On the way towards using hydroacoustic multifrequency techniques to assess Northeast Atlantic mackerel (*Scomber scombrus*)

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Summary

Hydroacoustic and plankton data were determined in the area western of Ireland (Porcupine Bank) and the Celtic Sea, in spring 2013 during the German contribution to the triennial ICES Mackerel and horse mackerel egg survey (MEGS). Spawning stock biomasses (SSB) for Northeast Atlantic mackerel (*Scomber scombrus*) were estimated from multifrequency echosounder data and plankton hauls of sampled mackerel eggs. Estimated biomasses of both methods show clear similar spatial distribution patterns and size ranges. Additionally tests for differences between the spatial distributions of the estimated biomasses from both methods were performed.

Introduction

The triennially conducted, ICES-coordinated mackerel and horse mackerel egg survey (MEGS) is carried out as a series of individual cruises, with the main goal to produce both an index and direct estimate of the biomass of the Northeast Atlantic mackerel stock. This survey is the main source of information on this stock. Generally, hydroacoustic measurements of backscatter values are accepted as the best available tool to provide stock estimates of pelagic schooling fish. Up to now, application of traditional acoustics has only been applicable to a limited extent to mackerel, given they lack a swimbladder and hence are weak scatters on the traditionally used 38 kHz echograms. However, due to their peculiar backscattering characteristics at different sounder frequencies, mackerel can be hydroacoustically detected applying multifrequency techniques. We present results of a hydroacoustically derived SSB estimate of mackerel from multifrequency echosounder data sampled during the 2013 German MEGS survey and provide a comparison of the results to the indices derived from the established Annual egg production method (AEPM) and Daily egg production method (DEPM).

Materials and Methods

Sampling was carried out during the German contribution to the triennial ICES Mackerel and horse mackerel egg survey (MEGS) in spring 2013. RV "Walther Herwig III" investigated the west of Ireland (Porcupine Bank) and the Celtic Sea during survey period 3. Overall, 83 double oblique plankton hauls (two hauls every half statistical ICES rectangle) were conducted using a towed Gulf type high-speed plankton sampler "Nackthai" (HydroBios). Maximum sampling depth was set to 200m or 5m above the bottom in shallower areas. Fish eggs were sorted on board according to species and development stage. Hydro-acoustic data were recorded continuously with a calibrated scientific Simrad EK60 echo sounder, with hull-mounted 18 kHz, 38 kHz, 120 kHz and 200 kHz transducers. Only those data sampled within the limits of rectangles with corresponding and mostly concurrent plankton hauls were analyzed. Atlantic mackerel was identified from hydroacoustic data using a multifrequency algorithm developed by Korneliussen (2010) and implemented in Echoview by S. Fässler and J. van der Kooji (pers. Comm.). Biomasses were estimated per half-rectangle based on NASC values allocated to mackerel. Data analysis was based on the manual for international pelagic surveys (IPS) (ICES 2012). According to echogram indications of fish concentrations, targeted fishery hauls were conducted. Additional catch data from three more hauls conducted on other vessels participating in MEGS 2013 were included in the analysis. Additional trawls were taken from Scottish RV "Scotia" and RV "Altaire" from the same area and time period. Daily egg production as well as corresponding biomass estimates were calculated following ICES (2013). Additionally, a backward-calculation for the western mackerel stock, based on the spawning stock biomass (SSB) results of the MEGS 2014 report (ICES 2014) was conducted to achieve higher precision in biomass estimates. For statistical analysis R was used. A Syrjala test, based upon a generalization on the two sample Cramer-von- Mises test, was performed to test for differences between the spatial distribution of the estimated biomasses from both methods. Also further tests for comparison between single half-rectangles were performed.

Results and Discussion

Echoes originating from mackerel were mainly recorded between 30- 200m with only few echoes below. Altogether, 437 mackerel were sampled and their age, length- weight distribution and fecundity were analyzed. Of all eggs sampled and identified, 71% were mackerel eggs. Both highest mackerel egg concentrations and NASC values were recorded on the shelf slope as well as above Porcupine Bank and on some particular "hotspots" westwards of the Irish coast and in the western Celtic Sea. The daily egg production analysis resulted in a spawning stock biomass (SSB) estimate of 3.78 million tons for the western component. The backward- calculation for this stock, based on the spawning stock biomass (SSB) estimated from the total annual egg production results of the MEGS 2014 report, lead to a SSB of 387.700 tons representing only sampling period 3 and the surveyed area. SSB estimates from hydroacoustic data for the same area and time period resulted in 700.032 tons. The Syrjala test with an estimated p-value = 0.209 suggests that across the study area, the normalized distributions of the two estimated biomasses are the same. Further tests for comparison between single half-rectangles suggest spatial comparability on small scale areas. Accordingly, mackerel distribution patterns derived from hydroacoustic data do not differ significantly from those calculated from egg data. Differences between estimated biomasses based on backward calculated AEPM and the almost twice as high hydroacoustic data estimate, could result from an underestimation in the egg sampling method and a slight overestimation from acoustic data. Patchiness of stationary egg aggregations difficult to sample could lead to different estimates, compared to hydroacoustic records of more flexible and highly mobile mackerel schools. Furthermore, hydroacoustic methods allow a higher spatial coverage of the sampling area and could therefore lead to higher estimates. Overall, concurrent hydroacoustic sampling has proven as a reasonable tool to estimate mackerel SSB in conjunction with MEGS. Comparable patterns of mackerel distribution were evident from egg and acoustic data. Taking into account the higher temporal and spatial resolution of hydroacoustic recordings, further applications of hydroacoustic methods in Atlantic mackerel stock estimates should be considered, either during the regular egg surveys or in dedicated alternative surveys.

References

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