Number 14, October 2011

BONUS briefing

SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

PREHAB
Providing tools for sustainable development of the Baltic Sea

Growing populations and economic development create new challenges for sustainable use of the Baltic Sea. Many of these challenges are reflected in the HELCOM's Baltic Sea Action Plan and the EU Marine Strategy Framework Directive. In order to meet their requirements, it is imperative to develop new instruments for local and regional marine spatial planning and environmental impact assessments (ecological as well as socio-economic) based on sound principles and the best available scientific knowledge. Tools for obtaining reliable information about how biological values are distributed, i.e. maps, are central for the development of these instruments. PREHAB develops tools for cost-efficient mapping of coastal habitats and sets out to illustrate how these can be used to evaluate ecological and socio-economic benefits of different management options.

OVERVIEW

PREHAB has developed scientifically based advice for ecological mapping and economic valuation of coastal benthic habitats in the Baltic Sea. Predictive modelling allows managers to obtain useful maps on the distribution of species and habitats. Furthermore, with scenario modelling, ecosystem responses can be predicted and the effects of alternative management options be better understood. PREHAB also shows how mapping and scenario modelling can be used as a tool to assess the economic benefits from management actions such as the Baltic Sea Action Plan. PREHAB has estimated the monetary value of the improvements in some selected benefits associated to marine ecosystems in two coastal areas of the Baltic: the Swedish-Finnish Archipelago Sea and the Lithuanian coast. The results indicate that the Baltic Sea citizens are willing to pay for mitigation actions, but that there are differences between different areas of the region. PREHAB is producing a user-friendly web-resource for communicating these results to relevant stakeholders around the Baltic Sea that will be launched in January 2012.

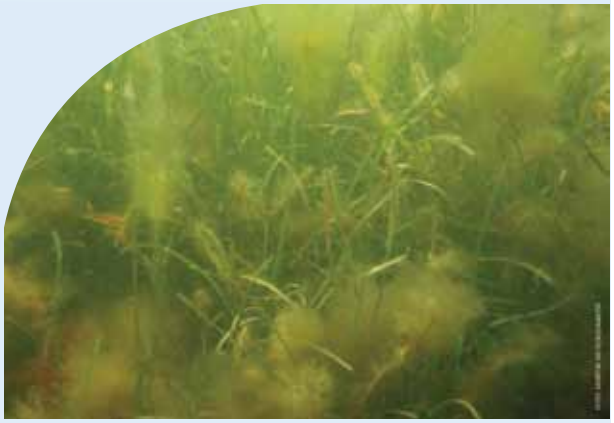
OUTLINE OF KEY RESULTS

MAPS ARE ESSENTIAL

Successful spatial planning in the sea, as well as on land, requires a common understanding about the distribution of valuable resources in the area. Knowledge of the distribution of biodiversity and the associated ecological goods and services therefore provides an important basis for sustainable planning of the Baltic Sea.

Land and sea - different conditions

On land, coherent maps of ecological properties of the landscape, such as the structure and the extent of vegetation cover, can often be derived from remote sensing methods, e.g. satellite or aerial photography. These methods may sometimes be applicable also in shallow marine areas. But for most types of ecological information



Unseen biodiversity. Knowledge of the spatial distribution of biodiversity and associated ecological goods and services is crucial for a sustainable planning of the Baltic Sea.

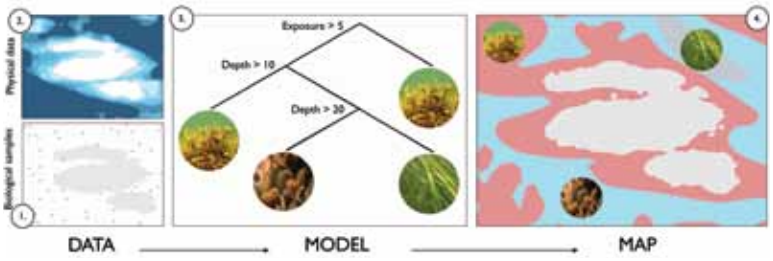


Figure 1. Mapping procedure. Predictive mapping involves four steps: (1) Sampling of biodiversity at a limited number of sites, (2) compilation of full-coverage physical data (e.g. depth, exposure), (3) development of statistical model and (4)construction of full-coverage GIS-map of biological features.

and for the vast majority of depths, these methods are not useful in Baltic coastal waters.

Biological sampling in the marine environment is very expensive and is carried out in small units such as grab samples, dive-transects or photos. Therefore detailed large-scale maps cannot be constructed from direct sampling. Instead, underwater maps can be constructed by combining biological sampling with statistical modelling to integrate scattered biological information into coherent maps (Figure 1).

ISSUES FOR MODELLING

Using data from four case-study areas in different parts of the Baltic Sea (Figure 2), PREHAB conducts research to evaluate:

- **What can be modelled?**
  PREHAB is assessing how well the abundance and distribution of fish, vegetation, bottom fauna and various important ecosystem services can be predicted. This will allow us to give advice to users on how reliable maps they can expect.

