ICES SGGIB Report 2005

ICES Baltic Committee
CM 2005/H:04

Report of the ICES-IOC-SCOR Study Group on GEOHAB Implementation in the Baltic (SGGIB)

7–8 April 2005

Flødevigen, Norway

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Executive Summary

New findings on HABs and HAB modelling in the Baltic

Reports on recent HAB research in the Baltic Sea included a presentation of occurrence and toxicity of *Dinophysis* spp. in the Gulf of Finland, presentation of regional and basin wide modelling of HABs, and presentations where results of the EU-project HABILE, and the SMHI phytoplankton database were introduced.

2004 distribution of HABs in the Baltic; prepare the HAE-DAT reports

HAB distributions in the Baltic in 2004 were presented in ToRs a, b and f. The compatibility of the HAE-DAT reporting format in case of Baltic cyanobacteria blooms was discussed. It was decided that cyanobacteria blooms need to be reported in HAE-DAT only if they cause actual "harmful effects" such as beach closures, fish kills, or sickness symptoms in animals or humans.

Checklist of the harmful species of the Baltic Sea

The taxonomic experts of the SGGIB discussed and updated the checklist of the harmful phytoplankton and cyanobacteria species of the Baltic Sea (Annex 5).

Concentrations of nodularin and other HAB toxins in different compartments of the Baltic ecosystem

Two presentations were given reviewing nodularin concentrations in the Baltic. Nodularin has been detected in water, sediments and many Baltic organisms, including zooplankton, fish, mussels, clams, mysids and eider, and the concentrations vary widely. Concentrations found in the benthic foodweb are higher than those found in the pelagic food chain. As for dinoflagellate toxins (see also ToR a), ocadaic acid has been found from flounders and blue mussels **previously** by Sipiä et al. and Pimiä et al, and pectenotoxin-2 (PTX-2) and its seco acid have been identified from *Dinophysis norvegica* by Goto et al. New findings include pectenotoxin-2 (PTX-2) and dinophysistoxin-1 (DTX-1) from suspended matter co-occurring with *D.acuminata, D. norwegica* and *D. rotundata*.

Effects of HAB toxins in the Baltic biota

A review of toxic effects of *Nodularia spumigena* was given. Studies on allelopathic effects show that extracts of *Nodularia, Aphanizomenon* and *Anabaena* decrease the growth of cryptophytes and diatoms. Effects on zooplankton vary, but, despite the low concentrations of nodularin in the pelagic food chain, foraging on a food chain containing cyanobacteria causes deleterious effects in fish (growth of pike larvae and threespined sticklebacks is retarded).

Long term trends in HABs in the Baltic

Four presentations on long-term trends on HABs (mainly cyanobacteria) were given. The evidence supports the view that, while the cyanobacteria blooms are strongly dependent on hydrographical and weather factors, their intensity and duration is increasing along with the eutrophication of the Baltic Sea.

Planning of the open sea field study for summer 2005

The plan for the HAB study cruise for Gulf of Finland was presented and joint activities were planned and discussed. Polish participation was confirmed.

GEOHAB implementation plan for the Baltic

It was held imperative that the proposal for a Cooperative HAB study in the Baltic Sea would be finalised. A sub-group was nominated for updating the proposal. After comments from the rest of the group the plan will be submitted for GEOHAB SSC for endorsement.

1 Background

SGGIB has met twice (Dublin and Stockholm) under the chairmanship of Kaisa Kononen, Finland, and has produced an extensive proposal for a cooperative study to investigate HABs in the Baltic Sea. In 2003 the SGGIB met by correspondence under the chairmanship of Markku Viitasalo (Finnish Institute of Marine Research). In 2004 SGGIB met in Helsinki, with an open call to ca. 40 HAB-interested scientists around the Baltic Sea. It was decided that the group meets in 2005 back to back with the ICES Working Group for Harmful Algae Bloom Dynamics (WGHABD), with the objective of the two groups to interact.

2 Welcome and opening of the meeting

The ICES-IOC-SCOR Study Group on GEOHAB Implementation in the Baltic (SGGIB) met in 7–8 April 2005 at Flødevigen Marine Station, Norway, hosted by the Institute of Marine Research. Altogether 16 scientists from Finland, Estonia, Latvia, Poland, Germany, Norway, Sweden, Spain and Canada participated. The list of participants is presented in Annex 2 and the meeting agenda in Annex 3.

The meeting was opened by the Chair, and the participants introduced themselves. The agenda was approved, and group members kindly agreed to act as Rapporteurs for different Terms of Reference.

The Chair reviewed the comments of the Baltic Committee on the SGGIB report presented during the 2003 statutory meeting in Vigo. The Committee had appreciated the structure and content of the SGGIB report and was aware that “the Group is making substantial progress towards an improved understanding of HAB dynamics in the Baltic Sea and how they might impact other components of the ecosystem”. The terms of reference were reviewed and approved, and the meeting place was confirmed.

3 Terms of Reference for 2005

At the 92nd Statutory Meeting (2004), Vigo, Spain, the council approved the SGGIB terms of reference (C. Res. 2004/2H04):

The ICES-IOC-SCOR Study Group on GEOHAB Implementation in the Baltic [SGGIB] (Chair: M. Viitasalo, Finnish Institute of Marine Research, Finland) will meet in Flødevigen, Norway, 7–8 April 2005 to:

a) report and discuss new findings on HABs and HAB modelling in the Baltic

b) report observations on 2004 distribution of HABs in the Baltic; prepare the HAEDAT reports for ICES use;

c) update the checklist of the harmful species of the Baltic Sea;

d) compile existing observations on concentrations of nodularin and other HAB toxins in different compartments of the Baltic ecosystem;

e) summarise observed toxicological effects in the Baltic biota;

f) review existing information on long term trends in HABs in the Baltic;

g) continue planning an open sea field study and workshop for summer 2005;

h) review and update the GEOHAB implementation plan for the Baltic.

4 Concentrations of HAB toxins in the Baltic Sea

Reviews on nodularin concentrations in the Baltic seawater, sediments and biota were given by Hanna Mazur (University of Gdansk, Poland) and Markku Viitasalo (Finnish Institute of Marine Research) in ToR d. Concentrations vary widely. Although the highest nodularin concentrations in seston usually occur during the strongest blooms, there seems to be no strict correlation between the strength of the bloom and toxin concentrations at the higher trophic levels. Furthermore, despite the fact that the cyanobacteria blooms are mostly recycled in the surface layer, concentrations found in the benthic foodweb, especially mussels and flounders, are higher than those found in the pelagic food chain, e.g., zooplankton, herring, and salmon. Abstracts of the presentations are in Annex 4.

