ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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ICES Science Plan

(2009–2013)

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Sections changed as compared to version of 8 September:

Section 4.3	Marine Living Resource Management Tools
Section 4.3	Contributions to socio-economic understanding of ecosystem goods and services, and forecasting of the impact of human activities

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1 Introduction

The recently updated ICES Strategic Plan includes the requirement for a "Science Plan" that addresses both ongoing short-term needs as well as longer term strategic issues. It is recognized that ICES should enhance its role as a leader in the coordination of research in the North Atlantic, in particular on topics of relevance to "sustainable fisheries" and the integrated management of marine activities. As some of the issues are of a global nature, ICES may need to expand its geographic scope and establish new alliances with non-member countries, international and intergovernmental organizations and conventions. It is also recognized that because of the emerging needs of advice on "ecosystem considerations", a broader range of scientific expertise is required. As such, ICES needs to further engage the marine science community, including a wider range of experts from universities and diverse ministries in the member countries.

The ICES Strategic Plan has six goals, two of which are addressed in this 2009–2013 Science Plan.

Goal 1 (Science) is to:

- Plan and implement a programme of science in partnership with member countries to deliver the needs to customers and stakeholders.

Goal 2 (Collaboration) is to:

- Establish effective mechanisms of collaboration within ICES and with others (organizations, etc.) to deliver and add value to ICES science and advisory programmes.

This Science Plan, while targeted at the ocean science community in the ICES area, will be of interest to managers and clients in ocean industries that depend upon the advice that ICES provides. It was prepared with broad input from the ICES community, from the national delegates as well as from the members of the Committees and Expert Groups.

2 A Changing Environment for Oceans and Coastal Management

Interest in the oceans and coastal zone has increased rapidly in recent years. The poor state of many commercial and recreational fisheries has caused concerns among conservationists as well as those dependent on fisheries as an economic activity or source of food. Rapid climate change poses many challenges not only for the sustainability of fisheries and aquaculture but also for the marine environment. Changes in ocean climate affect whole ecosystems, from the physical driving forces through the lower trophic levels to fish and higher predators. There are new pressures, such as the developing interest in offshore renewable energy and the enhanced use of the sea for recreation. Rapid coastal development affects the coastal zone as a result of discharges of substances of human origin and industry. Moreover, urban, industrial, and recreational developments are causing the loss of coastal habitats. While many of these developments have been of benefit to human society, they have come at a cost to the marine ecosystems.

ICES advice and science has primarily been directed at fisheries and environmental management agencies, which have endeavoured to maintain sustainable fisheries and mitigate the harmful effects of development respectively. Achievement of the latter goals has not been without challenges. Policy responsibility in these areas was often divided between different government departments and ministerial portfolios. Over the last decade, there has been a growing recognition that human activity in the oceans and especially coastal areas needs to be managed in an integrated way if the many uses of

the sea are to be maintained in a balanced and sustainable way. Marine policy has therefore embraced the ecosystem approach to management (EAM) of human activity, since it is the ecosystem that must support the multiplicity of services provided by the marine environment.

The scientific needs for an ecosystem approach to management (EAM) are an overarching motive for the ICES Science Plan. EAM has application to fisheries, other industry sectors (e.g., coastal development, recreation, energy production), and ecosystems as a whole. Over the last decade or so fisheries management has evolved toward EAM by increasingly addressing the impacts of fishing on marine ecosystems (including bycatch, physical alteration of habitats, modification of trophic webs) and taking account of the impact of the marine environment on fisheries. At the same time, there is increasing interest, and in some cases experience, working across sectors to balance benefits and impacts of multiple human uses of ecosystems on ecosystem structure and function as a whole. These sectoral and cross-sectoral approaches should converge. The ICES Science Plan aims to create the scientific capacity to inform both approaches.

