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North Atlantic Right Whale **(*Eubalaena glacialis*)**

Passive Acoustic Detections Report: **December 2022 – May 2023**

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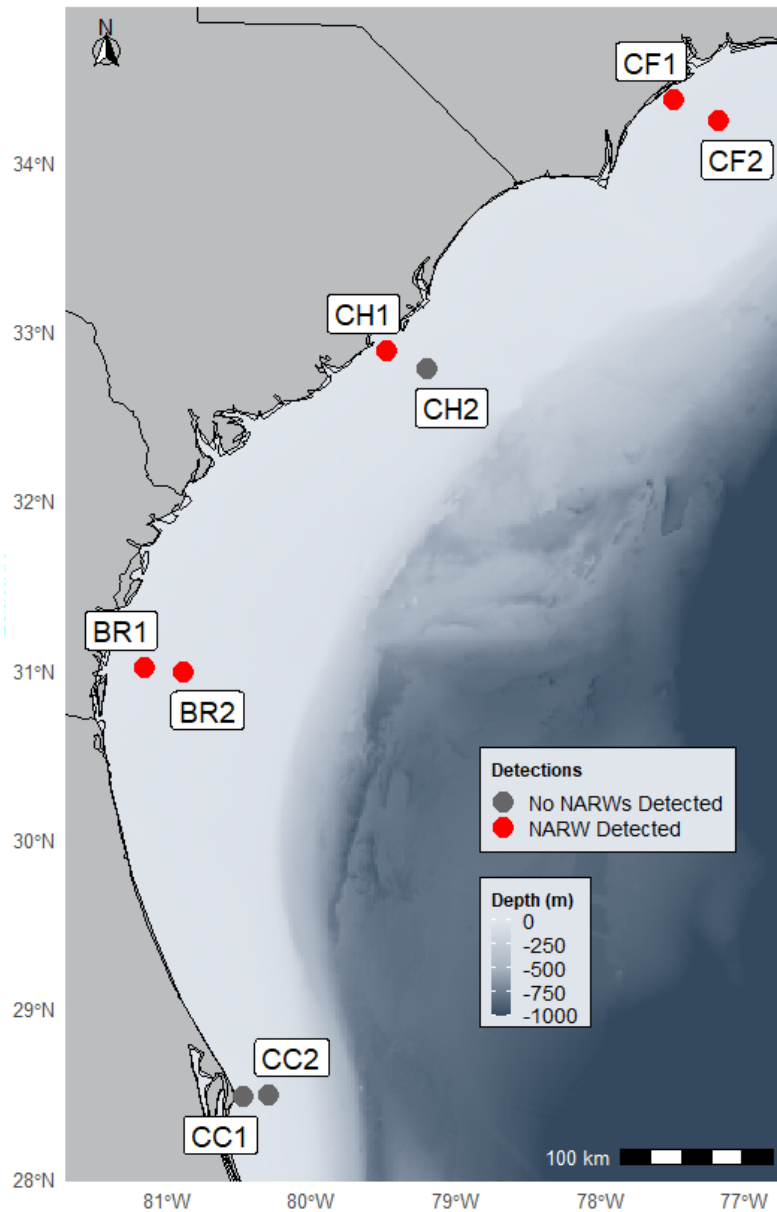


Figure 1. Map of acoustic recorder locations.

INTRODUCTION

The North Atlantic right whale (*Eubalaena glacialis*) is an endangered baleen whale that primarily occupies coastal and shelf waters of the western North Atlantic Ocean, and has a population size of around 370 individuals (Linden, 2024). In these urban waters, North Atlantic right whales are especially at risk for collisions with vessels and entanglement in fishing gear (Moore *et al.*, 2021). Their distribution has been shifting in recent years (Davis *et al.*, 2017), and improved knowledge of the full extent of their calving grounds and location of their migration route is needed to minimize interactions with human activities. Long-term moored passive acoustic monitoring is an efficient and effective tool for monitoring rare whale presence to understand distribution and occurrence patterns. Right whales produce a variety of acoustic signals, including stereotyped, frequency modulated upsweep calls, gunshot calls, variable calls, and moans (Parks *et al.*, 2005, Parks *et al.*, 2019a), which can be identified to species level by trained analysts. To further explore the seasonal movements and distribution of migrating and calving right whales and the soundscapes they inhabit, we deployed long-term passive acoustic recorders at 8 coastal sites from North Carolina to Florida and evaluated recordings for the presence of North Atlantic right whale upcalls.

