

## Theme Session R

### **The ecosystem approach: what's the impact on marine science, science-based advice, and management of marine ecosystems?**

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#### ICES CM 2007/R:01

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##### **ECOVUL/ARPA Interdisciplinary Project: Looking for a model to study the interaction between deep-water bottom fisheries and their supporting oceanic ecosystems**

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Deep-water bottom fisheries, as any other industrial activities like oil-prospecting and ocean mining, medicine-prospecting, etc., imply interaction between men and deep-ocean. Traditional fisheries management based on individual fish populations turned out to be unsatisfactory, and nowadays the ecosystem approach is commonly accepted as the appropriate new way to manage fisheries ensuring the long-term sustainable use of the ecosystem. Despite their relatively new establishment, many deep-water fisheries were quite developed before the implementation of the ecosystem approach and generally were managed in the traditional way. But nowadays, scientists, managers and industry, need to deal with new challenges according to the new approach, with the additional trouble of the fact that aspects well investigated in shallow-water fisheries, are poorly known in deep-water ones. From the point of view of a traditional fishery biologist, besides the aforementioned issues, one of the bigger challenges is the study of the effects of the deep-water bottom fisheries on the ecosystems and habitats, in order to advise on which areas of those fisheries can be developed and which areas, due to their vulnerability or ecological relevance, need protection to ensure sustainability. This paper presents the ECOVUL/ARPA project, a case study on incorporation of ecosystem target in the setting of management measures, which is being developed by Spain in the Hatton Bank (ICES VIb1 & XIIb) to research the interaction between deep-water bottom fisheries and their supporting ecosystems. Our approach integrates traditional Fisheries Science, Benthic Ecology, Geomorphology, and Sedimentology, and tries to find a suitable model to apply in other deep-water Spanish fisheries.

Keywords: interdisciplinary research, vulnerable ecosystems and habitats, Hatton Bank, deep-water, bottom fisheries, benthic ecology, geomorphology, sedimentology, closed areas, protection.

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#### ICES CM 2007/R:02

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##### **Bridging the gap: fleets, fisheries and the ecosystem approach**

Stuart Reeves and Clara Ulrich

Current ICES advice for fish stocks is based on single-species stock assessments. As such they involve giving advice on individual species, across a large area, based on detailed data. In contrast the requirements of the ecosystem approach involve advice on a much wider range of species and a much finer spatial scale, for which there is typically much more limited data. Assessment and management of mixed-species, multi-fleet fisheries represents an intermediate situation between single-species fisheries management and the application of a full ecosystem approach, in terms of their complexity, data needs and spatial scale. As a result, recent developments in approaches to give advice on a fishery basis, rather than a stock basis, offer a way to bridge the gap between existing single-species management and the needs of the ecosystem approach. Here we describe these approaches and discuss their possible extensions and applications to the ecosystem approach to fisheries management.

Keywords: ecosystem approach, fish stocks, mixed species.

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#### ICES CM 2007/R:03

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##### **Integrated management in British Columbia, Canada: challenges in identifying conservation objectives**

Glen S. Jamieson, Cathryn Clarke, and Barbara Lucas

In support of Integrated Management (IM), regional Ecosystem Overview Reports are being produced to provide IM planners, managers and stakeholders with relevant information on ecosystem properties and components. As part of this process, Ecologically and Biologically Significant Areas (EBSAs), Ecologically Significant species (ESSs), Depleted Species, and Degraded Areas have been identified in Canadian waters, with focus here on the Pacific North Coast. This knowledge is required to identify areas and species that require enhanced management for both the conservation of special features or species, and to determine permitted human activities. Some EBSAs may also be considered “areas of interest” in the future establishment of marine protected areas. Using the above lists, conservation objectives are being identified, and a process will soon begin to determine appropriate indicators and minimum thresholds that species or features should not cross. A complementary process is developing “desirable” objectives, which will consider socio-economic parameters to determine desired levels above the minimum science-recommended thresholds for each conservation objective.

