Climate change impacts on biodiversity

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extracted from
Dahl, K.; Josefson, A. B.; Göke, C., Aagaard Christensen, J. P.; Hansen, J.; Markager, S.; Rasmussen, M.B.; Dromph, K.; Tian, T.; Wan, Z.; Krämer, I; Viitasalo, M.; Kostamo, K.; Borenäs, K.; Bendtsen, J.;Springe, G.; Bonsdorff, E. 2012: Climate Change Impacts on Marine Biodiversity and Habitats in the Baltic Sea – and Possible Human Adaptations. Baltadapt Report # 3.

The problem
Global warming will not only influence temperature but also freshwater runoff and consequently also salinity in the Baltic Sea. A side effect will possibly also be decreased oxygen concentrations in the bottom water. Climate change, thus, is likely to induce substantial changes in the Baltic Sea, where virtually all species live close to their environmental tolerance range.

The questions
How will species distributions change with freshening of the Baltic Sea? And which benthic species will be favoured/disfavoured by decreased oxygen? And how will ecosystem functions be changed?

The approach

Positions of future salinity iso-halines were obtained by modeling. Present distribution limits of selected species were estimated from the literature. Future distribution limits of species were estimated by moving present distribution limits the same distance as the iso-halines over 100 yrs.

An example is given below of a species that likely will have a competitive advantage if oxygen deficiency affected areas will increase, and its possible effects on organic matter circulation and oxygen demand.

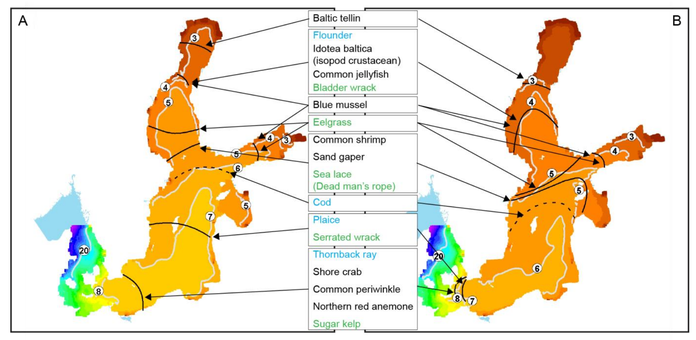
To the right:

Scenarios on future biogeographic distribution changes 100 yrs from now of selected Baltic Sea species induced by salinity changes.

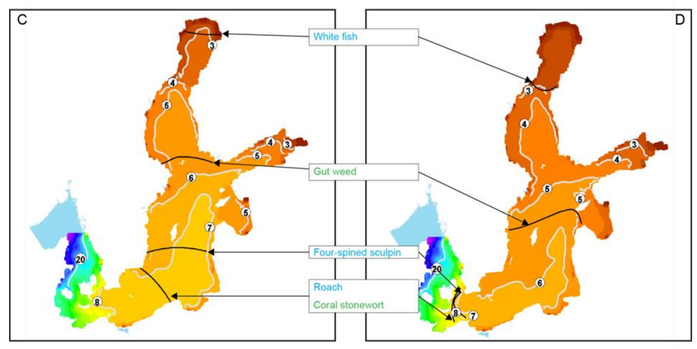
Distribution of selected macrophytes, fish and benthic invertebrate species today (A and C) and predicted based on modeled future climate (B and D). Surface salinities (top 3 m) in the Baltic Sea modeled by Meier et al. (2011) and the present distribution of species with marine origin in A and with freshwater origin in C are taken from Bonsdorff (2006) . Surface salinity iso-halines are labelled by encircled numbers

The predicted changes are solely based on simulated salinity changes and not changes in ice cover and oxygen deficiency

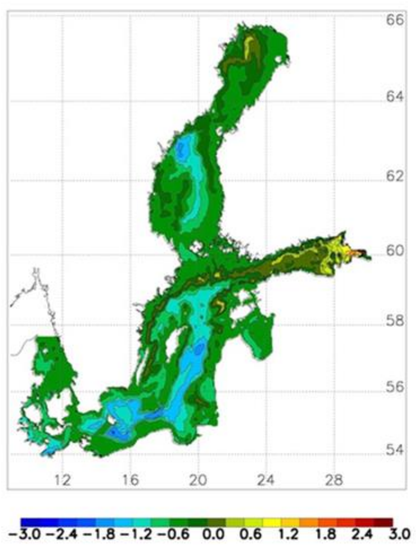
Marine species will retreat southwards and westwards



Fresh-water species will expand southwards and westwards



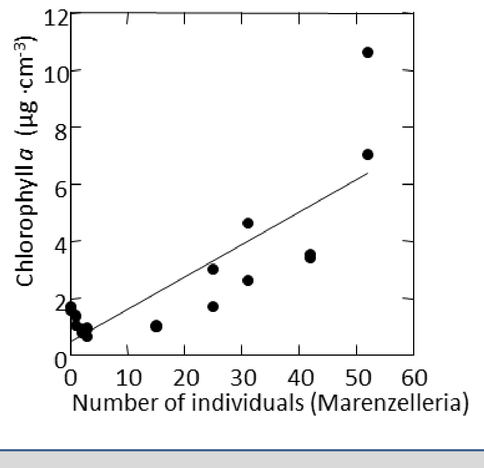
The mean change in the annual bottom oxygen conc-entrations (ml/l) between 2070–2099 and 1969–1998 based on four simulations (Meier et al. 2011)



One consequence of increased areas with low oxygen may be spreading of the invasive bristle worm *Marenzelleria*, as has already occurred in the Bay of Finland (Maximov 2011). Although invasive species sometimes have a negative impact on the native ecosystem, this seems not to be the case for *Marenzelleria* in the Baltic, which have the potential to provide important ecosystem services in the form of mitigating hypoxia in bottom areas earlier populated by native fauna.

1) By irrigation *Marenzelleria* binds phosphorous In the sediment making it unavailable for pelagic production (Norkko et al. 2012)
2) *Marenzelleria* buries fresh algal matter at > 10 cm depth in the sediment which may slow down oxygen consumption (Josefson et al. 2012). Example to the right from the Bay of Finland showing increase deep in the sediment of Chl *a* with increasing *Marenzelleria* abundance.

Photo: Jan-Erik Bruun



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Conclusions

- The two possible side-effects of Global warming, freshening of the Baltic Sea and increasing oxygen depletion in the bottom waters will have profound effects on species distributions and ecosystem function.
- Because many species in the Baltic live on the edge of their salinity tolerance, freshening of the Baltic Sea will affect spatial distribution of species. Species with marine affinities will retreat , and freshwater species wil spread southwards and westwards in the Baltic Sea system.
- Increasing oxygen depletion, will have a profound effect on both species distributions and ecosystem function. Macrobenthic communities will disappear in areas where permanent oxygen depletion will develop in the future, and in areas with some but little oxygen communities will change towards more tolerant species, like the bristle worm *Marenzelleria*.
- The phosphorous binding and burial functions exhibited by this bristle worm are partly new to the Baltic Sea system and implies that increased dominance of the worms will have significant effects on carbon cycling and oxygen dynamics in the Baltic Sea. A likely implication of such a species shift is a build-up of the organic pool in sub-surface sediments and that overall mineralization rates are likely to decrease and thus mitigate hypoxia in the bottom waters.

AARHUS UNIVERSITY
Baltic Sea Region Programme 2007–2013

Part-financed by the European Union
(European Regional Development Fund)