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NOTE OPEN ACCESS

Recent Acoustic Detection of *Eubalaena japonica* South of the Bering Strait

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The North Pacific right whale (NPRW; *Eubalaena japonica*) is one of the most endangered whale species (Brownell et al. 2001; Young et al. 2024). It comprises genetically distinct western and eastern populations (Pastene et al. 2022), both of which were decimated by legal and illegal whaling in the 19th and 20th centuries (Ivashchenko and Clapham 2012, Ivaschchenko, Clapham and Brownell 2017, Shelden et al. 2005). Today, the endangered western population is believed to number in the hundreds (Pastene et al. 2022), while the Critically Endangered eastern population numbers less than 50 (Cooke and Clapham 2018; Wade et al. 2011).

Mid-19th century whaling records indicate that at that time, NPRWs ranged northward to the Bering Strait (Smith et al. 2012). However, some uncertainty remains as to whether some of the northern records were actually bowhead whales (*Balaena mysticetus*), as these two species were not consistently distinguished from one another at the onset of American commercial whaling in this area (Smith et al. 2012). For the past three decades, the remnant eastern population has occurred predominantly in the southeastern Bering Sea (Shelden et al. 2005; Zerbini et al. 2015).

Recently, both visual observations and acoustic detections have confirmed the presence of right whales in the northern Bering Sea. Notably, a known male right whale was observed feeding approximately 15 km south of St. Lawrence Island on 26 July 2018, and was resighted feeding off the Chukotka Peninsula 3 weeks later (Crance and Kennedy 2024; Filatova et al. 2019; Figure 1). Until the publication of this Note, the northernmost acoustic record of a right whale came from a moored acoustic recorder located 185 km south of St. Lawrence Island in 2016 (Figure 1), with calling detected from 27 July through the end of recording on 25 September (Wright et al. 2019). These detections included gunshot calls, defined as brief (< 0.2 s), broadband signals that can be produced in bouts for periods ranging from 30 min to several hours (Crance et al. 2017, 2019; Rone et al. 2012) as well as bouts of right whale upcalls, which are defined as ~1 s 80–160 Hz frequency sweeps that occur in irregular spacing and are the presumed contact call of all three right whale species (McDonald and Moore 2002, Munger et al. 2008, Parks 2022).

Since 2012, the NOAA Alaska Fisheries Science Center Marine Mammal Laboratory (AFSC-MML) has maintained a network of subsurface moorings with passive acoustic recorders in the US Arctic waters. The northernmost Bering Sea mooring—NM01—has been stationed 107 km south of the Bering Strait (Figure 1, Table 1). All acoustic data from the NM01 recorders[1] between August 2012 and September 2022 have been manually analyzed by trained analysts using an in-house MATLAB script, *SoundChecker* (Wright et al. 2019), for NPRW calls in addition to bowhead whale, humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), walrus (*Odobenus rosmarus divergens*), minke whale

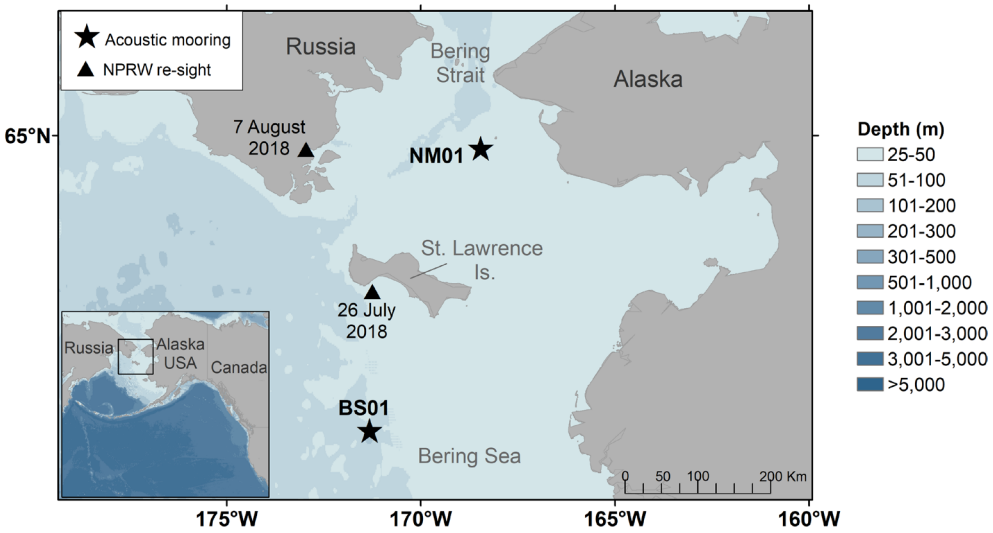

FIGURE 1 | Map of the study region. Stars indicate passive acoustic mooring locations—NM01 (this study) and BS01 (which recorded North Pacific right whale calls in 2016; Wright et al. 2019). Triangles indicate confirmed North Pacific right whale sightings in 2018 (Crance and Kennedy 2024; Filatova et al. 2019).

TABLE 1 | Recorders stationed at mooring NM01.