EBSAs are largely focused around both bathymetric and oceanographic features that result in locally higher than average ocean productivity and biodiversity, as such areas tend to be significant for a relatively wide diversity of species; and bottleneck areas, where a relatively minor impact can have disproportionately large negative consequences. Species, or species groups, are identified as ESSs if they have potentially controlling influence on ecosystem structure and function, either because a species has a crucial trophodynamic role or because it provides three-dimensional structure important to biodiversity and productivity.

Keywords: integrated management, conservation objectives, Canada.

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## ICES CM 2007/R:04

### Linking large- and small-scale fish surveys with the feeding ecology of seabirds

Andreas Dänhardt and Peter H. Becker

The state of North Sea fish populations and stocks is annually assessed by means of extensive survey programmes as the basis for fisheries management. Yet since standard research vessels are restricted to deeper water, shallow coastal areas of the North Sea ecosystem pivotal to particular stages in the life cycles of target and non-target species are not covered. Local surveys often are limited in space and/or time and are not coupled to the regular North Sea wide surveys.

The Wadden Sea is a large intertidal zone, serving many ecologically and economically important fish species as a nursery, including herring, sprat, plaice, sole, cod and whiting, which together account for more than 75% in weight of annual catches North Sea wide. In addition to their meaning to recruitment processes to the adult stock (and eventually to the fishery), the juvenile stages of these species also form the nutritional basis for piscivorous seabirds that breed in large numbers along the North Sea coasts and have synchronized their reproductive phenology with the availability of their prey fish.

Based on annual, diurnal and tidal cycles of fish occurrence we describe principles for monitoring fish in the Wadden Sea considering relevant phenological aspects. We suggest a possible link with offshore sampling programmes and propose an integration of the large- and small-scale survey programmes to be put into context with seabird feeding ecology.

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## ICES CM 2007/R:05

### How could indicators be used in an ecosystem approach to fisheries management?

Marie-Joëlle Rochet and Verena M. Trenkel

Fishery papers on ecosystem indicators, or ecological indicators, have flourished over the last ten years, and many were justified by referring to the ecosystem approach to fisheries (EAF). However, the reason(s) why indicators are relevant to an EAF are not always clear. Still less clear is the way(s) indicators might be used to give management advice in the context of an EAF.

In this presentation we recount the emergence of the indicator concept in the EAF context. The concept being overloaded with two many roles and interpretations, we propose to split it into three separate tools fulfilling the functions of control, audit, and communication. We suggest these could be articulated by a conceptual model linking the problems to be managed and the possible management actions. The approach is exemplified for the Bay of Biscay multispecies fisheries.

Keywords: ecosystem approach to fisheries; indicators; metrics; science-based advice.

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### ICES CM 2007/R:06

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#### **Ecosystem-based psychology, or, how I learned to stop worrying and love the data**

Peter Koeller

The emerging fisheries science paradigm may be drifting in what some applied fisheries scientists consider an intractable assignment – Ecosystem-Based Fisheries Management (EBFM). In this paper I suggest that the lack of progress in implementing EBFM is partly psychological and that the multidisciplinary approach to it should include psychology, a discipline that to date has largely ignored the overwhelming problems of fisheries management.

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### ICES CM 2007/R:07

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#### **Eastern Channel Habitat Atlas for Marine Resource Management (CHARM) – From a descriptive approach (phase I) to a process-oriented approach (phase II)**

A. Carpentier, C. Warembourg, F. Coppin, L. Curet, J. -C. Dauvin, J. -P. Delpech, N. Desroy, J. -M. Dewarumez, L. Dupuis, P. D. Eastwood, B. Ernande, M. Fischer, A. Foveau, C. Garcia, P. R. Just, P. Koubbi, N. Leader-Williams, A. Lefebvre, S. Mackinson, C. S. Martin, G. J. Meaden, J. Morin, Y. Ota, S. Rogers, R. J. Smith, N. Spilmont, S. Vaz, C. Villanueva, and S. Harrop

