

Theme session M

Modelling social-ecological systems: methods and tools for scenario development and prediction

Conveners: Olivier Thébaud (France), Jan Jaap Poos (The Netherlands), Jörn Schmidt (Germany)

The domain of integrated ecological-economic scenario building is rapidly developing with a broad range of approaches, methods and models. This is a timely development as the requirements are growing internationally for such scenarios, not only within the International Panel on Climate Change (IPCC), but specifically in contexts such as the International Panel of Biodiversity and Ecosystem Services (IPBES) or the pursuit of the Sustainable Development Goals (SDGs).

This session thus aimed at stimulating contributions on methods and tools for the development of scenarios and analysis of their impacts on marine social-ecological systems.

The session had in total 23 contributions, 17 talks and 6 posters. Whereas the majority of contributions presented different model frameworks to analyse effects of different scenarios on marine social-ecological systems, some focussed specifically on tools for scenario development.

The session started with a very nice overview by Mark Dickey-Collas, presenting current use and routes for future applications of social sciences within ICES. This did set quite nicely the scope for the session. The presentation was followed by a presentation by Charlotte Weber, presenting an interesting method for text analysis. Using **machine learning** and **topic modelling** to analyse articles in 13 fisheries journals from 1990-2016 showed an interesting approach to dig out existing knowledge in this domain.

Presentations on the development of scenarios focussed on ways of facilitating collaborative work and the use of serious games to engage with different actors in a system. Per Arneberg presented results from a workshop on **scenario development for the Barents Sea**. One of the main challenges was the integration of individual perspectives. The key element of the presented framework is to keep the individual perspectives throughout the scenario development process, before integrating them into multidisciplinary storylines about the future. He also presented a **web tool for collaborative writing**, which can facilitate the process, also when different actors are physically separated. Alice Lapjover presented an **interactive experimentation platform**, which used companion modelling to develop three **serious games** for scientists, managers and fishermen. By playing the games, the stakeholders developed and explored scenarios, while at the same time learned about the perspectives of the other stakeholders.

The presentations on methods, tools, modelling and frameworks span across a wide range of different approaches. Diego Salgueiro presented a new approach to analyse adaptation in small-scale fisheries under climate change using the **Ostrom framework, vulnerability assessment framework (IPCC) and resilience thinking**. The approach is used to identify key variables like trust or diversity of actors and can serve as a **toolbox for quantifying trade-offs in social-ecological variables**. The Galician case study was based mainly on literature data, but the approach could be used to guide the collection of empirical information and data. Mélodie Dubois presented a study on using a dynamic and spatially explicit trophic model (**Ecopath**

with **Ecosim**) to analyse **different fishing scenarios** in a coral reef fishery. She showed that the way that communities use marine resource through fishing, affects different key ecological processes, and has different consequences on the resilience of the coral reef ecosystem, posing the question: can fishing sometimes help an ecosystem to recover? **Alan Haynie** showed a modelling approach of analysing total allowable catch (TAC), allowable biological catch (ABC) and actual catch of commercial species in the Bering Sea by **analysing management and harvest scenarios**. The study showed that different policies can have a larger impact on quota and catch than climate change. **Gavin Fay** presented the **conceptual modelling approach** of the ICES Working Group on the Northwest Atlantic Regional Sea (WGNARS). Using different qualitative modelling approaches (Mental Modeler, QPress, LoopAnalyst) the group assessed tradeoffs between objectives across two environmental scenarios.

Ernesto Carella presented POSEIDON, an **agent based modelling framework**. Applied to the west Florida shelf reef fishery its wider aim is to expand this to different data rich and data poor case studies globally. The aim is to simulate fisher behaviour to potentially reduce uncertainty in operating models in MSEs. **Emilie Lindkvist** also presented an **agent based model**, applied to fisheries in the Gulf of California. The model uses information about fisher behaviour derived from already existing interviews and data. Social networks are used to identify mobility patterns. The model is used to understand the mechanisms determining the movement of SSFs following scenarios of overfishing and stock collapse. **Maxime Depalle** investigates the issues surrounding the definition of spatial units on analyzing and assessing models' sensitivity to spatial discretization, known as the **Modifiable Areal Unit Problem (MAUP)**. His results show the trade-offs that exist in modelling fishing effort allocation, when using high-resolution information to capture drivers of behavior that operate at finer scales. **Julia Calderwood** used survey data collected from research vessels and observer data collected from commercial fishing vessels to produce maps identifying discarding hotspots. She analyses how **behavioral change** can decrease bycatch and the effect of choke species on fisher profit. **Brad Franklin** presented a **quantitative species distribution model** fed with expert knowledge on species vulnerability and coupled to an input-output model to analyze the effect of future species distribution on fisheries operating from different ports in New England. **Annukka Lehtikoinen** studied the impact of different fishing regulations and fish-eating recommendations to find ecologically and socially sustainable ways to use Baltic herring and salmon under the threat of dioxin contamination. She used a **DPSIR framework and Bayesian influence diagram model**. The integrated model can be used as a planning tool. **Hannes Höffle** presented a **quantitative economic model** of fishing enterprise behavior, integrating economic motivations and choices related to soft constraints. **Sakari Kuikka** showed a history of **Bayesian decision models** in the Baltic. Some key aspects, e.g. beauty of the sea or recreational values are rarely mentioned and used in model approaches.

