Towards acoustic discrimination of tuna species associated with FADs

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Summary

Acoustic technology could be the means to selectively catch tropical tuna associated to FADs, targeting species and sizes for which stocks are known to be in healthy condition, while reducing their impact on small yellowfin and bigeye. This technology could also support science, by providing direct data on species composition and biomass at FADs, at the temporal and spatial scales necessary to address key questions on highly migratory species. Acoustic frequency response of skipjack and bigeye tuna were determined at 38, 120 and 200 kHz. Skipjack showed stronger response at higher frequencies. On the contrary, bigeye showed stronger frequency responses at lower frequencies. The robust pattern shown in frequency responses of the two species demonstrates the potential to predict abundance and species proportions based on purely acoustic measures. The rapid technological advances introduced in fishing technology, such as echo-sounder buoys used to quantify biomass under FADs, make it possible to design and implement systems that can bridge the existing data gaps. We present advances on tropical tuna species discrimination as well as the conditions that need to be met to successfully apply this technology for tropical tuna management.

Introduction

Given the fact that the entire aggregation around FAD is encircled and captured during the purse seine operation and the three main tropical tuna species may be present, one of the key challenges that purse seine fleets fishing with FADs face in all oceans is to be able to target species in healthy condition such as skipjack, while reducing impacts on bigeye and yellowfin, in areas where there is a need to reduce fishing pressure on these species. Acoustic technology represents an indispensable fishing tool that purse seine vessels targeting tropical tunas use to detect tunas, evaluate school size and position and assist in making the set (Moreno et al. 2019, *in press*). There is great value in understanding acoustic properties of tropical tuna, as species-specific target strength (TS) measurements are needed to allow the scaling of acoustic signal strength to biomass and to accurately identify species and discriminate size.

Our research has the aim of obtaining fundamental information on acoustic properties of main tropical tuna species to develop a technological tool to address undesired tuna mortality as well as to gather species-specific abundance data to support stock assessment and FAD behavioral studies (Capello *et al*. 2016; Moreno *et al*. 2016; Santiago *et al*. 2016).

Material and methods

The acoustic data were obtained during 2 scientific cruises organized by the International Seafood Sustainability Foundation (ISSF) with the support of FAO GEF Common Oceans project. In order to explore the different frequency response of the tuna species found at FADs, acoustic data were collected onboard 2 purse seiners from Albacora company, with a SIMRAD EK60 scientific echo-sounder using different frequencies, 38 kHz, 120 kHz and 200 kHz. Each time acoustic EK60 data was recorded sampling of the catch was conducted (from around 0.8 to 2 tons per set). Data was analyzed following the procedure used by Boyra *et al*. (2018), applying a school detection algorithm to retain the main aggregation (attributed to tuna) while the echoes outside the aggregation (considered plankton and/or micronekton) were rejected (Fig.1).

Results and Discussion

Skipjack showed stronger response at higher frequencies. On the contrary, bigeye showed stronger frequency responses at lower frequencies (Fig.2). This difference in frequency response is due to the lack of swimbladder in skipjack and the presence of swimbladder in bigeye tuna. The robust pattern shown in frequency responses of the two species demonstrates the potential to predict abundance and species proportions based on purely acoustic measures. Concerning abundance estimation for all the species found at a given FAD together, the significant relationships between acoustic backscattering and the catches showed the potential of this type of data to provide quantitative abundance estimations to be used to support stock assessment and behavioral studies. Although frequency response and target strength for yellowfin tuna have not been obtained yet (ongoing research), from our preliminary analysis it is expected a pattern similar to that of bigeye tuna, due to the presence of swimbladder in these species. However, the frequency response slope, as shown in Fig 2, will be flatter for yellowfin compared to bigeye due to the late development of the swimbladder in yellowfin tuna. Once echo-integration and TS-base frequency response for the 3 species are known, it will be possible to create a multifrequency acoustic mask to discriminate at least tuna with swimbladder (bigeye and yellowfin) and tunas without swimbladder (skipjack and small yellowfin) and provide estimates (and measures of uncertainty) of their proportion at FADs. Acoustic discrimination could be the key factor for a fisher to identify the most sustainable fishing by avoiding undesired species and by choosing among the diverse FADs available. This strategy would be especially useful if vessel or fleet-specific quotas are enforced.

