Theme Session S – Responses to climate variability: comparison of northern hemisphere marine ecosystems

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The number of participants at the Joint ICES/PICES Theme Session changed between 70 to 120, reflecting the large interest in the respective theme. The total number of oral presentations was 18. Two 15 min. periods of extra discussion were included in the session to allow for comparing results from different papers. 10 presentations focussed on the Atlantic, 5 on the Pacific and 3 were direct comparisons of both oceans. The success of this theme session demonstrates the value of this kind of joint ICES/PICES initiatives.

Atlantic

The previously reported seesaw relationship of air and sea temperatures between the Labrador Sea and the Norwegian/Barents Sea regions from the 1950s to the mid-1990s was confirmed by **Drinkwater *et al.*** (S:03). However, temperatures on both sides of the Atlantic are now in phase since the mid-1990s, due to a spatial shift of atmospheric pressure patterns and a weakening of the NAO, clearly indicated by strong warming and reduced ice cover in both regions with concomitant ecosystem consequences.

Getzlaff *and al.* (S:01) studied the impact of the four winter climate regimes in SLP over the North Atlantic, which had been identified by Hurrel and Deser (2009) from cluster analysis, on the Baltic Sea for the period from 1948-2008. The different atmospheric regimes determine the circulation patterns in the Baltic Sea through their impacts on direction and strength of prevailing winds and thus influence ecosystem structure and processes.

Sherman *et al.* (S:15) showed that reactions of Large Marine Ecosystems bordering the North Atlantic rim were different between the eastern and western side. The higher warming rates in the NE Atlantic seem to influence particularly higher trophic levels, whereas nutrient over enrichment in relation to harmful algal blooms and hypoxic conditions are more important in the NW Atlantic.

Johannesen *et al.* (S:10) compared the impact of climate variation and fishing on the Eastern Scotian shelf and the Barents Sea with a particular view to cod stock dynamics. In the early 1990s, climatically induced warm water penetration has led to a strong increase of the cod stock in the Barents Sea, whereas demersal fish collapsed through high fishing pressure and cold water in the Eastern Scotian shelf, leading to a trophic cascade favouring forage fish and affecting lower trophic levels.

The Gulf of Maine experienced a pronounced shift in salinity, primary and secondary production which led to significant changes in herring and tuna condition (**Golet *et al.***, S:20).

Alheit and Wagner (S:12) showed that the Atlantic Multidecadal Oscillation (AMO) has driven multidecadal dynamics of many NE Atlantic small pelagic fish populations of herring, sardine and anchovy since at least early last century through lasting

warm and cold periods, as demonstrated by examples from Moroccan waters in the south to Norwegian waters in the North.

After about 40 years of absence, anchovies and sardines have re-invaded the North Sea and adjacent waters such as the Irish and Baltic seas and established there again spawning populations (**Alheit *et al.***, S:14). Whereas sardine arrived in larger quantities around 1990, very likely in response to warmer winter temperatures associated with the pronounced increase of the NAO index, anchovy followed only in the mid-1990s. Anchovy was probably driven into the North Sea because of warmer summer temperatures due to the sudden increase of the AMO or the northeast shift of the NAO pressure centers or the contraction of the North Atlantic sub-polar gyre or a combination of them.

Based on a long-term time series which was started at 1919, **Johannessen** (S:19) showed that gadoid fish suffered repeated abrupt and persistent recruitment collapses which seem to have been caused by gradually increasing nutrient loads. These resulted in abrupt changes in the plankton community with negative consequences for 0-group gadoids. Global warming might increase these abrupt changes and enhance recruitment collapse.

Otero *et al.* (S:13) demonstrated that contemporary ocean warming and freshwater conditions contribute to delay the completion of maturation of Atlantic salmon, among possible reasons being changed composition of marine zooplankton communities and increased precipitation and number of springtime flooding events.

Pacific

According to **Bulatov and Klyashthorin** (S:02), long-term trends in climate indices such as PDO, ALPI, NPI, Arctic temperature anomalies and Total Solar Irradiance exhibited synchronous dynamics over the last 100 years with 60-65 years cycles and with peaks in the decades of the 1940s and 2000s and a low around the 1960s/1970s. Over the last 30 years, walleye pollock biomass has shown very similar dynamics. Based on these relationships, walleye pollock biomass is projected to decline up to 2020-30.

The adjacent eastern Bering Sea (EBS) and the Gulf of Alska (GoA) ecosystems are inhabited by similar species communities and affected by similar anthropogenic and large scale forcing. **Hunsicker *et al.*** (S:06) evaluated, how environmental and demographic factors influence the variability in spatial overlap of arrow tooth flounder and pollock, for a better understanding of their predation interactions.

Hollowed *et al.* (S:20) compared the impact of climate driven shifts in ocean conditions on forage fish (young walleye pollock and capelin) in the GoA and the EBS. Hydrography and bathymetry are important for the distribution of these forage fish and frontal systems and predator avoidance plays a major role.

Interannual variability in Northern California Current food web structure was studied by **Ruzicka *et al.*** (S:08) using different models, whereby the relative importance of alternate energy pathways at intermediate trophic levels (small pelagic fish, euphausiids, jellyfish) for the efficiency of the system and the productivity of the top trophic groups was particularly considered. Euphausiids seem to more important in the energy transfer to top trophic level production than small pelgic fishes.

Tian and Kidokoro (S:05) show that there was no regime shift in the Tsushima Warm Current region in the Japan Sea in the mid-1970s, as reported for the central and eastern North Pacific. Instead, abrupt changes were observed in the early 1970s with

cold-water fish species such as sardines and walleye pollock increasing and warm-water species such as anchovy and horse mackerel decreasing.

Comparison Atlantic - Pacific

Bi *et al.* (S:07) compared the influence of climate variability by AMO and PDO on zooplankton communities from the east and the west coast of the USA and demonstrated that

The decadal-scale PDO affected west coast communities, but the multi-decadal AMO did not cause consistent responses in east coast zooplankton over the period of observation from 1978-2008.

Durant *et al.* (S:09) studied the ecological consequences of fisheries effects on population properties, such as intrinsic growth rate, in relation to fishing intensity and climate, using data from Barents Sea cod, European hake (three stocks) and Bering Sea pollock. The different stocks exhibited different reactions, whereby three stocks showed evidence of a truncated age structure, which was caused by fishing pressure, influencing population persistence.