In 2003, a Franco-British Interreg IIIA project, 'Eastern Channel Habitat Atlas for Marine Resource Management' (CHARM-Phase I, <http://charm.canterbury.ac.uk/>), was initiated to assess the status of benthic invertebrate fauna and key commercial fish species of the Eastern English Channel. Available physical and biological data, including suitable habitat maps, were compiled into an atlas, accompanied with a review of the policy and legal framework for the protection of marine living resources and their habitats in the study area. The atlas constitutes an up to date reference of the status of living marine resources and their habitats in this area and may be used to elaborate guidelines for their conservation in the face of climate change and anthropogenic disturbances. CHARM phase II will extend this initial effort and use a process-oriented approach to further explain phase I's results and develop predictive tools for assessing management options. For instance, both habitat models and fisheries statistics on commercial fish stocks will serve as forcing variables and inputs to an integrative spatially explicit modelling approach of the marine ecosystem of the area. Two types of models are foreseen for the Eastern English Channel: (i) a model of the ecosystem functioning using mass-balance food web models (Ecopath with Ecosim) will be built to evaluate management scenarios and (ii) a conservation plan using the MARXAN spatial planning software should enable to identify important sites for conserving biodiversity. The project's outputs will be available to the public through an interactive Web atlas.

Keywords: Eastern English Channel, CHARM, marine ecosystem modelling, spatial conservation planning.

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**ICES CM 2007/R:08**

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**The ecosystem approach to fisheries – science driven or issue driven?**

Kjellrun Hiis Hauge

The ecosystem approach to fisheries (EAF) represents a multi-objective aiming at 1) broadening the management perspectives from single species to including ecosystems considerations, 2) maintaining a precautionary approach, and 3) increasing the involvement of stakeholders. ICES, as a science community and provider of advice, has a particular responsibility in these respects, but giving advice in accordance with the EAF has proven difficult. Within the ICES science community, there is a highly divergent view on what kind of advice and science the EAF requires. I argue that the science communities augment two problems in our demand for political attention to knowledge gaps, often in our own field of interest. First, the managers are implicitly advised to postpone the EAF until the knowledge gaps are filled, which is in contradiction with the precautionary approach. Second, the focus tends to be removed from possible urgent issues. A solution to this problem is to consider scientists as stakeholders and involve all interested parties when deciding what should be the present priority of ecosystem issues. This may, of course, introduce some challenges to management and will require other forms of scientific advice. I here present some scenarios of ICES' future roles as a provider of advice for the EAF, with stakeholder participation and the handling and communication of the uncertainty as key factors. I discuss these scenarios and factors in relation to efficiency, transparency and science credibility.

Keywords: EAF, participation, transparency, uncertainty.

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**ICES CM 2007/R:09**

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**Effects of the ecosystem approach on the analysis of fishing activity: Samplings, statistics and procedures**

Carmen Hernández, A. Punzón, and Pilar Pereda

The effective management of ecosystems requires knowledge of how they function and on the ability to predict their productive capacity and the consequences of management actions with some degree of reliability. Data collection programmes must develop a new sampling procedure in order to provide this information. It is necessary to change traditional systems of management, which have tended to focus on individual stocks or species to a metier-based market sampling. Several adaptations of current sampling strategies are therefore necessary, and pilot studies to show the viability and suitability of these to the new requirements of the DCR (Data Collection Regulation, 2009), "Fleet-based approach" (FBA), "Ecosystem Approach" (EA) and ICES WGs are indispensable. If the EA or FBA protocols cannot be adopted, the best way of responding to these needs must be chosen. Changes will also be necessary in the information contained in log books, WMS (Warehouse Management System) and sales slips (such as how to establish smaller statistical rectangles, landing declarations from the fleet of vessels of less than 10 metres, making available information haul by haul and of all species independent of their weight, etc.). All the resulting information should be made readily accessible to fisheries researchers. In addition to analyzing these initial problems, possible effects on the structure of the working teams of National Programs, on raising processes and on outputs will be considered. All of these aspects will be dealt with in the present study.

Keywords: ecosystem approach, fleet-based approach, data collection regulation.

