PROJECT Nº 96/068: INTENSIVE MONITORING OF SPAWNING POPULATIONS OF THE BALTIC HERRING

KEY WORDS
Cost-efficient sampling, biological monitoring, spawning, Baltic herring (*Clupea harengus membras*), database, population parameters, environmental factors, stock assessment.

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OBJECTIVES
The main objectives of the study were:

- To develop a cost-efficient, scientifically competent sampling system for the biological monitoring of spawning Baltic herring (*Clupea harengus membras*).
- To establish a common database for the population parameters of the spawners.
- To find the key ecological variables for detecting and describing the state of the spawning populations, with respect to changes in environmental conditions and fisheries.
- To present an overview of the present state of the herring populations in the study areas.

APPROACH AND METHODOLOGY
The purpose of the study reported here was to design a monitoring program, a database and the appropriate sampling and handling routines specifically adapted to monitoring spawning populations of the Baltic herring (*Clupea harengus membras*). The emphasis on spawning fish and reproductive parameters was intended to supplement the monitoring and stock assessment procedures routinely implemented for the species. Herring populations were sampled annually in two spawning areas, the Greifswalder Bodden in the southern Baltic (Rügen herring), and the Archipelago Sea in the northern Baltic (Airisto herring).
Random samples of 100-200 fish were taken from commercial trap net catches throughout the spawning season lasting 2-3 months in both areas. Basic population parameters determined for males and females separately were fish length, weight, age, condition and gonad weight, but also the genetic structure and other characteristics of the populations were investigated. The database consisted of basic information from 12,300 herrings from the Archipelago Sea and 10,000 herring from the Greifswalder Bodden, collected during 1997-1998, and samples describing the genetic structure of the two spawning populations. The study also utilised data collected previously, especially in the statistical analyses of parameter variation.

**MAIN FINDINGS AND CONCLUSIONS**

Genetic analyses using mitochondrial DNA and allozyme data indicated high diversity in the herring at the individual level, but no differentiation was found among the sampling locations within the spawning areas, or between the southern and northern populations. High variation was characteristic also of the population parameters of the Airisto herring, which complicated the statistical analyses. The parameters were tested with two-way analysis of covariance, using two alternative models - an individual-based model where all individual observations were included, and a shoal average model, where only sample means were used.

In Airisto, the models indicated that population structure was independent of spatial factors (i.e. no variation between sampling locations). Instead, temporal factors, such as sampling year and date (DOY = day-of-the-year), accounted for most of the variation explained by the models. The relationship between DOY and each of the examined variables was unpredictable on an annual basis. In Rügen, all variables were affected by DOY, but the regression was always negative. Additionally, the analysis suggested that the population structure is dependent on spatial factors.

It was concluded that in both areas, sampling has to cover the spawning season sufficiently and a weekly sampling over the season is therefore recommended. In Airisto, herring samples can be taken from any location in the spawning area, while in the Greifswalder Bodden samples representative of the population may be obtained only in given locations.

The population data and other results of the study, suggested that salinity conditions strongly modify herring characteristics in the northern Baltic Sea. In the Airisto population, results indicate a trade-off between fish growth and reproduction at low salinity. The reproductive strategy of the Baltic herring, it seems, is to reduce body size while maintaining reproductive
output. For this reason, herring growth may not indicate fishing pressure in the northern Baltic Sea. In the Rügen herring, the growth rates, among other data, suggested a high fishing pressure outside the spawning area.

In both areas, herring spawning has continued uninterruptedly over the years, in spite of the high influence of man. The tendency to spawn in river estuaries makes herring reproduction highly vulnerable to environmental disturbances, as these largely accumulate in estuarine areas. High egg mortalities were found in both spawning areas, and the spawning beds are progressively reducing in number and area, due to disappearance of aquatic vegetation. This process is connected with increased water turbidity, caused by high load of nutrients and increased sedimentation in the coastal areas.