Theme session S

Basin scale dynamics at lower trophic levels in the North Atlantic

Conveners: Astthor Gislason (Iceland), Claudia Castellani (UK), and Peter Wiebe (USA)

The session was proposed by the WGZE recognizing that the shelf and oceanic ecosystems of the North Atlantic are influenced at basin scale by a common atmospheric forcing. The session therefore encouraged people to present findings from a large area preferable with a comparative view from both sides of the North Atlantic. More specifically, the purpose of the session was to provide a forum for presentations on:

1) The role of key species in the biological carbon pump.
2) Distribution of key species and ecosystem types.
3) Trophic pathways and production.
4) The dynamics of living resources and their utilization.
5) Modelling efforts that integrate the biological and physical characteristics of the region.

The Euro-Basin project (2011–2014) funded by the EU, is an example of a research project that was designed to further our understanding of past, present, and future ecosystem dynamics of the North Atlantic and associated shelf seas on a basin scale. Several contributions derived from that project, however a number of the talks were not related to this project, but had a pan-Atlantic or basin wide scope.

The session attracted 26 high quality research contributions from11 countries of which 18 were presented orally and 8 as posters. The presentations may be grouped broadly into presentations on dynamics of lower trophic levels and living marine resources, both with modelling components. The following discussion provides an overview of the session based on this division.

Lower trophic levels dynamics

One presentation (S:05) focused on the basin-scale patterns of micro zooplankton feeding in the Atlantic Ocean and found substantial differences in their feeding on bacteria and phytoplankton in the different biogeochemical regimes. An overview of the comparative hydrography of the Norwegian, Iceland, Irminger, and Labrador Seas was presented by a poster (S:21). There were several presentations that examined the dynamics of key zooplankton species in North Atlantic waters. Calanus species were the focus of three talks and one poster. In time-series of plankton samples north of the Faroe Islands, in 2003 there was a substantial shift in the timing of spring reproduction with the early life stages of *C. finmarchicus* appearing earlier in the year and *C. hyperboreus* disappearing from the sample area (S:18). In the Iceland Basin during spring bloom there was a build-up of marine snow particles of diverse origin and a flux that may have caused the wake-up of *C. finmarchicus* from diapause (S:16). The reported decline of biomass of *C. finmarchicus* in the Norwegian Sea over the past decade was simulated in a coupled physical/biological model (S:14). The results indicated that summer Calanus biomass varied by a factor of three and was largely controlled by bottom up processes. The vertical distribution of the three Calanus species (hyperboreus, glacialis, and finmarchicus) and lipid content was described for

a Franz Josef Land sampling site (S:25). Two species of euphausiids (*Meganyctiphanes norvegica* and *Thysanoessa inermis*) were found to be very important contributors to the total ecosystem biomass in waters around Iceland (S:19).

Marine plankton community structure was the focus of five presentations and three posters. One focused on the structure of plankton in the Kara Sea during summer (S:01). Two talks and one poster presented results from a Euro-Basin cruise that sampled the Norwegian, Iceland, Irminger, and Labrador Seas (S:03, S:11, S:22). These four Arctic boreal basins had significant differences in taxonomic composition and the intensity of Diel Vertical Migration. On another Euro-basin cruise, the trophic position of meso zooplankton in the Labrador, Irminger, and Iceland basins were compared using stable isotopes and a size spectrum analysis (S:10) with significant differences observed between basins and between methods. A similar approach using size spectra was applied to samples collected along the Portuguese coastline and showed that while there was similarity in the size spectra, the composition of the taxa contributing to the spectra differed among the locations (S:29).

Climate effects on zooplankton were analysed using simulation models or a combination of field and model studies in three presentations. A long term dataset from the Barents Sea coupled with a particle tracking model was used to examine the variation of summer zooplankton biomass and showed that bottom–up effects of food availability on zooplankton persist from spring to summer in this region (S:07). Past and future changes in key copepod species in the Northwest Atlantic Canadian waters were presented using Atlantic Zone Monitoring Program data and a habitat model (S:13); climate change is projected to have both positive and negative effects on distribution and abundance depending upon the species habitat preferences. A more generalized ecosystem simulation of climate effects on the biogeography of the North Atlantic lower trophic levels showed that by the end of the 21st century, there would be a decrease in primary and secondary production throughout the region, a decrease in carbon export, and a northward shift of all biogeographic regimes (S:17).