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**ICES CM 2007/R:10**

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**Bed-fellows or fellow-travellers? – The relationship between ecosystem-based management and stakeholder participation in marine fisheries**

Tim S. Gray and Jenny Hatchard

The relationship between ecosystem-based management of marine fisheries and stakeholder participation, is often taken for granted, but is actually very complicated. The literature reveals four possible interpretations of this relationship: that they are 1) logically linked; 2) ethically linked; 3) instrumentally linked; and 4) complementarily linked. We examine these four formulations in the light of recent research on interactions between fisheries and their environment. We conclude that the 'Stakeholder participation–Ecosystem-based management' relationship manifests itself as predominantly instrumental in character. Within this mutually beneficial, but uneven, relationship, ecosystem-based management benefits particularly from stakeholder participation in terms of knowledge, practical roles played by stakeholders and added systemic legitimacy.

Complementary and ethical links between ecosystem-based management and stakeholder participation are less common but, respectively, command pragmatic and moral force.

Keywords: stakeholder, participation, ecosystem-based management.

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## ICES CM 2007/R:11

### **Incorporating environmental variability in stock assessment – predicting recruitment, spawner biomass and landings of sprat, *Sprattus sprattus*, in the Baltic Sea**

Brian R. MacKenzie, Jan Horbowy, and Fritz W. Köster

Temperature has a significant positive impact on recruitment of sprat in the Baltic Sea. Here we evaluate whether an existing recruitment model for the yearclasses 1973–1999 can forecast recruitment for five new yearclasses. The coefficient of variation (CV) of predictions was 5% and four of five new yearclasses were within 95% confidence limits of predictions made by the earlier model. We then assimilated climate-oceanographic-recruitment linkages into the standard ICES assessment procedure to predict key advisory-related variables such as spawning stock biomass (SSB) and landings. These linkages enable prediction of recruitment earlier than the annual assessment meeting. Predictions made using the North Atlantic Oscillation for the 2006 yearclass showed that spawner biomass would be 15% lower than spawner biomass calculated using the ICES standard methodology. The difference in perception of future biomass does not affect the advice for the stock because  $SSB > BPA$ . However, when this is not the case, or when it is desirable to broaden the ecosystem basis for fisheries management, incorporation of knowledge of recruitment processes may be beneficial.

Keywords: sprat, recruitment, predictions, Baltic Sea, climate, temperature, North Atlantic Oscillation, ecosystem.

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## ICES CM 2007/R:12

### **Exploring rules of thumb for ecosystem-based fisheries management reference points**

Michael J. Wilberg

Current goals for ecosystem-based fisheries management (EBFM) include sustaining human uses while maintaining the integrity of the ecosystem. Predicting how species will respond to a perturbation in the ecosystem is an integral component of EBFM. Despite much research in this area, few quantitative targets for EBFM have been applied. In part, this is due to difficulties in quantifying and describing interactions among species. Unfortunately, these interactions are often complex, difficult to quantify or predict, and may change over time, through both density dependent and environmental processes. Additionally, most models used to evaluate ecosystem indicators do not allow for the full range of potentially important species interactions, such as non-lethal and facilitative predation effects, which may have consequences for EBFM. Quantitative targets have been developed and are routinely applied within single-species management, and fisheries will continue to be managed on a single species basis in the near term. Therefore, adjusting these targets to account for probable effects of species interactions in the environment may lead to heuristics for managing single species in an ecosystem context and provide a way to merge single species and EBFM. Species interactions are often nonlinear, and, within certain ranges, species removals may be expected to have less than proportional effects. In this talk, I will discuss evidence for these kinds of thresholds in terrestrial and freshwater systems, where much of the research on trophic interactions has been conducted. Also, I will discuss how these kinds of interactions may be useful for developing rules of thumb based on single-species reference points.