Recorder	Lat (°N)	Long (°W)	Recorder start	Recorder end	Water depth (m)	Days with recordings	Days with calls	Details
AW12_AU_NM01	64.84735	168.38977	8/20/2012	8/21/2013	42	366	0	
AW13_AU_NM01	64.84837	168.39058	8/22/2013	9/21/2014	42	395	0	
AW14_AU_NM01	64.84863	168.39007	9/22/2014	8/20/2015	48	332	0	
AW15_AU_NM01	64.84760	168.38977	9/10/2015	9/23/2016	44	379	0	
AL16_AU_NM01	64.84868	168.39280	9/24/2016	8/5/2017	41	315	0	
AL17_AU_NM01	64.84898	168.39172	8/5/2017	8/8/2018	44	368	0	
AL18_AU_NM01	64.85133	168.39455	8/10/2018	8/9/2019	45	364	0	
AL19_AU_NM01	64.85350	168.39380	8/11/2019	9/9/2020	45	395	0	
AL20_AU_NM01	64.85350	168.40200	9/22/2020	11/16/2021	42	420	0	
AL21_AU_NM01	64.85413	168.46563	11/17/2021	9/21/2022	44	308	2	13 July; 18:07:30–18:54:15 UTC 14 July; 14:10–15:20 UTC

(*Balaenoptera acutorostrata*), and unidentified pinniped calls. Raw recordings were divided into 10-min .wav files, and spectrograms (225-s windows; 0–800 Hz) were generated to enable manual analysis of signals within this frequency range. Each signal was classified visually at the 225-s resolution using pregenerated spectrograms and, when necessary, confirmed through auditory review. Only NPRW results are presented in this Note.

Right whale sounds were distinguished from other species using call characteristics (e.g., intercall intervals, frequency ranges, and call length) and contextual clues (e.g., presence of additional species and season; Wright et al. 2025). For example, NPRW can produce high-density bouts of gunshots (an average 69–133 gunshots h^{-1} were observed in prior NPRW studies; Crance et al. 2017; Rone et al. 2012), which can include patterned sequences, and in some cases, form songs in at least the eastern population of NPRW (Crance et al. 2019). While bowhead whales also produce gunshot calls (Würsig and Clark 1993), there is no evidence to indicate that bowhead whales produce high-density bouts despite extensive prior work on bowhead whale acoustic repertoire and songs (Clark and Johnson 1984; Clark et al. 2015; Cummings and Holliday 1987; Stafford et al. 2008, 2018; Tervo et al. 2009).

Right whale calls were not detected at site NM01 between the onset of recording (August 2012) and June 2022. In July 2022,

high-density gunshot bouts of variable spacing were detected on 2 consecutive days at NM01—13 and 14 July (Table 1; Figure 2). Distinct bouts were defined using a temporal threshold of 5 s between bouts (Crance et al. 2019). On 13 July, a total of 996 gunshots were recorded from 18:07 to 18:54 UTC, occurring in 19 total bouts averaging 52.4 gunshots per bout (Table 2). On 14 July, a total of 2494 gunshots were detected between 14:10 and 15:20 UTC, occurring in 37 total bouts averaging 67.4 gunshots per bout. These rates are higher than previously reported for NPRW, which range from an average of 69–133 calls per hour to a maximum of 835 calls per hour (Rone et al. 2012; Crance et al. 2017, 2019). Nevertheless, the number of bouts on both days was within the range previously reported for NPRW (3–75 bouts/day; Crance et al. 2019). Due to the sampling design, it is unknown whether these detections represent calls from a single individual or multiple animals. None of the detected bouts matched any of the four previously documented NPRW song types (Crance et al. 2019). However, the timing of these detections aligns with the seasonal occurrence of NPRW song at southern recording sites in the Bering Sea in prior years (Crance et al. 2019). Alternatively, the discrepancy between our findings and prior studies of NPRW could reflect differences in calling between the eastern and western populations. Call rates and evidence of song behavior for western NPRW are currently unknown.

We hypothesize that the recent acoustic detection of NPRW in this area is associated with changing environmental conditions affecting prey distributions on the whale's primary foraging grounds. Since 2000, the southeastern Bering Sea shelf has experienced alternating "warm" and "cold" regimes, defined by seasonal sea ice extent and wind strength (Stabeno et al. 2012). Reduced seasonal sea ice in this area results in a smaller area of cold bottom meltwater—known as the "cold pool"—on the eastern Bering shelf during summer months (Rohan et al. 2022). The cold pool is a key oceanographic feature structuring ecosystem dynamics across the eastern Bering shelf (Mueter and Litzow 2008; Stabeno et al. 2012), including fewer calanoid copepods, the predominant prey of NPRW, on the southeastern Bering sea shelf during years with smaller cold pool extents (Kimmel et al. 2018).