An increasing number of ICES member countries have developed a marine policy that seeks to manage the use of the marine environment in a more comprehensive way than has hitherto been the case. Fishery management is now explicitly linked to environmental policy and there is a stronger emphasis on monitoring the overall status of the seas through a suite of indicators that characterize the ecosystem and its environmental conditions. The European Union, for example, is moving towards a Directive that will require EU member states to restore their seas to a healthy environmental state as measured by a variety of indicators. Similar approaches are already operating in other ICES member states. These developments imply that ICES must build its scientific capacity to support these policy changes. It will require greater integration of science disciplines and collaboration with an ever-widening network of scientists within ICES and other partner organizations.

3 Scope of ICES Science Activities

Since ICES was established in 1902 as an intergovernmental organization, the study of the ecosystems of the North Atlantic Ocean, and especially of its living resources, has always been a primary focus. The organization has been dedicated to promoting and encouraging science for the sustainable use of the ocean. Studying marine ecosystems, the physical drivers as well as biological processes and their variability, requires a broad assembly of disciplines. The core expertise in ICES still lies in the knowledge and understanding of the limits of resilience of ocean systems against a background of societal uses.

ICES coordinates science and provides advice on a wide range of issues of a short- to medium-term nature through over a hundred Expert Groups (EGs). This requires undertaking diverse activities – from coordinating research to enhancing understanding of population and ecosystem processes, through monitoring programmes, assessments and their methodologies; to strategies, decision support tools and implementation. Thus the EGs consider a diverse suite of issues including, for example, the design of surveys for fisheries, environmental and oceanographic monitoring, as well as the development of standard methods of analysis of physical, chemical, and biological parameters that are part of long-term monitoring programmes in the North Atlantic. Another category of research issues addresses the translation of emerging policies, such as the “ICES Code of Practice for the Introduction of Species” and the EAM, into practical frameworks for implementation. A third category of research activity includes the planning and implementation of medium-term strategic issues considered to be

critical to the demands for scientific advice in a five- to ten-year time period. This latter category of research activity is the primary focus of this 2009–2013 Science Plan.

The emphasis in this Science Plan on defining medium to longer term research themes, particularly relating to marine ecosystems, does not diminish the efforts ICES will continue to give in the shorter term to innovative science on fish and fisheries that support the immediate needs of the advisory process. Advice on fisheries will continue to be a prominent part of ICES activities, although there is likely to be progressive integration of fisheries and environmental science with the increased application of the ecosystem approach to management. The provision of high quality advice requires a robust scientific grounding; increases in understanding of all aspects of marine science, from oceanography to fish, are therefore essential. In terms of maintaining quality of the research, development of new methods, and ensuring that fisheries science is considered within the wider context of the marine ecosystem, ICES has been and will remain a world leader.

The success of ICES science in the future depends on strengthening the links between environmental science, physical and biological oceanography, fisheries science, and socio-economic sciences, and in developing integrated programmes. At the same time it is important to ensure that the individual disciplines are able to advance and flourish. The science plan will facilitate this endeavour, thus ensuring that fisheries and environmental sciences remain strong, dynamic, and adaptive to the research and advisory needs of ICES.

4 High Priority Research Topics

Based upon a review of the emerging research priorities in the member countries, and wide consultation in the ICES community, sixteen research topics have been identified as being of strategic importance to the advisory needs of ICES member countries and clients in the coming decade. These topics have been organized in three thematic areas.

The first thematic area is entitled ***Understanding Ecosystem Functioning***. The research topics include:

- Climate change processes and predictions of impacts;
- Fish life history information in support of EAM;
- Biodiversity and the health of marine ecosystems;
- The role of coastal zone habitat in population dynamics of commercially exploited species;
- Top predators (marine mammals, seabirds, and large pelagics) in marine ecosystems;
- Sensitive ecosystems (deep-sea coral, seamounts, Arctic) as well as rare and data-poor species;
- Integration of surveys in support of EAM.