METHODS

During the 2022 - 2023 winter calving season, over the period from 6 December 2022 to 7 May 2023, 8 moored autonomous recording units were deployed in coastal waters from North Carolina to Florida, with 2 sites per line, and one line per state (Figure 1, Table 1). Moorings consisted of a SoundTrap ST600 STD long-term recorder tethered 3 m above the seafloor, flotation, a Vemco VR2AR acoustic release, and ballast weights (Appendix). The ST600 recorders are factory calibrated at 250 Hz, have a sensitivity of $-177\text{dB re } 1 \mu\text{Pa/V} \pm 3 \text{ dB}$ with a full bandwidth frequency range between 20 Hz – 60 kHz, and can record continuously for up to 6 months. During the study period, all ST600s were set to record continuously to 60-minute files at a 24 kHz sample rate, with high pre-amp gain, and no high pass filter. SoundTraps were programmed in SoundTrap Host software version v4.0.15 (Ocean Instruments, 2023). Prior to deployment, SoundTraps from each line were time-synchronized with 10 impulses to aid in time alignment. The VR2AR acoustic release and Vemco tag receiver was programmed to opportunistically record nearby acoustic tags transmitting at 69 kHz using VUE software version v2.12.5 (Innovasea, 2022).

Following retrieval, acoustic data were offloaded from microSD cards, decompressed from sud to wav files, decimated to 2 kHz, and reviewed for quality control. To automatically detect and classify tonal signals, such as those produced by baleen whales, the automated Low Frequency Detection and Classification System (LFDCS; Baumgartner & Mussoline, 2011) was run. LFDCS created a conditioned spectrogram with 512 FFT at a 75% overlap, 3.9 Hz resolution per bin and 64 ms timestep, and then detected tonal signals and created pitch tracks. The tonal pitch tracks were classified into call types based on a pre-existing call library (gom9) for right whale upcalls, and manually validated for true upcalls by trained analysts. Other right whale call types (Parks *et al.*, 2005) were not classified by LFDCS and are not used in this analysis.

RESULTS

North Atlantic right whale presence by month (Table 1) and week (Figure 2) is summarized for the 8 sites over the 6-month deployment period. North Atlantic right whale upcalls were acoustically present between 0.65 and 5% of days at sites CF1, CF2, CH1, BR1 and BR2, with highest days present at sites CF2 and BR1. North Atlantic right whale upcalls were not detected at sites CH2, CC1 and CC2. Right whales are considered present at a site if three true upcall detections are found in one day. These results indicate minimum right whale presence. A specific date range may contain few or no detections; this does not mean right whales were not present. Passive acoustic monitoring can only determine presence of vocally-active individuals calling within detection range of a recorder. Silent animals, or those calling beyond the range of the recorders, are not represented.

The results presented here represent preliminary analyses. More detailed analyses of call types and total calls per day are in progress. Call detections of low-frequency calls such as those from baleen whales are highly dependent on sound propagation conditions and noise. The data used for this study will be archived at NOAA National Centers for Environmental Information (NCEI).

Table 1: Deployment details and number of days with North Atlantic right whale upcall presence / number of total recording days per month. Months with no recording effort are indicated by x/x.

Location	Site	Recording Period		2022-12	2023-01	2023-02	2023-03	2023-04	2023-05
Cape Fear, NC	CF1	2022-12-07	2023-04-10	1 / 25	0 / 31	0 / 28	0 / 31	0 / 10	x/x
Cape Fear, NC	CF2	2022-12-07	2023-05-07	1 / 25	1 / 31	4 / 28	0 / 31	0 / 30	0 / 7
Charleston, SC	CH1	2022-12-06	2023-05-06	0 / 26	1 / 31	0 / 28	0 / 31	0 / 30	0 / 6
Charleston, SC	CH2	2022-12-06	2023-05-06	0 / 26	0 / 31	0 / 28	0 / 31	0 / 30	0 / 6
Brunswick, GA	BR1	2022-12-08	2023-05-05	2 / 24	3 / 31	2 / 28	0 / 31	0 / 30	0 / 5
Brunswick, GA	BR2	2022-12-08	2023-05-05	1 / 24	0 / 31	1 / 28	0 / 31	0 / 30	0 / 5
Cape Canaveral, FL	CC1	2023-01-02	2023-05-04	x/x	0 / 30	0 / 28	0 / 31	0 / 30	0 / 4
Cape Canaveral, FL	CC1	2023-01-02	2023-05-04	x/x	0 / 30	0 / 28	0 / 31	0 / 30	0 / 4

