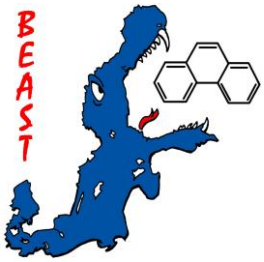
Biological Effects of Anthropogenic Chemical STress: Tools for the assessment of Ecosystem Health



Project Acronym	BEAST
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Introduction

The BEAST project fulfilled all of its milestones and deliverables planned for each three WPs and tasks (subregions) for the year 2010. BEAST received a considerable amount of national and international attention in different scientific and stakeholder events in 2010. As a result, and among one of the most important achievements of the project in 2010, was its nomination as one of the flagship projects of the EU Strategy for the Baltic Sea Region (EUSBSR) Priority Area 3. This recognition also signifies greatly improved opportunities in receiving further funding for future BEAST activities, most immediately from the 4th and final call of the EU BSR Programme (BSRP) closing in March 2011.

Results from the BEAST project were continued to be presented in 2010 at various scientific symposia and conferences, while the 1st General Meeting of the project gathered 30 scientists for a three full-days event in St. Petersburg (Russia). Numerous BEAST partners made significant contributions concerning the main themes of the project related to activities carried out at international organisations, most importantly in the ICES Expert Groups SGEH, SGIMC, WGBEC and WGDPMO. Planning of BONUS-related special sessions to ICES ASC and BSSC conferences in 2011 was also participated. During 2010, many BEAST partners made significant contributions to HELCOM activities, including a key input to the HELCOM Assessment of Hazardous Substances in the Baltic Sea (HAZAS), especially concerning the writing and co-ordinating the compilation of the "Biological effects" chapter of the assessment. Related work initiated later in the HELCOM CORESET project Hazardous Substances component is also strongly supported by participation and inputs from several BEAST experts. Several abstracts describing results gained from Beast have been submitted and will be presented at Euro SETAC meeting 2011.

In regard to field and laboratory work, some modifications to the sampling and analysis programme had to be made along the way; mainly, some of the intended number of analyses, target species and parameters had to be reduced, however, new analyses were also added. Several BEAST sampling campaigns were successfully carried out in 2010 in the different study regions (*see report on WP1*). As in 2009, BEAST attracted a number of various non-BONUS projects related to biological effects of contaminants and ecosystem health, leading to fruitful collaborations and the planning of joint scientific contributions. The execution of the general project plan of BEAST concerning the planning and arranging of courses, workshops and seminars and other educational activities was continued (*see report on WP2*). The BEAST website (www.environment.fi/syke/beast) was also opened at the beginning of 2010 and is planned to be improved in 2011. The joined BEAST/BALCOFISH database (BonusHaz) was finished and being filled with data from both BONUS+ projects and other relevant sources (*see report on WP3*).

In November, the BEAST Steering Group held a meeting (also partly attended by representatives from BONUS Secretariat and HELCOM) where a general agreement was made that further funding will be sought for the continuation of the BEAST network and research activities also in the future with an increased number of scientific partners/network companions and updated targets and work plan.

The scientific progress achieved in the second year of BEAST is given in detail in the specific WP reports.

WP 1: Field studies and experiments in selected sub-regions of the Baltic Sea

Gained scientific results during the reporting period

WP1 is focused on studies regarding biological effects of hazardous substances in a variety of target organisms (bioindicators), reflecting different taxa and habitats in different sub-regions of the Baltic Sea, i.e. Belt Sea, Gulf of Gdansk, Gulf of Riga, Gulf of Bothnia and Gulf of Finland. By using field studies (sub-regional sampling and caging) combined with laboratory exposure experiments, WP1 addresses specific basic research topics related to geographical locations, methods, species and chemical compound groups. The biological-effects measurements are carried out at various levels of biological organisation, i.e. sub-cellular, cell, tissue, organ, whole organism, and represent lower-order and higher-order responses, reflecting different degrees of ecological relevance. The biological effects and chemical analysis studies are divided into two categories: **core programme**: carried out at each 5 sub-region with a minimum of 2 sampling campaigns in each region and **research and development (R&D) programme:** carried out in 1-4 sub-regions according to resources and feasibility.

Four field campaigns have successfully been performed during 2010. The planned cruise in December 2010 was divided in two parts to be able to reach more coastal areas and the more shallow coastal parts were visited in January 2011**.**

1/ **Gulf of Bothnia;** Amphipods (*Monoporeia affinis*) for genetic analyses and analyses of body burden of contaminants were sampled in August in the Bothnian Bay. Sediment for contaminant analyses (trace metals, PAHs, PCBs, DDT, TBT and chloroguaicols) were collected at the same sites with KVB 005 (SE). R/V Aranda (FI) operated in August/September in the Bothnian Sea**.** Hydrography (nutrients, salinity, pH, temperature and oxygen content) were measured. Sediment for bioassays and contaminant analyses and mussels (*Macoma balthica*) for PAH content in biota and biomarker analyses were collected on a transect. Abundance, biomass and structure of benthos, phytoplankton and zooplankton communities were measured. *Mytilus edulis* was caged in June – August. R/V Walther Herwig III (DE) operated in December for fish examination (fish diseases) and sampling (eelpout and herring) in the Bothnian Sea. In addition, hydrographic measurements were done. KVB 005 visited Bothnian Sea in January 2011 for sampling of amphipods and sediment for contaminant analyses.