The second thematic area is entitled ***Understanding Interactions of Human Activities with Ecosystems***. The research topics include:

- Impacts of fishing on marine ecosystems;
- Carrying capacity and ecosystem interactions associated with mariculture;
- Influence of development of renewable energy resources (e.g. wind, hydropower, tidal and waves) on marine habitat and biota;
- Population and community level impacts of contaminants, eutrophication, and habitat changes in the coastal zone;

- Introduced and invasive species, their impacts on ecosystems and interactions with climate change processes.

The third thematic area is entitled ***Development of options for sustainable use of ecosystems***. The research topics include:

- Marine living resource management tools;
- Operational modelling combining oceanographic, ecosystem, and population processes;
- Marine spatial planning, including the effectiveness of management practices [e.g. Marine Protected Areas (MPAs)], and its role in the conservation of biodiversity;
- Contributions to socio-economic understanding of ecosystem goods and services, and forecasting of the impact of human activities.

The 16 research topics in the three thematic areas are critical to the advisory process, both in the short and the long term. To fully appreciate the role of ICES in providing advice to clients, it is worthwhile to consider the nature of this advice. Advice generally relates to informing ICES clients on the potential influence of some natural occurring process on human society (e.g. the influence of climate change) or the impact of some human activity on an ecosystem component (e.g. harvesting of a stock). In order to judge the level of impact that an ecosystem component can sustain, reference points of assessed indicators are required. To produce these, knowledge and understanding of the ecosystem / population processes implicated are required. It is then necessary to monitor and assess the level of identified indicators in relation to the reference points. Having judged the level of apparent impact, decisions need to be made by ICES clients regarding strategies and implementation that are required to mitigate the negative effects of the impacts. ICES has been engaged in providing advice related to each element of the management process – from information on population and ecosystem processes, through monitoring and assessment to decision support and implementation.

Prior to efforts to undertake EAM, the advisory chain from ecosystem understanding to implementation generally involved consideration of the impacts of specific human activities on individual ecosystem components (e.g. harvesting on each fish stock; mariculture on bay ecosystems). The move towards EAM requires an expansion of the scope of impacts of human activities (e.g. bycatch in fisheries) together with consideration of cumulative impacts on priority ecosystem components across all human activities. The research topics outlined in this plan are designed to support EAM strategically, and involve all elements of the advisory process.

Not all research topics link to the elements of the advisory process in the same manner. Some are closely associated with knowledge development of ecosystem and population components, while others are closely associated with decision support and implementation. Besides these direct linkages, many research topics have indirect links to the elements of the advisory process in that the new knowledge and understanding that they produce is indirectly applied in other advisory elements. It is recognized that virtually all research topics influence each element of the advisory process to some degree. Here, only the main linkages are highlighted.

The research topics in category one (ecosystem understanding) are most directly linked to that element of the advisory process involved in furthering knowledge and understanding of how ecosystems and their components function. This knowledge is critical to defining which indicators should be assessed and what are the limits of human impacts; thus these research topics are indirectly linked to assessment and decision support.

The research topics in category two (ecosystem / human interactions) are most directly linked to the decision support and implementation elements of the advisory process. While mitigation of the influence of human activities requires knowledge gained from category one research topics, the research undertaken in these topics is most directly associated with determining ways and means to limit harm. There is an indirect link to the assessment element as an assessment is required to gauge the level of harm that requires mitigation.

The research topics in category three (development of options) are most directly linked to assessment and decision support, with an indirect link to implementation. Again, the development of management options to address the impact of climate change and human activities will draw heavily upon research undertaken in category one. However, the main focus in this category is decision support based upon this knowledge. This also applies for marine spatial planning, with perhaps here a direct link to implementation (e.g. MPA network design). Socio-economic research has a direct link to decision support and implementation in that it will inform ICES clients on which management options and actions are most likely to be effective.

