ICES/PICES Theme Session B
Responses of living marine resources to climate change and variability: learning from the past and projecting the future

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Session B of the 2013 ICES ASC was fortunate to host a large number of high quality scientific presentations that comprised 30 posters and 48 talks. The session spanned three days. The main goal of this session was to bring together various forms of research, which explores the associations between climate and living marine resources. The schedule of talks was organized by theme or region and a fifteen-minute discussion panel followed each set of talks allowing extra interaction among the speakers, conveners, and audience. The session included a wide range of research covering multiple regions within the Atlantic, Pacific, and Arctic basins. Some of the local regions where multiple studies took place were the U.S. Northeast Shelf, Barents Sea, North Sea, and Baltic Sea. Studies included contemporary observations and future projections under various climate change scenarios using both empirical data and models. While much of the research focused on changes in the abundance and/or distribution of commercially important fishes, some studies investigated climate-driven changes in key processes affecting larval stages, predator-prey interactions, and food web dynamics including primary and secondary producers. Other topics included ocean acidification and the interaction between fishing and climate.

A variety of approaches were used to examine the impacts of climate on living marine resources. Methods ranged from statistical models of historical distribution to more complex, physiology-based models that consider the bioenergetics of feeding and growth. Whereas some studies used fisheries (catch) data to assess impacts, others used fisheries-independent (survey) data. Projections of the response of living marine resources to climate change were based on global climate and/or Earth system models that are assessed by the Intergovernmental Panel on Climate Change (IPCC). Studies focused on climate impacts assessment ranged from global to regional biodiversity patterns to projecting the implications for fisheries and conservation planning.

Species shifts in distribution and depth associated with the warming of ocean waters were reported in a variety of studies. Typically, but not always, commercial fish species shifted poleward with warming ocean temperatures, or followed local climate velocities. Temperature and the associated oceanographic changes are generally identified as the main drivers, although the mechanisms associated with the reported shifts were not always examined or couldn't be discerned due to insufficient data. In some cases, unexpected patterns of changes in fish distribution were reported such that warm- or cold-water adapted species showed no range shift or an equatorward shift with warming. One such region was the North Sea, an area which has warmed at nearly four times the global average rate over the past four decades but where a substantial number of commercial species have not moved poleward as expected.

Major issues that were consistently discussed in the talks, posters, and panels were the uncertainties in the mechanisms driving shifts in the distribution and abundance

as well as the constraints that species face when entering into new waters. Disentangling the effects of fishing from those of climate is still very challenging, even with the increasing availability of long time-series (~100 years). Another uncertainty, specifically for groundfish inhabiting shelf seas, is the availability of essential bottom habitat allowing expansion or shifts into new waters. Many presentations showed predator and prey species shifting in synchrony with temperature change and it was unclear if predator species were simply following their resources or whether the shift was a response of the predator to avoid physiological decrements associated with sub-optimally warm waters. Other challenges include understanding and projecting effects from multiple stressors, including warming, hypoxia, and ocean acidification. Finally, attributing the observed responses of living marine resources to anthropogenic climate change versus natural climate variability is extremely challenging and might only be disentangled via longer time-series, more detailed data collection and, ultimately, by gaining a much clearer understanding of how species inhabiting specific marine systems have responded to climate variability in the past.

Based on the high number of presentations within this session, it is clear that exploring climate impacts on living marine resources is a major research component of the ICES/PICES community. However, it is also clear that continued, more empirical research is needed to reduce the uncertainties associated with the mechanistic underpinnings driving the response of individual commercial fish populations to both natural climate variability and anthropogenic climate change. Accomplishing this will be a daunting task given the high complexity of marine food webs, impacts of fishing, and high levels of natural climate variability in many marine ecosystems. However, as more regional studies begin to surface, which include a higher diversity of commercial species, and comparisons across ecosystems and across methods within an ecosystem, a more thorough, mechanistic understanding can be gained which will reduce the uncertainty in the projected response of living marine resources to climate change. Reducing or quantifying this uncertainty will be crucial for fisheries management bodies that need to consider the impacts of climate on marine ecosystems and commercial fish stocks.

The conveners of this session encourage authors within this ICES-PICES theme session B and scientists who attended the ICES-PICES workshop in May of 2013 to submit manuscripts to a special issue of the ICES Journal of Marine Science.