The final talks were 3-minute pitch talk presentations of the posters. **Mia Pihlajamäki** presented exploratory scenarios and **Bayesian belief network (BBN)** to structure and examine quantitatively the implications of changes in the societal driving forces to the social-ecological system (SES) of Baltic herring and salmon fisheries. **Sakari Kuikka** showed a **flexible Bayesian model** of fisheries discards with priors defined by expert knowledge to evaluate discards in the Ligurian and northern Tyrrhenian Seas and the Greek part of the Aegean Sea. **Eckhard Bethke** presented a **biomass model** consisting of a von Bertalanffy-growth function and a simple exponential growth model to explore different management strategies. Finally, **Marcos Llope** presented a study on the Gulf of Cadiz anchovy. Using **time series analysis** to understand the effect of natural and anthropogenic influences on anchovy early life stages, the approach allows the quantification of trade-offs between different land and marine based sectors.

The session ended with a short general discussion, raising some general points.

One of the challenges for scenario development and analysis are the different spatial and temporal scales of different activities. Especially anthropological tools and analyses are often on a very local scale, ecosystem effects spanning across communities and economic drivers can be even outside the study region. One aspect that is rarely included (although there are projects working on this) is well-being of coastal communities.

While developing possible storylines of future development to derive scenarios, which can be tested in a model framework, the perception is that there is still a large gap between stakeholder engagement and modelling itself.

The final question that was raised, but due to lack of time not thoroughly discussed, was where does ICES want to go in the future in this domain?

Contributions

Mark Dickey-Collas: [Where does social-ecological modelling fit in ICES?](#)

Charlotte Weber: [Using machine learning to uncover hidden topics of fisheries models](#)

Per Arneberg: [Uncertain future ahead, how can scientists, managers and stakeholders get prepared together?](#)

Alice Lapijover: [Co-constructing a shared vision of marine territories using serious games](#)

Per Arneberg: [Serious games for building scenarios for the future of marine socioecological systems](#)

Diego Salgueiro: [One step further: understanding adaptation to climate change in social-ecological systems](#)

Mélodie Dubois: [Towards management and have a larger impact than for resilience: Combined effects of natural disturbances and fisheries dynamics on coral reef ecosystem functioning.](#)

Alan Haynie: [Forecasting species-specific total allowable catch under an ecosystem cap in the US Bering Sea and Aleutian Islands](#)

Gavin Fay: [Conceptual and qualitative modeling for Management Strategy Evaluation of social-ecological systems in the Northwest Atlantic](#)

Ernesto Carella: [Development of a new generalizable systems model emphasizing the human dimension; the POSEIDON framework](#)

Emilie Lindkvist: [Spatial and sequential stock depletion through increased fisher mobility: An agent-based modeling approach](#)

Maxime Depalle: [The Modifiable Areal Unit Problem \(MAUP\) in the analysis of fishery behavior: new insights from VMS data](#)

Julia Calderwood: [Modelling fishing behaviour to determine how changes in fishing tactics may assist Irish vessels operating under the Landing Obligation](#)

Brad Franklin: [Economic Impacts and Adaptation Strategies for Fishing Communities Facing Climate-Driven Species Changes](#)

Annukka Lehtikoinen: [To eat or not to eat? Two systems analytic approaches to evaluate the sustainable use of the dioxin-rich Baltic herring and salmon](#)

Hannes Höfle: [Is a single dimension enough to explain fishers' decision-making?](#)

Sakari Kuikka: [Practical experiences in applying Bayesian decision models to fisheries and environmental problems: lessons learned](#)

Mia Pihlajamäki (poster): [Combining exploratory scenarios and Bayesian belief network to model social-ecological systems – case study on Baltic herring and salmon fisheries](#)

Marcos Llope (poster): [Natural and land-based factors in the Guadalquivir estuary affect the abundance of anchovy in the Gulf of Cadiz \(SW Spain\)](#)

Eckhard Bethke (poster): [The Eco² Model – A basic bio-economic module for the description of the dynamics of cohort biomass in response to exploitation](#)

Sakari Kuikka (poster): [Development of a flexible Bayesian model of fisheries discards with priors defined by expert knowledge](#)

Jiangxiao Qiu (poster): [Developing a methodology to promote resilient socio-ecological systems in South Florida, USA](#)

Adam Mytlewski (poster): [Challenges for the Baltic sprat supply in the face of purchase behavior changes in Poland. The results of the Prohealth project survey](#)