

## Theme Session P

### **Ecological-foodweb and network analysis: a tool for Ecosystem-based management?**

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The concept of an ecosystem approach to management (EAM) of marine ecosystems and their resources has been broadly accepted. Sound management within the EAM includes considering not only the direct effect on the exploited resources, but also the indirect effects on adjacent trophic levels and the whole foodweb. Furthermore, questions on stability of foodwebs in the contexts of overexploitation, species extinctions and climate change have to be considered. Network Analysis has developed into an interdisciplinary search for generalities in the topology of different kinds of network and their resistance to change, i.e. stability. Within this framework Ecological Network Analysis (ENA) has become an important field of research mainly in terrestrial and freshwater ecosystems. Network research in marine areas remains fragmented yet, mainly because of the enormous sampling effort needed for reliably constructing comprehensive networks of marine ecosystems. Nevertheless, the research programme of ENA is considered to have a large potential in delivering lacking knowledge needed for an EAM as well as in delivering insight into general ecological principles. It can especially help in defining baselines (indicators) for a sustainable use of healthy marine ecosystems. Hence, the goal of this theme session was to synthesize the existing knowledge on marine networks and compare them to e.g. terrestrial habitats as well as lakes and streams. We invited papers and posters dealing especially with the effects of global change such as climate and human exploitation on both temporal and spatial structure and function of marine foodwebs.

In total 11 presentations were given during the session. 4 studies were dealing with general approaches to ENA. A study (P:11) linked the topological structure of a variety of marine ecosystems to species identity and their functional roles and demonstrated that not every species is equally important. Instead, some species may be characterized as drivers (by being able to compensate for the loss of other species) and others as passengers, suggesting that it is increasing functional diversity rather than species richness per se that facilitate ecosystem functioning. Another study (P:06) presented the trophic spectrum, a tool for assessing the effects of fishing on marine ecosystems at a global scale. This work was based on 57 published Ecopath models representing various marine ecosystems in terms of size, latitude, productivity, type of ecosystem, and exploitation. By this the authors identified key factors of ecosystems' resilience to fishing, which should be considered in an ecosystem-based management perspective. Study P:10 synthesized our understanding of foodweb topology, allometric scaling, population dynamics, and community evolution using a population-dynamical matching model which reproduces the major known macroecological patterns relating body sizes, abundances, species richness, trophic position, and foodweb structure. The model was applied to issues of

ecosystem-based fishery management such as (i) the validity of single-stock fishery models, (ii) the effects of fishing pressure on species richness among fish and at lower trophic levels, (iii) the effects of fishing pressure on the community size structure. Furthermore, a qualitative foodweb modelling approach for predicting the joined directions of change of population and community indicators was presented (P:02). Using population and community indicators derived from scientific trawl surveys in several European marine ecosystems, we empirically tested whether joined time-trends in abundance and length (proxy for age) indicators allowed the identification of the most likely pressure changes as predicted by model analyses. The results demonstrated that qualitative modelling can provide the theoretical foundation for the integrated assessment of marine communities under multiple pressures.

During the further course of the session regional case studies on ENA covering ecosystems at Georges Bank, the Baltic and North Seas as well as the Ionian Sea were presented (P:01, P:04, P:07, P:03, P:12). An end-to-end budget for was used for Georges Bank to determine the plankton and benthos production available for the three predator guilds (planktivores, benthivores, and piscivores) under a range of scenarios describing possible climatic changes and habitat disturbances. For the Baltic Sea long-term changes indices of ecosystem change were calculated using ecological network analysis and tested for decadal regime shifts. Topological ENA and multispecies modelling have been used in a further study comparing the North and Baltic Seas ecosystem, revealing clear dependencies of the utility of the approaches to data quality and availability. Furthermore, the large-scale response of North Sea cod and whiting populations to varying prey fields was used using generalized additive models. This study demonstrates that current ecosystem models can be significantly improved by taking into account changes in spatial predator-prey overlap. Finally, mass-balance Ecopath model of the Greek Ionian Sea assembling and summarizing the existing information related to fisheries, and aspects.

The session ended with two studies investigating special aspect of species interactions. Grazing pressure of mesozooplankton under anthropogenic impact was studied in Ushuaia Bay, Argentina (P:09), while study P:08 demonstrated that the effect of predators on prey in the top-down controlled ecosystems can be modified by the degree of asynchrony.

The various presentations as well as the discussions during the theme session clearly demonstrated the potential of the various ENA approaches in support of an ecosystem-based management framework. However, a number of authors and participants of the session pointed towards the great importance of having appropriate data for supporting further development of ENA. Data are frequently lacking and need to be collected in the future. Further themes during the discussions were on how these models can be used to anticipate regime shifts.