up-calls were detected across all five sites, with the highest numbers on the sites nearest shore (**Figure 3**). These detections were not independent across sites, and some individual up-calls were detected on multiple MARUs. Analysis of the diel occurrence of detected up-calls showed an increase in calling activity during the late afternoon and evening hours (**Figure 4**).

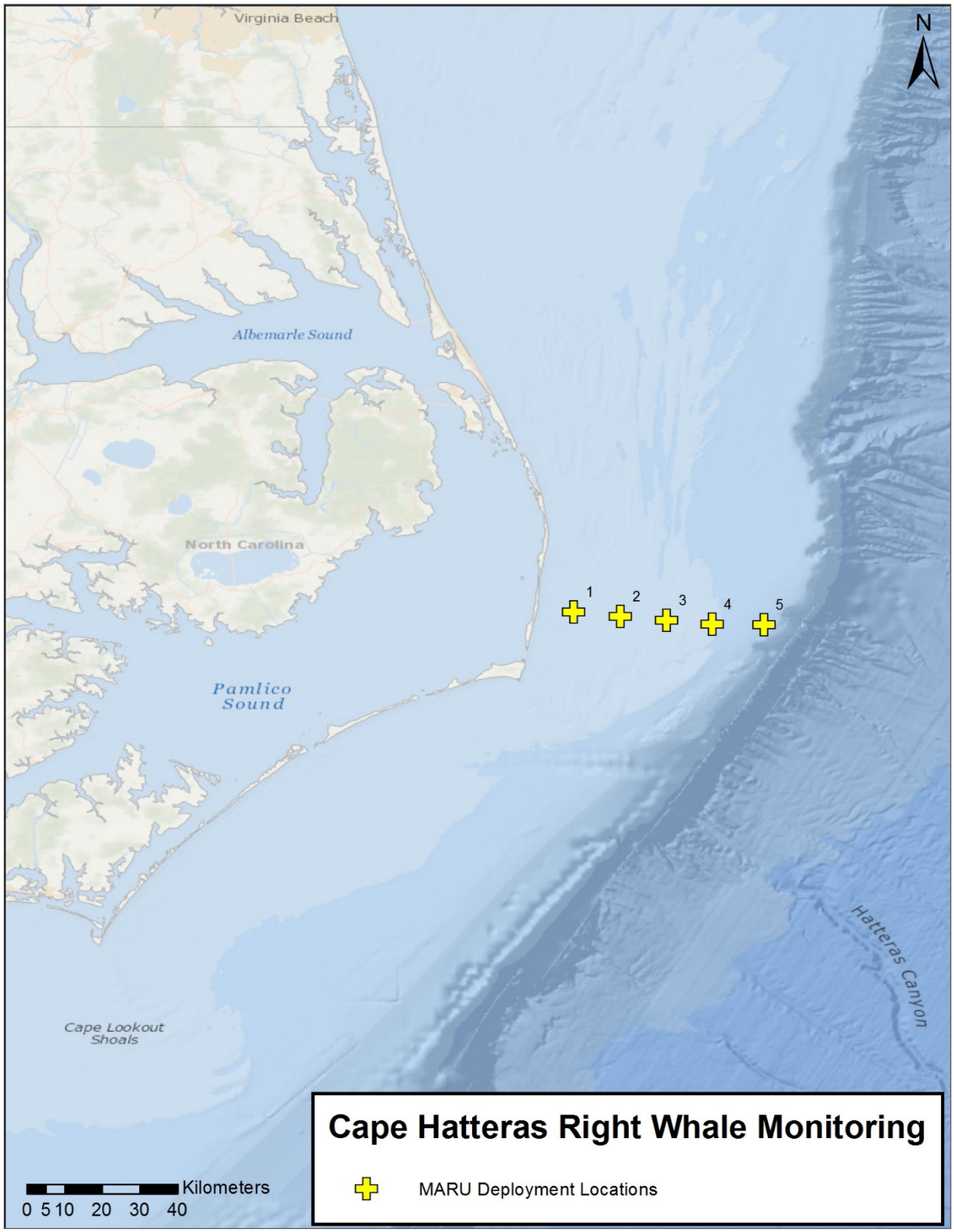

Figure 2. Locations of the MARU deployment sites off Cape Hatteras.

Table 1. Hatteras01 MARU deployment at Cape Hatteras, North Carolina, in fall 2013.

