

ICES Baltic Committee
ICES CM 2004/H:06

Report of the Study Group on Multispecies Assessment in the Baltic (SGMAB)

By correspondence

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<https://doi.org/10.17895/ices.pub.9148>

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1 Introduction

The multispecies interactions in the Baltic are rather clear and strong. Thus it is relative easy to demonstrate how species interactions effect our assessments of the state of the stocks and our perception of the interactions. The Baltic multispecies assessment process started more than 20 years ago and presently the following multispecies assessments and data are available for the Baltic Sea according to ICES sub-divisions (ICES 2003):

Baltic Main Basin: Years 1974–2003

- cod in Sub-divisions 25–29 + 32
- sprat in Sub-divisions 25–32,
- herring in Sub-divisions 25–29 + 32,

Western Baltic: Years 1977–2001

- cod in Sub-divisions 22 + 24 (Sub-division 23 included in 1996–2001),
- sprat in Sub-divisions 22–24,
- herring in Sub-divisions 22–24 including Division IIIa.

Baltic Main Basin: Years 1974–1999, area dis-aggregated MSVPA:

- cod in Sub-divisions 25, 26, and 28
- sprat in Sub-divisions 25, 26, and 28
- herring in Sub-divisions 25, 26, and 28

In the case of Baltic herring in the Baltic Main Basin, the assessment unit is directly comparable to the units used by the Baltic Fisheries Assessment Working Group; although at their 2001 meeting WGBFAS (2001) used new stock assessment units for Baltic herring in the Main Basin. As the sprat population in Sub-division 30 is rather low and in Sub-division 31 almost non- existing, the Baltic Main Basin stock estimates are basically also referring to Sub-divisions 25–32. Consequently the effect of ignoring the two Sub-divisions should not hamper a direct comparison between single species and multispecies assessment output in the case of cod and sprat.

Experience in developing multispecies models goes back to the first North Sea and Baltic Sea models and their operational successor the MSVPA/MSFOR. The 4M package (Multi-species, Multi-fleet, Multi-area Model) is the newest version routinely used by SGMAB for Baltic Sea. The 4M package allows to conduct a full ICES assessment including tuning taking biological and technical interactions into account. In most recent years the focus on multispecies modelling have been: i) incorporating of ecosystem objectives in advice on fisheries management using existing models, ii) visualization of complex multispecies assessment results, iii) utilisation in research projects addressing Baltic fish stock dynamics in relation to reproductive success and species interaction and iv) enhancement of process sub-models or input parameters (e.g., quarterly rations).

This relevant process-oriented work has covered *inter alia* prey selection, consumption, growth and maturation as well as distribution and habitat utilisation. Also some experience exists on the incorporation of enhanced interacting process models, e.g., coupled consumption, growth and maturation for Baltic cod. Additionally work has been done on evaluation of biological reference points in multispecies context for the Baltic and construction of a stochastic multispecies stock production model.

In the nearest future there are plans to develop a stochastic age-length based multispecies model (SMS), which include likelihood functions for catch-at-age, CPUE and stomach contents. There are plans to integrate environmentally sensitive process sub-models on prey selection, growth and maturation into both 4M and SMS as well as implement this mainly in the North Sea and the Baltic Sea multispecies assessment. Enhanced models should be able to quantify consumption rates by major predators including marine mammals and sea birds, and natural mortality rates of key prey species, e.g., cod and clupeids.

2 SGMAB supporting projects

ICES framework

Under the ICES framework the SGMAB has benefited from the activities of Baltic Fisheries Assessment Working Group (WGBFAS). WGBFAS compiles the main input information needed for SGMAB since 1997 for both the western and the central Baltic multispecies assessment units.

The WGBIFS (Baltic International Fish Survey Working Group) reports information on weight-at-age in the stock for cod based on 1st quarter and 4th quarter bottom trawl surveys and compiles the information for VPA tuning files for all three species from the international bottom trawl survey and the international hydroacoustic survey, respectively.

Data on weight-at-age in the stock for herring and sprat is available from international hydroacoustic surveys. Also these data are provided by WGBIFS and these data sets could be used to establish a stock specific weight at age, however, not covering all quarters, which consequently requires modelling of seasonal growth to ensure complete seasonal coverage.

There have been activities on modelling growth, sexual maturation, and egg production of cod in relation to food consumption, food availability and environmental conditions, especially temperature in the framework of the EU projects STORE and SAP (Sustainable Fisheries), which have and will be used by SGMAB.

SGMAB will benefit from the Baltic Sea Regional Program (BSRP) and its working groups/study groups. For instance, SGBFFI reviews existing knowledge on environmental processes affecting fish stock dynamics in both the open sea and coastal areas of the Baltic. This information will be useful for SGMAB work in relation to the incorporation of environmental variability and spatial heterogeneity in fish stock modelling.

