

Theme Session H – Effects of Environmental Changes on the Biology, Physiology and Behaviour of Pelagic Fish

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Background

Changes appeared in the 1990s in the major characteristics of pelagic fish in several areas of the world, e.g. changes in the spatial distribution and schooling behaviour of anchovy in the bay of Biscay, and on the backscattering cross section of herring in the Baltic Sea. Such observation demonstrated that fish were sensitive to environmental changes and changed their major anatomical, physiological and behavioural characteristics to adapt to these changes. A Study Group on the Target Strength estimation of Herring in the Baltic Sea has met since 2001 and obtained a series of results that would be interesting to compare with observations on other populations. A wider overview of the effects of changes on the biology, physiology, behaviour of Clupeids in a changed ecosystem would enrich the existing knowledge on the capacities of response by pelagic fish, and help to evaluate the impact such changes and adaptation may have on stock assessment. A theme session on the effects of environmental changes on pelagic fish was organized with the aim to:

- 1) measure the effects of biological changes on the TS of clupeids in the Baltic
- 2) model the impact of the different biological/physiological/behavioural changes on the acoustic characteristics of the Baltic Clupeoids
- 3) relate the environmental changes to the changes in the traits of the biology of pelagic fish
- 4) evaluate the impact of changes in fish biology on stock assessment and acoustic estimates.

Introduction

Theme of the session was directly matched to the new ICES trends, indicating a necessity of ecosystem based procedures on providing the research and the advices on fishery stocks. Changes in the ecosystem, associated with climatic instability and short-term dynamics can produce significant variability in the description of the resources. The variability can be observed in quality (biodiversity) and quantity (biomass assessment). Both situations were presented in the papers submitted for the session.

Summary of the talks

The scientific level of the talks and the presentation of the talks in Theme Session H were very good. One of the papers (H:03) obtained the Award of the best paper in the Conference. The content of the papers met the announcement. But the number of the papers was not adequate to the importance of the session theme. It can be considered that the significant delay in applying the ecosystem based philosophy on fishery research is observed. The delay can be partly explained by the higher degree of difficulty in providing new type of the approach. The talks covered mostly the problem of the differences and variabilities of the target strength of the Baltic clupeoids (5). The problem has been described by different type of modeling (3) and by analyses of the cruise results, taken over many years of research (2). Two talks were dealing with environmental pressure on the recruitment and the biodiversity in the North and Barents Sea.

Synthesis of papers

The common features of the all papers was to show the variability of results of the survey, according to the changes of environmental factors *in situ* or by application of modeling.

Two papers (H:01 and H:04) were describing the environmentally controlled situation in biological state of the fish resources. First of them described the modulation of the structure of recruitment process by environmental variability, while the second one showed the intrusion of the snake pipefish to the Barents Sea due to increase of the water temperature.

All remain papers (H:02, H:03, H:06, H:07, H:08) were dealing with the problem of the target strength of the clupeoids in the Baltic. In some way they express the final product of the ICES SG on Target Strength Estimation in the Baltic Sea. Due to differences in salinity and biological characteristics—the clupeoids in the Baltic Sea were considered as significantly different from the North Sea ones. In a consequence the necessity of recalibration of the target strength formulas, taken till now from Norwegian measurements was discussed and surveyed.

Three papers (H:03, H:07, and H:08) were presenting discussion on possible values of the TS on the basis of modeling herring acoustic properties by the swim-bladder shape and volume. In H-03 (Award for the best paper in the Conference) the authors present the model calculations of expected values of the herring TS, assuming difference in the fat content of the herring in Baltic and different density of the water. The difference at the level of 50 m depth is close to 2 dB and the Baltic herring gives a higher value of TS.

