Theme Session M
How Much Habitat is Enough? Evaluating habitats in terms of their ecosystem function, goods, and services.

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Many of the laws and regulations involving management of living marine resources include requirements to protect or conserve habitat. Ideally, decisions on habitat management should be supported by quantitative assessments using measurable biological benchmarks based on an understanding of how the status of living marine resource(s) varies with the amount and condition of available habitat. Significant amounts of data on the associations of habitat and species life-history stages have been collected and occasionally synthesized as maps. Nonetheless, huge gaps still remain in the inventory of habitats and in our knowledge of the functional relationships between habitats and their associated ecological services. The process for filling these gaps with empirical data will be slow and costly. Hence, it will be necessary to make habitat management decisions using ecological modeling approaches based on best available, but often very meager, sets of data, and best practices in the analytical methods.

There were three main foci in the request for papers: 1) inventory and characterization of habitats and the role of habitats in the ecosystem; 2) valuation of habitats in a socio-economic context, including market values of harvested resources as well as the sustainability of habitat services; and 3) habitat mapping and modeling.

Fifteen papers were presented in the session. Most of the papers consisted of a combination of focus areas 1 and 3 by presenting the results of field studies of species associations with habitat, which were analyzed statistically and through mapping. Only one paper addressed focus area 2 by extending the results of field studies through analysis of economic data. In addition, two papers covered aspects of governance.

The papers addressing focus areas 1 and 3 presented a diversity of field and analytical approaches. Several utilized existing long-term surveys to examine relationships between distribution and/or abundance of particular species or species groups and habitat characteristics, primarily physical factors such as depth, temperature, salinity, and bottom type. Other papers involved specialized studies designed to address more specific research questions. In general, some statistically significant relationships were detected, enabling development of predictive models and production of digital habitat maps using geographic information systems. The statistical significance of the associations, and thus the predictive power of the models derived from the statistical relationships, varied among the studies.

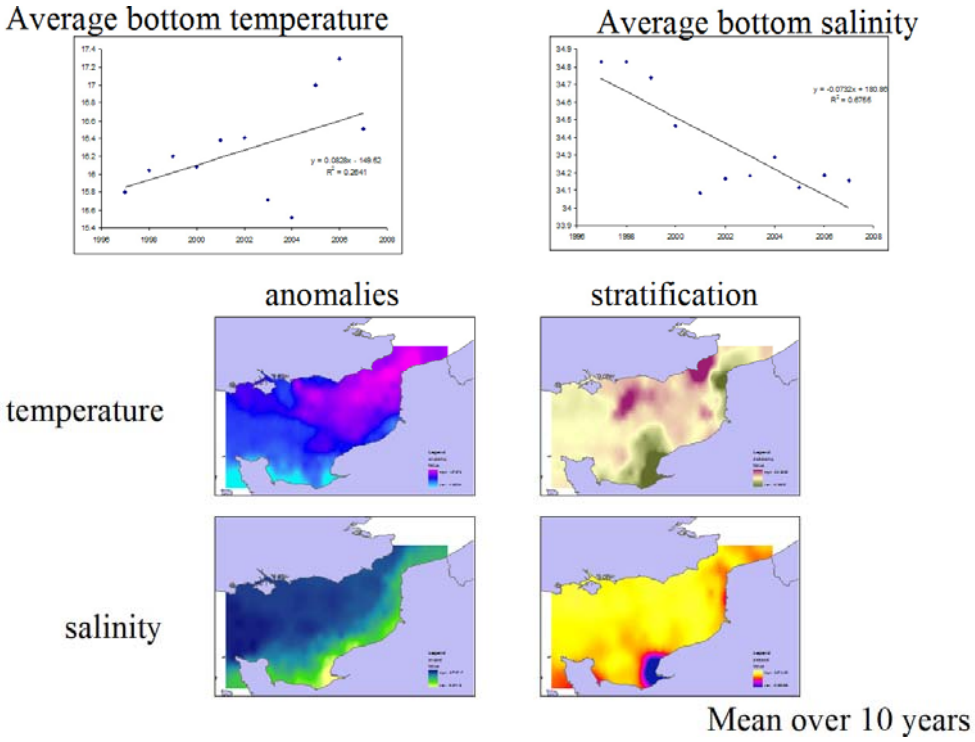

Figure 3 Changing environment characteristics: Trends in Mean annual bottom temperature (top left) and salinity (top right), spatial patterns of anomalies and stratification of temperature and salinity (bottom) ICES CM 2008/M:02 Modelling Fish Community Habitat in the Eastern English Channel: Tentative prediction of habitat distribution change under different climatic variation scenarios. Irene Mantzouni and Brian R. MacKenzie