Nodularin

The highest field concentrations found ($\mu g\ g^{-1}$ DW) have been: water 18135, sediments $0.95\ 10^{-3}$, phytoplankton 18100, zooplankton 0.62, mysids 0.56, threespined sticklebacks 0.17, benthic crustaceans (*Gammarus* sp.) 0.107, benthic molluscs (*Mytilus* sp.) 1.49, young herring 0.015, salmon liver 0.0049, flounder liver 0.399 and sand-eel 2.94.

Dinoflagellate toxins

Observations on dinoflagellate toxins were presented by Pirjo Kuuppo (Finnish Environment Institute) in ToR a. Previous findings of DSP toxins include: *Dinophysis* ocadaic acid from flounders and blue mussels in the Baltic Seaand pectenotoxin-2 (PTX-2) and its seco acid from *D. norvegica*. Studies carried out in 2004 on SW coast of Finland showed *Dinophysis* spp. in densities up to 8200 cells per litre, with maximum abundances above the thermocline. The toxic content of *Dinophysis* varied between 1.4–22.1 pg PTX-2 $cell^{-1}$. DTX-1 was found in the samples after middle of August in concentrations between 0.1 and 159 pg DTX-1 $cell^{-1}$. DTX-1 and PTX-2 were also found in sediment traps, with concentrations of 79–190 ng DTX-1 $m^{-2}\ d^{-1}$ and 0.6–15.4 ng PTX-2 $m^{-2}\ d^{-1}$.

5 New findings on HAB effects and HAB modelling in the Baltic Sea

Reports on recent research on HAB effects and HAB modelling in the Baltic Sea included a presentation of regional and basin wide modelling of HABs in the Baltic (Wolfgang Fennel, IOW, Germany), and two presentations by Bengt Karlson (SMHI, Sweden), where results of the EU-project HABILE and the uses of the SMHI phytoplankton database were introduced. Also, reviews of toxic effects of Baltic cyanobacteria on phytoplankton and other biota were given by Sanna Suikkanen and Markku Viitasalo (Finnish Institute of Marine Research). Abstracts of the presentations are in Annex 4.

Allelopathy

Studies on allelopathic effects of cyanobacteria show that extracts of *Nodularia, Aphanizomenon* and *Anabaena* decrease the growth of cryptophytes and diatoms. Nodularin is probably not the cause of allelopathy in *N. spumigena*.

Ecosystem effects

Evidence begins to accumulate that foraging on a food chain containing cyanobacteria causes decreased reproduction and growth in zooplankton and fish: e.g. growth of pike larvae is retarded, and RNA/DNA ratio of threespined sticklebacks decreases, after feeding on zooplankton that has been pretreated with *Nodularia spumigena*. Notably, fish larval growth may be retarded even if they are not themselves in contact with cyanobacteria. It was also noted that nodularin is not necessarily the only substance causing harmful effects. Other bioactive compounds may also play a role. Also, the group noted the recent finding by an international research group that most cyanobacteria taxa (including Baltic *Nodularia spumigena*, *Aphanizomenon flos-aquae* and *Nostoc* 268) contain *β-N*-methylamino-L-alanine (BMAA), a neurotoxic amino acid that has been connected to the Amyotrophic Lateral Sclerosis Parkinsonism Dementia Complex in humans.

Modelling

W. Fennel (IOW, Germany) noted that HAB modelling has advanced to foster interaction of theory and observation. The existing generation of models has matured to allow quantitative, regional and basin wide assessments of the system responses. Operational models for predictions of a few days are feasible. Gaps in knowledge regarding HAB modelling include: (1) over-wintering dynamics of HAB species; need for studying the potential seed bed areas with models; (2) toxicity; need for developing model components to describe toxicity, i.e., improved 'dynamical signatures' (switches in response to external or internal signals); (3) top-down control (a link to GLOBEC); need to include stage resolving zooplankton components; and (4) physical –biological interaction; need to describe the vertical motion of cells versus turbulent mixing. Other issues are the quantification of drift properties of surface accumulations as well as the role of meso-scale advection (convergences, divergences, eddies). Future generation of models will bridge the gap between the lower part of the foodweb and fish. This would allow simulating how toxic substances propagate through the foodweb and accumulate at the upper trophic levels.

6 Checklist of HAB species in the Baltic Sea

A complete list of the species forming toxic or harmful blooms in the Baltic Sea had been prepared by Seija Hällfors and Guy Hällfors during the SGGIB Helsinki 2004 meeting. The checklist was discussed and updated (Annex 5). Among others, the following comments were received by the taxonomic experts of the group:

(1) *Alexandrium excavata* -cysts are not distinguishable from those of *Alexandrium tamarense*. It is also questionable whether *Alexandrium excavata* is a different species from *Alexandrium tamarense*. If so, the presence of *A. excavata* has to be proven by the study of vegetative cells. (2) There is no confirmed record of *Gymnodinium catenatum* in the Baltic Sea and in the North Sea. Published records of *G. catenatum* in northern European waters are confusions with *Gymnodinium nollerii* or *Gymnodinium impudicum* (single record in Danish waters, pers. comm. by Per Andersen, Denmark). (3) The toxicity of *Prorocentrum balticum* has not been confirmed, and the species needs to be deleted from the list. (4) Some, but not all *Prorocentrum minimum* strains are toxic (chemical compound unknown) to zooplankton. Toxicity to man has not been confirmed. (5) *Protoperidinium curtipes* and *P. crassipes* have been suggested to produce azaspirazids, but not DSP or NSP. *P. curtipes* is present in the Baltic Sea at least down to Kiel Bight. (6) As for *Phaeocystis* species in the Baltic, the harmful effects (anoxia and hypoxia) are probably caused by *P. globosa. P. pouchetii* is a cold water species not growing at temperatures above 8°C and does not usually form blooms.

7 HAB distributions in 2004

HAB development and distributions in the Baltic in 2004 were presented in ToRs a, b and f. It was noted that very different views of the strength of the blooms emerge in different regions of the Baltic. This calls for a regular monitoring and reporting of the blooms to a common database by the Baltic countries.