4.1 Understanding Ecosystem Functioning

Climate change processes and predictions of impacts

There is a dual focus for this broad topic. One focus is to better define responses at the individual and population level of representative species to changes in temperature, pH, salinity, oxygen, turbidity and other environmental variables. Changes in distributional patterns at the species and community levels in relation to changes in the marine environment during the past decades will also be evaluated. The second focus is the prediction of shelf seas and coastal zone oceanographic and ecological responses to selected climate change future scenarios (as developed by IPCC). The shelf seas and coastal zone circulation and mixing models will be driven by state-of-the-art basin scale models, while the ecological responses are to be based on physical-biological interactions that will in part be formulated using ICES data sets covering the past century. Regional shelf seas and coastal zone models will focus on productivity, distribution of species, migration routes, and the possibility of regime shifts. It is anticipated that the ICES niche in this topical global research area will be the modelling of ecosystem responses to the selected physical oceanographic scenarios.

Fish life history information in support of EAM

The context for fisheries management has broadened to include ecosystem effects on fish populations. Also, high levels of exploitation of fish populations have, in many instances, resulted in increased variability and vulnerability to detrimental effects. Management and conservation must now include characterization of a wide range of environmental, biological, and ecosystem factors that influence the viability of fish populations. Challenges are twofold: (i) monitor the status of populations and ecosystems with indicators and appropriate statistical techniques, and (ii) achieve predictability of population distributions, connectivities, and recruitment levels using complex fish–ecosystem coupled models and simulations. To achieve these objectives, information on population life history and life cycles, as well as the relative influence of environment and genetics on these traits need to be integrated and coupled with information regarding environmental and ecosystem conditions. More precisely, life cycle spatial organization of fish populations need to be documented and modelled using cross mapping and their coupling to habitat requirements and vulnerability to anthropogenic activities. Habitat characterization is becoming increasingly important. It will also be necessary to characterize

biological functions of growth, reproduction, and feeding that rely on the quality of habitats. Understanding of fish physiology and behaviour, and their genetic basis, is essential to such coupling at small scales. Also at a regional scale, connectivity of larval transport between populations, fish behaviour and movements need be understood and modelled. A spatial setting which incorporates operational oceanographic products would provide essential structure to all these studies.

Biodiversity and the health of marine ecosystems

Biodiversity can be considered at a number of scales in marine ecosystems – from the genetic and population level, through the species level up to the community level. It may be a key element of the capacity of an ecosystem to absorb disturbance without shifting to another regime – its resilience. It is generally accepted that relatively high (i.e. intact or non-reduced) biodiversity operating at each level confers plasticity and resilience. These are essential attributes under conditions of change due to natural and anthropogenic factors and thereby indicators of a healthy ecosystem. The study of the relative resilience of shelf seas exploited ecosystems through a comparative approach will provide knowledge and understanding of biodiversity which will be of importance to several research topics.

The role of coastal zone habitat in population dynamics of commercially exploited species

Coastal zone habitat includes highly productive estuaries and bays, which are essential nursery grounds for a number of commercial and recreational fish species and home to a number of invertebrates (e.g. clams, crabs). As well, this habitat is critical to successful mariculture operations. These habitats are threatened by human activities associated with urbanization, energy production and harvesting. Sustaining ecosystem goods and services, while meeting growing societal needs, requires ecosystem-based marine spatial planning. This topic will focus on processes linking habitat to spatial patterns at the population and community levels.

Role of top predators (marine mammals, seabirds, and large pelagics) in marine ecosystems

Top predators may have an important role in the functioning of marine ecosystems (e.g. in "top-down" controlled systems). In recent decades, there has been both a systematic removal of larger fish and in some areas increases in marine mammals and seabirds. This topic will include comparative analyses of ecosystem dynamics in response to changes in abundance and relative composition of top predators.