The terms of reference of SGBFFI are specifically part of the Implementation plan for Component 1 of the BSRP. At this stage a joint meeting day is planned for 2005 for SGBFFI and SGMAB at the end of February or at the beginning of March to integrate their findings. SGBFFI has planned and is able to supply time-series data on other food species for cod (i.e., *Saduria*, *Harmothoe*, *Mysidae*, etc.), and this is very welcomed by SGMAB.

EU framework

The work of the SGMAB depends also heavily upon the results of various European Union-funded projects. Within the European Union, SGMAB has benefited and will benefit from results of a number of other, either completed or ongoing projects and study projects. Such completed projects were CORE (Cod Recruitment, completed in 1998), ISDBITS (International Standardization of Baltic Bottom Trawl Surveys, completed in March 2001), BALTDAT (Baltic International Hydroacoustic Surveys, completed in March 2001), BITS (Baltic International Trawl Survey Database, completed in April 2001) and IBSSP (International Baltic Sea Sampling Project I–II, completed in July 2001) and STORE (Environmental and fisheries influences on fish stock recruitment in the Baltic Sea) completed in 2003. At the beginning of year 2002 the European Union established a new framework for the collection and management of data needed to evaluate the situation of the fishery resources and the fisheries sector in general. This kind of framework will be operative until the end of 2006.

In EU the countries' national programmes are defined for the collection and management of fisheries fish stock data. The programme covers the information strictly necessary for the scientific evaluations and moreover to define an extended Community programme which includes, in addition to the information of the minimum programme, information likely to improve in a decisive way the scientific evaluations. There are also possibilities to include some extra sampling on special issues in both the minimum and the extended programme. The quality of assessments of Baltic fish stocks, also multispecies assessments, will be very much dependent on these sampling schemes and minimum and extended programmes.

In 2004 a number of European Union FP6 programs started to be operative and especially programs such as BECAUSE, PROTECT, COMMIT and EFIMAS will focus on species interactions, closed areas as a management tool, and evaluation of fisheries management regimes. The programs are policy oriented (FP6 priority 8), but contains research components related to the work of SGMAB and collaboration is envisaged.

Considerations of environmental factors, both abiotic and biotic, will make a substantial difference on how to manage Baltic fish stocks. Our perception of the production potential of Baltic Sea benefits of including environment in fish stock assessment and is conditioned by our ability to relate environment to population parameters. The benefits of including environmental processes in stock assessment may extend from short-term to medium-term projections but need to be evaluated in the context of specific stocks. All these are linked to SGMAB work and in this respect the results of the new EU programs' are important. Especially, the BECAUSE project focusing on important species interactions with a case study in the Baltic has many common aspects in multispecies modelling.

The BECAUSE work program for (2004–2007) contains four working packages:

- Development of conceptual foodweb models and analysis of processes driving critical interactions including environment;
- Prediction of stock trends applying improved multi-species forecast models;
- Improving multispecies assessment models;
- Analysis of fisheries management implications.

Improvement of multispecies assessment models is certainly the one linked to SGMAB work. Within the BECAUSE work program the following multispecies issues have been included:

- Development of enhanced deterministic and stochastic multispecies models equipped with enhanced process sub models.
- Formulation of alternative, less data demanding multispecies models.
- Quantification of historical trophic transfer rates in critical interactions and historical stock sizes quantified by application of improved multispecies models
- Quantification of structural and parameter uncertainties in deterministic, stochastic and alternative multispecies models.
- Construction and implementation of enhanced deterministic, stochastic and alternative multispecies forecast models.
- Performing short, medium- to long-term scenarios predictions with/without environmental processes affecting species interactions and recruitment utilizing multispecies forecast models.
- Performing short, medium- to long-term prediction of effects of existing and alternative fisheries management strategies and technical measures on critical interactions and on stock dynamics.
- Comparing results and associated uncertainties in projections obtained by application of improved stochastic and deterministic models
- Evaluation of multispecies fisheries management strategies (e.g., biological reference points) considering identified critical biological links under variable environmental conditions
- Evaluation of multispecies management strategies and technical measures that enhance the incorporation of environmental concerns with emphasis on the food web effects

BECAUSE is essentially a modelling project. Quantitative population abundance, structure and diet data are used to run foodweb models and to parameterise species interaction models of different complexity from simple conceptual food web models to stochastic multi-species simulation models. In SGMAB, development of large multispecies models is not feasible and in this respect SGMAB will benefit substantially from activities within BECAUSE.

3 Description of the future work

SGMAB considers that it is necessary to keep the capability of running multispecies models for the Baltic within the ICES community and should ensure further progress in multispecies modelling in the Baltic and to promote the utilization of the multispecies models by the Baltic Fisheries Assessment Working Group as a standard assessment tool addressing different stock units as necessary.

As basis of constructing environmentally based short-term prediction and medium- to long-term projection models, it is necessary to review available information on environmental processes affecting the population dynamics of cod, sprat and herring. SGMAB should, formulate process models for most important population dynamic key rates, integrate these into the present multispecies assessment and prediction models, start to introduce statistically based multispecies frameworks in the Baltic, if possible spatially explicit, i.e., allowing modelling of migration rates in comparison to observations from tagging experiments.