2/ **Belt Sea**, A field campaign was performed in April to May. Sediment, mussels, snails, amphipods and eelpout were collected for contaminant analyses, bioassays, reproduction success and biomarker analyses with a national vessel. During December 2010, R/V Walther Herwig III operated in the western Baltic Sea and collected fish samples (flounder, herring) and carried out fish disease examinations and hydrographic measurements.

3/ **Gulf of Riga**; Field campaigns were performed in June and September. Amphipods were collected and analysed for reproduction success and biomarker response in June. Body burdens of trace metals, PAHs, and PCBs were analysed. R/V Aranda visited the Gulf of Riga in September. Hydrography (nutrients, salinity, pH, temperature and oxygen content) were measured. **S**ediment for bioassays and contaminant analyses and mussels (*M. balthica*) for PAH content in biota and biomarker analyses were collected. Abundance, biomass and structure of benthos, phytoplankton and zooplankton communities were measured. Results showed that methods concerning reproductive success evaluated for *M. affinis* could be used for all species of amphipods and good response to the contaminant situation was showed.

4/ **Gulf of Gdansk.** Amphipods were collected and analysed for reproduction success and biomarker response in June. Body burdens of trace metals, PAHs, and PCBs were analysed.

Bioassays; 1/ *M. affinis*, *Gammarus zaddachi* and *Bathyporeia pilosa* were used in bioassays for acute toxicity testing of sediments from the Gulf of Bothnia and Gulf of Riga. Sediments from the Gulf of Gdansk and Belt Sea have not been processed yet. 2/Sediment from the Bothnian Bay and Baltic proper were tested for reproductive success in *M. affinis* and biomarkers for oxidative stress, AChE and LMS were measured.

Experimental work: 1/ Linking biomarkers to reproduction success in amphipods and comparison between field and lab exposure were performed in the Bothnian Bay. 2/ Correlation between contaminant concentrations in sediment/body burdens in amphipods to malformed embryos was assessed in the Gulf of Bothnia, Baltic proper, Gulf of Riga and Gulf of Gdansk. 3/ Behavioural and electrophysiological responses were measured in crucian carp (*Carassius carassius*) to study effect of pH. 4/ Injections of contaminants in eelpout to study embryo malformations and biomarker response have been performed during autumn 2010.

Comparison with the original research and financial plan
Work in BEAST WP 1 proceeded principally according to plan.

Statement if the research plan and schedule of deliverables had to be adapted
No changes were necessary.

Do results of third parties will have influence on the working programme?
Results of recent research resulted in minor changes of e.g. the R&D programme. Some suggested methods have been ruled out while others have been added. Financial problem could also influence the original schedule.

Are there any changes in the future working plan expected?
No changes are expected.

Are there any changes expected for the deliverables?
No changes are expected.

WP 2: Application and validation of methods in monitoring and assessment in the Baltic Sea

Gained scientific results during the reporting period
The identification and validation of suitable methods for integrated monitoring and assessment (Deliverable 2.1) is underway and will be finalised at the end of the project, based on the practical experiences made and the results of the integrated data assessment (BEAST WP 3 task). The field sampling programme designed in 2009 in collaboration with BEAST WP 1 and the regional Task Leaders for the five Baltic Sea sub-regions under study (Gulf of Bothnia, Gulf of Finland, Gulf of Riga, Gulf of Gdansk, and Belt Sea) was applied successfully and the final major sampling campaign took place end of 2010. Work on the handbook with Guidelines and Standard Operating Procedures (SOPs) for integrated monitoring and assessment of contaminant and biological effects in sub-regions of the Baltic Sea proceeded in 2010 (Deliverable 2.2) and the draft handbook has been uploaded to the BEAST Central Desktop and is constantly updated with so far missing information. The goal is to publish the handbook and make it available for future national and HELCOM Baltic Sea monitoring and assessments. The handbook and the results achieved in WP 3 will form the basis for recommendation for future monitoring and assessment of contaminants and their biological effects in the Baltic Sea to be finalised at the end of the project duration. In 2010, the following training activities and intercalibration exercises took place (Deliverable 2.3.2): Training and intercalibration of methods for field sampling of biomarkers and fish disease studies (Lead: vTI/FOE, SYKE), intercalibration exercise on measurement of PAH metabolites in fish bile (Lead: vTI/FOE), intercalibration of measurements on histochemical biomarkers (Lead: AWI). Plans have been made for further activities scheduled for 2011 and for possible follow-up activities after the end of BEAST.

