Benthic-pelagic coupling in coastal seas – modeling macrofaunal biomass production in response to organic matter input

Eva Ehrnsten[1,2,*], Karen Timmerman[3], Barbara Bauer[2], Alf Norkko[1] and Bo Gustafsson[2]

[1] Tvärminne Zoological Station, University of Helsinki, Finland
[2] Stockholm University Baltic Sea Centre, Sweden
[3] Department of Biosciences, Aarhus University, Denmark

*Contact: eva.ehrnsten@su.se

Why study macrofauna?

Benthic macrofauna is an important ecosystem component linking the pelagic and benthic, especially in the productive coastal zones.

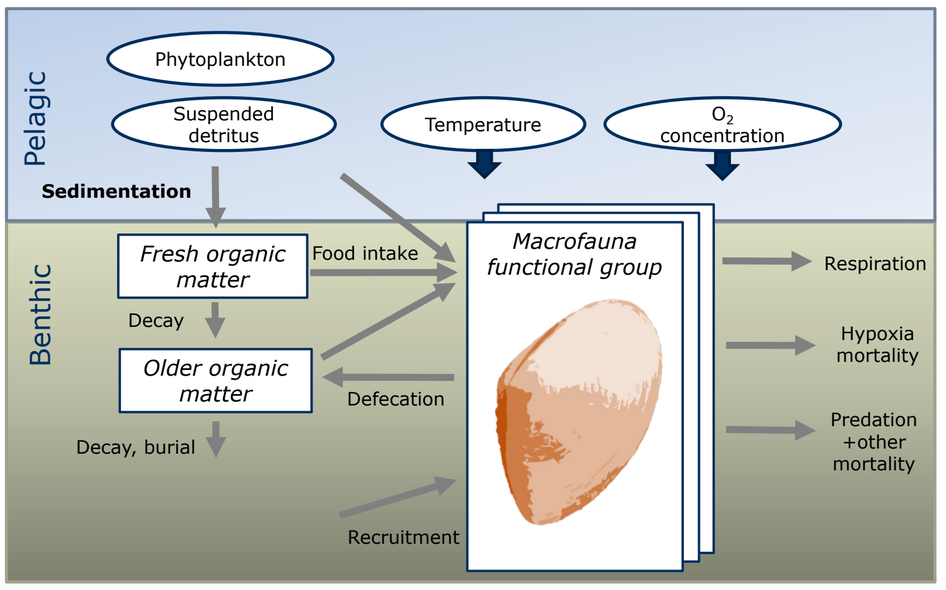
- Affect fluxes of carbon, nutrients and oxygen between the sediment and water column through metabolism and behaviour, which in turn affects e.g. the frequency of plankton blooms and water clarity.
- An important food source for commercially exploited fish, such as cod and flatfish.
- Benthic macrofauna is used an indicator of environmental status in the Baltic Sea.

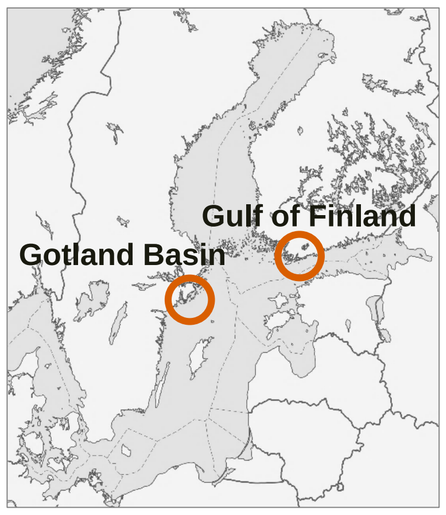
Aims

- Develop a process-based dynamic model of benthic macrofauna.
- Investigate the relationship between organic matter input and benthic macrofaunal biomass in the coastal zone.

Materials & methods

The model simulates the carbon dynamics of three functional groups of benthic macrofauna**:** ***Macoma balthica,*** **surface deposit-feeders** and invertebrate **predator/scavengers,** as well as their sediment food sources. All functional groups share the same processes as shown in the conceptual model below. The benthic model is linked to the physical-biogeochemical BALTSEM model. Here we implemented it in two coastal soft-bottom areas of the Baltic Sea during 1993 to 2005.