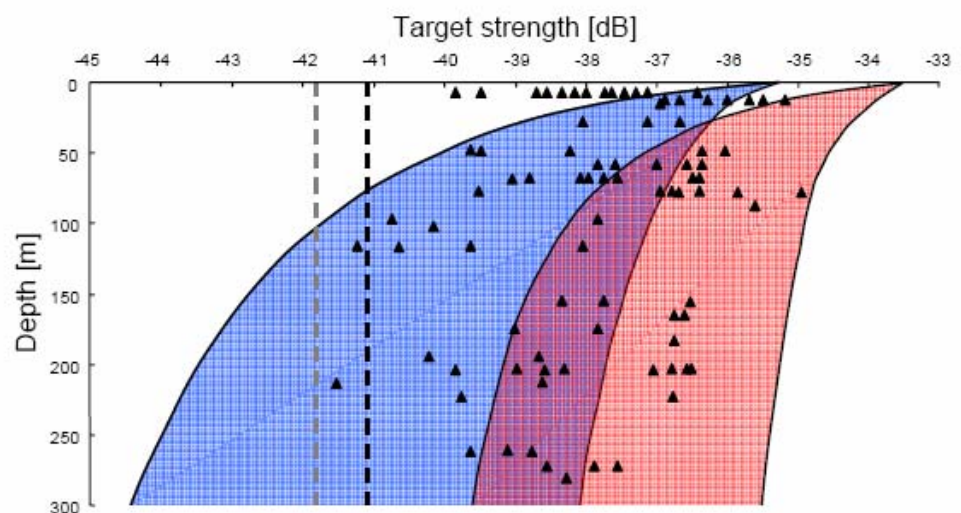


Figure 5. Modelled depth dependent mean target strength values for Baltic (red shaded area) and Norwegian spring spawning (blue shaded area) herring compared to measured *in situ* values for Norwegian spring spawning herring (Ona 2003) standardised to a fish size of 32cm (black triangles). Borders of the shaded areas are defined by the extreme cases of swimbladder contraction rates, i.e. assuming maximum ($\alpha = 1/3$, $\beta = 1/3$) and minimum ($\alpha = 1/2$, $\beta = 0$) compression factors, respectively. Length based target strength relationships currently used for stock assessment are drawn as dashed lines for both Norwegian spring spawning (grey) and Baltic (black) herring.

Figure above cited from H:03.

Similar situation is shown in the paper H:07 In the paper H:08 the author shows a modeling of the dependence of the result of the transformation of the TS measured distribution on average value of the tilt angle of the fish. In the cited illustration it is very easy to realize that the tilt angle of the axis of the swim-bladder can very strongly influence on quantity and quality of the fish acoustic response, producing very significant error on

Papers H:02 and H:06 were giving a wide analysis of the Baltic clupeoids measurements characteristics made *in situ*.

In H:02 the author described selected characteristics of clupeoids, describing the variability of environmental factors, within their short- and long-term life cycle. The analysis of abiotic factors was enhanced by presentation of cross-sections of fish in different stages of the gonad maturity. It was shown, that the acoustic response of the fish was strongly dependent on the time of the day and the moment of the vertical migration. Average difference between the day and night $\langle \sigma \rangle \approx \langle S_A \rangle$ was approximately 200%, while the extreme differences exceeded 500%. It has to be underlined, that the same size can represent the error of stocks assessment.

