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Multidisciplinary acoustic surveys with focus on fishes and plankton: how understanding species interaction can support fish stock assessment and management activity

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Summary
It was shown that uncertainty in semipelagic species assessments is to the great extent determined by existing biomass distributed in the pelagic zone and becomes unavailable to the bottom survey being traditional method for estimating such species. The authors provided multidisciplinary acoustic survey (in the pelagic layer above the near-bottom layer covered by the bottom trawl) and supplemented bottom surveys with acoustic observations to investigate drivers of spatial distribution of semipelagic mackerel icefish (*Ch.gunnary)* and increase reliability of survey estimates for this commercial fish in Antarctic water. It was revealed that the significant amounts of icefish (in some years nearly 50-60%) may distribute in the pelagic zone being unavailable to bottom survey. Variability of icefish spatial distribution in the near-bottom layers revealed that bottom survey indices are often of random nature and depend on the location of trawl stations as well as on the trawl efficiency. Simulation model for estimating statistical characteristics of semipelagic abundance indices by age groups with combining their pelagic and bottom components were developed. The authors show that new abundance indices result not only in new stock assessment and population parameters of icefish, but also may significantly change the TAC value.

Introduction
Efficiency and reliability of any surveys are to the great extent determined by the conformity of sampling and data processing methods with fish behavior and distribution patterns. The examples of long-term bottom trawl surveys, being traditional method for estimating semipelagic species, clearly demonstrated the above said. Uncertainty in semipelagic species assessments is to the great extent determined by existing biomass distributed in the pelagic zone and becomes unavailable to the traditional bottom survey. Semipelagic mackerel icefish (*Ch.gunnary)* is one of the most important commercial species in the Antarctic water. The authors applied multidisciplinary acoustic surveys to investigate the drivers of icefish spatial distribution and vertical migrations based on study species interactions between icefish and key species of its foodweb as krill (Antarctic plankton) and Myctophidae fish. Acoustic observations were also used to investigate fish distribution near bottom layer for increasing reliability of bottom survey estimates. Survey method for estimating semipelagic fish based on integrating acoustic and bottom trawl data are shown.

Material and Methods
Bottom trawl survey and multidisciplinary acoustic survey (in the pelagic layer above the near-bottom layer covered by the bottom trawl) were carried out within the same polygon during the day-time. The bottom trawl surveys were accompanied by the acoustic observations (Simrad EK500, 38 kHz) at the trawl tracks and tracks between stations to investigate the fish distribution in near bottom layer and estimate bottom trawl efficiency. Acoustic multifrequency data (Simrad EK500, 38, 120 and 200 kHz) accompanied with biological and CTD sampling were collected during acoustic surveys for investigating pelagic component of icefish biomass (above the headline of bottom trawl) and interaction between icefish and key species of its foodweb (krill and Myctophidae). Acoustic data

processing was provided using Echoview software. Simulation model for estimating statistical characteristics of icefish abundance indices by age groups with combining their pelagic and bottom components were developed. This model allows integrating uncertainty in acoustic and bottom surveys estimates and taking into account bottom trawl efficiency (Kasatkina and Gasyukov, 2003).

Results and Discussion

Acoustic observations revealed the heterogeneity of fish horizontal and vertical distribution in the near-bottom layer. The coefficient of variation of the acoustic density between the trawl stations may exceed 100%. *The latter is the evidence that trawl survey results are often of random nature and depend on the location of trawl stations.* Revealed heterogeneity of fish distribution, especially vertical distribution, has effect on bottom trawl efficiency which may considerably vary from trawling to trawling during the bottom survey. Efficiency of different type of bottom trawls was compared.
Multidisciplinary acoustic surveys revealed information on distributions of icefish, krill and Myctophidae (*G. niccholsi, E. carlsbergi, E, antarctica, P. tension)* in the broadening scope of their spatial-temporal variability and clearly demonstrated that krill pattern is main driver for vertical migration of icefish into pelagic layers. The significant amounts of icefish (in some years nearly 50-60%) may distribute in the pelagic zone above the sampling range of the bottom survey. Moreover, pelagic and bottom components of icefish can be formed by different length classes. As rule, recruitment indices were especially underestimated from bottom trawl surveys. The new abundance indices accompanied with uncertainty estimates were obtained from integrated trawl and acoustic data. It was shown that estimates of the standing stock based solely on bottom trawl results will be biased (underestimated). The authors show that new abundance indices result not only in new stock assessment and population parameters, but also may significantly change the TAC value.

References

Kasatkina S. and Gasyukov P., 2003. Investigations of mackerel icefish (*C.gunnari*) spatial distribution in relation to improvements in stock estimates by trawl-acoustic survey. Document ICES CM 2003/Q:05, 17pp.