- **Which type of information can be used for modelling?**
  PREHAB is assessing what kind of data is necessary for successful and cost-efficient mapping. Advice on useful environmental variables, such as depth, wave-exposure, substrate and turbidity will be communicated to commissioning authorities and consultants.

- **Which statistical tools can be used for modelling?**
  PREHAB is assessing state-of-the-art statistical methods for modelling and develops robust recommendations on methods to use and how to ensure proper quality control.

Predictive mapping – a promising alternative

Preliminary results show that predictive mapping based on biological sampling and subsequent modelling is a realistic alternative in all case-study areas. Using criteria from the scientific community, predictive models are generally sufficiently precise; there are differences among the techniques but all produce useful models under certain circumstances. In general, models of abundance and diversity of benthic invertebrates and macrophytes perform best, whereas the models of fish reproduction areas tend to be slightly less accurate. There are, however, large differences among species that possibly can be explained by differences in the amount of data and size of the study area. Furthermore, access to precise information on depth and bottom substrate is particularly important for the performance of models.

PREHAB results show that predictive mapping allows managers to obtain useful and explicit spatial information – maps on the distribution of species and habitats.

MODELLING THE EFFECTS OF MANAGEMENT

Models can be used to predict and map the current distribution of biodiversity from biological samples. Similarly, models can be used to predict how the distribution of biodiversity changes if environmental conditions change, including human pressures such as eutrophication and coastal constructions.

Eutrophication in the coastal zone reduces water clarity and thus impacts the distribution of many species. It is a pressing problem in the Baltic, and the HELCOM member states have committed to take extensive measures to reduce eutrophication through the Baltic Sea Action Plan.

Scenarios on eutrophication

In PREHAB, we explored how predictive mapping can be used to assess the ecological effects of changing eutrophication levels in a number of scenarios relating to mitigation measures. Using models involving water clarity (Secchi depth) which is the main indicator for eutrophication in the Baltic Sea Action Plan, we evaluated effects on the distribution of five important species of vegetation (bladderwrack, eelgrass, the red alga *Furcellaria lumbricalis)* and fish (perch and pikeperch) in the Baltic Sea under different eutrophication scenarios corresponding to the Baltic Sea Action Plan target and reference conditions. The results suggest that we can expect large differences in response to management actions depending on the species in question. The predicted changes will have direct effects on the ecosystem goods and services provided by the species.

Figure 2. Four case study areas. The potential for ecological mapping and economic valuation is assessed in four case-study areas representing a variety of conditions and geographic regions: I. Swedish-Finnish Archipelago Sea; II. The Lithuanian coast; III. Coastal Kattegat, Sweden; IV. Coastal Baltic proper, Sweden.

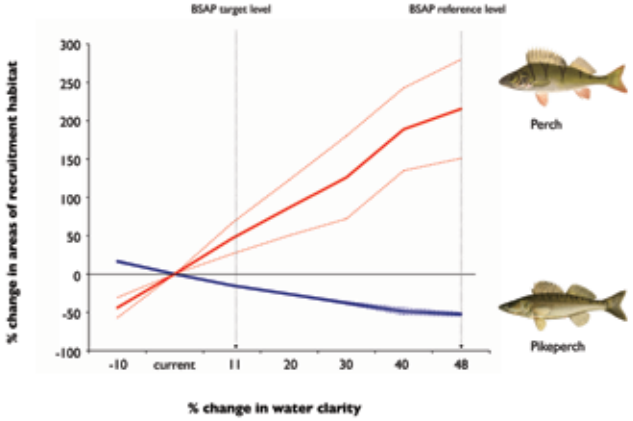


Figure 3. Example of scenario modelling: predicted changes in habitat distributions for perch and pikeperch with changing water clarity (Secchi depth). Dotted lines show standard errors of predictions from three different modeling methods. The arrows indicate Secchi depth changes according to BSAP target and reference levels.

Spatial context needed

Reducing eutrophication is predicted to have strong positive effects on the coverage of bladderwrack and the red alga while the effects on eelgrass are expected to be small. For fish, the results are even more intriguing (Figure 3). On the one hand, recruitment areas for perch are predicted to increase as a result of management actions decreasing eutrophication. On the other hand, habitats suitable for pikeperch will be negatively affected. The predicted changes will have direct effects on the ecosystem goods and services provided by the species: Perch and pikeperch are predators with a key role in the coastal ecosystem, and at the same time they are two of the most valuable species for commercial and recreational fisheries. PREHAB's scenario analyses illustrate the usefulness of ecological modelling to explore ecosystem responses to environmental changes. Apart from revealing patterns that are important both from a biological and socio-economic perspective, these examples clearly demonstrate the absolute need to put management actions in a spatial context when evaluating alternative measures.