Northward shifts in right whale prey distribution on the Bering shelf have been correlated with contracted cold pools and warming shelf waters (Kimmel et al. 2018, 2023) and these shifts have

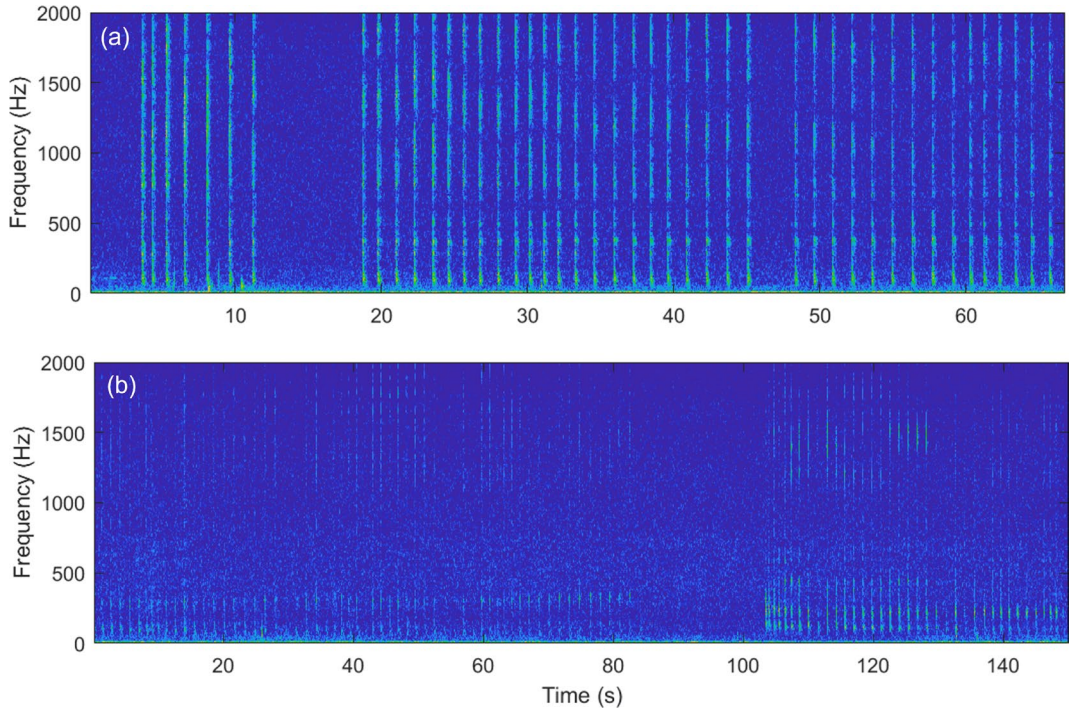

FIGURE 2 | Spectrogram of North Pacific right whale gunshots on (a) 13 July 2022 from 18:03:52 to 18:04:57 UTC and (b) 14 July 2022 from 15:10:50 to 15:13:15 UTC.

TABLE 2 | Summary table of gunshot bouts for the 2 days with detections, including the total number of gunshot bouts (Bout Num.), mean number of gunshots per bout (Mean gunshots bout^{-1}), standard deviation of the number of gunshots per bout (SD gunshots bout^{-1}), the minimum number of gunshots per bout (Min gunshots bout^{-1}), and the maximum number of gunshots per bout (Max gunshots bout^{-1}).

	Bout num.	Mean gunshots bout^{-1}	SD gunshots bout^{-1}	Min gunshots bout^{-1}	Max gunshots bout^{-1}
13 July	19	52.4	19.8	7	83
14 July	37	67.4	28.3	24	169
Overall	56	62.3	26.5		

also been replicated in zooplankton community modeling efforts (Wright et al. 2023). The 2018 sightings of right whale in the northern Bering Sea coincided with the most severely contracted cold pool on record in the eastern Bering Sea (Stabeno and Bell 2019). Similarly, reduced cold pools formed again in 2019 and 2021 (with no in situ sampling in 2020; Rohan et al. 2022), indicating a sustained period of limited summer cold pool extent. Therefore, although the cold pool extent was larger in 2022 (Rohan et al. 2022), the preceding multiyear contraction may have altered prey distribution on the Bering shelf, contributing to the presence and acoustic detection of NPRW at NM01. Telemetry data show differences in the movement and distribution of NPRW between the warm and cold regimes on the Bering shelf in the 2000s (Zerbini et al. 2015). Additionally, the distribution of fish species with zooplanktivorous life stages has also shifted northward into the northern Bering Sea under reduced cold pool conditions (Duffy-Anderson et al. 2019; Eisner et al. 2020).

Model projections forecast continued low seasonal sea ice extent, resulting in persistently contracted cold pools on the Bering shelf over the coming decades (Overland and Wang 2025). As such, the recently observed ocean conditions in the Bering Sea are expected to persist, and it is likely that NPRWs will continue to occur in the northern Bering Sea during the summer. The results of this Note will be incorporated into a scientific manuscript of acoustic occurrence of NPRW across the eastern Bering shelf, providing a broader context and better understanding of ecological drivers of the presence and absence of NPRW acoustic detections on their Bering Sea feeding grounds.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Endnotes

[1] Autonomous Underwater Recorders for Acoustic Listening devices (AURALs, Multi-Électronique, Rimouski, QC, Canada), set to record 80–85 min every 5 h (Table 1). Recording system specifications, including frequency response, system sensitivity, dynamic range, and spectral noise floor, can be found in Wright et al. (2025).

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