Sensitive ecosystems (deep- sea coral, seamounts, Arctic) as well as rare and data- poor species

Sensitive habitats or ecosystems need to be identified and mapped as a basis for their conservation and management. This can include further development of habitat classification systems and mapping tools. Fisheries constitute a particular threat to previously unfished deep-sea habitats such as cold-water coral reefs, coral gardens, sponge aggregations, and other communities. These habitats may be found on edges and slopes of oceanic islands and continental shelves as well as on summits and flanks of seamounts and guyots. Many deep-water fishes are long-lived and slow-growing, and these life history traits make them vulnerable to exploitation. The deep-sea and Arctic habitats and biota are generally not well known; there is a need for basic studies on the biology and ecology of these species and ecosystems in relation to water circulation, productivity, and climate change. Rare species are a

particular challenge as they may be genuinely rare and require conservation attention, or apparently rare because we have so far missed them in sampling the relevant seafloor habitats. There are likely to be a large number of new species that are as yet unknown to science in these special environments, especially in relation to rarer structures such as hydrothermal vents and cold seeps.

Integration of surveys and observational technologies into operational ecosystem surveys

An ecosystem monitoring programme will be developed for the ICES area based on existing time-series activities of member countries, emerging survey methodologies, and enhanced coordination (plankton nets, acoustics, optics, trawling); with the aim of providing indicators in support of advisory needs of integrated management and ecosystem status reporting. Elements will include remote observations (satellite and aircraft observations) and observations from buoys, gliders, moorings, and tracking of biota. Coordination of deep-sea monitoring will be addressed, as well as optimizing the use of vessels involved in "ICES surveys". A permanent network of ICES fixed stations using similar protocols will be proposed. Protocols for diverse components of the programme will be developed and data sharing and availability enhanced.

4.2 Understanding of Interactions of Human Activities with Ecosystems

Impacts of fishing on marine ecosystems

Under EAM, it is important to better understand the impacts of fishing on all components of the ecosystem. This implies that information be gathered on biota of all types, whether they are landed, discarded at sea, or subject to increased mortality through unobserved interaction with fishing gear, and on habitat. This research topic will focus on the technical challenges associated with collecting and interpreting the data required to assess fishing impacts, and the research and technical challenges associated with modifying or developing, and implementing fishing gears designed to minimize these impacts. ICES is well-positioned to take a leadership role in this research because of its long-standing record of success in developing and implementing monitoring and observational technologies, in researching and understanding fishing gear performance and function, and in developing and implementing improved fishing gears. Strategies to reduce the costs of fishing require attention.

Carrying capacity and ecosystem interactions associated with mariculture

Aquaculture is a growth area within the global economy and, to be ecologically sustainable, has to be based on environmentally appropriate production technology and practices. A key priority is the definition of carrying capacity for cultured species within diverse coastal environments where there is an increasing competition for space. An emerging research area to be addressed is mitigation of the impacts of aquaculture through the development of multi-trophic aquaculture systems (e.g. kelp, salmon and mussel). Challenges also include interactions between wild and "farmed" species, contaminants associated with disease control and feeds, and escapement impacts.

Influence of development of renewable energy resources (e.g. wind, hydropower, tidal and waves) on marine habitat and biota

Renewable energy resources are valuable sustainable alternatives to traditional energy sources. Consequently, the global search for new sources of renewable energy as well as the development of

proven technologies is accelerating. However, the placement of infrastructure in marine environments, such as marine wind farms, can impact structural habitat features. They also can influence ocean circulation and mixing, which in turn are important to ecosystem structure and function. Thus, while recognizing the benefits of renewable energy, it is important to minimize the potential impacts of its development on marine ecosystems. Coordination of multi-disciplinary research will be undertaken to augment the existing knowledge base, evaluate risk potential impacts, and identify mitigation options in these energy-related activities.