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**ICES CM 2007/R:13**

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**An ecosystem approach for oyster restoration and management**

E. W. North, D. M. King, J. Xu, R. R. Hood, R. I. E. Newell, K. T. Paynter, M. L. Kellogg, M. K. Liddel, and D. F. Boesch

In addition to harvest, the eastern oyster (*Crassostrea virginica*) in Chesapeake Bay provides ecosystem services such as removing suspended particles, enhancing water clarity and creating benthic habitat. Our objective was to create a flexible ecosystem-based decision-making tool to support oyster restoration and management. This Oyster Restoration Optimization model (ORO) incorporates predictions from three-dimensional water quality (NPDZ) and larval transport models, calculates size- and salinity-dependent growth, mortality, and fecundity of oysters, and incorporates economic costs of restoration efforts. An optimization approach (genetic algorithm) is used to identify the most suitable locations for oyster population restoration that maximize one or more benefits such as reduction in total suspended solids, increase in light penetration, spawning stock enhancement, and harvest. The iterative solution technique incorporates and estimates uncertainty caused by climate variability. Preliminary results indicate that restoration in three sub-systems of Chesapeake Bay would maximize a different suite of benefits due to the interaction between salinity gradients, salinity-dependent growth and mortality rates of oysters, the residence time of water in the sub-systems, and the relationship between size of oysters and the number of bushels harvested. The strengths and constraints of the ORO model as applied to ecosystem-based fisheries management will be discussed.

Keywords: eastern oyster, modeling, optimization, ecosystem-based management.

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**ICES CM 2007/R:14**

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**Interaction and integration of observation and models – the EcoFish approach**

Olav Rune Godø, Kjellrun Hiis Hauge, Svein Iversen, Olav Sigurd Kjesbu, and Einar Svendsen

Meteorology and physical modelling of the ocean have long used advanced models, which enable assimilation of available data at various time steps of the model. Traditional assessment models of exploited fish stocks are based on quasi-synoptic survey information combined with commercial catch statistics. This approach is not very data demanding, but it does not conform to the ecosystem approach as species interactions and environmental effects are difficult or impossible to take into account. The EcoFish project aims at supporting advice for the ecosystem approach to fisheries by 1) improving the data basis in general, 2) by creating a model complex that can assist traditional assessment tools, e.g. in developing indicators or analysing ecosystem based trigger points for harvest control rules and 3) develop supplementary tools for spatial management. The EcoFish concept therefore challenges new technologies with respect to producing high quality, relevant data that will enable geographical and seasonal resolution for exploited fish stocks. Models will be used to predict distribution of target stock that can be used for designing an improved sampling regime of the scientific surveys. On the other hand non-systematic sampling, e.g. acoustics and catch rates, from the commercial fishing fleet will be used to monitor distribution and migration patterns as well as co-occurrence of predators and prey. The project is in its first year of operation and but some operational examples exist.

Keywords: ecosystem approach, modelling, observation schemes.

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**ICES CM 2007/R:15**

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**The Global Reporting and Assessment of the Marine Environment**

Jake Rice (on behalf of the GRAME Group of Experts)

The commitment to apply an ecosystem approach to management of human activities in the sea extends beyond national and regional agencies to the United Nations itself. Resolutions at the UN General Assembly have called for a “Regular Process for the Global Reporting and Assessment of the Marine Environment including Social and Economic Aspects”. The Regular Process should periodically produce Integrated Scientific Environmental Assessments at regional and global scales. These assessments should inform policy makers of status and trends of the regional and global marine ecosystems, including their social and economic aspects, serving both as a basis for identifying policy gaps that should be addressed and for evaluating progress towards achievement of policy objectives that have been set. It is expected that the Regular Process primarily would integrate at regional scales information from assessments already being

conducted at local, national, or regional levels, with these assessments likely prepared in different ways and for different clients.

To facilitate this ambitious task, the UN General Assembly mandated UNEP and UNESCO to coordinate work of a “Group of Experts for the Assessment of Assessments”, to set up that Regular Process. The Group of Experts includes 20 experts covering a broad range of physical, chemical, biological, social and economic science disciplines, experienced both in their scientific disciplines and in application of their disciplinary knowledge to policy development. There is also a steering committee of comparable size overseeing the work of the Group of Experts. Over the next two years the Group of Experts group will consider information, knowledge and policy advice generated through a broad range of different kinds of assessment processes relevant to the marine environment. In reviewing existing assessments it will consider scientific quality and legitimacy, policy relevance, “usefulness”, and communications. Its goal is to recommend best practices and guidelines for how the Regular Process will conduct the global reporting and assessment of the marine environment.