The compatibility of the HAE-DAT reporting format in case of Baltic cyanobacteria blooms prompted a vivid discussion. It was decided that cyanobacteria blooms need to be reported only if they cause actual “harmful effects” such as beach closures, fish kills, or sickness symptoms in animals or humans. It was however recognised that cyanobacteria also cause more subtle harmful effects, such as loss of recreative use of Baltic waters, non-lethal effects on biota, as well as possible harmful effects on fisheries, yet to be explored.

8 Long-term trends in the HABs in the Baltic Sea

Regular monitoring of HABs in the Baltic has been undertaken only for some 10 years now. Reviews on long-term trends of HABs (mainly cyanobacteria) were given by Inga Lips (Estonian Marine Institute), Bengt Karlson (SMHI, Sweden), Sanna Suikkanen (Finnish Institute of Marine Research) and Norbert Wasmund (Baltic Sea Research Institute, Germany). Abstracts of the presentations are in Annex 4.

According to Inga Lips’ analysis on cyanobacteria blooms in 1997–2004, two factors — PAR and pre-bloom upwelling intensity index — explain about 98% of preconditions for bloom formation. Sanna Suikkanen showed that, in the Gulf of Finland in 1979−2003, salinity and silicate concentrations have been decreasing, while water temperature and winter DIN have increased. Consequently green algae, flagellates and cyanobacteria have been increasing in summer. Bengt Karlson reviewed cyanobacteria bloom intensity during the past 10 years based on remote sensing data. Norbert Wasmund reviewed the connection between climatic scale factors and cyanobacteria abundance. Cyanobacteria blooms have been present in the Baltic Sea for at least 7000 years, and they are strongly dependent on hydrographic and weather factors. Evidence from more recent sediments however supports the view that their intensity and duration have increased along with the eutrophication of the Baltic Sea, especially after the 1960s. Obviously there still are several gaps in the knowledge concerning the environmental factors that influence the long-term trends of HABs (both cyanobacteria and dinoflagellates) in the Baltic Sea.

9 GEOHAB implementation in the Baltic

The Chair presented the plan of the multiship experiment to be implemented in July 2005. The cruise will be made with two Finnish vessels, R/V Aranda and R/V Muikku, and will focus on determining the distributions and production rates of phytoplankton, zooplankton and fish (mainly herring, sprat and three-spined sticklebacks) in the open Gulf of Finland, where cyanobacteria probably dwell. Polish participation on the cruise was confirmed and joint activities were agreed upon. In addition to HAB dynamics and ecosystem effects, it was held important that also sediment would be studied in order to determine the toxin flux to the benthic foodweb. Further, it was decided that histological samples will be collected to check for symptoms in affected organisms (especially fish).

It was confirmed that it is necessary to submit the proposal of the Cooperative HAB study (cf. Annex 3 of the SGGIB 2002 report) for GEOHAB endorsement. M. Viitasalo presented the history of the previous plans. The proposal was held a relevant plan for what should be done, with some modifications. A sub-group was nominated for updating the plan. After comments from the rest of the group the plan will be submitted for GEOHAB SSC.

A questionnaire concerning the effects of cyanobacteria on fisheries has been sent to Finnish professional fishermen. The results of the study will be presented in ICES ASC 2005. It was suggested that the questionnaire could be translated to other languages, and sent to other countries for a similar study.

10 Other business

Markku Viitasalo (Finnish Institute of Marine Research) was re-elected for the next term as the SGGIB Chair. However, the continuation of the Study Group was thoroughly discussed. It was decided that it is essential to finalise the GEOHAB implementation plan (proposal for the cooperative study), and to start implementing it, before a prolonged continuation of the Study Group is confirmed. It was decided that the Group will meet in 2006 with the focus on finalising the Cooperative plan and discussing its future implementation. Most other Baltic HAB issues were decided to be presented as items in the WGHABD meeting, which was suggested to be held adjacent to the SGGIB meeting. This idea was welcomed by the WGHABD Chair.

Annex 1: Draft Terms of Reference 2005

The ICES-IOC-SCOR **Study Group on GEOHAB Implementation in the Baltic** [SGGIB] (Chair: M. Viitasalo, Finland) will meet in Gdynia, Poland, 6–7 April 2006, to:

a. report and discuss new findings on HABs and HAB modelling in the Baltic

b. update the checklist of the harmful species of the Baltic Sea

c. review the concentrations of HAB toxins in the upper trophic levels of the Baltic foodweb; estimate the health hazard of cyanobacteria and dinoflagellate toxins to humans

c. finalize the proposal for a Cooperative HAB study in the Baltic Sea; agree upon its implementation

Supporting Information

Priority:	The current activities of this Group will lead ICES into issues related to the effects of HABs on Baltic Ecosystem, as well as fisheries. Consequently these activities are considered to have a high priority.
Scientific Justification and relation to Action Plan:	Action Plan No: 1. *Term of Reference a)* There is currently an intense research activity on HABs in the Baltic. Among other studies, especially studies on toxin transport and transportation, other ecosystem effects, and modelling studies are being actively made. It is in the interest of ICES, IOC, SCOR and GEOHAB to foster international cooperative HAB research in the Baltic Sea. *Term of Reference b)* A list of potentially toxic and bloom forming species was prepared during the SGGIB meeting in 2004. Due to the rapidly developing taxonomy and new observations on blooms, it is necessary to keep updating this list annually. *Term of Reference c)* Scattered information on the concentrations of HAB toxins in Baltic biota exists. Summarising this information will help in determining the potential risks of HABs for the Baltic environment. Also, it is necessary to estimate if the concentrations found in commercially important fish pose a health hazard to humans. *Term of Reference d)* Development of HAB studies in the Baltic Sea provide a unique opportunity in studying HABs at the scale of one ecosystem. Initiation of the cooperative study is necessary for GEOHAB implementation in the Baltic Sea.
Resource Requirements:	Part of the research that provides input to this group are already underway in the participating countries, and resources are already committed. Additional resources are required to build an international cooperative HAB study in the near future.
Participants:	The Group is normally attended by some 10–20 members and guests
Secretariat Facilities:	None.
Financial:	No financial implications.
Linkages To Advisory Committees:	There are no obvious direct linkages with the advisory committees.
Linkages To other Committees or Groups:	There is a very close working relationship with several working groups in the Oceanography Committee (Harmful Algae Bloom dynamics, Phytoplankton Ecology and Phytoplankton and Protist Taxonomy) and Baltic Committee (Working Groups in support for the BSRP).
Linkages to other Organisations:	The Group is fulfilling the requirements of GEOHAB and IOC to foster international cooperative HAB research in the Baltic Sea.
Secretariat Marginal Cost Share:	

Annex 2: List of participants

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Annex 3: Meeting Agenda

SGGIB Terms of Reference for 2005

a) report and discuss new findings on HABs and HAB modelling in the Baltic

b) report observations on 2004 distribution of HABs in the Baltic; prepare the HAEDAT reports for ICES use;

c) update the checklist of the harmful species of the Baltic Sea;

d) compile existing observations on concentrations of nodularin and other HAB toxins in different compartments of the Baltic ecosystem;

e) summarise observed toxicological effects in the Baltic biota;

f) review existing information on long term trends in HABs in the Baltic;

g) continue planning an open sea field study and workshop for summer 2005;

h) review and update the GEOHAB implementation plan for the Baltic.

