Annual Report 2015:

Passive Acoustic Monitoring for North Atlantic Right Whales at Cape Hatteras, North Carolina, Using Marine Autonomous Recording Units,

October 2014 – March 2015

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Marine Acoustic Recording Units. Photo courtesy of Duke University.

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Table of Contents

Figures

Tables

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. Data collection for this project is now complete, and a manuscript with final results will be prepared for publication in 2016. This report details passive acoustic data collection from October 2014 through August 2015 and results of analysis conducted on data covering October 2014 through March 2015

2. Methods

2.1 MARU 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.**

Continuing the data collection effort that began the previous year (Stanistreet et al. 2015), five MARUs were deployed at Cape Hatteras on 6 October 2014 (**Figure 2; Table 1**). MARU 03-3 surfaced during a strong storm on 7 December 2014. This unit was tracked via the ARGOS satellite system as it drifted south and eventually came within 55 kilometers of shore near the Bahamas. A recovery effort was launched from Great Abaco Island, and the MARU was successfully picked up on 31 March 2015. The remaining four units were recovered on 9 March 2015, and were replaced with five new units in the same locations (**Table 2**). No MARUs from this deployment were lost, and all five units were recovered from the deployed locations on 20 August 2015, completing data collection for the project.

Table 1. **Hatteras03 MARU deployment at Cape Hatteras, North Carolina, in fall 2014.**

Site	Deployment Date	Retrieval Date	In-water Recording Start Date	Recording End Date	Latitude (°N)	Longitude (°W)	Depth (m)	Sampling Rate	Duty Cycle
03-1	6-Oct-14	9-Mar-15	6-Oct-14	9-Mar-15	35.40077	75.40158	21	2 kHz	continuous
03-2	6-Oct-14	9-Mar-15	6-Oct-14	9-Mar-15	35.36869	75.28465	25	2 kHz	continuous
03-3	6-Oct-14	31-Mar-15	6-Oct-14	7-Dec-14	35.36739	75.17415	28	2 kHz	continuous
03-4	6-Oct-14	9-Mar-15	6-Oct-14	9-Mar-15	35.36174	75.07080	31	2 kHz	continuous
03-5	6-Oct-14	9-Mar-15	6-Oct-14	9-Mar-15	35.36113	74.94650	90	2 kHz	continuous

kHz = kilohertz

Table 2. **Hatteras04 MARU deployment at Cape Hatteras, North Carolina, in spring 2015.**

Site	Deployment Date	Retrieval Date	In-water Recording Start Date	Recording End Date	Latitude (°N)	Longitude (°W)	Depth (m)	Sampling Rate	Duty Cycle
04-1	9-Mar-15	20-Aug-15	9-Mar-15	20-Aug-15	35.40117	75.40137	20	2 kHz	continuous
04-2	9-Mar-15	20-Aug-15	9-Mar-15	20-Aug-15	35.36884	75.28403	22	2 kHz	continuous
04-3	9-Mar-15	20-Aug-15	9-Mar-15	20-Aug-15	35.36747	75.17331	33	2 kHz	continuous
04-4	9-Mar-15	20-Aug-15	9-Mar-15	20-Aug-15	35.36181	75.07053	35	2 kHz	continuous
04-5	9-Mar-15	20-Aug-15	9-Mar-15	20-Aug-15	35.36148	74.94601	91	2 kHz	continuous

kHz = kilohertz

The Hatteras03 deployment in fall 2014 resulted in 153 full recording days on four MARUs (7 October 2014–8 March 2015), and 61 usable recording days on MARU 03-3 before it went adrift (7 October 2014–6 December 2014). The Hatteras04 deployment in spring 2015 resulted in 163 full recording days on all five MARUs (10 March 2015–19 August 2015).

