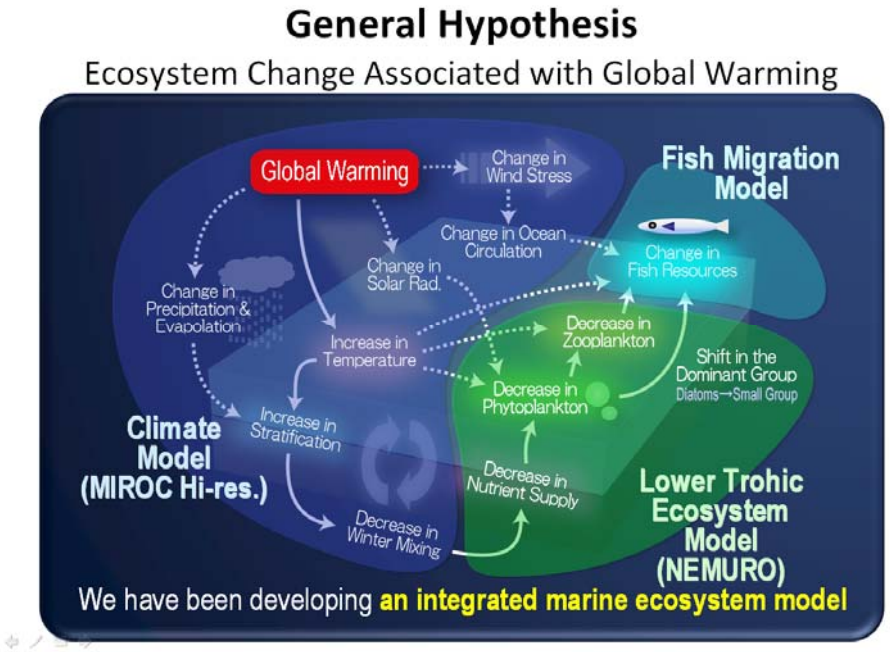
Theme Session Q
Evidence of global warming effects on zooplankton populations and communities, including larvae of benthic invertebrates and fish

Conveners: Wulf Greve (Germany), Steve Hay (UK), and Peter H. Wiebe (USA)

To a large extent our current assessments of the ecosystem effects of climate change have been most effectively demonstrated by reference to the observed spatial and temporal changes in abundance, distribution, and phenology of plankton communities and key species. Some ecosystem regime shifts and links with fisheries harvests, recruitment etc. have been demonstrated over a range of scales, from the basin scale in the Atlantic and Pacific oceans down to different responses noted for different regions of the North Sea. But more remain to be discovered and described. Understanding the effects of such changes across the continuum of marine habitats demands a coming together of observations, ideas, and research efforts.

Theme session Q was designed to bring together zooplankton specialists studying 1) the variability in spatial distribution, productivity, and timing of life cycles, 2) the population dynamics in varied species and environments, 3) the rates and functional relationships of species, and 4) the modelling of these processes.

The session attracted a total of 22 contributions with 14 presented as talks and eight presented as posters. Unfortunately, the last two presentations (Q:15, Q:16) in the oral session were not given. One was cancelled a few days before the meeting start as a result of a lack of travel funds for the participant and the other because the individual, while pre-registered, failed to make it to the meeting.



CM 2008/Q:08. Simulation of the impact of climate change on migration pattern and growth of Japanese sardine. Takeshi Okunishi, Taketo Hashioka, Hiroshi Sumata, Shin-ichi Ito, and Yasuhiro Yamanaka

Some highlights of the presentations include:

1) Several papers examined the response of larval fish to changes in zooplankton food composition in response to climate change. Such changes were observed in the Baltic Sea (Q:01), in the North Sea (Q:12), and Gulf of St Lawrence (Q:02). In the latter paper, a case was made that study provided the first field-based evidence linking climate and in situ plankton prey to early feeding and growth, and eventually year class strength in a commercially exploited marine fish (mackerel). All three of these papers found evidence that successful recruitment was dependent upon have the "right" zooplankton prey species available at critical times. In addition, another paper (Q:13) showed evidence of dramatic fluctuations in indices of abundance, larval mortality, and spawning period for the Atlantic herring in a long time-series on the Northwestern Atlantic shelf. These changes have not yet been linked to variations in food availability or other environmental factors.

2) State of the art coupled physical / biological models were used to study the Japanese sardine in Western Pacific waters east of Japan (Q:08). The results indicate that climate change (warming) will cause significant changes in the spawning sites, migration patterns, and ultimately their distribution. This effect is already taking place in fish populations in the Indian ocean (Q:18). A note of caution was introduced(Q:03) in the approach used to characterize zooplankton ingestion rate change as a function of prey density because some currently used formulations can lead to dramatically different and unstable results. How this functional response is modeled is pivotal for ecosystems dynamics studies.

3) Timing of the spring bloom and temperature were linked to the success or failure of recruitment of the shrimp *Pandalus borealis* in the Gulf of Maine (Q:14) and of the copepod *Calanus finmarchicus* in the Labrador Sea (Q5) with warmer temperatures and earlier spring blooms giving rise to more successful recruitment.

4) Oceanic forcing has been correlated with substantial changes in zooplankton species assemblages or abundance of species off the coast of Ireland (Q:20), along the Scotian Shelf (Q:21), and around Iceland (Q:04). In none of the cases was a unidirectional temporal trend detected.

5) A very interesting paper (Q:06) provided very important insight into the impact of increasing CO2 in the worlds oceans on all forms of marine animals from microzooplankton to whales that is independent of ocean acidification per se. Experiments have demonstrated that increased CO2 can significantly reduce the respiration capacity of the animals. The impact of this effect will first be evident in mid-water regions of the open ocean where low oxygen concentrations exist and in coastal suboxic and anoxic regions. The areas affected will expand as the CO2 levels increase throughout the ocean water columns. This is clearly an important research area for the future.

The session was well attended with between 50 to 150 individuals present for the talks.