Results

1. Macrofauna biomass limited by organic matter input

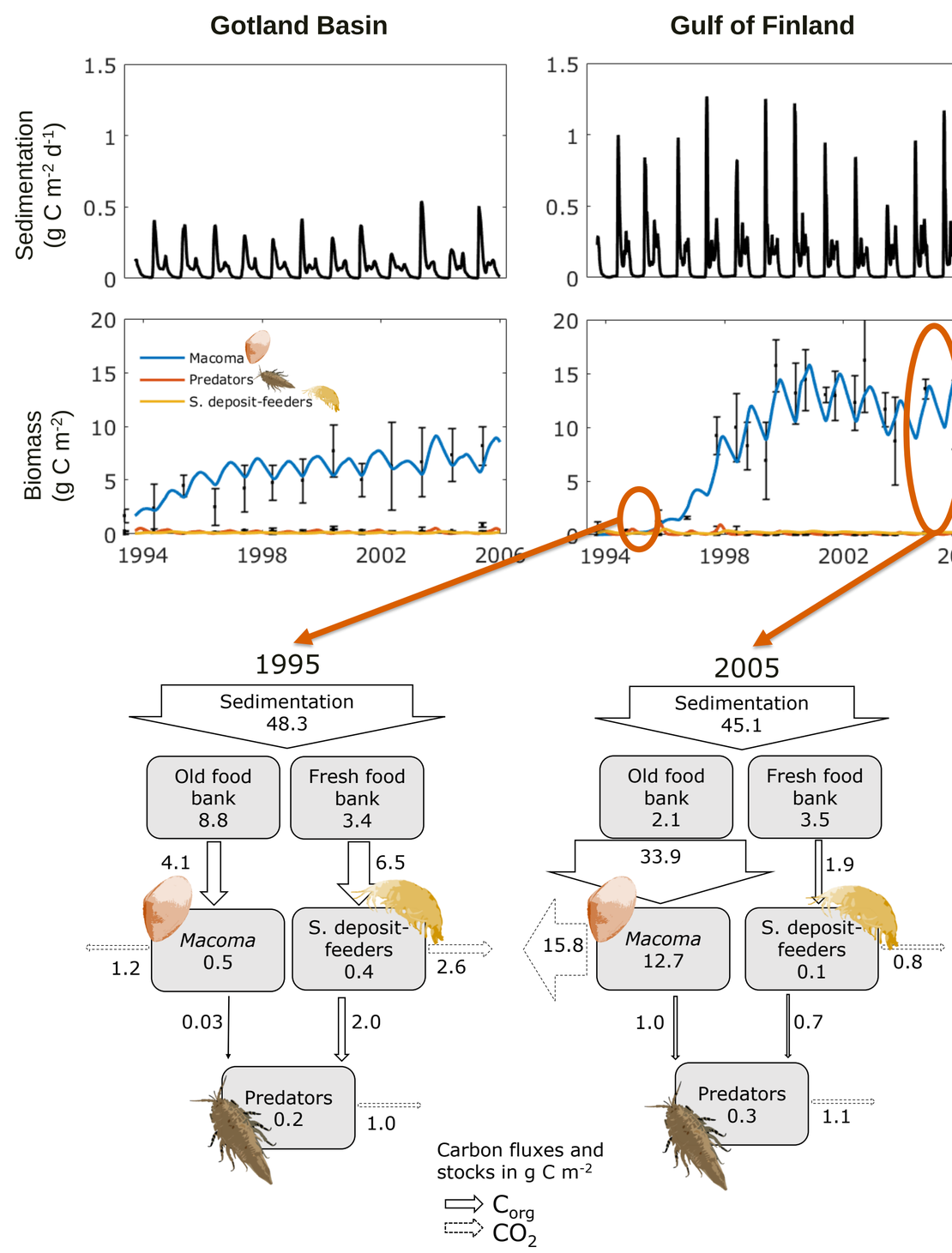
Eutrophication increases primary production and sedimentation rates, which in turn provides food for the benthos. In the two study areas with similar oxygen, temperature and salinity regimes, different sedimentation rates can explain the much higher benthic community biomass in Gulf of Finland site compared to the Gotland Basin site. Simulated biomass development correlated well with measured time-series from national monitoring, shown as mean ±SD of replicates (R^2=0.95, p<0.001).

2. Increasing biomass alters the carbon cycle

In both sites, the biomass of the deposit/suspension-feeding bivalve *Macoma balthica* has increased in the 1990s and dominates the benthic community biomass. The radical increase in biomass has altered the pathways of organic matter degradation: in the Gulf of Finland site 40% of organic matter input was mineralised to CO_2 by macrofaunal respiration in 2005 compared to 10% in 1995.

3. Future: eutophication increases biomass in coastal oxic areas, but hypoxia and ocean warming decrease biomass

We performed a systematic sensitivity analysis to study the effects of changing nutrient loads and climate on simulated benthic biomass. While reduced nutrient loads might lead to improved oxygen conditions and recovery of benthic fauna in deep parts of the Baltic Sea, we expect a decrease in benthic biomass in the coastal zone due to decreased food availability, especially in combination with increased temperatures.



This study was part of the BONUS BALTICAPP project and has received funding from BONUS (Art 185) funded jointly by the EU, the Academy of Finland and the Swedish Research Council Formas.