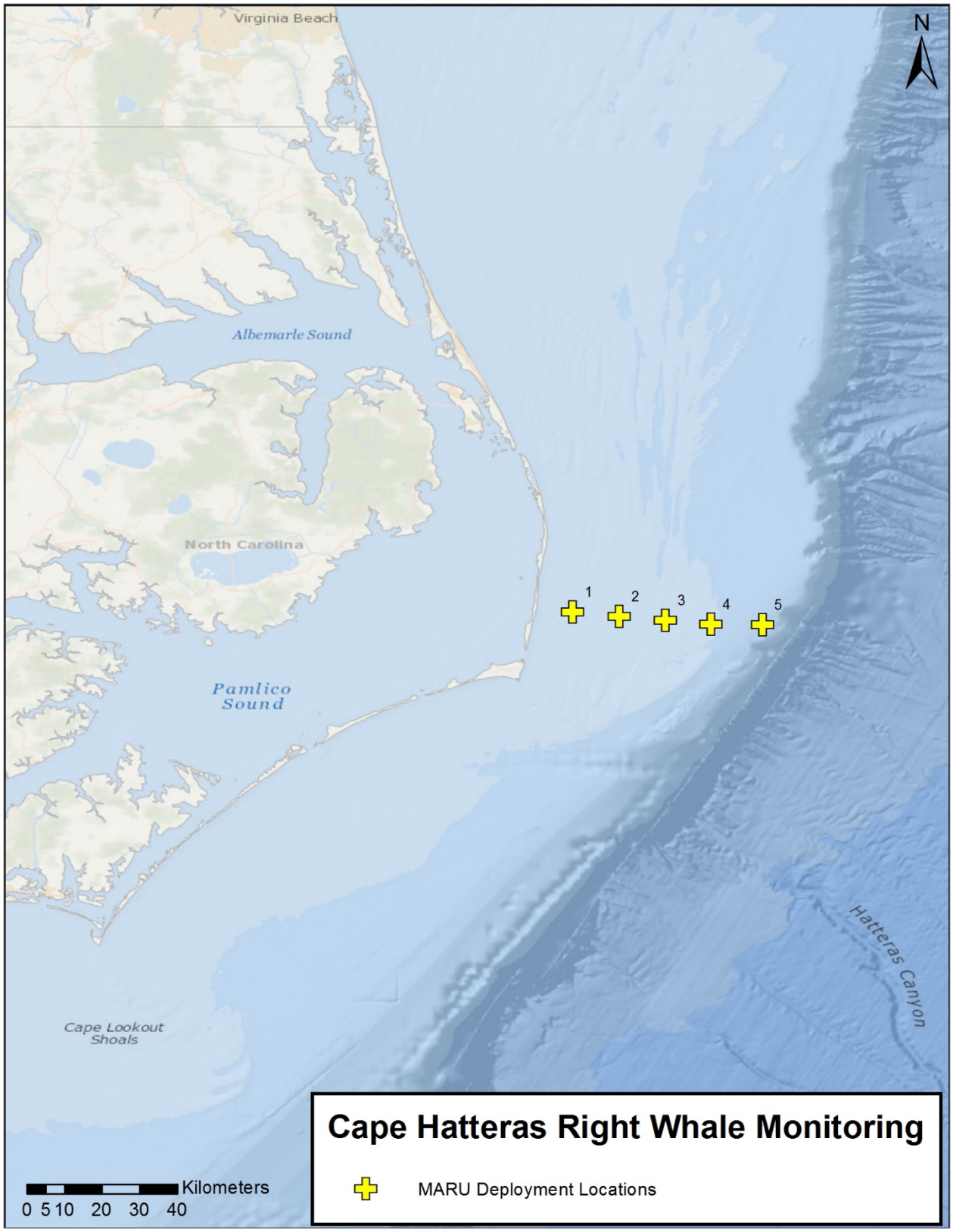

Figure 2. **Locations of the MARU deployment sites off Cape Hatteras.**

2.2 Analysis

Data from all recovered MARUs from the Hatteras03 deployment have been analyzed for North Atlantic right whale up-calls. Analysis of the Hatteras04 dataset is still in progress, and the results for that dataset are not reported here. 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. Some right whale up-calls were recorded on multiple MARUs simultaneously, so to avoid counting these calls more than once, only the first detection of each call (on the MARU nearest to the calling whale) was included in subsequent analyses. 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 62 of 153 recording days in the Hatteras03 dataset (41 percent of days). Up-calls were detected between 27 October 2014 and 8 March 2015. There were unique detections across all five sites, with the highest occurrence of up-call detections at Site 2, peaking in early January (**Figure 3**). Detections at sites 4 and 5 occurred later in the season, with a peak at Site 5 in mid-February (**Figure 3**). Analysis of the diel occurrence of detected up-calls showed an increase in calling activity during the late afternoon and evening hours (**Figure 4**).