This Assessment of Assessments has a number of implications for ICES. It looks to ICES as a source of experience and lessons learned about disciplinary and integrated assessments. It also provides an additional incentive for ICES to consider how its assessments could be integrated with social and economic assessments, to complete the picture needed by the Regular Process. This talk will provide information about the approach selected by the Group of Experts, the themes that it will address, and the nature of the products that are expected. These will be discussed in terms of the potential role that ICES could play in achieving the goals of the UN and its member states, for periodic scientifically sound, policy relevant integrated marine assessments.

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## ICES CM 2007/R:16

### **The Canadian national approach to implementing an ecosystem approach to integrated management**

Jake Rice, Camille Mageau, Liisa Peramaki, and Kim Houston

Canada’s Oceans Act calls for application of an integrated and ecosystem approach to the management of human activities in the sea. To develop the capacity and concepts to fulfil this mandate, government-wide efforts were initially focused in five Large Ocean Management Areas (LOMAs). A national working group developed guidance on how to integrate the knowledge available about the marine environment and assess the condition of key structural and functional properties of the system in order to identify conservation objectives for the LOMA. A complementary process is developing guidance on integrating social, economic and cultural knowledge in order to identify associated social and economic objectives. Together, these two streams of knowledge and objectives inform the integrated management process. For each LOMA there is:

- 1) an Ecosystem Overview of the information available on ocean physics and chemistry, populations and communities, industries, and community dependencies;
- 2) an Ecosystem Assessment that identified three major classes of interactions – physical forcing on the biological systems, species interactions and industry-ecosystem uses and impacts (sometimes in separate documents);
- 3) four candidate classes of Conservation Objectives: Ecologically Significant Areas, Ecologically Significant Species and Community Properties, Degraded Areas, and Depleted Species;
- 4) a process and guidelines for combining and ranking the candidate Conservation Objectives;
- 5) a governance system involving governments, industries and interested parties to set social, cultural and economic objectives and develop integrated management plans for each LOMA, based on the results of 1–4.

This paper will describe the components of steps 1–5 in more detail. It will focus on the efforts made to maintain a balance between the flexibility needed to accommodate regional circumstances and the consistency needed to meet standards of national accountability. The talk will also highlight some lessons learned by the national process that may be relevant to any region intending to develop Objectives-based integrated ecosystem management approaches, based on best available science.

**Keywords:** integrated management, ecosystem approach, ecosystem assessments, objectives.

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**ICES CM 2007/R:17**

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**A rationale for matching monitoring requirements with obligations to assess ecosystem effects**

Simon Northridge and Len Thomas

The impacts of fisheries on commercial fish species are relatively well studied, because much of what is caught is brought to shore, where it may be quantified. The effects on a broader range of non-target species are more difficult to quantify, and generally it is necessary to implement discard or bycatch monitoring schemes in order to do so. An important consideration for such schemes is to determine how much monitoring is required. The objectives of monitoring schemes may be cast in terms of targeting the precision of a catch or bycatch estimate, as is the case in the Cetacean Bycatch Regulation (Council Regulation 812/2004). Yet this is not necessarily an optimal strategy and can lead to over-sampling. An alternative approach is to determine for each non-target species of interest, or group of species, what level of bycatch might cause concern, and then to design monitoring schemes to ensure that bycatches in excess of this limit can be detected with some level of certainty. Here we have developed statistical tools for determining appropriate levels of monitoring to detect significant bycatch rates for several cetacean species. Often the requirement to achieve a bycatch estimate with a specified CV for example will necessitate a very high level of sampling, especially for species where bycatch events involve a highly variable number of individuals. Using examples of the observed bycatch rates of several non-target species in UK fisheries, we compare the implications for monitoring requirements under these differing strategies.

Keywords: observer schemes; monitoring requirements; bycatch.