Living marine resources

There were ten presentations related to living marine resources. Trophic interactions of mackerel and herring around Iceland were studied by stable isotope analysis coupled with traditional analysis of stomach content data (S:26). The results showed that the main zooplankton prey of both herring and mackerel are copepods (primarily *C. finmarchicus*), euphausiids, pteropods, amphipods, and appendicularians, while the diet of mackerel also includes fish prey such as larval sandeel, herring, and capelin. The idea of 'predator–prey synergism, defined as predator–prey relationships enhancing abundance of both predators and prey, was presented by a poster (S:24). In the North Sea, estimates of long term changes in productivity were used in an Ecopath/Ecosim model to explore the affect of fishing pressure and primary production on a planktivorous fish species (S:27). A study of early fish life history controlling factors and the mismatch between spawning and first-feeding in cod-fish larvae revealed that there was a significant relationship between mean first-feeder timing and mean copepod naupliar timing across the North Atlantic (S:06). A meta-analysis of the functional responses of North Atlantic fish eggs to increasing temperature showed that egg development times as a function of temperature had similar slopes, but quite different intercepts (S:15). A study of environmental conditions and zooplankton dynamics on the body size and recruitment of Atlantic herring stocks in the Gulf of St Lawrence, showed that there was a small influence of fishing and a large bottom–up effect driven variations in zooplankton dynamics (S:28).

Pelagic fish distribution/shifts were the focus of several presentations. The nature of dramatic distributional shifts of three pelagic species (mackerel, herring, blue whiting) in recent years whether normal or new was explored using environmental niche modelling (S:02). For blue whiting, there seemed to be density-dependent effects resulting in both summer distributional shifts and spawning site shifts. The environmental determinates of blue whiting spawning distribution was explored using the long Continuous Plankton Recorder time-series (S:12). Evidence was presented that the expansion and contraction of the Subpolar Gyre was a strong driver where blue whiting spawn. A third presentation based on a three area model suggested that blue whiting may be composed of more than one stock and this may have implications because the fish is now managed as a single-stock (S:04).

Meta-analysis of crustaceans stocks in European and Mediterranean waters showed that most stocks are fully exploited, but stable (S:08). A reduction in fishing pressure was recommended, but difficult to accomplish in the Mediterranean because of the nature of the mixed fishing effort.

The session was well attended with between 40 to 80 individuals present for the talks.

Countries of Contributors:

Canada, Denmark, Faroes, Germany, Iceland, Norway, Portugal, Russia, Spain, UK, USA

Best presentation of the session by an early career scientist

We nominated Klas O. Möller for the best presentation of the session by an early career scientist. His talk was on "Small-scale distribution of plankton and marine snow in the North Atlantic". The presentation was clear, the flow of information was logical and the subject was novel. Using advanced imaging instrumentation, he highlighted the importance of marine snow in marine ecosystems and was able to differentiate types of marine snow originating in diatoms, Phaeocystis, krill, and others. He was able to show that two species of copepods (Oncaea and Microsetella) occurred in close association with particular kinds of snow particles. He presented a new and important hypothesis that the flux of marine snow particles during spring bloom into the mesopelagic depth zone may stimulate the "wake-up" of diapausing *Calanus finmarchicus*.

CM code: S:16 Oral

Title: Small-scale distribution of plankton and marine snow in the North Atlantic

Authors: Klas O. Möller, M. St John, B. Christiansen, and C. Möllmann

Keywords: marine snow, zooplankton, North Atlantic, Video Plankton Recorder (VPR), *Calanus finmarchicus*.

This presentation was selected among nominations from all sessions and the author presented the ICES Early Career Scientist Award.