Site	Deployment Date	Retrieval Date	In-water Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
01-1	4-Oct-13	N/A	4-Oct-13	N/A	35.39104	-75.40189	21	2 kHz	continuous
01-2	4-Oct-13	23-Feb-14	4-Oct-13	23-Feb-14	35.3805	-75.28949	26	2 kHz	continuous
01-3	4-Oct-13	23-Feb-14	4-Oct-13	23-Feb-14	35.37138	-75.1795	26	2 kHz	continuous
01-4	4-Oct-13	23-Feb-14	4-Oct-13	23-Feb-14	35.3619	-75.07161	32	2 kHz	continuous
01-5	4-Oct-13	23-Feb-14	4-Oct-13	23-Feb-14	35.35806	-74.9517	87	2 kHz	continuous

Key: kHz = kilohertz; m = meter(s); N/A = not available/applicable

Table 2. Hatteras02 MARU deployment at Cape Hatteras, North Carolina, in spring 2014.

Site	Deployment Date	Retrieval Date	In-water Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
02-1	23-Feb-14	7-Mar-14	23-Feb-14	7-Mar-14	35.39134	-75.40128	21	2 kHz	continuous
02-2	23-Feb-14	7-Jun-14	23-Feb-14	7-Jun-14	35.38071	-75.28926	25	2 kHz	continuous
02-3	23-Feb-14	N/A	23-Feb-14	N/A	35.3712	-75.17887	27	2 kHz	continuous
02-4	23-Feb-14	7-Jun-14	23-Feb-14	7-Jun-14	35.36169	-75.07072	32	2 kHz	continuous
02-5	23-Feb-14	7-Jun-14	23-Feb-14	7-Jun-14	35.36094	-74.94641	91	2 kHz	continuous

Key: kHz = kilohertz; m = meter(s); N/A = not available/applicable

Table 3. Hatteras03 MARU deployment at Cape Hatteras, NC in fall 2014.

Site	Deployment Date	Retrieval Date	In-water Recording Start Date	Recording End Date	Latitude	Longitude	Depth (m)	Sampling Rate	Duty Cycle
03-1	6-Oct-14	N/A	6-Oct-14	N/A	35.40077	-75.40158	21	2 kHz	continuous
03-2	6-Oct-14	N/A	6-Oct-14	N/A	35.36869	-75.28465	25	2 kHz	continuous
03-3	6-Oct-14	N/A	6-Oct-14	N/A	35.36739	-75.17415	28	2 kHz	continuous
03-4	6-Oct-14	N/A	6-Oct-14	N/A	35.36174	-75.0708	31	2 kHz	continuous
03-5	6-Oct-14	N/A	6-Oct-14	N/A	35.36113	-74.9465	90	2 kHz	continuous