Population and community level impacts of contaminants, eutrophication, and habitat changes in the coastal zone

Although considerable progress has been made on understanding the impacts of contaminants at the individual level, there has been limited progress at the population and community levels. In addition, challenges remain in estimating the cumulative impacts of contaminants, eutrophication, and changes in habitat substrate. Cumulative impacts are particularly important in the coastal zone, due to the multiple uses of these marine and estuarine ecosystems. A synthesis of knowledge will be undertaken on the impacts of diverse land-based and marine activities, with the aim of characterizing the status of regional coastal zone ecosystems and causal relationships. The rich data sets for the coastal zone that are available to the ICES community suggest that advances in ecological understanding will emerge from such a synthesis, as well as the identification of gaps in knowledge and monitoring needs.

Introduced and invasive species, their impacts on ecosystems and interactions with climate change processes

This topic will focus on the intentional and accidental introductions of species in the North Atlantic. This will include not only the processes that facilitate these introductions (e.g. assessing the role of climate change) but also their impact on the distribution and abundance of native biota through niche displacement as well as their broader impact on ecosystem structure (e.g. biodiversity) and function (e.g. food chain processes). Risk assessment modelling for evaluation of management options is an additional activity. This research is required to support the development of regulatory frameworks and implementation of management measures through member countries and IMO, OSPAR, and HELCOM.

4.3 Development of Options for Sustainable Use of Ecosystems

Marine living resource management tools

Since the mid-1990s, Management Strategy Evaluation (MSE) has been used to guide the sustainable exploitation of individual stocks. More recently, efforts have been made to expand this approach to provide the basis for the exploration of management options under the "ecosystem approach" with the development of indicator-based evaluations of a range of species and habitats at different spatial scales, with associated reference points. These evaluations are designed to address the broad range of issues associated with integrated management (e.g. conservation objectives including biodiversity, productivity, and habitat features of ocean and coastal areas). The research topic will consider the operating needs of EAM. These include the spatial extent of management areas, strategies to meet conservation objectives (both fishery or ecological objectives, e.g. MSY, reference points, ecological indicators), and the reporting on ecosystem characteristics.

Operational modelling combining oceanography, ecosystem and population processes

There is a need to facilitate the availability and dissemination of long-term high quality data required to advance the scientific understanding of the North Atlantic. It is therefore important to provide analysis, forecasts, and model based products describing the marine conditions and to give a reliable description of the actual marine conditions including physical and ecosystem variables. The accuracy of the predictions need to be evaluated, as well as limits to forecasting. Subsequent to the evaluation phase operational models will be further developed to support the specific needs for the advisory process. Examples include forecasting of trends in recruitment as a function of oceanographic variables and prediction of spatial pattern in populations and community properties due to changes in the environment. Operational models will also be a useful tool in predicting the development and spreading of harmful algal blooms and for assessing the extent of environmental effects in the event of oil spills in the sea.

Marine spatial planning, including the effectiveness of management practices (e.g. MPAs), and its role in the conservation of biodiversity

Marine spatial planning is an emerging priority for member countries of ICES who are undertaking the integrated management (IM) of the multiple uses of the oceans. The main goal of this research topic is to develop and evaluate spatial planning tools to assist IM managers. The degree to which benthic habitat spatial patterns can be predicted based on a combination of geomorphological and oceanographic properties (which can be described and/or modelled at relatively fine scales) will be evaluated. The utility of MPAs (with a range of sizes and spatial patterns) will be evaluated for diverse conservation objectives under IM. The sensitivity of diverse benthic habitats to disturbance will be synthesized to produce reference points on the limits to disturbance for a range of anthropogenic impacts. GIS methods will be evaluated with respect to the specific needs of marine spatial planning.

Contributions to socio- economic understanding of ecosystem goods and services, and forecasting of the impact of human activities

ICES is being increasingly asked for advice on management plans and mixed-fisheries interactions.

