

Ecosystem modelling in support of the MSFD Non-indigenous Species Descriptor

MEECE is an EU FP7 project which has developed regionally-focused ecosystem models. The new European Marine Strategy Framework Directive (MSFD) provides a transparent, legislative framework to apply an ecosystem-based approach to the management of human activities in the marine environment. The Directive aims to achieve 'Good Environmental Status' (GES) across Europe's regional seas by 2020. The MEECE Descriptor fact sheets highlight how MEECE science can be used in support of the MSFD.

Non-indigenous species and the MSFD

Non-indigenous species (NIS) are those that are introduced from their native range through the ballast water of ships, through marine and inland canals, via culture and stocking procedures, or by other unintentional or deliberate human vectors.

Some NIS may become invasive, increasing their abundance and spreading over large regions, with adverse impacts on native biodiversity, habitats and ecosystem functioning, and even economy and human health. Such an adverse alteration of ecosystems is called biological pollution (biopollution). GES is achieved if non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.

How MEECE science can support this descriptor

The environmental status of marine waters is traditionally evaluated by taking into account the effects of various forms of chemical pollution, eutrophication, habitat destruction and overfishing. Biopollution in some cases may surpass the impacts of those "traditional" stressors; but is very rarely covered in environmental assessments. This is because, a formal classification of biopollution impacts has been challenging due to the diverse mechanisms of such impacts and a lack of an agreed terminology.

Invasive NIS cause adverse environmental and economic effects only after attaining a critical level of abundance and only when occupying a sufficiently large area. To classify the level of invasive species impacts an integrative method, the "Biopollution level index" (BPL), was proposed for aquatic ecosystems (Olenin et al. 2007). The index is based on the classification of the abundance and distribution range of NIS and the assessment of the magnitude of their impacts on native communities, habitats and ecosystem functioning. BPL ranges from 0 ("no measurable impact") to 4 ("massive impact"), equivalent to the Beaufort Scale used for measuring winds. Such a scale for biopollution impacts helps to reduce subjectivism in measurement and reporting impacts, but also makes possible initial and trend assessments to determine the status quo according to MSFD requirements.

The MEECE project supported development of the online Biological Invasion Impact / Biopollution Assessment System (BINPAS) based on BPL methodology. BINPAS was created using open source web technologies and relational database management systems. It provides a user-friendly interface to calculate BPL and allows for the sharing of ecological data, providing inter-regional comparisons and meta-analysis of biological invasion effects at different spatial and temporal scales.

EC decision on criteria and methodological standards on GES of marine waters (EC 2010/477/EU) call for scientific and technical development of indicators of impacts of invasive NIS (such as bio-pollution indexes).