Thursday, 7 April 2005

12:00 LUNCH

13:10 WELCOME AND INTRODUCTION
Review by the Baltic Committee
Adoption of agenda and Terms of Reference of SGGIB for 2005

ToR a: **Report and discuss new findings on HABs and HAB modelling in the Baltic**

13:20 Occurrence and toxicity of *Dinophysis* spp. in the Gulf of Finland, the Baltic Sea (Pirjo Kuuppo, Finnish Environment Institute)

13:40 Regional and basin wide modelling of HABs in the Baltic (Wolfgang Fennel, IOW, Germany)

14:20 Modelling of cyanobacterial blooms in the Baltic in the EU-project HABILE - Harmful Algal Blooms Inititation in Large European Marine Ecosystems (Bengt Karlson, SMHI, Sweden)

14:40 Phytoplankton database at SMHI which is coupled to the hydrographical database (Bengt Karlson, SMHI, Sweden)

15:00 BREAK / Discussion on ToR a

ToR b: **Report observations on 2004 distribution of HABs in the Baltic; prepare the HAE-DAT reports for ICES use**

15:20 This ToR was also dealt with in WGHABD. Discussions on the HAE-DAT reporting practise in the Baltic.

ToR c: **Update the checklist of the harmful species of the Baltic Sea**

15:40 Updating will be prepared by the SGGIB experts before the meeting and sent to SGGIB beforehand; in Floedevigen mainly brief presentation of the checklist (M. Viitasalo, FIMR), discussion, possible editions

ToR h: Review and update the GEOHAB implementation plan for the Baltic

16:00 Review of the earlier GEOHAB implementation plan (M. Viitasalo, Finnish Institute of Marine Research).

16:30 Discussion on ToR h

~18:00 ADJOURN FOR THE DAY

Friday, 8 April 2005

08:15 TRANSPORT FROM HOTEL

ToR g: Continue planning an open sea field study and workshop for summer 2005

08:40 Results from the cruise in the Gulf of Finland in July 2004 and presentation of the plan for July 2005 (Markku Viitasalo, Finnish Institute of Marine Research)

09:00 Discussion on ToR g: Presentation of potential contributions to the cruise and discussions on other cooperation (Hanna Mazur, University of Gdansk, Poland).

ToR d: Compile existing observations on concentrations of nodularin and other HAB toxins in different compartments of the Baltic ecosystem

ToR e: Summarise observed toxicological effects in the Baltic biota

09:20 Nodularin and its concentration in water, mussels and sediments from the Gulf of Gdansk (Hanna Mazur, University of Gdansk, Poland)

09:40 Review of the existing knowledge on HAB toxin concentrations and their effects in the Baltic (Miina Karjalainen, Sanna Suikkanen and Markku Viitasalo; FIMR, Finland)

10:00 Discussion on ToRs d and e; identification of gaps in the current knowledge re HAB toxins and their effects

BREAK

ToR f: Review existing information on long term trends in HABs in the Baltic

10:20 Long-term dynamics of cyanobacterial blooms in the Gulf of Finland (in 1997-2004) - an analysis of controlling factors (Inga Lips, Estonian Marine Institute)

10:40 Distribution on surface accumulations of cyanobacteria blooms in Swedish waters, 1997-2004 (Bengt Karlson, SMHI, Sweden)

11:00 Long-term changes in summer phytoplankton communities in the open Gulf of Finland, Baltic Sea (Sanna Suikkanen, Maria Laamanen and Maija Huttunen; Finnish Intitute of Marine Research, Finland)

11:20 Review of long term trends in Baltic HABs (Norbert Wasmund, Baltic Sea Research Institute, Germany)

11:50 Discussion on ToR f; identification of gaps in the current knowledge re HAB long-term trends

12:00 Organising the report writing;

12:15 LUNCH

Other business

13:00 SGGIB continuation in 2006;

Deciding the meeting place for 2006; Tor's for 2006;

Election of the SGGIB Chair for the next 3-year term

13:30 Start of report writing

14:30 MEETING ADJOURNMENT

Annex 4: Abstracts of the presentations

Occurrence and toxicity of *Dinophysis* spp. in the Gulf of Finland, the Baltic Sea

Pirjo Kuuppo[1], Pauliina Uronen[2], Anika Petermann[3], Timo Tamminen[1] and Edna Granéli[4]

[1]Finnish Environment Institute, Finland, [2]University of Helsinki, Finland, [3]Friedrich-Schiller-Universität Jena, Germany, [4]University of Kalmar, Sweden

Dinophysis acuminata, *D. norvegica* and *D. rotundata* are common dinoflagellates in the Baltic Sea summer plankton community. *Dinophysis* ocadaic acid has been found from flounders and blue mussels in the Baltic Sea. Furthermore, pectenotoxin-2 (PTX-2) and its seco acid have been identified from *D. norvegica*. We studied the occurrence and toxicity of *Dinophysis* by sampling the water column on SW coast of Finland weekly/biweekly in late July–September 2004. For DSP toxin analyses, 160 l water samples were collected from thermocline and filtered on GF/A filters for HPLC/MS. In addition, *Dinophysis* toxins were analysed from organic material collected with a sediment trap. *Dinophysis* spp. were found in densities up to 8200 cells per litre, with maximum abundances above the thermocline. The samples contained pectenotoxin-2 (PTX-2) during the whole study. The toxic content of *Dinophysis* varied between 1.4-22.1 pg PTX-2 cell^{-1}. DTX-1 was found in the samples after middle of August in concentrations between 0.1 and 159 pg DTX-1 cell^{-1}. DTX-1 and PTX-2 were found in all sediment trap samples: 79−190 ng DTX-1 m^{-2} d^{-1} and 0.6−15.4 ng PTX-2 m^{-2} d^{-1}.

