Office for PhD Education

Popular science summary of the PhD thesis

PhD student	Sieme Bossier
Title of the PhD thesis	Evaluating Major Baltic Fish Stocks under Climate, Eutrophication and Fishing Pressure using a Holistic end-to-end Ecosystem Model
PhD school/Department	DTU Aqua

The Baltic Sea is exposed to several pressures and human impacts. Large amounts of nutrients flow out from land via the rivers into the sea, there is extensive fishing targeting only a few fish species and also climate change influences the Baltic sea. Climate change can lead to an increase in temperature, a possible increase in rainfall resulting in lower salinity, as well as increase in acidification and frequency of storm events. The current study aims to find out how all these pressures will impact the marine ecosystem as well as to help relevant managers to make informed decisions. All this with the aim to reach the goal of creating a sustainable environment with good environmental status (GES) according to e.g. good oxygen levels, high biodiversity, and healthy fish stocks. Achieving GES in the Baltic Sea region requires holistic and cross disciplinary scientific support tools to compare alternative fisheries management strategies and to compare the responses of fish and fisheries to changing climatic and eutrophication (the excess of nutrients brought into the ecosystem) conditions. This covers for instance what amounts of fish that can sustainably be caught or which areas are sustainable to be fished, in relation to the fish stocks and the broader marine ecosystem with respect to biological groups and their physical habitats. It also covers scientific advice on impacts of nutrient loads on the marine environment and ecosystem to inform managers in relation to regulations on the amount of nutrients allowed to enter the Baltic Sea.

We therefore applied a comprehensive mathematical model, called the Baltic Atlantis. The Atlantis end-to-end whole-of ecosystem model explores climate, eutrophication, fishery and spatial management scenarios. It incorporates the dynamics of the whole Baltic Sea ecosystem, such as the currents, temperature and salinity, small phytoplankton organisms which produce oxygen, species living in and on the sea bottom, fish, seabirds and seals, but also human activities like the fishery. By doing so, it links oceanography, biogeochemistry, food web, habitat, fish population and human sector dynamics. We applied temperature, salinity and currents forcing from the RCO-SCOBI biogeochemical climate model to enable the projections of future climate change and eutrophication. Such a holistic tool that incorporates the whole ecosystem is needed because of the complexity of the system and because all these pressures affect the ecosystem at the same time and also interact with each other. The results of the research indicates that excess nutrient loads is the main driver of the changes in the ecosystem. For the main fish stocks, this results in a decrease in cod and an increase in sprat and herring under high nutrient load levels. However, climate change will have a stronger impact on the ecosystem than eutrophication once certain hydrographical thresholds, which fish require to spawn, are reached such as minimum oxygen or salinity levels or maximum temperature levels. This would for instance lead to a decrease in the cod population, which is one of the main commercial Baltic fish species. However, determining the exact effect of climate change and eutrophication and their combined effect is difficult because there is a degree of uncertainty surrounding the climate model projections, which is often difficult to quantify, especially because the climate scenarios incorporate several future unknowns. Therefore, further research is needed to continue to develop and implement such holistic models. This is necessary in order to provide informed strategic management advice considering long-term integrated impacts of e.g. eutrophication, climate change and fisheries potentially resulting in changed carrying capacities of the different biological functional groups in the system.