ESTIMATING THE ECONOMIC CONSEQUENCES

Marine benthic habitats provide a variety of benefits for citizens in the Baltic Sea countries. These are derived from ecosystem goods and services provided by the habitats and include both use values, e.g. fish and recreational possibilities, and non-use values, e.g. knowledge on the existence of marine ecosystems and species. Besides ecological assessment, sustainable coastal management needs monetary estimates of these benefits, to be set against market-based profits from human exploitation. In PREHAB, we have developed a strategy for using scenario modelling and mapping as a tool for assessing the economic benefits from management actions such as the Baltic Sea Action Plan.

Willingness to pay reflects value

We have performed monetary estimates of some selected benefits associated to marine ecosystems in two coastal areas of the Baltic: the Swedish-Finnish Archipelago Sea and the Lithuanian coast (see map). In a choice experiment survey, respondents from Sweden, Finland, and Lithuania declared their willingness to pay for future environmental changes of the marine habitats. Improvements in selected properties of marine ecosystems (amount of healthy vegetation, preservation of currently pristine areas and size of fish stocks) were associated with a cost to a management fund, and the respondents were asked to choose from a set of alternatives. The alternatives were constructed in connection to ecological changes modeled in PREHAB eutrophication scenarios above.

Regional differences

In general, the results demonstrate that citizens of the Baltic Sea countries really value a clean and healthy sea and are willing to spend their money to ensure it (Figure 4). Overall, the willingness to pay for marine improvements in each country is substantial. For instance, in Finland and Sweden, the total willingness to pay for the implementation of the Baltic Sea Action Plan is about ten times larger than the estimated costs.

Preliminary results show significant differences among the sampled populations. For the Archipelago Sea, the willingness to pay is about three times higher in Sweden than in Finland. A preliminary investigation shows that this difference can be explained by e.g. the state of knowledge of ecosystem services provided by the Archipelago Sea, the current status of the water quality in the area and the attitudes regarding who should finance the conservation. Lithuania has the lowest willingness to pay, even with adjusted regional price differences. However, this figure is not directly comparable with the willingness to pay in Finland and Sweden as the Lithuanian sea area and its ecosystem services, e.g. recreational qualities, are different from the Archipelago Sea.

Attribute	Country	Mean citizen WTPs (€)	Aggregated national WTPs (millions of €)
Amount of healthy vegetation (macrophytes)	Swe	2,8	18,5
	Fin	0,9	3,8
	Lit	0,3	0,8
Preservation of currently pristine areas	Swe	2,1	13,9
	Fin	1,0	4,3
	Lit	0,2	0,6
Size of fish stocks	Swe	2,3	15,6
	Fin	0,7	3,1
	Lit	0,2	0,6

Figure 4. Valuating mitigation actions. Willingness to pay (WTP) in Sweden, Finland and Lithuania for a one percent improvement in selected properties of marine ecosystems. The attributes were chosen in connection to ecological changes modeled in PREHAB scenarios.

NEXT STEPS AND FUTURE PLANS

The PREHAB information will be accessible to relevant users in regional and local authorities as well as decision-makers and consultants all around the Baltic. PREHAB will summarise the results of the project in a user-friendly web-resource. This resource will provide robust advice for mapping and the assessment of ecological and economic consequences of management actions. The launch of the web-resource will be in January 2012.

IN BRIEF

PREHAB
Providing tools for sustainable development of the Baltic Sea

PREHAB develops tools for cost-efficient mapping of coastal habitats, using biological sampling and predictive modelling and illustrates how these tools can be used to evaluate ecological and socio-economic benefits of management actions.

KEY RESULTS

- Predictive modelling allows managers to obtain useful maps on the distribution of species and habitats.
- PREHAB's scenario analyses illustrate the usefulness of ecological modelling to explore ecosystem responses to environmental changes. Apart from revealing patterns that are important both from a biological and socio-economic perspective, it clearly demonstrates the absolute need to put management actions in a spatial context when evaluating alternative management measures.
- The citizens of the Baltic Sea countries value a clean and healthy sea and are willing to pay for mitigation actions, but between different areas of the region there are clear differences.

WHO NEEDS THE INFORMATION

Authorities working with spatial planning issues on local, regional and national levels in the Baltic coastal regions. Consultants working with mapping and planning in benthic marine coastal environments. Marine environmental policy-makers at local, regional, national and EU level.

PROJECT PARTNERS AND COORDINATOR

Sweden
University of Gothenburg (Coordinating partner)
Swedish University of Agricultural Sciences
AquaBiota Water Research

Finland
Finnish Environment Institute, SYKE
University of Helsinki
Åbo Akademi University

Lithuania
Klaipeda University, Coastal Research and Planning Institute

Project coordinator
Associate professor Mats Lindegarth, email: mats.lindegarth@marecol.gu.se

www.prehab.gu.se
www.bonusportal.org/prehab

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More information about BONUS:
bonus@bonuseeig.fi
www.bonusportal.org

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