Regional and basin wide modeling of HABs in the Baltic Sea

Wolfgang Fennel and Thomas Neumann

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The main Baltic harmful algal booms, HABs, are obviously caused by cyanobacteria. The harmfulness is only marginally due to toxicity, but more due to noxious surface accumulations. There is an obvious need to understand the spatio-temporal variability of cyanobacteria at different scales. One issue is to predict the spreading of a detected bloom over the next few days. The other issue is to understand quantitatively the interannual variability in the occurrence of HABs.

Both aspects can already be addressed by models, such as the IOW model system. The current models involve, however, still a set of physical-biological interactions which need to be better understood and quantified. The work to be done requires a high degree of interdisciplinary cooperation. The talk highlights some issues, which could be part of a HAB research initiative in the Baltic Sea.

Nodularin and its concentration in water, sediments, fish and mussels from the Gulf of Gdansk

Hanna Mazur-Marzek

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Massive blooms of the cyanobacterium *Nodularia spumigena* have always resulted in the increased concentration of the monocyclic pentapeptide hepatotoxin, nodularin (NOD-R). Apart from NOD-R with a general structure: cyclo[-D-MeAsp-L-Arg-Adda-D-Glu-Mdhb-], *Nodularia* produces at least five other nodularin variants. Two of them were identified in cultures of *Nodularia* isolated from the Gulf of Gdansk.

In 2004, water, sediment, fish and mussel samples were collected from 7 July till 5 September. The analyses of the samples revealed toxin accumulation in different compartments of the Gulf of Gdansk. At the turn of July/August cell-bound nodularin concentration in water temporarily reached 25 mg/L (4.0 mg/g dw). It was one of highest nodularin concentration recorded here in the last ten years. In sediment samples collected after the bloom, at the beginning of September, nodularin concentration ranged from 0.9−1.6 µg/L (0.45−0.95 ng/g ww).

In these studies nodularin concentration in different organisms was measured as well. Concentration of the toxin in blue-mussels increased with *Nodularia* bloom development from 18−26 ng/g dw on 7 July to119 ng/g dw on 4 August.

On 31 July, dead fish were found in water and on the beaches of the Gulf of Gdansk. In young forms of *Ammodytes tobianus* 1.6–2.8 µg/g of the toxin was detected. Much smaller amounts were found in fish and other aquatic animals collected before the peak of the bloom.

Review of the existing knowledge on HAB toxin concentrations and their effects in the Baltic

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A review on nodularin concentrations reported this far in Baltic seawater, phytoplankton, zooplankton, mysids, bivalves, and various fish species will be given. A slight bioconcentration seems to take place at least between cyanobacteria and zooplankton, but the concentrations in the upper trophic levels are low. The long-term effects on the higher trophic levels however remain obscure. Interestingly, *Nodularia spumigena* was recently reported to contain BMAA, which has a connection to occurrence of nervous diseases such as alzheimer, parkinson and ALS.

Extracts of both toxic (*Nodularia spumigena*) and non-toxic Baltic Sea cyanobacteria (*Aphanizomenon* sp. and *Anabaena* sp.) have been found to decrease the growth of cryptophytes and diatoms in experimental studies. In a natural plankton community, cyanobacterial extracts also caused a stimulation of other cyanobacteria, nano- and dinoflagellates and chlorophytes. In addition, there are indications of mutual allelopathy between *N. spumigena* and *Aphanizomenon* sp. Nodularin is unlikely the cause of allelopathy in *N. spumigena*, although the toxin may be incorporated into phytoplankton cells exposed to it.

Reported effects on multicellular organisms include decrease in reproduction (copepods), grazing (zooplankton, fish and amphipods), as well as lowered groth (fish larvae). In experimental studies regarding allelopathic effects of cyanobacteria, extracts of both toxic (*Nodularia spumigena*) and non-toxic Baltic Sea cyanobacteria (*Aphanizomenon* sp. and *Anabaena* sp.) decreased the growth of cryptophytes and diatoms. Nodularin is however unlikely the cause of allelopathy in *N. spumigena*. In a natural plankton community, cyanobacterial extracts also caused a stimulation of other cyanobacteria, nano- and dinoflagellates and chlorophytes. Further, there are indications of mutual allelopathy between *N. spumigena* and *Aphanizomenon* sp.

Long-term dynamics of cyanobacterial blooms in the Gulf of Finland (in 1997–2004) – an analysis of controlling factors

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Blooms of cyanobacteria are recurrent phenomena in the Baltic Sea, including the Gulf of Finland. The spatial extension, duration, intensity and species composition of these blooms varies widely between years. The question connected with the bloom occurrences is whether these blooms are natural phenomena or triggered by human activities. Data collected between 1997–2004 is analysed to determine the main factors controlling the intensity and species composition of cyanobacterial blooms in the Gulf of Finland. It is demonstrated that the outcome of the bloom is highly dependent on weather conditions such as photo-synthetically active radiation (PAR) and water temperature (especially for *Nodularia* Mertens). On the other hand, there are clear indications that nutrient conditions, especially the surplus of phosphorus related to the pre-bloom upwelling events in the gulf, determine the intensity of blooms (especially for *Aphanizomenon* (L.) Ralfs). Two factors — PAR and pre-bloom upwelling intensity index — explain about 98% of preconditions for bloom formation.

Long-term changes in summer phytoplankton communities in the open Gulf of Finland, Baltic Sea

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Changes in the biomass and species composition of phytoplankton communities may reflect changes in various environmental factors. We investigated the relationships between the late summer biomass of different phytoplankton species and environmental factors, and their long-term (1979–2003) trends in the open Gulf of Finland, which is probably one of the most eutrophied parts of the Baltic Sea. An increasing trend was found in late summer temperature and chlorophyll *a* data, as well as in winter DIN concentrations and DIN:SiO_4 ratio. Simultaneously, the biomass of cyanobacteria, haptophytes, chrysophytes and chlorophytes increased, whereas that of cryptophytes decreased. Redundancy analysis indicated that summer temperature and salinity as well as winter silicate and DIN concentrations were the most important factors explaining the changes in the phytoplankton. Phytoplankton communities seem to reflect the ongoing eutrophication process in the Gulf of Finland.