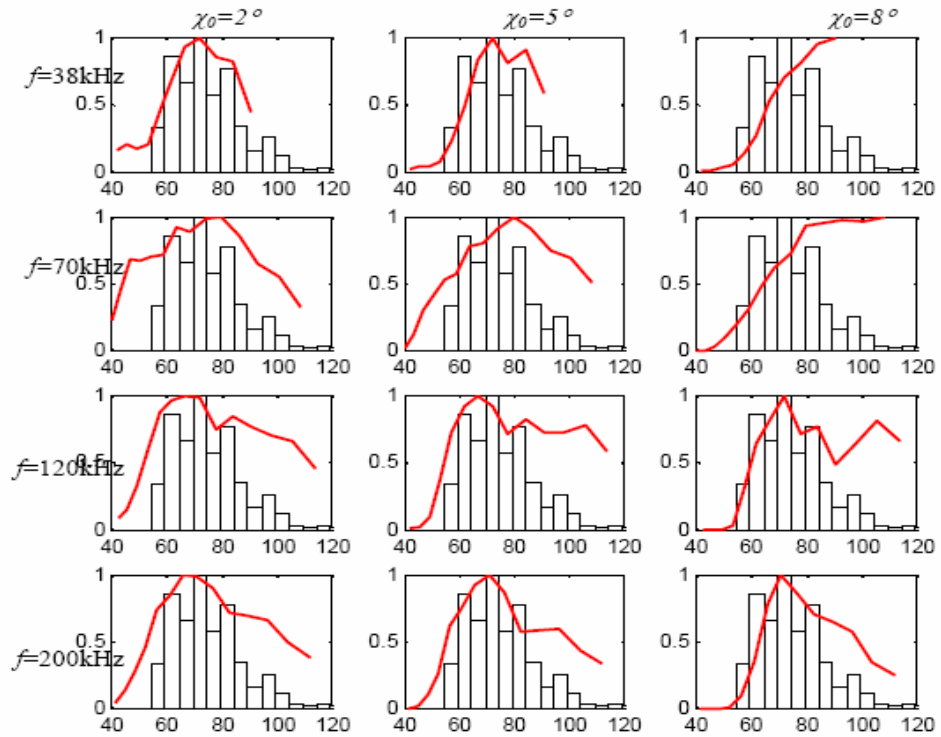


Fig. 3: Normalized inverse reconstruction of fish length distribution for different frequency records (rows represents 38kHz, 70kHz, 120kHz and 200kHz) and for different assumed swim bladder tilt angles (columns represents 2°, 5°, 8°) along with catch histogram.

Figure above cited from H:08.

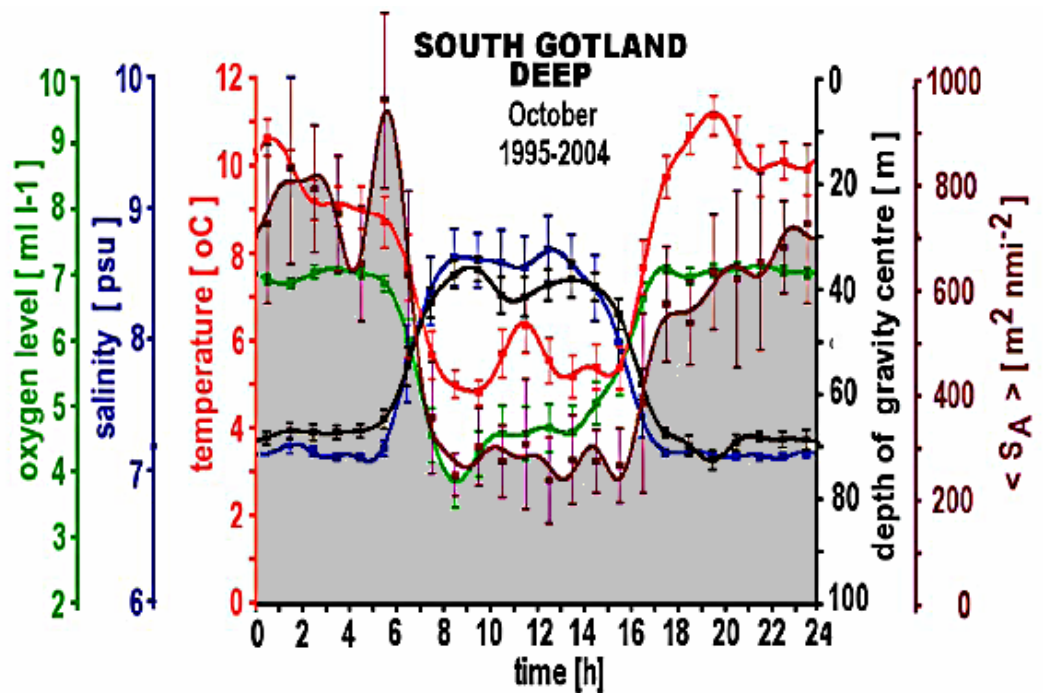


Figure 8. Diel characteristics of clupeoids diel cycle: depth of the centre of gravity, expressed by trigonometric polynomial approximations (11th degree). The comparison is made for the autumn cruises carried out in 1995-2001 period.

Figure above cited from H:02.

Paper H:06 was analyzing the morphometric differences of the herring and sprat over the longest series of the research. Its basic conclusion was indicating strong biological factor in observed variability of the target strength.

Conclusions

All presented papers showed the significant variability of the observed physical and biological factors, modulated by parameters of the environment and by time dependent biological cycles. The importance of the ecosystem based research on fish resources was simply supported.

There are few conclusions and questions which result from presentations and discussion during the Session:

- strong necessity of research on ecosystem based variability of fish characteristics,
- analyses of factors of the mayor influence,
- finding the selected relations on that influence,
- estimation of the possible uncertainty of the instability of the population characteristics on final description of the marine stocks.

In particular all the aspects of the clupeoids behaviour should be taken into account in the procedures of measuring and modeling their target strength, specially in the specific Baltic circumstances.