**Status report for Month 16 (April 2010):**

**WP3: Impact on the food-web (DTU, BNI, IOW, TMBL, IOPAS)**

**Task 3.1: Process validation of food-web models (1-24)**

# *Deliverables:* Food-web model and BEM simulation results 1961-2004 (24), unified validation data sets (6), detailed assessment of model skills (24), analysis of regime-shifts in the food-web (24)

*Milestones and expected results*: Validated models for climate and nutrient load change scenarios; delineation of the impact of historically changing drivers on dynamics (life-histories, distributions and phenologies) of key species (e. g., cod).

**Activities in months 12-16:**

Work in first 6 months has primarily focussed on further developing foodweb models, including Ecopath-Ecosim model components.

BNI:

First version of the Ecopath with Ecosim (EwE) food-web model was calibrated to primary production (via which we will link up to the biogeochemical models), fisheries and climate data,   and the model behaves stable which is promising for some reasonable results in the near future

-  Integrated assessment work continues in order to find linkgages between the food-web components and to get an understanding of thresholds and their dynamics

- Data on Mysids and macrozoobenthos (besides phytoplankton biomass and different zooplankton and fish data) have been included to  in order improve  the EwE model calibration/validation routines

DTU Aqua:

There is close collaboration between BNI and DTU Aqua regarding development of foodweb models. Several new datasets on fish and climate-hydrography have been compiled for input to Ecopath-Ecosim:

        Data about catches of flatfishes collected

        Diet composition data for flatfishes collected

        Climatic and hydrographical historical data collected

The flatfish data and dietary will be incorporated to the model, which will be run in hindcast mode with the new biological components for historical periods (1900 – 1974  contrast to 2006 ). The objective is to build Ecopath models for different time periods under different climate-eutrophication situations and develop “snapshots” of food-web structure and functioning.

University of Gothenburg (UG):

Work has continued on development of bioclimate envelope models (BEMs) in relation to acidification effects on benthic Baltic biota, particuarly molluscan species. Discussions with BNI colleagues regarding viability of the approach and available field data for parameterizing models have been held and meta-data exchanges have taken place. There are some limitations to the approach, particularly based on correlations with field distributions and abundances.

Regarding experimental assessment of how acidification affects the target species of investigation (blue mussel, *Mytilus* sp.), preliminary results by show that fertilisation success under expected a modest reduction in acifidication in the Baltic by ca. 0.35 pH units may be relatively unaffected or in some cases even increased. Further experiments in 2010 will investigate the topic in more detail and in combination with changes in temperature. It is hoped that these results might contribute to development of a mechanistically-based bioclimatic envelope model for the species in the Baltic.

Additional experimental studies of acidification on fertilisation success are being conducted with cod as part of a jointly supervised Ph.d. project between UG and IfM-Geomar, Kiel. Preliminary results suggest no significant impact on sperm motility at a ph reduction of 0.4 unit. The sperm motility experimental results are in prepration for publication in Biogeosciences.

There are some other related issues regarding the experimental work and bioclimatic envelope modellig (BEM) for the Baltic. It has become clear that developing a useful and even reasonably accurate BEM is a major task requiring substantial information about the target species (which in many cases is lacking), and therefore doing so for multiple key Baltic species is likely to require more time (and expertise) than is available in this project. Partly this problem arises because genetic composition of Baltic populations of common species (eg *Mytilus, Macoma*) differ markedly from those of non-Baltic populations of the same species, and this limits markedly the applicability of environmental tolerance data from non-Baltic locations. It has also become clear that we lack relevant expertise to develop useful BEMs. There is a growing literature that highlights the limitations and questions the relevance of BEMs in general.

Plans for next 6-12 months

Considerably more effort will be allocated to analyses and interpretation of model outputs from wp1 and wp2 of historical data for the key variables that will be used in future scenaro modelling. Hindcasted data are now beginning to be available for key temperature, salinity and reproductive volume data from other WPs and these data will be compared and validated with field observations. The data will also start to be used in some population and foodweb models to check ability to describe past fluctuations in key response variables such as biomass and recruitment.

Experimental work on acidification effects on mussels and cod will continue.

Some dissemination of results will be made at meetings and in literature. See dissemination section at end of report.

**Task 3.2:** **Scenario simulations of the food-web (1-33)**

*Deliverables:* Food-web and fish population model simulations for 1960-2100 (33), calculated envelopes for resilience of species in future climate (33), cause-and-effect studies of simulated changes and analysis of various scenarios (33)

*Milestones and expected results:*To discover changes in the food-web due to future climatic changes and address questions such as whether cod or blue mussels can survive in the future BS

**Activities in months 12-16:**

See also subtask 3.1.

Preparatory work is scheduled for months 1-17. Full activity not scheduled to start until month 18. However, a large amount of preparatory work is being conducted in this sub-task, mainly in relation to other projects and activities.

Most wp3 partners are involved with the ICES – Helcom Working Group on Integrated Ecosystem Assessment of the Baltic Sea. This WG met in April 2010, in Copenhagen in mid-April shortly after the ECPSUPPORT conference call. Eco-support partners BNI and DTU-Aqua participated in both; a BNI colleague and an associated partner of Eco-support (SBF) are co-chairs of the WG. BNI and DTU-Aqua presented results of ongoing work related to environmentally-driven foodweb and fish population modelling and which will be developed further within Eco-support.