Review of long term trends in Baltic harmful algal blooms

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The most impressive phytoplankton blooms in the Baltic Proper are formed by the diazotrophic cyanobacteria *Nodularia spumigena* and *Aphanizomenon* sp. every summer. They are not wanted because *Nodularia spumigena* is toxic and their nitrogen fixation enhance eutrophication. There are arguments that eutrophication increases cyanobacteria blooms. However, we think that eutrophication cannot be fully responsible for an increase in diazotrophic cyanobacteria in nitrogen-limited seas because they supply themselves with the nitrogen needed. Moreover, an increase in bloom intensity could not be proved in the last 25 years.

Sediment cores showed that cyanobacteria blooms became a typical feature in the Baltic Sea when it changed from the fresh-water Ancylus Lake to the brackish Litorina Sea about 7500 years ago. The Litorina Sea was characterised by a permanent halocline and anoxic bottom water. During a cold phase (1250–1850 A.D.), the water column was well mixed and oxygenated, leading to binding of phosphorus in the oxic sediments and therefore to reduced cyanobacteria due to stronger P-limitation. When the recent warm period began in the middle of the 19^{th} century, cyanobacteria blooms reappeared. This was confirmed by notices on blooms in various publications. Since the mid of the 20th century, *Nodularia* seems to grow stronger than *Aphanizomenon*. A general increase in bloom intensity was observed in the 1960s and 1970s, together with an increase in phosphorus concentrations. The phosphorus was most likely imported from external sources but also internal sources may have a high importance especially for the strong year-to-year fluctuations. Salt water inflows bring oxygen into the deep basins and fix phosphorus in the sediments whereas this phosphorus is released again in stagnation periods and promotes cyanobacteria growth. This leads to fluctuations in cyanobacteria blooms rather than trends. Physical factors like irradiation, temperature and wind interfere with the chemical influences and make the blooms changing and rather unpredictable.

Other harmful blooms like those of *Prymnesium, Chrysochromulina* or *Pseudo-nitzschia* occur irregularly and are not systematically investigated and therefore not subject of this presentation.

Results from the cruise in the Gulf of Finland in July 2004 and presentation of the plan for July 2005

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In July 2004, a two-week field study was made with two research vessels, R/V Aranda and R/V Muikku, in the Gulf of Finland. The objective was to reveal the distributions of phytoplankton, cyanobacteria and zooplankton in the field, and to investigate how their variation affects the planktivorous fish. Hydrography and plankton distribution were determined with vertical sampling and continuously recording devices. Primary and secondary (copepod) production were studied with onboard experiments. Abundance, biomass and schooling behaviour of Baltic herring and sprat were determined with echosounding and trawling, and fish feeding patterns were investigated by stomach analyses.

Multivariate analysis confirmed an environmental gradient from SW to NE, where salinity decreased and zooplankton community changed from a copepod-dominated community in the SW to a “low saline” rotifer-dominated community in the NE part of the study area. Along the same gradient the abundance of cyanobacteria also increased and zooplankton production decreased. The analysis on the effects of cyanobacteria and fish (echograms) is still on the way. Other activities of the project include laboratory analyses of how cyanobacteria influence fish feeding, and a questionnaire on cyanobacteria-fisheries interactions, directed to all professional fishermen on the Finnish coastline.

Annex 5: Potentially harmful phytoplankton species of the Baltic Sea

Potentially harmful phytoplankton species of the Baltic Sea

REGULAR BLOOMS							
Species	*Division*	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through…*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Nodularia spumigena	CYAN	Nost	HT	water	O, C	whole Baltic Sea, except Bothnian Bay (occasional blooms in Gulf of Riga)	B
Aphanizomenon flos-aquae	CYAN	Nost	NT	water	O, C	whole Baltic Sea except Bothnian Bay (occasional blooms in Gulf of Riga)	B, F

OCCASIONAL BLOOMS							
Species	***Division***	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through…*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Microcystis aeruginosa	CYAN	Nost	HT	water	C	in estuaries and low saline coastal areas	F, B
Microcystis flos-aquae	CYAN	Nost	HT	water	C	in estuaries and low saline coastal areas	F
Anabaena circinalis	CYAN	Nost	HT, NT; PSP?	water	C	in estuaries and low saline coastal areas	F
Anabaena cylindrica	CYAN	Nost	HT, NT; PSP?	water	O, C	whole Baltic Sea except Archipelago Sea and Bothnian Bay	F, B
Anabaena flos-aquae	CYAN	Nost	HT, NT; PSP?	water	C	whole Baltic Sea	F
Anabaena lemmermannii	CYAN	Nost	HT, NT; PSP?	water	O, C	northern Baltic Proper and Gulf of Finland	B, F
Anabaena spiroides	CYAN	Nost	HT, NT; PSP?	water	O, C	whole Baltic Sea, except northern Baltic Sea, Archipelago Sea and Bothnian Sea	F
Planktothrix agardhii	CYAN	Nost	HT	water	C	in estuaries, in highly eutrophied coastal areas with low salinity and in Bothnian Bay	B

OCCASIONAL BLOOMS (CONTINUED)							
Species	*Division*	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through…*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Prorocentrum minimum (different strains)	DINO	Dino	depends on the strain	Oyster larvae	O, C	Kattegat, southern and central Baltic Sea, Gulf of Finland (in low numbers in the Gulf of Riga)	M, B
Dinophysis acuminata	DINO	Dino	DSP	mussels?	O, C	whole Baltic Sea	M, B
Dinophysis norvegica	DINO	Dino	DSP	mussels?	O, C	whole Baltic Sea	M, B
Heterocapsa triquetra	DINO	Dino	could be harmful in small inlets causing oxygen depletion	?	O, C	whole Baltic Sea except Bothnian Bay, (in low numbers in Gulf of Riga)	M, B
Alexandrium ostenfeldii	DINO	Dino	PSP, NSP	mussels?	O	Gulf of Gdansk	M
Ceratium fusus	DINO	Dino	anoxia, and harmful to invertbrate larvae	?	O	Kattegat, southern Baltic Sea	M
Dictyocha speculum, (flagellate form)	CHRY	Dict	IC	fish	C	western and southern Baltic Sea	M, B
Chrysochromulina spp. (at least about 40 species, e.g. C. polylepis, C. leadbeateri, C. brevifilum, C. kappa, C. strobilus)	HAPT	Prym	IC	fish	O, C	western Baltic Sea (sometimes in high numbers also in the northern Baltic proper)	M, B, (F)
Prymnesium parvum	HAPT	Prym	IC	water	C	coastal inlets with very low salinity	B, F
Chaetoceros borealis	CHRY	Diat	mechanical	fish	O	Kattegat and Belt Sea	M
Chaetoceros danicus	CHRY	Diat	mechanical	fish	O, C	whole Baltic Sea	M, B
Chaetoceros decipiens	CHRY	Diat	mechanical	fish	O	western and southern Baltic Sea	M
Chaetoceros impressus	CHRY	Diat	mechanical	fish	O, C	south-eastern Baltic Sea	M, B
Pseudo-nitzschia spp. (P. calliantha, P. delicatissima, P. multiseries, P. pseudo-delicatissima, P. pungens, P. seriata)	CHRY	Diat	ASP	mussels	O, C	Kattegat and Belt Sea, southern Baltic Sea	M