Comparison with the original research and financial plan
Work in BEAST WP 2 proceeded according to plan.

Statement if the research plan and schedule of deliverables had to be adapted
No adaptations were required in 2010.

Do results of third parties will have influence on the working programme?
This cannot entirely be excluded since there are other activities underway (e.g., under ICES, OSPAR, and HELCOM), addressing integrated monitoring and assessment of contaminants and biological effects, the results of which may be relevant for the BEAST project.

Are there any changes in the future working plan expected?
No major changes expected.

Are there any changes expected for the deliverables?
No major changes expected.

WP 3: Developing tools for Ecosystem Health assessment in the Baltic Sea

Gained scientific results during the reporting period

Set-up and maintenance of the BEAST database (BonusHAZ) has been continued. In close relation with all BEAST partners and discussions during the annual BEAST meeting in St. Petersburg, more parameters have been included and the report format for submission of data has been further improved. The BEAST partners have started to submit the data from the various field studies performed in 2009 and 2010 (WP1). Presently, data from about 130 stations covering all studied subareas and different biological effect measures have been included in the BonusHAZ. In addition, data have been added concerning biological effects measurements in eelpout (120 stations) and blue mussels (60 stations) originating from the Danish National Monitoring (NOVANA). Most of the station information and biomarker data from the EU project BEEP have also been imported into BonusHAZ. With the present set-up of the BonusHaz, a tool has been developed allowing the use of quality-assured data for the multivariate analyses foreseen for 2011.

In applying a subset of this data (BEEP offshore, flounder), a first trial was made combining biomarker data and chemical contamination data to test and compare different multivariate statistical analyses and biomarker indices such as the integrated biomarker method described by Belliaeff and Burgeot (2002). Differences between stations were found, possibly due to differences in contamination level. In using a PCA-based approach, station differences were not so clear. Presently, work is carried out to test some other integrated biomarker indices such as the Integrated Biomarker Index (IBR) or weigh of evidence approach.

As contribution to the HELCOM Integrated Thematic Assessment of Hazardous Substances in the Baltic Sea (HAZAS), the ”traffic light approach” was applied, using different biomarkers and indicators for reproductive disorders or prevalence of certain fish diseases, respectively (HELCOM, 2010).

Available monitoring data from pristine and contaminated areas along the Swedish coast were used to calculate limit values for malformed embryos of the amphipod *Monoporeia affinis* in the Baltic Sea, based on station mean values of 13 stations monitored from 1994-2009. More comprehensive analyses are presently carried out as contribution to the development of specific health indices in relation to reproductive success.

A first trial of an integrated assessment of TBT pollution has been presented during the BONUS Annual Science Conference (Vilnius, 2010), combining chemistry and biological effects measures, using relevant monitoring data from the Western Baltic Sea (Strand et al, 2010).

Based on a literature study and BEAST expertise, an overview paper is in preparation concerning “Indices for integrated assessment of Ecosystem Health” for application in Baltic Sea sub regions. First scientific report on this will be submitted in month 26 (Deliverable 3.3)

In collaboration with ICES SGEH, background documents are in preparation to develop Baltic Sea specific Assessment Criteria needed for the application of biological effects measures as monitoring tool.

As part of the task to develop and apply tools for a science-based assessment and management, BEAST has used the existing knowledge to select suitable biomarkers and other measures (i.e.

reproductive success or fish disease index) for the HELCOM CORESET project. It is an ongoing activity which will be continued in 2011.

Comparison with the original research and financial plan
No changes necessary regarding financial plan. Work in relation to set-up and maintenance of database proceeded according to plan. Submission of data from field work took longer than anticipated but no serious delays in fulfillment of the research plan are expected.

Statement if the research plan and schedule of deliverables had to be adapted
No changes were necessary regarding research plan, but one WP3 deliverable has to be postponed by 1 month, see also below.

Do results of third parties will have influence on the working programme?
This cannot entirely be excluded since presently HELCOM activities are underway (CORESET project) addressing adaptation of future monitoring in the Baltic Sea in order to fulfill one major goal of the BSAP, i.e. “Baltic Sea life undisturbed by hazardous substances”. Moreover, activities in relation to Marine Strategy Framework Directive (MSFD, Descriptors 8, 9 and the assessment of achievement of good Environmental Status (GES) could also be relevant for BEAST WP3.

Are there any changes in the future working plan expected?
No major changes expected.

Are there any changes expected for the deliverables?
One deliverable for WP3, due in months 25, is a scientific report on "Indices for integrated assessment of Ecosystem Health". The report is in progress, but discussions with BEAST external experts and the general outcome of a workshop to be held in Helsinki on 1. Feb 2011 should be included. Thus, the submission of this deliverable will be postponed by 1 month.

Work on Deliverable 3.6 (Scientific publications) will start in month 25+ and continued during 2011.