SGMAB should also explore possibilities to implement more simple multispecies models in assessing the state of the stocks, especially in view of uncertainties in catch-at-age and weight at age data (inconsistencies in age determinations) observed in recent years. The major advantage of these models are that they do not require to resolve the age structure of the population, which seem to appropriate especially in the case of Baltic cod, where we still have a serious problem in age determinations. Candidates for future work are the available multispecies stock production model and length-based assessment models, e.g., FLEXIBEST type models.

As approved by the Annual Science Conferences in 2002, this Study Group concentrated 2003 initially on issues related to medium- to long-term multispecies prediction methodology and considered the development of different types of multispecies prediction models. This new activity of the Study Group was considered to i) lead ICES into multispecies stock predictions taking into account also environmental processes affecting species interactions and

recruitment success and ii) outline the necessities and strategies to expand the multispecies approach into an ecosystem approach. However, this activity is far to be complete.

This approach is of high priority for future management advice of ICES. The Study Group's tasks have been expanded furthermore to explore the necessary actions to broaden the ecosystem modelling approach considering interactions to other ecosystem components and estimation of the carrying capacity of the Baltic and its various subsystems with respect to biological (including fish) production and review present activities on ecosystem modelling in and outside the Baltic Sea.

4 Draft resolutions for 2005 meeting

The **Study Group on Multispecies Assessment in the Baltic** [SGMAB] (Co-Chairs: E. Aro, Finland, and F. Köster, Denmark) will meet in Riga, Latvia from 9–13 May 2005 to:

- a) update the multispecies key runs up to 2004 covering both Western and Eastern Baltic by appropriate units;
- b) review, revise and update the multispecies database (i.e., catch in numbers, maturity ogives, mean weight at age, stomach data etc) and explain historical trends and changes in mean weight at age of key species;
- c) review available information on environmental processes, which are affecting the temporal and spatial changes in Baltic herring population dynamics;
- d) develop, apply and validate enhanced multispecies models for assessment and prediction including
 - i. prediction of weight-at-age and proportion of maturation at age, potentially depending in a feed back loop on prey availability and environmental conditions; and
 - ii. recruitment success in relation to parental stock status and environmental conditions;
- e) validate the revised consumption rates (by quarter of years), which presently contain inter-annual and spatial variability in stomach content, predator weight and ambient temperature, but ignore an impact of reduced oxygen concentrations;
- f) consider how the results of the Study Group on “Fish and Fisheries Issues in the BSRP (SGFEI)” can be incorporated into the work programme of this Study Group.
- g) prepare a workplan, including a schedule for deliverables.
- h) consider potential contributions to the 2006 Theme Session on Regional Integrated Assessments, as described in the 2003 report of the Regional Ecosystem Study Group for the North Sea.

SGMAB will report by 11 June 2005 for the attention of the Baltic Committee.

Supporting Information

Priority:	The activities of this Study Group will produce updated information issues of predator-prey relationships in the Baltic as well as evaluation of usability of single species precautionary reference points in multispecies context which should be considered to have high priority in future management advice.
Scientific Justification and relation to Action Plan:	<p>Action Plan:</p> <p>1.2 – a, b, c, d 1.2.1 – a-e 1.3 – c, d, e 1.6 – c, d, e 1.7 – f, g 3.2 – a, d 3.5 – a-e 3.15 – d 4.11.2 – a, d, 4.11.3 – a, d 5.6 – all</p> <p>As approved in previous years Study Group will concentrate initially on issues related to historical stock developments by traditional multispecies modelling and more sophisticated stochastic modelling as well as on medium- to long-term multispecies prediction methodology. Group has considered multispecies prediction models and has taking into account some environmental processes, which are affecting growth, maturation and subsequent recruitment success.</p>
Resource Requirements:	For the 2005 meeting (9–13 May) computer and printing facilities as well as copy machine should be made available from organising institute (Riga, Latvian Fisheries Research Agency).
Participants:	In order to have the latest information available at the meeting it is necessary to have the meeting after the WGBFAS meeting in 2005.
Secretariat Facilities:	None
Financial:	No direct costs to ICES
Linkages to Advisory Committees:	ACFM, The quality of stock assessments and management advice of Baltic herring, sprat and cod stocks
Linkages to other Committees or Groups:	WGBFAS, WGBIFS, Resource Management Committee, SGFEI (BSRP)
Linkages to other Organisations:	IBSFC, EU DG Fish
Secretariat Cost Share	ICES 100%

5 References

ICES. 2001. Report of the Baltic Fisheries Assessment Working Group. Gdynia, Poland 18–27 April 2001, Advisory Committee on Fishery Management ICES CM 2001/ACFM:18, 553 pp.

ICES 2003. Report of the Study Group on Multispecies Assessment in the Baltic. Charlottenlund, Denmark 2–4 April 2003, Baltic Committee, ICES CM 2003/H:03, 82 pp.