Key: kHz = kilohertz; m = meter(s): N/A = not applicable/available

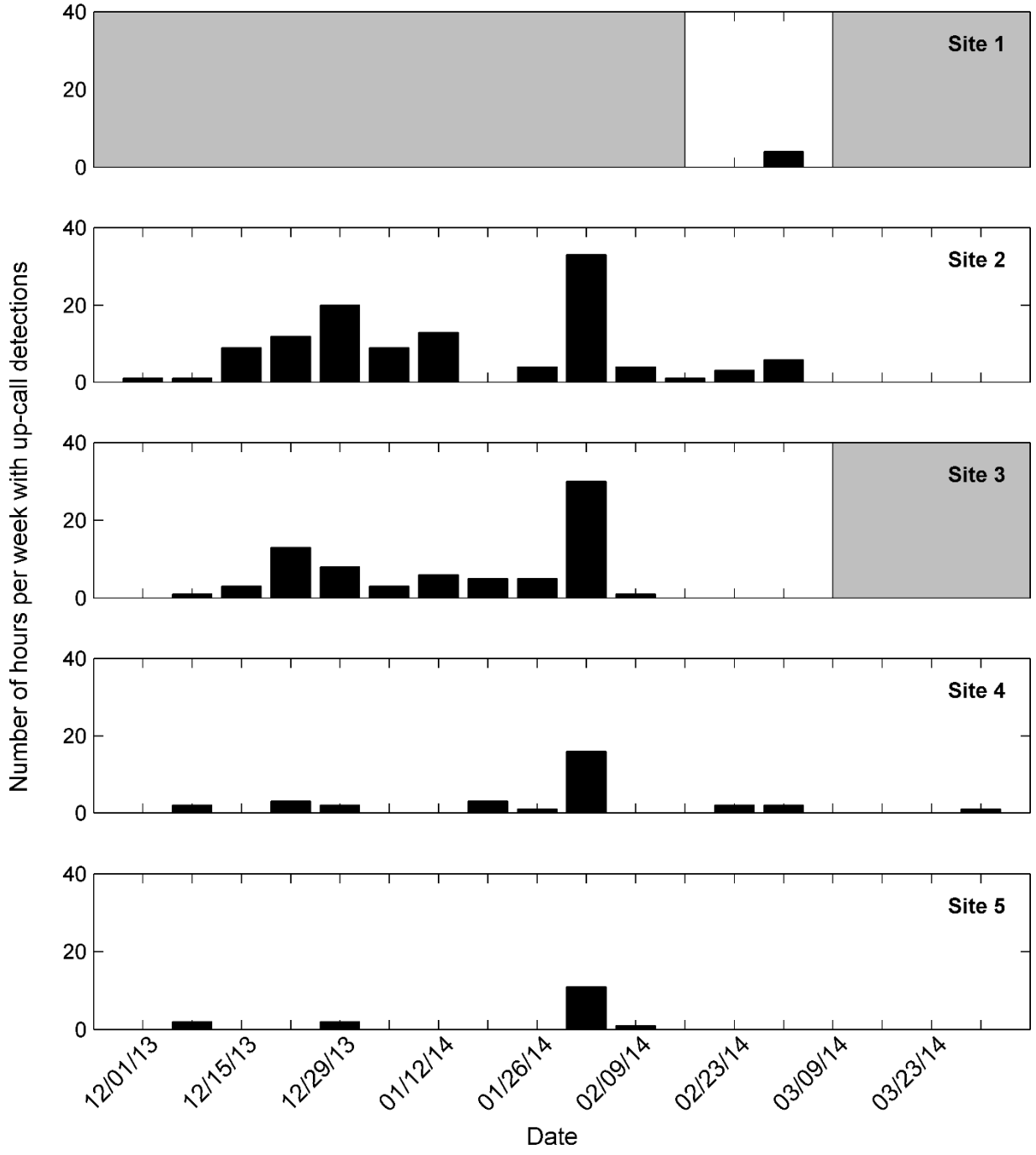

Figure 3. Weekly occurrence of up-call detections across all MARU sites between December 4, 2013 and April 4, 2014. Gray shading indicates periods of no data.

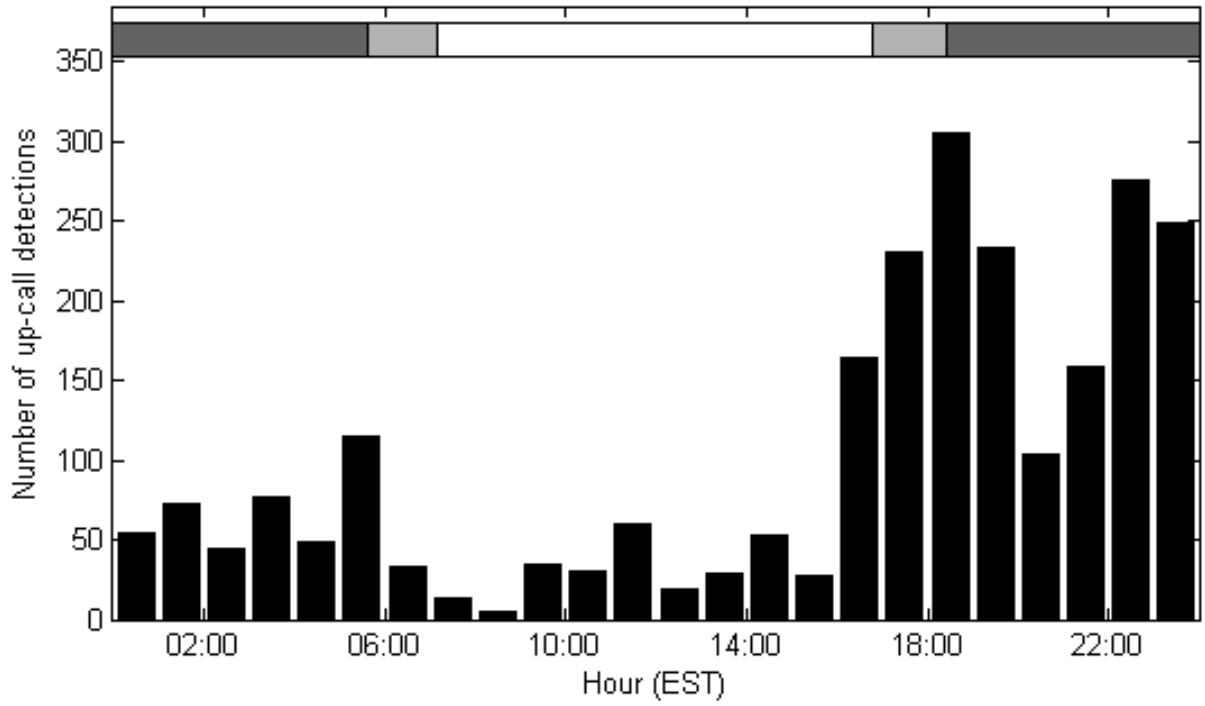

Figure 4. Diel pattern of right whale up-calls detected on all MARUs at Cape Hatteras between December 4, 2013 and April 4, 2014. Vertical bars represent the summed number of up-calls detected in each hour of the day. The horizontal bar indicates periods of darkness (dark gray), periods of daylight (white), and periods that were either dark or light depending on the time of year (light gray).

4. Acknowledgements

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5. References

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