Theme Session I

Monitoring requirements, observation technologies and methods (e.g. acoustics) for pelagic organisms at local and basin scales for input into ecosystem based fisheries management assessments

Conveners: Olav Rune Godø (Norway), Verena Trenkel (France), and Martin Dorn (USA)

This theme session was proposed by the ICES working group Working Group on Fisheries Acoustics Science and Technology (WGFAST). Its objective was to provide an update of current developments with regard to monitoring methods and tools for pelagic organisms in the context of the ecosystem approach to fisheries management. Information demands increase substantially under EAF. Modelling and use of indicators will be necessary for integrating complex observational data within the assessment process and may also be essential for identifying data needs and sampling priorities, defining survey strategies, and addressing cost effectiveness issues. The potential for acoustic data to provide both quantitative and qualitative indicators over a range of trophic levels and spatial and temporal scales has made it an attractive tool. Integrated monitoring studies based on acoustics can also provide new insights into ecosystem function that assist in the parameterisation of ecosystem models. In particular this session was focused on the monitoring requirements for trophic groups such as zooplankton, micronekton and fish with the use of existing and new tools such as multi-beam sonars/ echosounders and both conventional and unconventional platforms (e.g. vessels, buoys, moorings, gliders and AUVs). The session attracted an audience of around 30 people on average and was organized into three subsessions. Overall 20 oral presentations and six posters were presented. In the introductory presentation, convener Olav Rune Godø stressed the need for understanding functional relationships and ecosystem dynamics, which requires appropriate data collection and survey strategies (e.g. study of fine-scale temporal variations). He also pointed out that many data collection tools exist but need to be combined to make progress.

The sub-session on "Monitoring requirements and case studies" had 5 oral presentations and 4 posters. The papers in this session focused primarily on monitoring tools rather than requirements for ecosystem based management, with one exception. Two papers tackled the issue of using basin wide survey data (I:11) from multiple sensors, or data from a continuous monitoring station (I:21) in ecosystem models. In the first paper, the data was used to parameterize an existing model (Atlantis) and then used for identifying key functional groups for a monitoring program, while the second paper took the opposite approach and showed the development of a model for explaining the observations. The design of a autonomous monitoring stations was presented by two papers (I:21 & I:19). The second paper focused on how to produce a cheap buoy system for the open sea for deployment of a network of monitoring stations. Further technological developments for monitoring under sea ice were presented (I:14). The authors derived abundance information on phytoplankton and zooplankton from data collected with ADCPs. They developed an innovative autonomous survey station

that allowed carrying out depth profiles under the sea ice on a regular basis over an annual time period. All authors presenting data from autonomous stations collecting visual or acoustic data stressed the need for ground-truthing to confirm species identification. Finally, an observation system for monitoring shallow lagoons (I:30) and large lakes (I:23) was presented.

In the sub-session, "Enhanced use of existing technologies", there were 11 presentations. The papers dealt with various ways of collecting acoustic and biological information, and included sampling and survey strategies as important considerations. Fish behaviour caused by the observation vessel (I:03), by incident angle in relation to the acoustic beam (I:08), or simply the natural behaviour of the target species (I:16) are examples of how acoustic surveys can be improved and/or how the technique can be introduced to new fields and species. Behavioural aspects will probably become even more important when studying ecosystems, as they affect relationships between species in addition to the overall performance of the survey. Only one paper dealt with species recognition, mackerel recognition algorithm using multiple frequencies (I:09), although this is a key subject for enhancing understanding of ecosystems and monitoring of their status. Two papers discussed sampling issues for converting acoustic densities to biomass (I:05, I:13). Important lessons were that survey efficiency may be enhanced by a critical examination of current practice, and that accounting for selectivity in demersal trawl catches may improve acoustic survey results. The use of alternative platforms is considered an important factor for enabling collection of adequate data in time and space. Here there were two presentations using data from fishing vessels. One demonstrated the collection of acoustic data over time/season that normally are not accessible from standard survey programs (I:04), and the other showed how VMS data from fleet activities can be modelled and provide a basis for estimating fishing effort (I:15). Only one paper dealt with acoustic TS (I:01), in this case salps, and demonstrated a TS similar to krill, which presents a problem for species separation during krill abundance surveys. Survey effort is limited and financial limitations impede development of new effort dedicated to ecosystem monitoring. Two papers demonstrated how current survey strategies can be evaluated to free effort for ecosystem studies (I:10, I:20).

The sub-session on new technologies consisted of 5 contributions (3 papers and 2 posters) on technological developments with potential to expand the information collected on marine ecosystems. An innovative alternative to conventional tows and hand sorting of plankton was presented in a series of papers about an optical system for plankton sampling (I:12), software for automated analysis of plankton images (I:17), and a data storage system for plankton images (I:27). Continuous plankton collection systems are able to resolve fine-scale distribution patterns along oceanographic features such as fronts and eddies, which are areas of high productivity and strong biological interaction. The challenge of another difficult sampling environment, that of shallow water and smaller research vessels, was addressed with a new design for a compact cassette plankton sampler (I:29). Multi-beam echosounders have the potential to greatly expand the sampling volume of acoustic systems, however quantitative analysis of multi-beam data must deal with complexities of two-dimensional acoustic images that can be ignored in single-beam systems. A paper compared multi-beam biomass estimates with single beam estimates, both with simulated data and *in situ* data (I18), a necessary step for validating the new technology. A simpler approach

was developed for estimating krill density using distance sampling methods, which depend on strong distributional assumptions (I:22).

Although the individual papers are fragments with respect to the overall goal of the session, they all identify and give insight to new or improved ways to enhance an ecosystem based fisheries monitoring. The breadth of the contributions provided opportunities for many lively discussions.

In the final discussion it emerged that currently there are gaps in large scale monitoring tools and methods, in particular for phytoplankton, in addition to the information provided on the survey layers by satellites. Though not treated in this session, the benthos should also be noted as the area for which cheap, rapid, large scale monitoring tools are still missing. Models were suggested as the way forward to go from local information to global estimates and projections. The gap between the spatio-temporal scale of data and existing large scale models needs to be filled by dedicated intermediate scale models that focus on ecological processses. This requires strong liaison between scientists involved in data collection and those developing models. In order not to disperse forces it is essential to identify key areas for large scale deployment of autonomous monitoring stations, and to have a coordinated international approach.

The final recommendations of this session are:

- Improve communication between technology developers, survey scientists and ecosystem modelers and continue model development at appropriate spatial and temporal scales with optimal utilization of available technologies and knowledge.
- Develop analytical tools to evaluate present and new approaches in allocation of survey resources, taking account of multiple objectives (abundance indices, functional understanding, species interaction etc.).
- Develop a conceptual model for an array of acoustic moorings for continuous monitoring of the pelagic environment, and coordinate an international joint effort for production and deployment the moorings.
- Enhance the use of advanced acoustic and optic technologies as tools for validation and parameterization of ecosystem models.