Acoustic Occurrence and Distribution of Blue, Fin and Sei whales off Eastern Canada

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Background

Our current understanding of blue (*Balaenoptera musculus*), fin (*B. physalus*) and sei (*B. borealis*) whale occurrence and distribution off eastern Canada varies by species but is systematically biased towards summer and a few areas regularly surveyed for population monitoring or mitigation surrounding oil and gas activities. To address these data gaps, 24 acoustic recorders were deployed from May 2015 to July 2016 between the western Scotian shelf and the southern Labrador shelf (Figure 1).

Data Collection

- 24 Autonomous Multichannel Acoustic Recorders (AMAR) deployed (23 retrieved).
- Duty cycle: 11 min 18 s at 8 kHz, 1 min 4 s @ 250 kHz, 20 min cycle.
- Suspended mooring design used (Figure 2) except for 3 bottom-mounted recorders (Stn 3, 7 and 9).

Data Analysis

- Automated detection focused on the following call types: blue whale A/B calls (Mellinger and Clark, 2003); fin whale 20-Hz pulse (Watkins et al, 1987); sei whale downsweeps (Baumgartner et al, 2008).
- Unable to use sei whale's automated detections due to the effects of seismic airgun shots and other baleen whale signals on the detector performance so manually validated detections were used instead.
- Blue and fin whale broadband downsweeps were not reliably detected, which restricts each species' detectability to their song production period.
- Detection validation (Figure 3) performed for 1% of 8 kHz files to 1) define detection count thresholds below which detection within a time unit are ignored; 2) define detector performance metrics.
- Critical review of detection time series to exclude remaining false detections triggered by identifiable, time-restricted events such as seismic surveys.

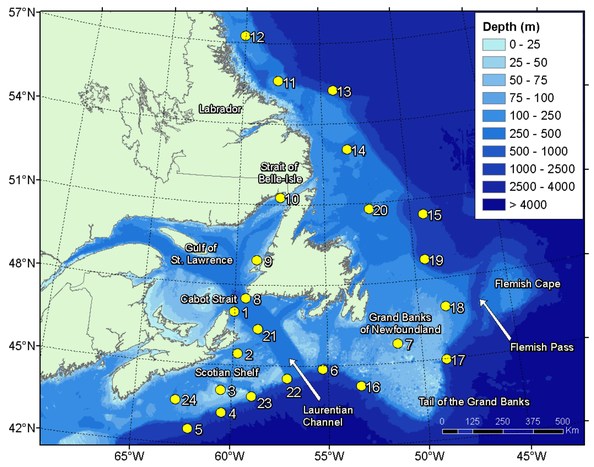

Figure 1. AMAR locations

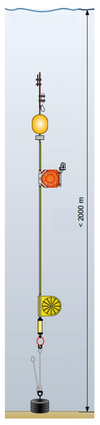

Figure 2. Mooring design (deep areas).

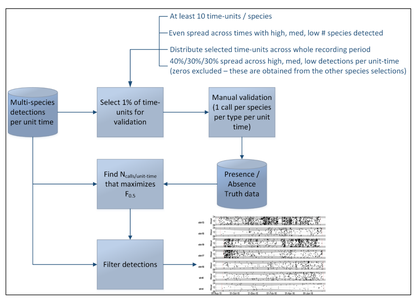

Figure 3. Stages of the protocol used to validate automated detections.

Sei Whale Acoustic Detections

- Figure 4 represents a minimum estimate of sei whales' occurrence off eastern Canada based on the partial manual validation of automated detections.
- Two main periods and areas of occurrence identified: 1) the central Scotian Shelf in spring/early summer and fall; 2) the outer shelf/continental slope areas off southern Labrador and the northeastern Grand Banks in fall (October and November) and spring.
- Results appear consistent with the current understanding of sei whale movements and stock structure in the Northwest Atlantic, which assumes a stock centered around Nova Scotia ranging from slope waters in the US to southern Newfoundland and another ranging between Northwest Africa/Azores and the Labrador Sea (Mitchell and Chapman,1977; Prieto et al., 2014).