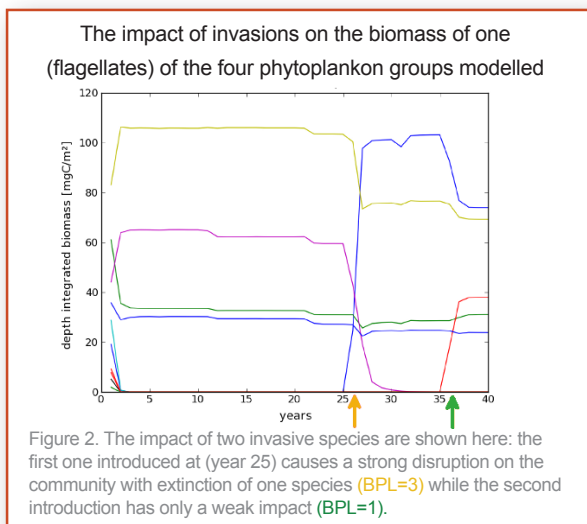
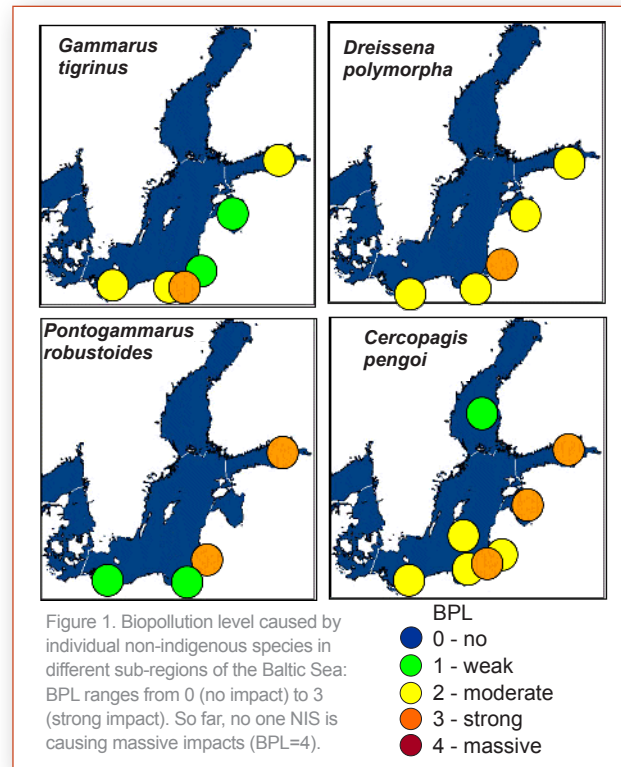
On an EU scale, BINPAS is the first example of such a development.



The slipper limpet, *Crepidula fornicata*. Originally from North America, those snails colonized a large part of the European coastal waters, where they compete with oysters and other shellfish for food. Image by Sergej Olenin, KUCORPI

Integrated biopollution assessment on a regional scale: the Baltic Sea case study

BINPAS provided a platform for the overall regional biopollution analysis for the Baltic Sea performed within MEECE. The assessment covered nine Baltic sub-regions from 1990–2010. It revealed that ecological impact is only documented for 43 NIS (seaweeds, polychaetes, crustaceans, mollusks, etc.) out of 119 registered in the Sea. The highest biopollution (BPL = 3, strong impact) occurs in coastal lagoons, inlets and gulfs, and moderate biopollution (BPL = 2) in the open sea areas. No one sub-region of the Baltic Sea was completely free of biopollution. The methodology was also used to classify species into NIS (BPL = 0) versus ‘impacting’ species (BPL>0). The methodology proved useful for interregional comparisons and evaluating the bioinvasion effects of individual non-indigenous species (Fig. 1). It provided a good estimate of what proportion of the Baltic ecosystems have been strongly affected by NIS and also suggested strong regional differences in invasion impacts. Such an analysis may be feasible for other well-studied regions.



Modelling invasions

One of the MEECE biogeochemical models (ERSEM) has been modified to include phytoplankton diversity: each of the model's four phytoplankton types have been substituted with 10 different sub-types (or “species”) whose characteristics were randomly selected to simulate diversity. The community is set to develop spontaneously due to interspecific competition for the same resources. Invasions are then simulated by adding new species at 5 year intervals and the BPL assessment can look at the impact of the disruption on the local phytoplankton community.

Statement of confidence

BPL may be estimated only for the areas with known history of biological invasions. Data on abundance and distribution of NIS present in the system is a prerequisite for the assessment, and at least, basic knowledge on local native biodiversity and environmental impacts of invasive species is required. Extensive literature searches are required to make the assessment and despite robust rule-sets, still a certain level of subjectivity may be present in the assessments, because the assessor needs to deal with incomplete scientific information. However, all background data is stored in BINPAS may be easily extracted and checked for validity.

MEECE Links

The full suite of models developed in MEECE can be viewed through the Model Library with accompanying user guides. Outputs from the models applied across European regional seas during MEECE are available through our web based Model Atlas. This interactive website allows visitors to view and compare model projections per region for different variables affected by a range of scenarios including future climate and human induced drivers of change.

www.meece.eu/Library.aspx | www.meeceatlas.eu