COUNTRY: GERMANY

Project Title:
Trophic Interactions between Zooplankton and Fish under the Influence of Physical Processes

Source of information:
Jürgen Alheit, October 2003

National Representative/Contact:
Jürgen Alheit
Baltic Sea Research Institute
Seestr. 15
18119 Warnemünde
Germany

Tel.: +49 381 5197 208
Fax: +49 381 5197 440
juergen.alheit@io-warnemuende.de

Project Goal:
Clarification of trophodynamic interactions between zooplankton and planktivorous fish in relation to reproductive success under the impact of physical forcing.

Project Description:
The project aims for a better understanding of the interactions between zooplankton and fish under the influence of physical processes in order to elucidate the principal mechanisms accounting for the high variability of copepod production and of reproductive success of fish. The results will form the basis for strategic modelling of the recruitment success of fish. Over the last several decades, herring and sprat, but also numerous copepod populations, in the Baltic and in the North Sea have experienced high fluctuations in recruitment and biomass. Whereas a substantial decrease of individual weight of herrings and sprats at high biomass was documented in the Baltic Sea, a similar relationship was not observed in the North Sea. It is assumed that this phenomenon is caused by food (mainly copepods) limitation in the Baltic Sea. However, it is not clear whether this is due to direct effects of trophic interactions (internal dynamics) in the rather simple Baltic food web or whether the decrease of some copepod populations is a reaction to physical processes (external forcing). An interdisciplinary team of fisheries biologists, planktologists, physiologists, geneticists, physical oceanographers and modellers are required to investigate these hypotheses.

The influence of physical processes on zooplankton and on the spawn of two planktivorous fish species with different life histories, herring and sprat, and on their trophodynamic interactions will be studied in the Baltic and the North Sea, two ecosystems with very different oceanographic characteristics. This will be done using a combination of field studies, experimental investigations and modelling. The two seas under investigation exhibit a gradient from marine to almost fresh water conditions. Top-down and bottom-up processes will be studied comparatively in both ecosystems. As the Baltic Sea has a considerably lower number of species, the importance of food web complexity for ecosystem functioning can be studied in a comparative manner between the two systems. The same suite of species will be investigated in both areas: the planktivorous clupeids, herring and sprat, and their main food basis, the copepods *Pseudocalanus* spp., *Acartia* spp. and *Temora longicornis*. The focus will be on an intra-seasonal and regional comparison of the reactions of egg and larval cohorts of herring and sprat produced at different periods over the entire spawning season with respect to their continually changing physical and biological environments.

A tight coupling between field research and modelling is required to enhance our understanding of the two ecosystems. We expect that an improved understanding of the mechanisms governing population fluctuations at short time scales will finally give us insight into the causal relationships of major population fluctuations and ecosystem changes on the decadal scale.

Subprojects:

1. Spatial and temporal distribution, growth and mortality rates of fish spawn under the influence of physical processes (Dietrich Schnack, Kiel)

2. Predation pressure of fish on zooplankton and fish larvae and zooplankton abundance (Axel Temming, Hamburg)

3. Influence of meso-scale physical structures and processes on population dynamics of copepods, micro-zooplankton and trophodynamic relationships between fish larvae and their prey (Jürgen Alheit, Warnemünde)

4. Copepod population dynamics (Hans-Jürgen Hirche, Bremerhaven)

5. Interactions between phytoplankton and zooplankton dynamics under the influence of hydrographic conditions (Justus van Beusekom, Sylt)

6. Food preferences, food quality and condition of target species of zoo- and ichthyoplankton (Wilhelm Hagen, Bremen)

7. Coupled modelling of trophodynamics and advection (Dietrich Schnack, Kiel)

8. Modelling of the Baltic Sea ecosystem with particular emphasis on zooplankton (Wolfgang Fennel, Warnemünde)

9. Regional ecosystem model of the lower trophic levels of the North Sea including population dynamics of zooplankton and fish larvae (Andreas Moll, Hamburg)

10. Modelling drift and development of fish larvae based on active tracers and of the 3D current field of the southern North Sea (Thomas Pohlmann and Günther Radach, Hamburg)

The aim of this subproject of the German-GLOBEC is the development of a tracer model for fish larvae for the central and southern North Sea. The model will be forced by a thermo-hydrodynamical circulation model of the same area. The circulation data will be made available also for other subproject and in particular for the interpretation of the measurements taken during the North Sea field campaigns. In order to resolve the frontal processes, which play a dominant role with respect to the biological processes under consideration, the model has a horizontal resolution of 1.5 nautical miles and a vertical resolution of 5m in the upper 50m.

On the basis of this hydrodynamical model a tracer model for fish larvae has been developed. In this transport model the fish larvae are not only treated as passive and conservative tracers but exhibit also a number of active (trophical) properties. This active behaviour can depend on parameters provided by the circulation model, i.e. currents, temperature, salinity, eddy viscosity, or on external parameters like the food supply or predator density. The general concept of the model is the "Individual Based Model (IBM)" approach. In this approach one single tracer represents a certain group of individual fish larvae. The time scale of both models covers the range from hours, i.e. the model time step, to five years, which puts the GLOBEC field campaigns in a more general frame.

The following two central questions form the motivation of this subproject:

1. can we identify certain areas in the southern North Sea which are favourable for the growth of fish larvae?
2. is it possible to relate observed abundancy variations of larvae to biotic or non-biotic factors that they experience during their drift.

11. Data organisation of German GLOBEC Project (Stefan Zabanski, Hamburg)