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Acoustic identification of marine species using a feature library

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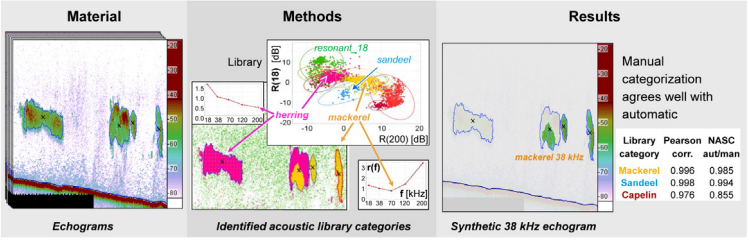
GRAPHICAL ABSTRACT



HIGHLIGHTS

- Echo data are categorized using an acoustic-feature library of ground-truthed target spectra.
- Automatic data-processing modules allow faster scrutiny, better quality and objectivity of results.
- Comparison of manual and automatic classification for three oceanic surveys in different ecosystems.
- High correlation between manual and automatic classification of backscatter for all case studies.

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ABSTRACT

Sonars and echosounders are widely used for remote sensing of life in the marine environment. There is an ongoing need to make the acoustic identification of marine species more correct and objective and thereby reduce the uncertainty of acoustic abundance estimates. In our work, data from multi-frequency echosounders working simultaneously with nearly identical and overlapping acoustic beams are processed stepwise in a modular sequence to improve data, detect schools and categorize acoustic targets by means of the Large Scale Survey System software (LSSS). Categorization is based on the use of an acoustic feature library whose main components are the relative frequency responses. The results of the categorization are translated into acoustic abundance of species. The method is tested on acoustic data from the Barents Sea, the Norwegian Sea and the North Sea, where the target species were capelin (*Mallotus villosus* L.), Atlantic mackerel (*Scomber scombrus* L.) and sandeel (*Ammodytes marinus* L.), respectively. Manual categorization showed a high conformity with automatic categorization for all surveys, especially for schools.

1. Introduction

The sustainable management of commercially exploited marine species requires reliable knowledge of their abundance as well as of that of their prey and predator species. This is often informed by spatially extensive surveys using a variety of sampling tools that catch the targeted species, or remotely detect their presence (King, 2007). A commonly used remote sensing method is acoustics, where echosounders are used to generate directed pulses of sound and the resulting backscatter from marine organisms is measured and mapped (Simmonds and MacLennan, 2005). Given knowledge of the backscatter and other characteristics for species of interest, it is possible to assign species or species groups to the backscatter. Then, when combined with a relationship between backscatter amplitude and species size one can derive an estimate of the species biomass in the surveyed area (Simmonds and MacLennan, 2005). Estimating and understanding the sources of uncertainty in biomass estimates is an important means to reduce uncertainty and improve the inputs to the fisheries management process.

A key procedure in acoustic biomass estimation is the correct assigning of backscatter to species or species-group level (MacLennan and Holliday, 1996; Horne, 2000), a process typically called scrutinizing or categorization. Categorization, supported by biological sampling and human experience is time-consuming and subjective and there is a need to make the process more objective so as to reduce human-generated bias and uncertainty in acoustic abundance estimates. It has been estimated that the systematic error associated with the categorization of acoustic backscatter can be as high as ±80% (Simmonds and MacLennan, 2005). Automated species identification can be a valuable input to the categorization process and offers the potential for a more objective result.

The potential for objective classification of targets from backscatter was recognized in the 1970s (Holliday, 1977; Deuser et al., 1979). The acoustic scattering characteristics of some species may not be reliably distinguished from others by acoustic means only due to similarities in morphology and behaviour. Tilt distribution, i.e. swimming upwards or downwards, usually results in decreasing backscatter with increasing frequency. However, groups of similar species may be distinguished from other species or scattering groups (e.g. fish with swimbladder vs. zooplankton or fish without swimbladder).