To allow ICES to carry out this advisory task, there is a need to develop an understanding of the behavioural responses/strategies of the users of ocean ecosystems. This requires more understanding on the social and economic motivations of ocean industries (e.g. fishers) than is currently the case. It requires a better understanding of how ecosystem goods and services are turned into “economic” value. This is an area where ICES needs stronger collaboration with organizations competent in the area of economics and sociology. In addition, efforts are underway within the ICES area that require marine science contributions to socio-economic understanding of ecosystem goods and services, and forecasting of the impact of human activities. Impact studies, and the evaluation of mitigation options, involve assessments of the resilience properties of marine ecosystems. The study of resilience includes the role of biodiversity at the species and genetic levels in ecosystem functioning. Such studies are related to ecosystem goods and services and to sustainable use of marine resources.

Many research projects have successfully combined biological and socio-economic expertise to address these types of questions. ICES needs to be actively engaged in this research and to make strategic linkages with relevant international organizations so that it can, within its area of competence, address the advisory questions of the future.

5 Delivery of Science Programme (2009–2013)

The 16 research topics summarized above are broad in scope and open-ended to a large degree. They are research topics that are likely to be of importance for a decade or more, and are presently being addressed by the broader international marine science community. ICES needs to define those aspects of the research topics for which it can make a significant contribution. In other words, it is necessary to define the specific ICES niche, based on organizational strengths and accepting limitations. The primary components of the ICES science activities are coordination and synthesis. In recent decades, with the exception of a few initiatives such as the North Atlantic GLOBEC Office and the BONUS secretariat, there has been no funding within ICES dedicated to the delivery of larger research programmes. It is important to note that ICES does not itself carry out research, but rather coordinates, provides synthesis on topical issues, and contributes specific requested products to the advisory process.

The delivery process of the science programme can be considered under three headings:

- provision of leadership at the European and North Atlantic scale to expand the financial support for research that is a priority to ICES (enhanced research coordination)
- increased efficiency and focus of the extant ICES science capacity with respect to addressing the strategic priorities and shorter term needs (improved governance)
- expanded ICES science capacity in a directed manner to address specific gaps, through engagement of scientists from the academic community and relevant ministries in the member countries, as well as through partnerships (enhanced science capacity)

5.1 Enhanced Research Coordination in the North Atlantic

With close to 100 scientific working groups with membership from 20 countries, ICES expertise covers the full range of marine scientific disciplines in the North Atlantic. Further, with a focus on the provision of sound science in support of sound ocean management, ICES scientists are acutely aware of the most urgent marine and fisheries research challenges facing Europe and North America. ICES is committed to work collaboratively with the broader research community and funding agencies to develop research programmes and coordinate research activities, which address the most critical social and ecological concerns particularly of a broad and multidisciplinary nature.

Toward this end, ICES should promote partnerships and dialogue with clients, the research community, funding agencies and stakeholders. It is expected that the ICES Secretariat will be instrumental in coordinating these activities.

Notably, because the ICES community spans the entire North Atlantic, ICES scientists are keenly aware of broad-scale issues including the effects of climate change on fish stocks and other biota, and these broad-scale issues are a major focus of ICES science. As research programmes are developed to address these issues, North American and European ICES colleagues should have expanded possibilities to establish trans-Atlantic research collaborations, which will promote transfer of information and technologies, comparative ecosystem analyses, and research of a pan-Atlantic and global nature.

It is emphasized that ICES in no way intends to compete for funds that might otherwise be available to laboratories in ICES member countries. Its objective is to increase the total amount of funding available to the ICES scientific community, to encourage the available funding to be used more effectively and ultimately to serve society. Identifying and promoting research priorities and

authoritative research strategies with positive expected net benefits should increase the amount of funding. Adding value to research conducted by scientists and laboratories of ICES member countries by coordinating activities or providing support (e.g., managing databases, publishing results) should make the research more effective. Existing ICES attributes and infrastructure which particularly underpin ICES leadership potential in this respect include:

- ICES as a premier network for North Atlantic marine and fisheries science;
- ICES support of an ecosystem approach to research and management;
- ICES support of integrated ecosystem assessments;
- Over 100 Expert Groups covering a broad suite of research disciplines, regional ecosystems, methodologies and technologies;
- Extensive oceanographic and marine biological databases;
- Extensive administrative and technical support; a journal and several publications, for the dissemination of announcements, research communications, as well as voluminous research reports;
- Websites to serve as a public interface with constituents and internally for project coordination and data exchange.