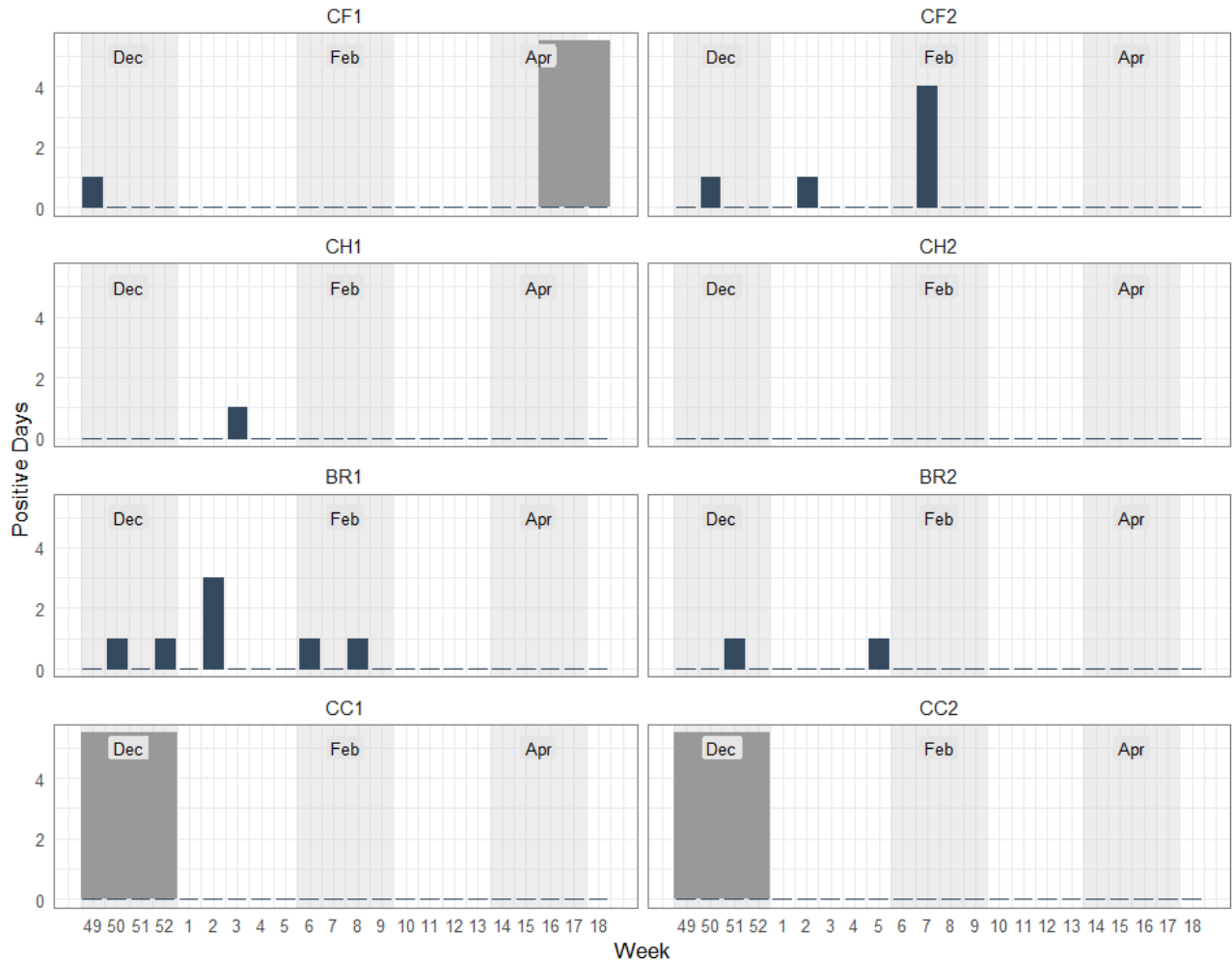


Figure 2: Daily presence of North Atlantic right whale upcalls per week per site over the 6 December 2022 to 7 May 2023 deployment period. Grey and white shading indicates months, with December, February, and April in grey and January, March, and May in white. Dark grey blocks indicate periods without recording effort.

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Appendix