References

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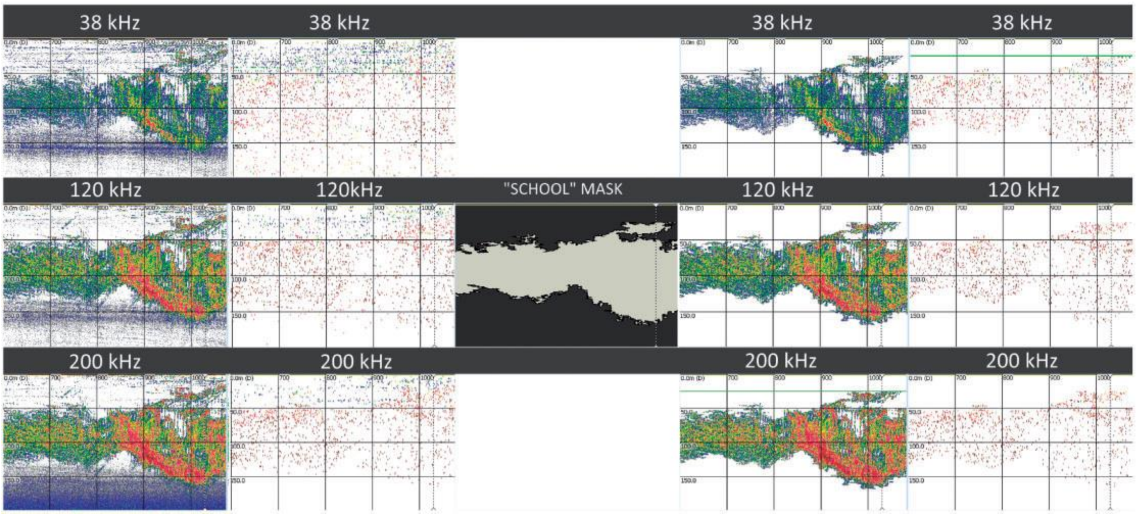

FIGURE 1. The procedure to attribute echoes to skipjack, illustrated by data from one set on skipjack. The original volume backscattering coefficient (S_V) and Target Strength (TS) echograms (columns 1 and 2 respectively) were filtered using a school detection algorithm, converted to a mask (column 3, row 2). The mask applied to original echograms resulted in data for putative skipjack tuna: S_V (column 4) and TS (column 5) echograms. From Boyra *et al*. 2018.

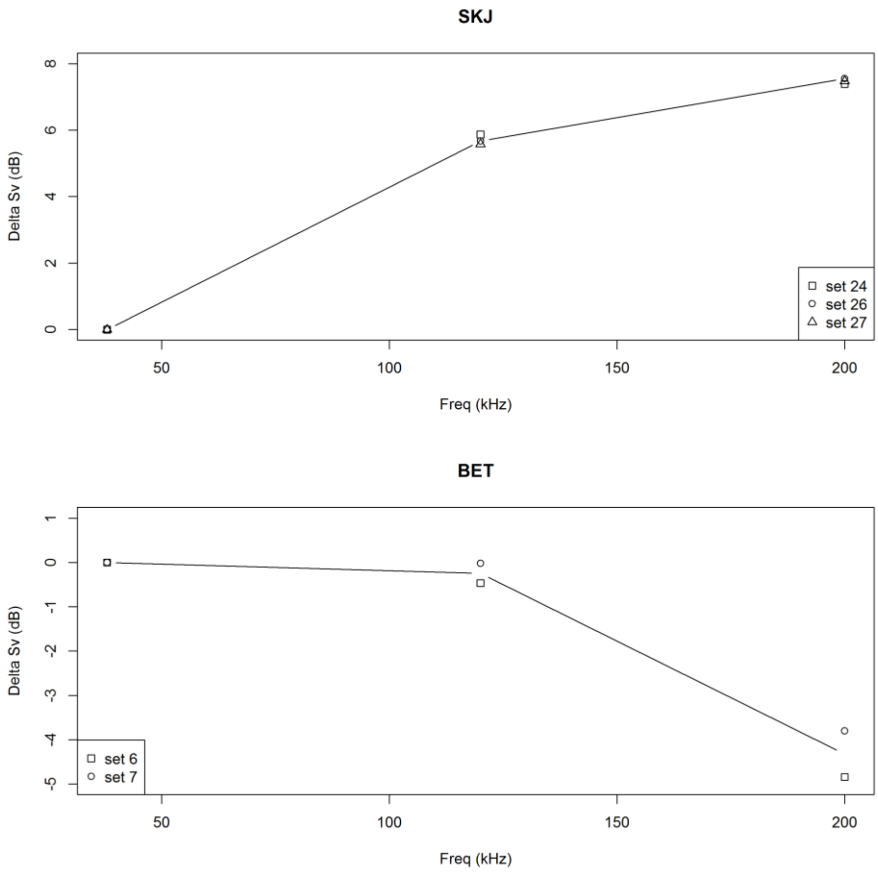

FIGURE 2. Frequency response of Skipjack tuna (top) and Bigeye tuna (botton). Skipjack shows stronger response at higher frequencies. On the contrary, bigeye shows stronger frequency responses at lower frequencies.