Stockholm Resilience Centre
Research for Biosphere Stewardship and Innovation
Stockholm University

NorMER norden
Top-level Research Initiative

NETWORK ANALYSIS ON THE EFFECT OF CLIMATE ON MARINE FOOD WEB INTERACTIONS AND SOCIAL-ECOLOGICAL SYSTEM DYNAMICS

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Introduction

Environmental and anthropogenic changes, such as climate and fishing, can affect food web structure and dynamics with consequences for ecosystem services[1]. Studying how changes in food web structure affect ecosystem dynamics and analyzing the linkages between humans and marine ecosystems are essential for resource management. Humans are a significant driver of changes in marine ecosystems, but also capable of changing their behavior when facing ecosystem changes[2].

Method

- Ecological network analysis (ENA) describes the composition and interactions of food webs and provides a conceptual framework for analysing the consequences of perturbations[4].
- Social network analysis has created a rich set of structural analysis concepts, which ecological network research can test and benefit from.
- Social network analysis in natural resource management creates understanding on which social network characters increase the likelihood of successful natural resource management and collective action[5].

Study Area

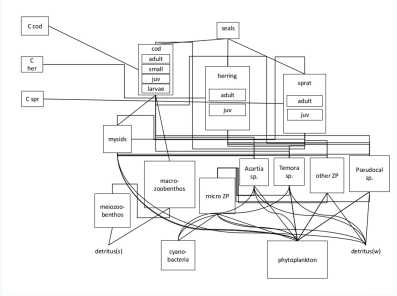
The study area consist of the Nordic seas included in the NorMER-region. The Baltic Sea is a semi-enclosed, brackish- water ecosystem affected by intensive fishery and anthropogenic eutrophication[6]. The main study region is the central Baltic.

Research Questions

Using the tools of ecological and social network analysis, my project aims to analyse the effect of climate on marine food webs in the context of social-ecological system dynamics.

My objectives are:

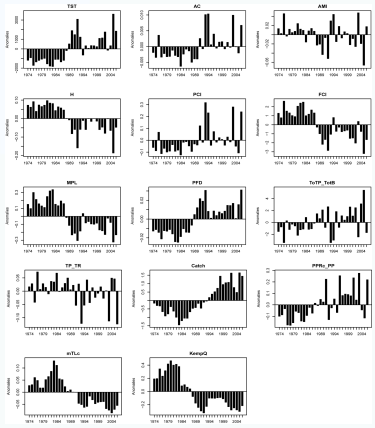
- To test new network approaches on marine food webs affected by multiple drivers
- To evaluate how climate contributes to past and future changes in the Baltic Sea, by applying multiple network analysis



The structure of the food web model[3].

Next Steps

- Coupling of benthic and pelagic food web dynamics for describing the ecological interpretability of the resulting network structure, including network alteration according to the climate change predictions.
- Test for integrating social and ecological marine networks to study the human and environmental interactions



Ecological indicators and ENA indices anomalies (note different scale) from 1974-2006[3].

Results

Our study[3] results indicate that

- The use of 15 different ecosystem ENA indices succeeded in detecting the changes in the food-web in 1980s and 90s, ENA clearly showing two regimes.
- Climate and fishing (external forcing) changed the structure and dynamics of the Baltic Sea food web.

Conclusions

- Network approach and indices proved to be very useful for detecting the structural and quantitative (flow) changes in the marine food web experiencing a regime shift.
- Our study emphasizes the importance of holistic approach: anthropogenic stressors need to be analysed in combination with ecosystem characteristics.

References

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2. Perry *et al.*, 2010
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4. E.g. Wulff *et al.*, 1989
5. Schneider *et al.*, 2003, Tomkin & Adger, 2004, Newman & Pale, 2004, Bodin *et al.*, 2006.
6. Wulff *et al.*, 2001, Möllmann *et al.*, 2009