Theme Session A Report 2024

From echoes to ecology: The application of active acoustics beyond biomass estimates

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Session Synopsis

Since the early 20th century, echosounders have developed from simple systems used for depth sounding to sophisticated multi-frequency systems that are routinely used in global fish stock assessments. While stock assessments are essential to ensure our sustainable use of the ocean, echosounder data have the potential to provide considerable insight into ecosystem function beyond biomass estimations.

Given the combined pressures of exploitation and climate change on marine ecosystems, it has never been more pressing to understand how ecological communities will respond to rapid environmental changes. Novel active acoustic techniques, when augmented with additional emerging technology, provide opportunities to assess environmental and ecosystem functioning simultaneously, across a variety of disciplines.

This session aimed to showcase the use of echosounders to provide insights into global marine ecosystems beyond standard stock assessment and explore the practical application of emerging technologies and complementary techniques to improve ecological understanding.

We welcomed oral and poster submissions covering three main topics:

Topic 1: Ecological and environmental insights: the application of acoustic data to monitor changes in oceanic processes and habitats, study organism behaviour and understand the effects of environmental change on ecological communities and trophodynamics.

This topic showcased innovative research using echosounder data with a focus on mapping and describing global marine ecosystems, community behaviour and species interactions. Variability in schooling behaviour from active acoustic surveys was identified by Aitor Lekanda Guarrotxena with a focus on small pelagic fish species, while Dominik Bahlburg highlighted the value of acoustic data from fisheries vessels to assess predator interactions with Antarctic krill. Likewise, analyses from Cecilia Liszka assessed krill migratory behaviour in under-sampled winter periods, challenging existing assumptions about krill behaviour.

The application of active acoustic data in large-scale ecosystem biome analyses was illustrated by Sarah Albernhe, using the SEAPODYM model, and Thibault Cariou, who assessed long and short temporal variability of these biomes with acoustic observations.

Interactions between pelagic species and natural bathymetric features such as sea mounts, and anthropogenic structures such as wind-farms, was considered by Danielle Eager and Natalie Isaksson, respectively. Natalie also raised the important question of how much data is ‘enough’ to appropriately assess change at different scales.

Topic 2: Optimising acoustics with interdisciplinary science: exploring the use of emerging and complementary techniques to support acoustic data and understand ecological processes.

Presenters in this topic explored the practical application of emerging technologies and complementary techniques to improve ecological understanding. The application of environmental

DNA (eDNA) was highlighted by invited speaker Dr Leonie Suter, who used DNA fragmentation to assess recent and older observations of Antarctic krill alongside an active acoustic survey. Similarly, Alina Wieczorek coupled eDNA methodologies with Ross Sea acoustic surveys to consider mesopelagic fish and zooplankton distributions.

Examples of the practical application of emerging technology included the novel use of multibeam imaging sonar to assess salmon behaviour by Rachael Hornsby, and interactions between marine mammals and tidal turbines by Gordon Hastie.

Figure 1. Gordon Hastie presenting echograms from multibeam imaging sonars to assess marine mammal interactions with tidal turbines.

The combined application of ship-based active acoustics with in-trawl cameras to classify targets in situ was considered by Taraneh Westergerling. These opportunities were expanded upon by Maria Tenningen, who incorporated the use of broadband acoustic analyses. Use of interdisciplinary techniques including camera imaging, telemetry, echosounder and bathymetric multibeam surveys was presented by Llucia Mascorda Cabre, assessing species interactions within marine protected areas and offshore mussel farms.

Topic 3: Autonomous and low-carbon technologies: the opportunities and challenges of using alternative bioacoustic platforms such as autonomous underwater and surface vehicles, fixed moorings, towed arrays, and automated processing to assist in ongoing ecological monitoring.

The use of autonomous systems for fisheries acoustics was highlighted by Prof Paul Fernandes, who delved into the pros and cons of these systems for variable applications. Use of these moored systems was demonstrated by Kjetil Thorvaldsen, who assessed behaviour of scatterers in the Arctic under-sea environment using autonomous echosounders. Similarly, Svenja Christiansen presented pelagic behaviours from a tethered mooring in the Oslofjord. These studies captured the benefits of novel technologies and platforms for increasing the temporal resolution of data collected in remote, hard-to-access regions.

Fostering interdisciplinary collaborations between fisheries acousticians and environmental scientists was a key aim of the session. We anticipated high numbers of participants with acoustic experience, but also benefited from significant participation from non-acoustic fields helping to achieve this goal.

Once general discussions were concluded, the participants were divided into three groups and asked to collectively address questions on flipcharts around the opportunities, barriers and solutions in applying active acoustics with complementary disciplines and platforms for ecological research. Groups spent three minutes collating ideas before swapping flipcharts to review and contribute to other groups ideas.

Key questions on flipcharts included:

1. Ecological insights:
    a. Using active acoustics, what are the ecological questions we can easily answer at present?
    b. What are the challenges or knowledge gaps in using acoustics? And what questions do you wish you could answer with acoustics?
    c. What are the future directions for acoustics in ecology?
2. Complementary techniques:
    a. What complementary techniques are we using, or know that people are using to bring greater insight to acoustic data?
    b. What barriers or challenges do you face in adopting complementary techniques?
    c. What resources do you need to adopt different techniques?
3. Autonomous platforms and low-carbon technologies:
    a. What autonomous platforms and field instrumentation are we currently using or know that people are using?
    b. What are the benefits and limitations of different platforms and instruments?
    c. What would you like to achieve, but is currently not feasible?

Figure 2: Participants networking and addressing key questions on flipcharts at the theme session.

Participants identified a suite of opportunities for ecological research amongst the various disciplines and platforms and highlighted the challenge of adopting new methods, namely, focusing on the benefit of interdisciplinary collaborations to support shared expertise. Major themes amongst

answers on these flipcharts were collated. Session participants were invited to contribute to a conference paper (now in preparation) describing the historical and present application of acoustics in ecology, as well as future directions, challenges, and community needs for effective monitoring.

Summary

Active acoustics is a fast-moving field. As ecologists, we need to keep abreast of rapidly evolving technology and the techniques available to us. The session showcased a range of exciting and innovative research combining acoustics with complementary techniques and autonomous platforms to gain greater ecological insights beyond traditional fisheries biomass estimates. We also identified future areas of work required to advance the field, and opportunities to encourage greater interdisciplinary collaborations.