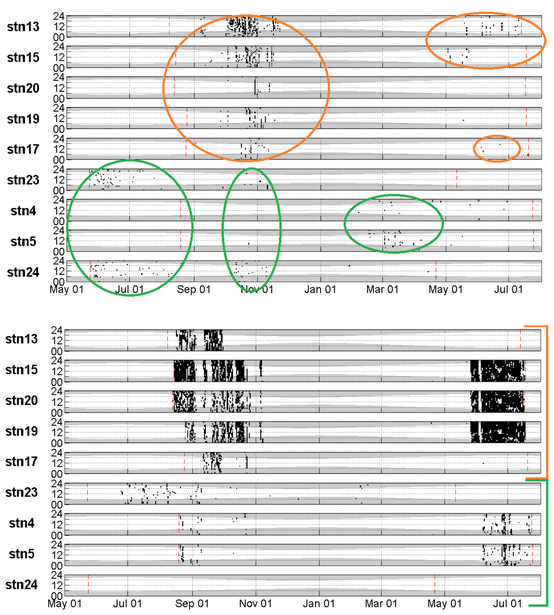

Figure 4. Daily and hourly occurrence of sei whale manual detections (top) and automated seismic detections (bottom) from 15 May 2015 to 15 Jul 2016. Shaded areas indicate periods of darkness. The red dashed lines indicate the AMAR deployment and retrieval dates. The colored ellipses/bars identify detections at stations similarly colored in Fig. 5.

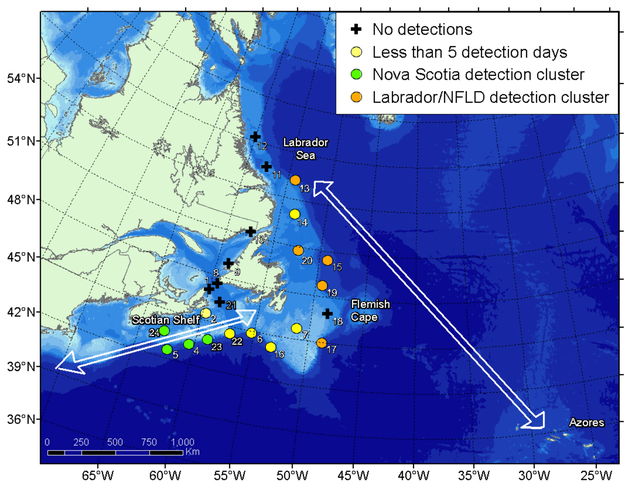

Figure 5. Documented or presumed migration routes of sei whales (white arrows). Stations in orange and green show the locations of similarly colored stations in Figure 4.

Blue Whale Acoustic Detections

- Occurred at 19 (of 23) stations (Figure 5 and 6) from August until March (in the Cabot Strait).
- Short detection bouts at the northern stations are consistent with rapid movement through the area (except at stn 14 and 15 in early fall).
- At stations where detections persisted into late February or March, the end of detections may be behavioral, reflecting the end of song production, rather than absence from the area.
- Highlight the importance of the Laurentian Channel as a wintering area.
- Similarly, the Scotian shelf appears to be used consistently in winter, possibly as a transit area towards southern wintering areas (see Lesage et al., 2017).
- Suggest a partial or differential migration model for western North Atlantic blue whales.

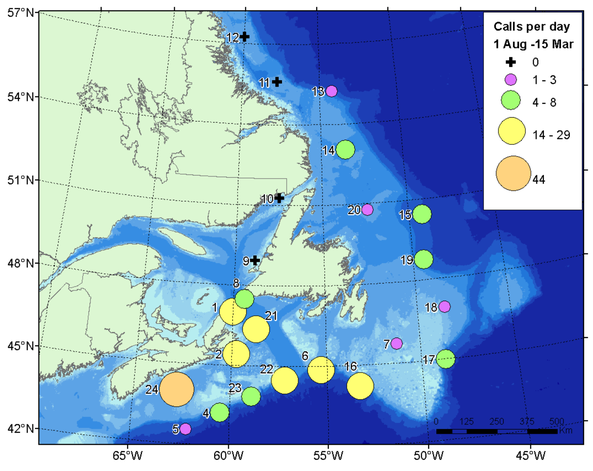

Figure 5. Average number of blue whale infrasonic moan detections per day by station from 1 Aug 2015 to 15 Mar 2016.