From these results, it appears that field studies, especially broad-scale surveys targeting many species over a large area, may not provide data that can support detailed characterization of the habitats utilized by marine species. Several factors may be contributing to this lack of detail. Some of these may be inherent in the study designs, such as the reliance on trawl surveys that cover more than one habitat type within a single tow. Broad-scale surveys may not collect data on important factors that define habitat for individual species, such as food availability or the presence of predators or competitors. Also, analyzing habitat relationships using data from these surveys may not account for density-dependent factors that affect habitat utilization. Moreover, the lack of concurrent data on habitat characteristics caused some of the studies to incorporate information from other, often older, studies (e.g., maps of bottom type), which may not been designed to provide information on the relevant variables and scales, and which may not have accurately represented current conditions.

Another factor that may be influencing the abilities of researchers to develop highly detailed assessments of species-habitat relationships is that these relationships may actually not be very strong. Some species simply may utilize a broad range of habitats. This may be particularly true of the life stages typically sampled in broad-scale surveys, which tend to focus on the adult life stages that are targeted by commercial fisheries.

Three notable studies developed approaches that focused more specifically on narrowly defined research objectives. Embling *et al.* (M:16) conducted surveys designed to determine the relationships among topography, tides, and time of day on the distribution and behavior of a prey species (sandeels) and a predator (kittiwakes) in the North Sea. Baker *et al.* (M:11) developed a life stage-specific population model of white shrimp in the Gulf of Mexico, showing that the vital rates of life-table parameters, particularly mortality, have profoundly different effects on productivity. Preliminary results are that even relatively small changes in

Table 1: Summary of white shrimp, Litopenaeus setiferus, life stages and demographic rates. ICES CM 2008/M:11 Assessing the link between coastal wetlands and white shrimp fishery production in the northern Gulf of Mexico

		duration	growth rate				
stage	**TL (mm)**	**(days)**	**(mm/d)**	**daily Z**	**stage Z**	**survivorship**	**fecundity**
egg/larvae	<6	16	-	-0.3918	-6.2686	0.0019	0
PL	Jun-27	30	0.75	-0.1169	-3.507	0.03	0
marsh	28-70	52	0.82	-0.0366	-1.9032	0.1491	0
bay	71-100	33	0.91	-0.0275	-0.9075	0.4035	0
adult	>100	234*	1	-0.0384	-8.9856	0.0001	500000
*adult stage duration = remainder of 365 days							

access to vegetated marsh habitat utilized by early life stages can have larger impacts on shrimp stocks than would changes in adult fishing mortality. Minello *et al.* (M:01) used this information on shrimp vital rates to estimate the economic value of marsh habitats, including restored marshes, based on the contributions of these habitats to shrimp production. Multiplying the shrimp production from marshes by the ex-vessel value of shrimp provided a defendable, and very conservative, estimate of the economic value of marshes. Based on these analyses, it was found that the cost of restoring marshes could be recovered through the harvest of increased shrimp production alone in as little as 12 years.

Two papers addressed issues related to governance. Houston *et al.* (M:13) summarized Canada's approaches for addressing habitat research needs. Through the establishment of a virtual Centre of Expertise, the Department of Fisheries and Oceans is shifting from a population and production-based approach to managing fisheries to an ecosystem-based approach of integrated management of sectors and places. This Centre will pursue a number of objectives related to linking habitat to production and biodiversity, including both natural and human-induced effects. Rice (substituting for M:06) presented a summary of recent international agreements on biodiversity and its relationship to habitat and fishing. By 2010, nations, including the ICES nations, are now committed to certifying that fisheries will not cause unsustainable impacts to vulnerable marine ecosystems, based on factors such as recovery time. The international community has also adopted scientific criteria for identifying representative habitats in the process of designating marine protected areas.

The theme session was very useful in providing new scientific information on relationships between marine species and their habitats. Most research is still oriented towards identifying and quantifying these relationships using statistical models, and on developing digital maps portraying these relationships. Information of this nature can be very useful in some management contexts, such as identifying and mapping habitats that appear to be important to some species and life stages.

However, progress is only beginning in addressing higher-level management issues that are increasingly coming to the fore in the context of marine spatial planning. Quantitative, or even qualitative, answers to questions on the actual "value" of marine habitats, not only in terms of fisheries production, but also in terms of overall ecosystem services, are not yet available, and are only beginning to be sought. Having this kind of information available for marine spatial planning would enable managers, and the societies that employ them, to make informed judgments about the relative merits of competing uses of space in the marine environment. Framing these questions into operational research programs and projects is a substantial challenge intellectually, technically, programmatically, and financially. Given the pace of change in the demands of society for managing natural resources, making progress on these difficult issues is becoming more important every day.