4. Future Directions

Data collection for this project is now complete, and a manuscript detailing spatial and temporal patterns in North Atlantic right whale acoustic presence at Cape Hatteras between October 2013 and August 2015 is being prepared for publication. In addition, data from this project are being incorporated into a broad-scale analysis of past and present trends in North Atlantic right whale occurrence along the migratory corridor, led by S. Van Parijs and G. Davis at the NOAA Northeast Fisheries Science Center.

A further 3-year data collection effort supported by the Atlantic Marine Assessment Program for Protected Species (AMAPPS) is ongoing, with 5 MARUs deployed off Cape Hatteras to record low frequency sound from October 2015 through September 2018. Please contact S. Van Parijs for further information on these data.

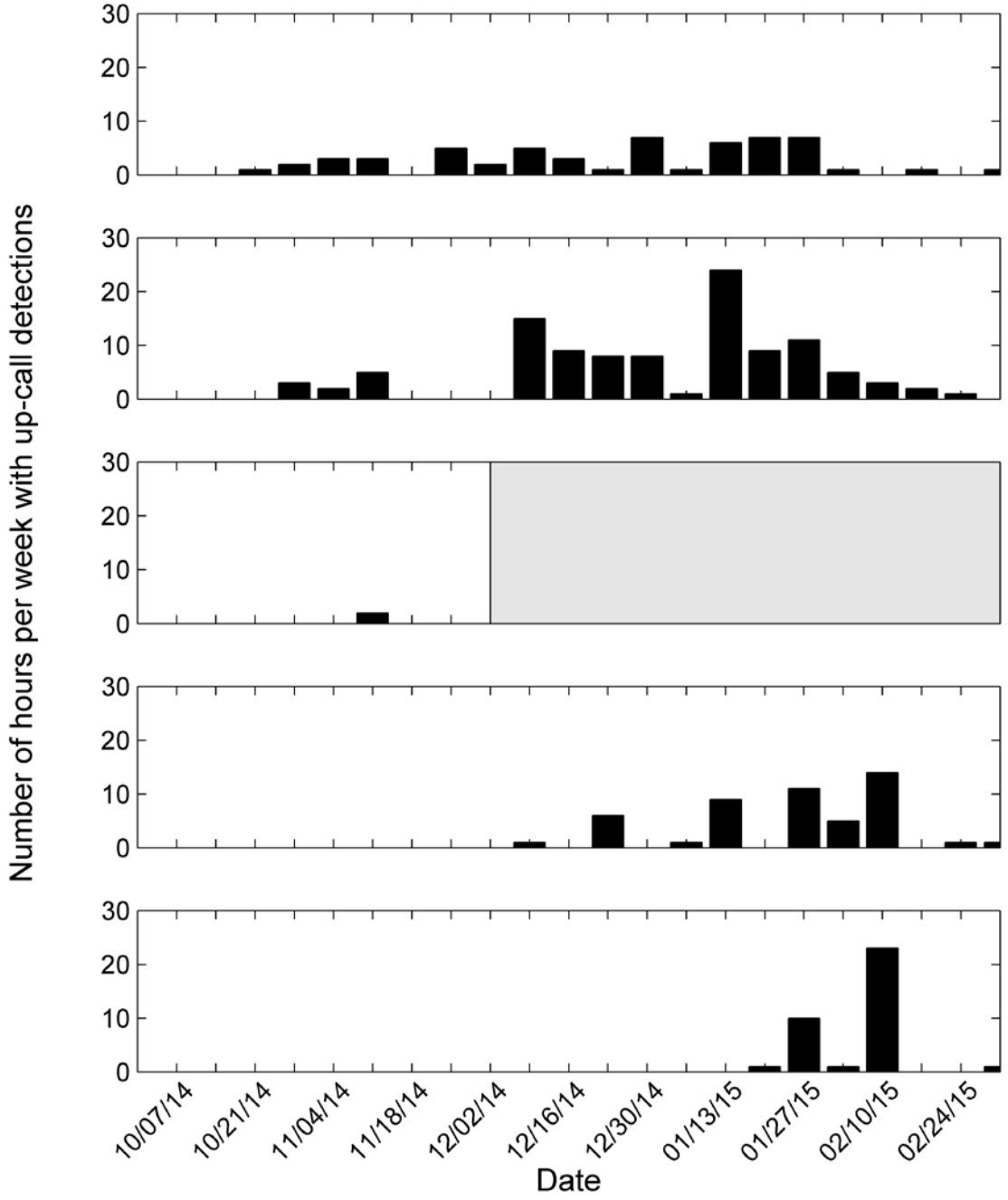

Figure 3. **Weekly occurrence of unique up-call detections across MARU sites 1 (top) through 5 (bottom) between 7 October 2014 and 8 March 2015. Gray shading indicates periods of no data.**

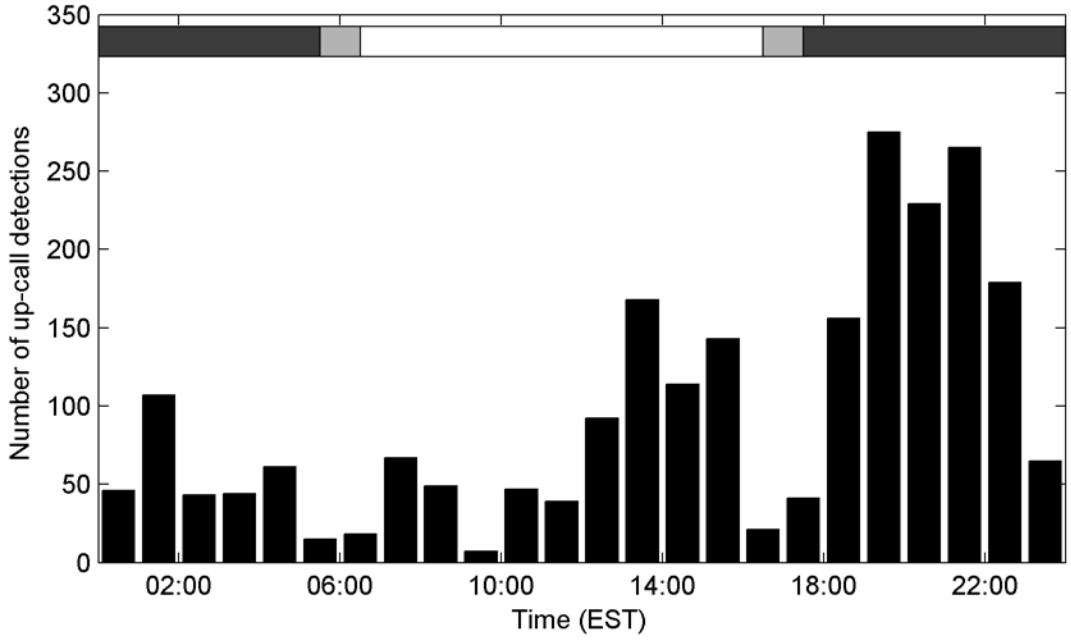

Figure 4. **Diel pattern of right whale up-calls detected on all MARUs at Cape Hatteras between 7 October 2014 and 8 March 2015. Vertical bars represent the summed number of unique up-call detections in each hour of the day. The horizontal bar indicates periods of darkness (dark gray), periods of daylight (white), and periods that were either dark or light depending on the time of year (light gray).**

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6. References

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