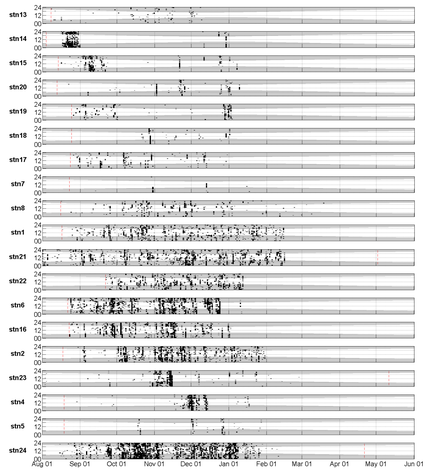

Figure 6. Daily and hourly occurrence of blue whale automated detections from 1 Aug 2015 to 1 Jun 2016.

Fin Whale Acoustic Detections

- Occurred at 22 (of 23) stations (Figure 7 and 8) from August to April.
- Detection rate hot spot on the southeastern Grand Banks….
- …But detection rates are not correlated with power spectral density levels at 20 Hz (Figure 7; Figure 9), reflecting the influence of bathymetry on detection ranges.
- Results do not support the idea of migratory movements out of Canadian waters in winter even though ice restricts access to the northern part of the study area in winter and spring (Figure 10).

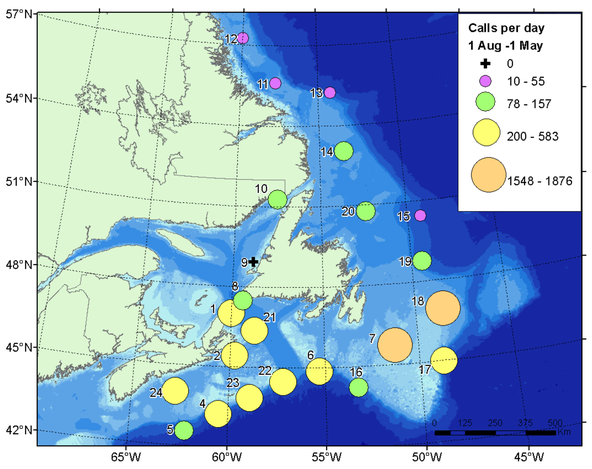

Figure 7. Average number of fin whale 20-Hz pulse detections per day by station from 1 Aug 2015 to 1 June 2016.

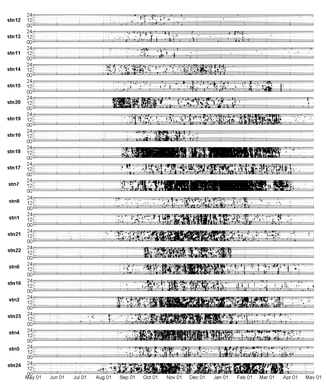

Figure 8. Daily and hourly occurrence of fin whale automated detections from 1 May 2015 to 15 May 2016.

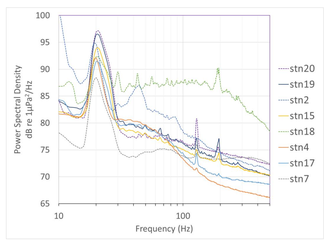

Figure 9. Power spectral density levels for a selection of on-shelf (dashed lines) and off-shelf (solid lines) stations from 4 Nov 2015 to 28 Feb 2016. No seismic surveys took place during this period.

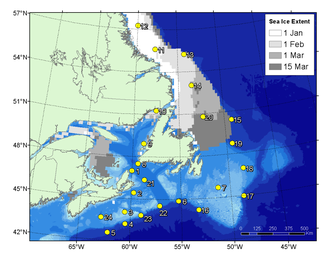

Figure 10. Timing of sea ice coverage increase until maximum extent was reached around 15 Mar 2016.

What's next

- Analysis of data recorded at stn 1-20 from July 2016 to July 2017.
- Investigating the contributing factors such as environmental (e.g. sea ice) or anthropogenic (e.g. seismic surveys) on potential inter-annual differences in acoustic occurrence.
- Increased effort on sei whale detector development and/or manual analysis.
- Further development of baleen whale moan detectors to allow discriminating downsweeps produced by blue, fin and sei whales outside of the song production period.

Acknowledgments

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