OCCASIONAL BLOOMS (CONTINUED)							
Species	*Division*	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through…*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Chattonella sp.	CHRY	Raph	clogging of fish gills by mucus excretion, gill damage by haemolytic substances; NT?	fish	O, C	Kattegat and Belt Sea	M

REGULARLY IN PLANKTON BUT NOT IN BLOOM AMOUNTS							
Species	*Division*	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through …*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Anabaena cylindrica	CYAN	Nost	HT, NT; PSP?	water	O, C	whole Baltic Sea except Archipelago Sea and Bothnian Bay	F, B
Anabaena lemmermannii	CYAN	Nost	HT, NT; PSP?	water	O, C	Gulf of Bothnia, Gulf of Riga, Central Baltic Sea, Southern Baltic proper	B, F
Dinophysis acuta	DINO	Dino	DSP	mussels?	O, C	whole Baltic Sea except Gulf of Bothnia	M, B
Dinophysis rotundata	DINO	Dino	DSP	mussels	O, C	whole Baltic Sea	M, B
Protoceratium reticulatum	DINO	Dino	yessotoxin	mussels?	O	whole Baltic Sea	M
Chrysochromulina spp.	HAPT	Prym	IC	fish	O, C	whole Baltic Sea	M, B, (F)
Chaetoceros spp.	CHRY	Diat	mechanical	fish	O, C	whole Baltic Sea	M, B

Occasionally in plankton in low numbers							
Species	*Division*	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through…*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Coelosphaerium kuetzingianum	CYAN	Nost	NT, HT	water	C	whole Baltic Sea, except Archipelago Sea and Bothnian Sea	F
Microcystis ichtyoblabe	CYAN	Nost	HT?	water	C	in estuaries, in highly eutrophied coastal areas with low salinity in Kattegat and Belt Sea, Arkona Basin, southern Baltic Sea	F
Microcystis viridis	CYAN	Nost	HT	water	C	in estuaries, in highly eutrophied coastal areas with low salinity in Arkona Basin, southern Baltic Sea	F
Microcystis wesenbergii	CYAN	Nost	HT	water	C	in estuaries, in highly eutrophied coastal areas with low salinity in Arkona Basin, southern Baltic Sea, Gulf of Riga, Gulf of Finland	F
Snowella lacustris	CYAN	Nost	HT	water	C	whole Baltic Sea in estuaries, in highly eutrophied coastal areas with low salinity	F
Woronichinia naegeliana	CYAN	Nost	NT, HT	water	C	whole Baltic Sea, in estuaries, in highly eutrophied coastal areas with low salinity	F

Occasionally in plankton in low numbers							
Species	*Division*	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through…*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Anabaena spp. (A. macrospora, A. planctonica)	CYAN	Nost	NT	water	O, C	southern Baltic Sea, Bothnian Bay	F, B
Aphanizomenon gracile	CYAN	Nost	PSP	water	O	whole Baltic Sea except Kattegat and Belt Sea	F, B
Trichormus variabilis	CYAN	Nost	NT	water	O	southern Baltic Sea, Gulf of Finland	F
Alexandrium spp.	DINO	Dino	PSP?	mussels	C	southern and western Baltic Sea	M, B
Prorocentrum lima	DINO	Dino	DSP	?	C	benthic, occasionally in littoral plankton, Kattegat and Belt Sea	M
Amphidinium carterae	DINO	Dino	Haemolytic compounds	?	O	Kattegat and Belt Sea	M
Amphidinium operculatum	DINO	Dino	Haemolytic compounds	?	O	Kattegat and Belt Sea	M
Gymnodinium aureolum	DINO	Dino	IC	water	O	southern and central Baltic Sea, Bothnian Sea	M
Akashiwo sanguineum	DINO	Dino	PSP	?	O	whole Baltic Sea	M
Karenia mikimotoi	DINO	Dino	IC	fish	O	Kattegat and Belt Sea	M
Karlodinium micrum	DINO	Dino	IC	fish	O	Kattegat and Belt Sea	M
Noctiluca scintillans	DINO	Dino	NH_3-producer	fish	O	Kattegat, Belt Sea and Arkona Basin	M
Peridiniopsis polonicum	DINO	Dino	?	fish	C	southern Baltic Sea, Gulf of Riga, Gulf of Finland	F
Protoperidinium crassipes	DINO	Dino	AZA		O	Kattegat and Belt Sea	M
Protoperidinium curtipes	DINO	Dino	AZA	?	O	Kattegat and Belt Sea	M
Scrippsiella trochoidea	DINO	Dino	IC?	?	O	whole Baltic Sea	M
Alexandrium tamarense	DINO	Dino	PSP	fish	O	Kattegat and Belt Sea	M

OCCASIONALLY IN PLANKTON IN LOW NUMBERS (CONTINUED)							
Species	*Division*	*Class*	*Toxicity and/or other harmful effect*	*Toxins in or harmful effect through…*	*Open sea/ coastal*	*Distribution in the Baltic Sea*	*Marine/ brackish/ fresh water*
Alexandrium spp.	DINO	Dino	PSP?	mussels	C	southern and western Baltic Sea	M, B
Ceratium tripos	DINO	Dino	Anoxia, hypoxia	?	O	Kattegat and the Belt Sea, southern Baltic Sea	M
Phaeocystis globosa	HAPT	Prym	Anoxia, hypoxia	?	C	Kattegat and Belt Sea, southern Baltic Sea	M
Dictyocha speculum	CHRY	Dict	IC?	water	O, C	southern and western Baltic Sea, Arkona Basin, Kattegat, Skagerrak	M

Divisions:

Cyanophyta (Cyanobacteria) - CYAN

Dinophyta (Pyrrhophyta) -.DINO

Haptophyta - HAPT

Chrysophyta (Heterokontophyta) – CHRY

Classes:

Nostocophyceae (Cyanophyceae) - Nost

Dinophyceae - Dino

Prymnesiophyceae (Haptophyceae) - Prym

Dictyochophyceae - Dict

Diatomophyceae (Bacillariophyceae) - Diat

Raphidiophyceae (Chloromonadophyceae) – Raph

Abbreviations of toxins:

ASP = Amnesic Shellfish Poisoning

AZA = Azaspiralids, shellfish toxins

DSP = Diarrhetic Shellfish Poisoning

HT = Hepatotoxic

IC = Ichtyotoxic

NT = Neurotoxic

PSP = Paralytic Shellfish Poisoning

Acknowledgements and references

This checklist of potentially harmful species of the Baltic Sea is an update of Table 2 (compiled by K. Kononen, M. Elbrächter, M. Balode, S. Hällfors, G. Hällfors, J. Göbel, S. Hajdu, I. Olenina, I. Konoshina, A. Jaanus, I. Ledaine & E. Dahl) in Report of ICES-IOC-SCOR Study Group on GEOHAB Implementation in the Baltic ICES CM 2002/H:02 Ref. ACME, Annex 3: Proposal for Cooperative HAB Study in the Baltic Sea.

Updates

Updated in April 2004 by Seija Hällfors and Guy Hällfors, according to:

Hällfors G. 2004: Checklist of Baltic Sea Phytoplankton Species including some heterotrophic protistan groups. - Baltic Sea Environment Proceedings Series No 95. 208 pp.

Wasmund N. 2002: Harmful Algal Blooms in Coastal Waters of the South-Eastern Baltic Sea. - Pp. 93−116 in Schernerwski, G. & Schiewer, U. (eds.): Baltic Coastal Ecosystems Structure, Function, and Coastal Zone Management. Springer Verlag, Berlin.

Hallegraeff, G. M., Anderson, D.M. & Cembella, A.D. (eds.) 2003: Manual on Harmful Marine Microalgae.-Monographs on Oceanographic Methology 11, UNESCO.

Moestrup, Ø. et al. 2004: IOC Taxonomic Reference List of Toxic Plankton Algae. Intergovernmental Oceanographic Commission of UNESCO. http://www.bi.ku.dk/ioc/.

Updated by Seija Hällfors in May 2005 according to comments by Malte Elbrächter, Bengt Karlson and Norbert Wasmund.

Annex 6: Action Plan Progress Review 2005

Year	Committee Acronym	Committee name	Expert Group	Reference to other committees	Expert Group report (ICES Code)	Resolution No.		
2004/2005	BCC	Baltic Committee	SGGIB		2004:\E:XX	XHXX		
Action Plan	Action Required	ToR's	ToR	Satisfactory Progress	No Progress	Unsatisfatory Progress	Output (link to relevant report)	Comments (e.g., delays, problems, other types of progress, needs, etc.
No.	Text	Text	Ref. (a, b, c)	S	0	U	Report code and section	Text
1.2, 1.7, 5.6		Report and discuss new findings on HABs and HAB modelling in the Baltic	a)	S			6.	
1.2.1, 5.6		Report observations on 2004 distribution of HABs in the Baltic; prepare the HAEDAT reports for ICES use	b)	S			8.	
1.2.1, 1.2.2, 1.5, 1.13, 4.11.1, 5.6		Update the checklist of the harmful species of the Baltic Sea	c)	S			7.	
1.5, 4.11.1, 5.6		Compile existing observations on concentrations of nodularin and other HAB toxins in different compartments of the Baltic ecosystem	d)	S			5.	
1.2.1, 1.2.2, 1.5, 1.7, 1.10. 1.12, 1.12.2, 1.13, 4.11.1, 5.6		Summarise observed toxicological effects in the Baltic biota	e)	S			6.	
1.2, 1.2.1, 1.7, 5.6		Report on existing information on long term trends in HABs in the Baltic;	f)	S			9.	
1.2, 1.2.1, 5.6		Continue planning an open sea field study and workshop for summer 2005	g)	S			10.	
1.2, 1.2.1, 1.13		Update and review the GEOHAB implementation plan for the Baltic;	h)		0		10.	
		Plan its 2006 meeting as a joint or overlapping meeting with at least one other Baltic SG (e.g., SGPROD, SGEH, SGFFI) in order to promote the development of integrated ecosystem knowledge and the integration of work across expert groups.	i)	S			11.	

Action Plan items to be crosslinked to TORs

1.2	Increase knowledge with respect to the functioning of marine ecosystems. This will be achieved through continued basic research on the biological, chemical, and physical processes of marine ecosystems and specific activities directed at improved understanding of observed and potential variability in the marine environment due to physical forcing and biological interactions. [MHC/OCC/LRC/RMC/BCC/DFC].* Particular planned activities include the following:
1.2.1	Understand and quantify the biology and life history, stock structure, dynamics, and trophic relationships of commercially and ecologically important species. [LRC/OCC/BCC/MHC/DFC]
1.2.2	Quantify the changes in spatio-temporal distribution of the stocks of important species in relation to environmental change, using survey and commercial data. [OCC/LRC/RMC/BCC/DFC]*
1.5	Develop and apply biophysical modelling, and improve capacity in such modelling to cover biological–physical interactions in the sea. [LRC/OCC/BCC/MHC/DFC]*
1.7	Play an active role in the design, implementation, and execution of global and regional research and monitoring programmes, in collaborations between the ICES and other international oceanographic research or monitoring programmes such as GOOS and GLOBEC. [OCC/LRC/MHC/BCC/DFC]
1.10	Develop better tools and training opportunities for monitoring and observation of physical, chemical and biological properties of marine ecosystems. [FTC]* [Other Science Committees]
1.12	Address the substantial need for improved data and information on components of the marine ecosystem in the Baltic Sea including:
1.12.2	Nutrient productivity and toxic blooms;
1.13	Enhance the efficiency of sampling tools and resource surveys by the following:
4.11.1	Continue and expand the development of tools, possibly ecosystem models, that facilitate the assessment of monitoring and scientific knowledge of ecosystem functions in a holistic manner. [MHC/OCC/RMC/BCC]*
5.6	Collaborate with and support the Baltic Global Environmental Fund Project for the Baltic Large Marine Ecosystem, and related projects from other areas such as NATO, IMO, etc. to develop integrated approaches for specific sea areas. [BCC]