Colleagues at DTU-Aqua and partners outside Eco-support have published a paper about fish projection models under future climate change and presented the results at ICES Annual Science Conference, Berlin, Germany, Sept. 2009. The model makes projections for cod, sprat and herring biomass for the 21st century based on historic (1970s-2005) abundance and hydrographic data, and including predation-competition among fish and zooplankton species.

New analyses using a simpler cod-environment recruitment have simulated how climate change, exploitation and a recovering seal population might affect development of the cod stock in the 21st century. A manuscript will be submitted to a peer-reviewed journal on this topic later in 2010.

All results must be considered as very preliminary. Nevertheless the attempts have been very successful in identifying and developing the links between various models.

Plans for next 6-12 months

Considerably more effort will be allocated to analyses and interpretation of model outputs from wp1 and wp2 of historical data for the key variables (e. g., cod reproductive volume, temperature, salinity) that will be used in future scenaro modelling. See also subtask 3.1.

The wp will arrange a small workshop for Ecosupport participants in late summer-early fall 2010 regarding how to use the output modelled data from wp1 and wp2 in foodweb and population models. Expected outputs are increased knowledge and experience of the practical implementation and handling of the output datasets for the biological and ecosystem modelling.

Some dissemination of results will be made at meetings and in literature. See dissemination section at end of report.

**Task 3.3: Quantification of uncertainty of future food-web projections (1-36)**

*Deliverable*: Probabilistic uncertainty assessments of biological responses (e. g., populations, food web structure) to model structure and forcing scenarios (33)

*Milestones and expected results:* Estimates of future development of populations and food webs in response to future scenarios of eutrophication, climate change and exploitation

**Activities in months 12-16:**

The sub-task is not scheduled to start until month 25. However, a large amount of preparatory work has been conducted in this sub-task, mainly in relation to other projects and activities.

The food web projections will be sensitive to both the climate development (including the CO2 emission scenario used), the eutrophication development and fishery developments.

Some preliminary analyses of uncertainty of the foodweb projections have been conducted by 2 Eco-support partners in the ICES – Helcom Working Group on Integrated Ecosystem Assessment of the Baltic Sea, which met in April 2010, in Copenhagen.

All results must be considered as very preliminary. Nevertheless the attempts have been very successful in identifying and developing the links between various models.

The results are documented and will be available in the 2010 report from the working group later in this year (available at <http://www.ices.dk/reports/BCC/2009/WGIAB09.pdf>).

Plans for next 6-12 months:

The wp will arrange a small workshop for Ecosupport participants in late summer-early fall 2010 regarding how to use the output modelled data from wp1 and wp2 in foodweb and population models. Expected outputs are increased knowledge and experience of the practical implementation and handling of the output datasets for the biological and ecosystem modelling.

**Gantt chart or similar to show the timing of different Work packages and Tasks**

Light grey: preparatory phase (some forcing data are still missing)

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| **W3.1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **W3.2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **W3.3** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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**Dissemination:**

**Past:**

Meetings, workshops, conferences:

Publications and reports:

Lindegren, M., C. Möllmann, A. Nielsen, K. Brander, B. R. MacKenzie, and N. C. Stenseth. 2010. Ecological forecasting under climate change - the case of Baltic cod. Proc. Roy. Soc. Lond. B (in press).

BNI and DTU Aqua participated in a special workshop in Jan. 2010 arranged by Baltic Sea 2020 on “Trophic Interactions in the Baltic Sea”. The group produced a joint statement which urged decisionmakers to more fully adopt an ecosystem approach (e. g., accomodating impacts of eutrophication, climate change, etc.) to management of the cod fishery. The statement was widely published as a “letter to the editor” in major newspapers around the Baltic Sea in different languages.

**Planned next 6-12 months:**

Meetings, workshops, conferences:

ICES/HELCOM Working group on Integrated Assessment of the Baltic Sea, Copenhagen, April 12-16, 2010

Blenckner, T. et al. EUTRO, June 2010, Denmark

Blenckner, T. et al. ECOSUPPORT conference/annual meeting, Oct. 2010

MacKenzie, B. R. et al. ECOSUPPORT conference/annual meeting, Oct. 2010

Tomczak, M. T., et al. ECOSUPPORT conference/annual meeting, Oct. 2010

Tomczak, M. T., Eero, M., MacKenzie, B. R., Niranen, S., Blenckner, T. Changes in the Central Baltic Sea Ecosystem During the 20th Century. Oceans Past III Conference, Dublin, Ireland, Nov. 2010.

Publications and reports:

Blenckner, T. et al. A manuscript will be submitted dealing with the analysis of the food-web dynamics in the main 6 Baltic Sea basins in relation to fishing pressure, eutrophication and climate. (in prep.)

Eero, M., B. R. MacKenzie, F. W. Köster, and H. Gislason. 2010. Multi-decadal responses of a cod (*Gadus morhua*) population to human-induced trophic changes, exploitation and climate variability. Ecol. Appl. (accepted).

MacKenzie, B. R., Eero, M., Ojaveer, H. Combined impacts of climate change, exploitation and a recovering seal population on expected cod population dynamics in the Baltic Sea during the 21st century. (In prep.)