Theme Session G – Linking oceanographic physical features with biological production and fish habitat potentials

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Oceanographic physical features are known to structure the marine environment. Modelling physical-biological interactions has made sufficient progress that the linkages are better understood and their consequences at larger scales can be understood. This theme session reviewed the state of the art and examined future directions in linking biological processes to physical features through mechanistic, stochastic and behavioural processes.

The theme session was divided into three broad categories (or sub-sessions): 1) Distribution, aggregation, and behaviour; 2) Models; 3) Larval transport, growth and lower trophic levels. There were open discussions after each sub-session. The theme session was very successful with 28 papers and the audience ranged from 70 to 100 people.

The talks were very diverse. The organisms ranged in size from plankton to whales, the techniques used included laboratory studies, numerical modelling and field work, and the methods range from traditional species identification to genetic methods. Several themes that emerged during the session are discussed in this session summary.

The primary role of physical variables in structuring the Baltic ecosystem was demonstrated by three papers showing how the vertical structure of temperature, salinity and oxygen control the vertical distribution of zooplankton, sprat and cod. As a result the physical environment plays an important role in structuring the trophic interactions.

The increasing sophistication and maturity of 3 d ecosystem models was displayed in four modelling studies of the North Sea. Three studies demonstrated the ability to integrate the system from nutrients to larval fish (sprat and cod). This is an important step towards investigating the influence of interannual variability in food supply on fish recruitment. The fourth study showed that demonstrating relationships between atmospheric forcing and the lower trophic levels requires explicit consideration of space and time as the different areas of the North Sea have different responses to the atmospheric and oceanic forcing.

The use of new technology in field studies was illustrated by the use of acoustic tags to track fish and whales to show how movements and distributions are related to the physical characteristics of the environment and by the use of genetic studies to demonstrate that oceanic fronts can limit gene flow among fish populations.

Laboratory studies showed that turbidity and patchiness, which are not generally accounted for in 3 d ecosystem models, can have a substantial impact on an organisms ability to find food.

One of the goals of linking physical oceanographic features with biological production and fish habitat is to develop quantifiable relationships that can be used to create predictive habitat maps. Several studies attempted to find explicit relationships between the physical environment (e.g. depth, water temperature, bottom type) and fish distributions. The efforts lead to mixed results. In general studies are more successful at finding powerful predictive relationships if they cover a small area and obtain high resolution data on the environment and the species of interest. The talk by Meri Härmä won the ICES award for “Best Presentation by a Newcomer.”

Important relationships between the physical environment and species distributions were also found using traditional techniques. Papers showed the importance of internal waves over offshore banks to euphausiids, birds and whales; equatorial Kelvin waves to sardinellas; estuarine dynamics to striped bass; flow patterns around the Falkland Islands to spawning red cod; wind, temperature and bottom type to small fish in the near shore; temperature and circulation to juvenile plaice; and Portuguese dogfish to bottom type.

The papers in this session support the following general ideas:

- The comprehensive 3 d models are starting to deliver on the promise to integrate the ecosystem from nutrients through to larval fish.
- Linkage between biology and physics were best identified at relative small scale. Inter-annual variations may contain processes involving larger scales. Behaviour and animal movement were identified as key for building the capacity to pass from small scale to larger scale.
- The field of predictive habitat mapping based on physical variables is just beginning. In general high resolution physical data is required for both building the models and doing the mapping and high resolution biological data is required for building and testing the predictive models (or relationships).

Laboratory and field studies that provide qualitative information on relationships between the physical environment and biological production and habitat are an important first step towards finding quantitative relationships that can be used in predictive models.