Through ICES enhanced engagement in identifying priority research in the North Atlantic and communicating this to the ICES community, it is expected that the scientific issues of greatest concern will be addressed more expediently than is currently the case. Moreover, as a coordinator especially of international, multidisciplinary research, it is expected that ICES will improve the efficiency of operations and speed the delivery of research products. Most importantly, ICES will directly promote the research which most strongly supports the ICES Science Strategy. The net result of these actions will be to improve the quality and credibility of ICES science, to broaden its scope, and to reinvigorate the scientific foundation of ICES advice.

5.2 New Governance of ICES Science

The challenge for ICES in delivering the science programme for 2009–2013 (and future years) is to create a balance between the ongoing shorter term activities in support of the immediate needs of the advisory process, and of the 16 strategic research priorities of a longer term nature (which are of critical importance to the quality and timeliness of future advice). This challenge requires more flexibility within the ICES science structure, and improved coordination across organizational units (EGs, Sub-Committees, and Programmes). The Science Committee of ICES has been tasked with this challenge.

There will be national representation in the Science Committee, which will be empowered to create and dissolve organizational units as required to facilitate delivery of the science activities. National representation should enhance the involvement of the delegates in the "science pillar" in a manner parallel to their engagement with ACOM and the "advisory pillar".

The Committee will prepare an implementation plan during 2009. The general approach is to make realistic progress on all 16 of the thematic areas, but to provide particular focus on several cross-disciplinary topics (such as climate change impacts, and spatial planning/MPAs). Programme Steering Groups are to be created for such horizontal issues in order to manage in a coordinated manner the diverse activities within and amongst relevant EGs. Development of a coding scheme for the Terms of Reference (ToRs) is underway to allow more efficient tracking of work done in relation to specific

goals of the implementation plan and the advisory requests. The empowered Science Committee is expected to play a greater leadership role, with direct links to the member countries and the delegates.

5.3 Enhanced Science Capacity

In addition to the improvements in the governance of the science activities of the existing ICES community (which is recognized to be in a state of flux in an ongoing manner), it is anticipated that there will be a need to fill important gaps in disciplinary expertise, and to develop strategic partnerships at the institutional level.

Some of the expertise needed will be within the academic community and other ministries of the member countries (which may not have a tradition of ICES participation). In addition, the new governance of ICES Science will require greater involvement and participation by EG Chairs to ensure effective implementation of the Science Plan. It is on both these fronts that a stronger role of the delegates is required.

Strategic partnerships for the 16 research topics are an additional requirement for enhanced capacity for effective delivery. Comments on the types of partnerships envisioned are provided for two potential programmes on horizontal issues. For climate change impacts, the expertise needed to compliment ICES involves the physical oceanographic modelling community that is developing future scenarios on North Atlantic and Arctic Ocean scale circulation and mixing properties, and how the predicted basin scale patterns and processes will influence the oceanographic conditions on shelf seas and the coastal zone. For partnerships related to spatial planning/MPAs discussions with the ongoing initiatives with the EU, CIESM, and PICES will be required. This is an active area of research within marine ecology and conservation biology, with several national and international initiatives underway. ICES has multiple strengths as a partner, given the rich data sets and existing multi-disciplinary expertise. The close linkage between research and advice within ICES ensures a pragmatic approach.

The Science Committee will address in a systematic manner the need and potential benefits of partnerships in the delivery of the science programme (including the core activities and the thematic areas of research).