

Localisation of North Atlantic right whale (*Eubalaena glacialis*) sounds using hydrophone arrays in the Bay of Fundy

Marjo Hannele Laurinolli, M.Sc. Candidate
Physical/Biological Oceanography

Abstract

The North Atlantic right whale (*Eubalaena glacialis*) population stands at <350 individuals. Population recovery depends on the reduction of ship-strike and entanglement mortalities. Grand Manan Basin, Bay of Fundy, is a primary summer and autumn feeding and nursery habitat for much of the population and overlaps a busy international shipping lane. Passive acoustic localisation of right whale sounds could augment weather and cost limited visual surveys and thus reduce the probability of anthropogenic mortality.

In 1999, a 3-h free-drifting 17-sonobuoy array pilot study provided 94 two-dimensional localisations of right whale sounds using arrival time differences determined from spectrogram cross-correlation analyses of two distinct sound types: tonal and gunshot. Maximum detection distances were ~30 km for both sound types. The mean RMS error in locations was 1.3 km for tonals and 1.7 km for gunshots and was 20% of the average range from receiving hydrophones due to uncertainty in sonobuoy location estimates. Seventy percent of the localisations occurred within the shipping lane.

Average signal-to-noise ratios (SNR) obtained from the sonobuoy data were 14 dB for tonals and 8 dB for gunshots. The SNR did not vary significantly with frequency of the sound. The mean received spectral density levels for tonals did vary with frequency from 75 to 102 dB *re* 1 $\mu\text{Pa}^2/\text{Hz}$. The mean received level estimated for the gunshot sounds was 96 dB *re* 1 μPa . Gunshot sounds were detected farther away than tonal sounds.

In 2000, arrays of four fixed-location ocean-bottom hydrophones were used to localise right whale sounds over four 11-h periods (two in daytime and two at nighttime). The results were compared to sonobuoy results. More gunshot sounds were heard at night than in the day. A total of 506 non-gunshot sounds, 18% of those heard, were localised, of which 302 were at night, to a maximum distance of 23 km. The RMS error in localisations increased with range at 10-15% of the average range to receivers and the mean RMS errors for low and mid-high frequency sounds respectively were 0.44 km and 0.37 km, substantially less than for the sonobuoy data. A comparison of whale locations with the barotropic tidal displacement suggests that right whale locations are significantly dependent on the tides.