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**ICES CM 2007/R:18**

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**Taking the consequences of international conventions, national policy and our own arguments: developing the way of working at the Institute of Marine Research, Norway, to deliver according to the ecosystem approach**

Ole Arve Misund, Ole Jørgen Lønne, Erlend Moksness, and Ole Torrissen

Over the years The Institute of Marine Research, has been developed to become the leading body for monitoring and exploration of marine ecosystems, development of the aquaculture industry and science-based advice on harvesting of living marine resources in Norway. The institute was built with a steadily growing classical hierarchical organization with departments according to scientific disciplines or ecosystem categories. During the nineties the institute operated with scientific centres on aquaculture, coastal zone, living resources, and marine environment, and received a rather favourable evaluation by an international panel in 2001.

Instead of continuing in a recognized way of functioning, a process of developing the organization of the institute to be better able to deliver science-based advice according to the ecosystem approach was adopted as the central principle for management of the ocean environment by the Norwegian Parliament in 2002. An organization with four research and advisory programmes, 19 research groups, a research technical department with eight sub-units, a central administration and a research vessel department was implemented in 2004. Recently, the organization has been adjusted and developed even further so that we now have 10 programs, five of them with a research and advisory profile, the others with a clear thematic profile. The research and technical groups have been integrated to obtain better cooperation and social interaction between the scientific and technical employees. We analyse how these structural changes have influenced the scientific production, the advisory activity, the “working environment” and the well being of the employees of the institute.

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**ICES CM 2007/R:19**

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**From stock to ecosystem-based advice: are reference points a moving target?**

Laurence T. Kell, Finlay Scott, and J-M. Fromentin

Most fisheries management advice provided by ICES is on a “single-species” basis. However, an important objective of the Common Fisheries Policy is to minimise the impact of fishing activities on marine ecosystems and to progressively implement an ecosystem-based approach to fisheries management (EAFM). From an ecological viewpoint, this implies taking account of environmental variability, non-stationarity in key biological processes and species interactions. This requires ecosystem targets and indicators to be defined and used alongside the stock-based biological reference points currently used by ICES. However,

exploitation and environment effects often interact and their impacts may be confounded. For example, temperature effects in recruitment failure are particularly problematic when SSB is at a low level due to overexploitation. In this study we undertake an exploratory analysis to test one of the classical paradigms in fisheries science that key biological parameters, such as  $r$  and  $K$  are assumed to be constant or stationary. We then discuss the incorporation of ecosystem targets when setting fisheries reference points and how to develop robust management regimes.

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**ICES CM 2007/R:20      Poster**

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**ECOVUL/ARPA interdisciplinary project: Sea-bed mounds on Hatton Bank situated within deep-water bottom fisheries zones (NE Atlantic Ocean)**

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The Spanish interdisciplinary research project ECOVUL/ARPA aims to identify vulnerable habitats, mainly cold-water corals, in the fishing grounds of the Spanish bottom trawlers along the Hatton Bank (ICES XIIb and VIb1). This work is based on data collected by the *Instituto Español de Oceanografía* and the *British Geological Survey* (Multibeam bathymetry, TOPAS and SPARKER seismic profiles). Data reveal parallel and elongated ridges between  $-700$  m and  $-1600$  m. These barriers, 5 km apart, extend more than 40 km and show common segmentation with sections of 2 km to 7 km length. The segments show four main orientations:  $N90^{\circ}E$ ,  $N78^{\circ}E$ ,  $N67^{\circ}E$  and  $N53^{\circ}W$ . The location and orientation of the ridges is influenced by the underlying geological compressional structure. Their heights vary between 5 m and 45 m, generally with steeper gradients downslope (up to  $17^{\circ}$ ) often into a moat with evidence of erosion. Ponded sediments, up to 30-m thick, can be seen on the upslope side of the ridges and debris fans on the downslope side. Along the crest of the ridges numerous mounds can be identified. The mounds have been suggested as sites of cold water coral accumulations. Seismic profiles show the mounds as irregular; often as symmetrically shaped individual features or as asymmetrically shaped clustered build-ups. Some mounds show a conical shape at their centre with clusters of smaller mounds around. Several mounds are buried by a cover of Hatton Drift sediments. The mounds themselves are seismically opaque possibly due to attenuation by the mound's structure and composition and are located on pre-existing topographic highs.

Keywords: mounds; ridges; cold-water corals; Hatton Bank; Northeast Atlantic.

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