Dual-frequency acoustic seabed classification on the Scotian Shelf, Canada

Andrew Cuff[1], John Anderson[2], Rodolphe Devilliers [1,3], and Sam Bentley[3]
1. Department of Geography, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador A1B 3X5 Canada ¶ 2. Department of Fisheries and Oceans, St. John's, Newfoundland and Labrador K1A 0E6, Canada ¶ 3. Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador A1B 3X5, Canada

Understanding surficial seafloor geology is important when mapping marine benthic habitats. Acquiring information on surficial seafloor geology is usually derived from acoustic measurements. Acoustic seabed classification (ASC) aims to objectively classify surficial seafloor substrate types based on acoustic energy reflected by the seabed (i.e., backscatter). The shape and intensity of acoustic backscatter is influenced by the physical properties of seafloor substrate, primarily grain size and roughness. In general, larger particles (e.g., boulder or cobble) reflect more acoustic energy than smaller particles (e.g., sand). Acoustic backscatter will also vary depending on a number of other factors, including the acoustic frequency. Lower frequencies penetrate deeper within the seabed than higher frequencies, whereas higher frequencies exhibit greater resolution than lower ones and therefore can detect smaller features. Therefore, lower frequencies reveal information on seabed substrate that higher frequencies will not, and *vice versa*.

Existing approaches to ASC typically use one acoustic frequency. This paper presents an approach that aims to quantify the variations in backscatter from two acoustic frequencies and to assess the improvement in dual-frequency ASC of surficial substrate. Two acoustic frequencies commonly used in fisheries sciences, 38 kHz and 120 kHz, were collected simultaneously at two study sites of the Scotian Shelf, Canada, using a single beam echo sounder sonar system. The acoustic data were processed for the near nadir (coherent) backscatter component, which emphasizes the contribution of particle size as opposed to surface roughness.

In each of the study sites, both frequencies provided a similar response over large distances (kilometres), but sometimes differed significantly locally (10–100 m). For example, in one study area, the backscatter response generally allowed the identification of two seabed substrate types, sand and gravel, over large distances. For each frequency, backscatter intensities were classified using univariate classification techniques and then compared in order to highlight differences in relative frequency responses that could be related to different substrate types. Analyses revealed that sand substrate generally produced higher relative 38 kHz backscatter as compared to 120 kHz backscatter, while gravel substrate was the opposite. Backscatter responses from each frequency were compared using a Wilcoxon Signed Ranks Test (non-parametric test) for each surficial geological unit to determine whether there are any significant differences in the backscatter response and significant differences were identified for a number of geological units. Finally, multivariate classification techniques were used to classify seabed surficial geology using acoustic backscatter, along with a number of morphology layers (e.g., slope and depth). Results revealed that using backscatter from two frequencies, as opposed to one, improved classification accuracy. These results suggest that combining acoustic frequencies can allow for a more accurate mapping of seabed surficial geology.

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