Theme session I

Tipping points complex nature and implications to marine social-ecological systems management (co-sponsored by PICES)

Conveners: Xochitl Cormon (Germany), Camilla Sguotti (Germany), Christian Möllmann (Germany), Mary Hunsicker (USA)

Introduction

Tipping points are critical thresholds for large, abrupt and (quasi-) irreversible changes happening anywhere in the biosphere including the seas and oceans. Those deep changes, generally referred as regime shifts, can reorganize an ecosystem with a total reorganisation of its structure and function. The resulting new state, stabilised by feedback mechanisms, is persistent in time, and impossible (or very difficult) to reverse due to hysteresis. Regime shifts usually have strong ecological, social and economic impacts and hence they need to be accounted to manage Earth´s natural resources sustainably.

The session aspired i) to explore links and interactions between tipping points of different natures connected to shifts in any marine ecosystems and ii) explore implications of tipping points for marine ecosystem-based management. We aimed to gather presentations from a variety of research areas to allow a cross-disciplinary discussion, an understanding of tipping point mechanisms and to support the development of more comprehensive marine management strategies.

Methods

We received 21 abstracts (16 oral and 5 posters requested). An evaluation grid was used to assess abstracts quality, relevance to the session and suitability for keynote. Each convener evaluated blindly all abstracts (abstracts were *a priori* made anonymous) before scores were averaged. After selection (and withdraws), a total of 11 oral presentations (including one which was selected for keynote) and 4 posters were presented at the theme session with a total of 8 females and 7 early-career scientists presenters (including our keynote). The session was attended by an average of about 120 conference participants.

The theme session had a dynamic format intending to enhance discussion. Presentations lasted only 7 minutes followed by 3 to 5 minutes of questions and poster presenters were given 1 minute to pitch their poster (without slide support). The morning was dedicated to presentations (6) exploring implications of tipping points to marine ecosystem-based management while the afternoon was dedicated to presentations (9) focusing on tipping point identifications. Additional discussion time was secured at the end set of presentations (total of 60 minutes).

Results and discussion

Investigation of fish stock dynamics (I:25; I:356; I:215; I:342; I:267) and assessment of system resilience (I:221; I:316) highlighted the cumulative effects of climate change and fishing at regional or more global scales. The role, value and limits of empirical methods such as CUSP (catastrophe model, I:267) or IRA (Integrated Resilience Assessment, I:221; I:316) was discussed due to concern about the inflation of methods in regime shift science lacking real knowledge about performance and sensitivity. The difficulties of selecting relevant and meaningful data to study an ecosystem (and potential lack of the latter), as well as the need to understand underlying mechanisms to get out of "*correlation science*" in favour of causation studies, were raised.

While literature analysis revealed that that scientific community might not be able to fulfil all management needs (I:347), the dilemma between providing managers with tools and information to support their decision and understanding mechanisms involved was raised. Mechanistic knowledge was acknowledged as an asset as was communicating with decision-makers, managers and/or any stakeholders, as it increases trust towards scientists and may reduce management failure risks (I:25; I:215; I:356) even if their inclusion may might appear of no, or of, little significance (I:342; I:25; I:215; I:356).

Material such as historical records (I:184.; I:390; I:630), stakeholder knowledge (I:144.) or time series of prices may complement ecological data and provide more comprehensive and precautionary indicators to manage a system (I:435; I:644) and may allow science to embrace social-ecological system complexity. An increase of inter/trans-disciplinary research and research at different spatial and temporal scales were advocated.

The issue of positive results bias in tipping point publications and the need to have more "success stories" relating system recovery or sustainable novel systems (I:44) was raised. In addition to conducting interdisciplinary research, stakeholders and scientists with opposing perspectives on tipping points and resilience need to get together to share knowledge and help identify common management targets. Communication issues between scientists from different disciplines, but also with stakeholders, were raised as a central challenge: from tipping point definition based on stakeholder knowledge (I:144) to the definition of tipping points and the confusion over tipping point terminology (I:347). If the idea of common definitions might appear utopic to some, all participants agreed that the best strategy to communicate to managers is to avoid buzzwords and fancy terms. The discussion on terminology was continued in an expert meeting right after the session.

Conclusion

Selected contributions successfully met session synopsis expectations in terms of interdisciplinarity and topics covered. The high quality of the presentation and the dynamic format of the session led to a constructive discussion, raising insights and direction for future research about tipping points applied to marine social-ecological system management.

Contributions

I:25, Timothy Essington, James Sanchirico, Marissa Baskett. What is economic value of ecological information in natural resource systems prone to tipping points?

I:44, Thorsten Blenckner, Yosr Ammar, Susa Niiranen, Christian Möllmann. Tipping points and novelty in the Baltic Sea.

I:144, Rebecca A.M. Lauerburg, R. Diekmann, C. Möllmann, V. Stelzenmüller. Stakeholder knowledge as an agent to identify tipping points–a novel approach to assess thresholds in socio-ecological systems.

I:184, Oliver Lehmann, Rudi Voss, Christian Möllmann, Karoline Schacht, Jörn Schmidt. Captain Jim Sparrows secret family chronicles reveal tipping points in the medieval Western Baltic herring fishery.

I:215, Anna-Marie Winter, Andries Peter Richter, Anne Maria Eikeset. Increased collapse probability of a fish population under the synergistic effects of fishing, climate and the Allee-effect and the limited human potential for collapse aversion and reversion.

I:221, Marcos Llope, Thorsten Blenckner, Paris Vasilakopoulos, Niall McGinty, Christopher P. Lynam, Pierre Helaouët, Joël M. Durant, Leif C. Stige, Guðrún Marteinsdóttir, Nils Chr. Stenseth. Continuous and abrupt changes in the resilience of northeast Atlantic marine ecosystems.

I:267, Leonie Färber, Camilla Sguotti, Joël M. Durant, Øystein Langangen, Saskia Otto, Christian Möllmann. Detecting catastrophic transitions – the case of North Atlantic herring.

I:316, Manuel Hidalgo, P. Vasilakopoulos, A. Esteban, C. García. Winners and losers in recent regime shifts in the Western Mediterranean Sea.

I:342, Leana Deris, Øystein Langangen, Joël Durant. Effect of stock collapse on predator prey relationships.

I:347, Xochitl Cormon, Camilla Sguotti, Liam Lachs, Christian Möllman. How does scientific research support management of marine social-ecological systems prone to tipping points? A systematic review.

I:356, Renato Rosa, Tiago Costa, Rui Mota. Integrating economics and critical depensation in the design of fisheries policies, an application to the Ibero-Atlantic sardine stock.

I:390, Karoline Schacht, Rudi Voss, Christian Möllmann. Tipping Points in the Western Baltic Fishery 1875-1960.

I:435, Leonie Färber, Cecilia Helmerson, Esther Schuch, Camilla Sguotti, Joël M. Durant, Christian Möllmann, Andries Richter. When “good enough” is optimal: defining the safe operating space of a fishery on the brink of collapse.

I:630, Eske Evers, Olga Mironenko, Oliver Lehmann, Jörn Schmidt, Karoline Schacht, Rudi Voss. The art of communication is the language of leadership.

I:644, Mary Hunsicker, Michael Litzow, Sean Anderson, Jin Gao, Chris Harvey, Sam McClatchie, Eric Ward and Stephani Zador. Developing indices for early detection of abrupt change in northeast Pacific Ocean ecosystems.