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DRAFT Overview of ICES work in relation to Marine Area Based Management and Spatial Planning

Input from Expert Groups

11/15/2011

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1 Overview of the Strategic Initiative on Area Based Science and Management (SIASM)

1.1 Background information on SIASM

This is a Joint SCICOM/ACOM Initative with the main objective to demonstrate to ICES clients, Member States (MS), stakeholders and to ICES itself that ICES has the expertise and facilities to deliver solid, robust and independent science and advice on marine area based management and spatial planning.

In March 2011 following a request from SIASM, the Chair of SCICOM and ACOM added the following Terms of Reference (TORs) to all Expert Groups (EGs) during 2011:

- take note of and comment on the Report of the Workshop on the Science for area-based management: Coastal and Marine Spatial Planning in Practice (WKCMSP) http://www.ices.dk/reports/SSGHIE/2011/WKCMSP11.pdf
- provide information that could be used in setting pressure indicators that would complement biodiversity indicators currently being developed by the Strategic Initiative on Biodiversity Advice and Science (SIBAS). Particular consideration should be given to assessing the impacts of very large renewable energy plans with a view to identifying/predicting potentially catastrophic outcomes.
- identify spatially resolved data, for e.g. spawning grounds, fishery activity, habitats, etc.

1.2 Scope of the Report

The aim of this report is to give an account of the ongoing work being carried out by ICES Expert Groups and the ICES community that is relevant to Member States in relation to Marine Area Based Management and Spatial Planning (MSP). Based on the responses received from the EGs it appears that a substantial body of current and planned work and research is being undertaken which has the potential to contribute to the delivery of MSP.

Given the broad range of relevant work identified by the EGs, it was considered best to structure the report around the following issues:

- Comments on the 2011 WKCMSP Report;
- Pressure indicators and assessing the impacts from renewable energy plans; and
- Identification of spatially resolved data.

1.3 Acknowledgements

This report is predominantly the work of ICES Experts Groups and their Chairs in response to the Terms of Reference provided by the SCICOM and ACOM Chairs. The work of Eavan Mongey and Christina Kelly, both of the Marine Institute, Ireland, in compiling and editing relevant sections of the Expert Group Reports is acknowledged.

1.4 Disclaimer

The content of this report and any views and opinions expressed are those from individual Expert Groups and do not represent the view of, or advice from, ICES unless otherwise stated. This report is intended to identify the broad range of work being undertaken within the ICES network and to provide an opportunity to anyone interested to follow up and seek further information. For the moment it will remain in Draft Form so as to allow the Experts Groups provide feedback or additional comments and should be seen as a living, evolving document.

2 Expert Groups Responses

2.1 Responses received and included in this draft

At the time of preparing this report, 48 EGs had published their 2011 workshop reports on the ICES website[1]. Out of these 48 reports, 22 groups (46%) made specific reference to the SIASM terms of reference. The EGs who responded were are shaded in the table below:

Acronym	Group	Chair
AFWG	Arctic Fisheries Working Group	Bjarte Bogstad (Norway)
BEWG	Benthos Ecology Working Group	Steven Degraer (Belgium)
HAWG	Herring Assessment Working Group for the Area South of 62˚N	Maurice Clarke (Irl) & Lotte Worsøe Clausen (Dk)
IBTSWG	International Bottom Trawl Survey Working Group	Francisco Velasco (Spain)
NWWG	North Western Working Group	Guðmundur Þórðarson (Iceland)
SGEH	SG for the Development of Integrated Monitoring and Assessment of Ecosystem health in the Baltic Sea	Kari Lehtonen (Finland)
SGIMC	Study Group on Integrated Monitoring of Contaminants and Biological Effects	Ian M. Davies (UK) & Dick Vethaak (Nl)
SGIMM	Study Group on Integration of Economics, Stock Assessment and Fisheries Management	Rasmus Nielsen (Dk) & Jorn Schmidt (Germany)
SGWTE	Study Group on Environmental impacts of Wave and Tidal Energy	Michael Bell (UK)
WGBAST	Working Group on Baltic salmon and Sea Trout	Johan Dannewitz (Sweden)
WGBFAS	Baltic Fisheries Assessment Working Group	Michele Casini (Sweden)
WGBIFS	Baltic International Fish Survey Working Group	Henrik Degel (Dk)
WGBOSV	ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors	Tracy McCollin (UK)
WGCRAN	Working Group on Crangon fisheries and life history	Ingrid Tulp (The Netherlands)
WGDIM	Working Group on Data and Information Management	Helge Sagen (No) & Ingeborg de Boois (Nl)
WGECO	Working Group on the Ecosystem Affects of Fishing Activities	David Reid (Ireland)
WGEEL	Working Group Eel	Russell Poole (Irl) & Cedric Briand (Fr)
WGEXT	WG on the Effects of Extraction of Marine Sediments on the Marine Ecosystem	David Carlin (UK)

[1] http://www.ices.dk/workinggroups/WorkingGroups.aspx

WGFAST	Working Group on Fisheries Acoustics, Science and Technology	Nils Olav Handegard (Norway)
WGHABD	ICES – IOC Working Group on Harmful Algal Bloom Dynamics	Joe Silke (Ireland)
WGHMM	Working Group on Hake, Monk and Megrim	Carmen Fernández (Spain)
WGITMO	ICES Working Group on Introduction and Transfers of Marine Organisms	Henn Ojaveer (Estonia)
WGMASC	Working Group on Marine Shellfish Culture	Pauline Kamermans (The Netherlands)
WGMEGS	Working Group on Mackerel and Horse mackerel Egg Survey	Jens Ulleweit (Germany)
WGMHM	Working Group on Marine Habitat Mapping	Jacques Populus (France)
WGMPCZ	Working Group for Marine Planning and Coastal Zone Management	Andreas Kannen (Germany)
WGNAS	Working Group on North Atlantic Salmon	Gérard Chaput, (Canada)
WGNSSK	WG on the Assessment of Demersal Stocks in the North Sea and Skagerrak	Clara Ulrich (Denmark) & Ewen Bell (UK)
WGPME	Steering Group on Ecosystem Functions	William K. W. Li (Can) & X. Anxelu G. Morán (Sp)
WKISS	Workshop on the Implications of Stock Structure	Niels Hintzen (NI) & Martin Lindegren (Denmark)

3 Comments on the 2011 WKCMSP Report

The Study Group on Environmental Impacts of Wave and Tidal Energy (SGWTE) acknowledge that although deployment of large scale wave and tidal arrays is a few years in the future in ICES member nations, they agreed that representatives of the wave and tidal energy sector need to be linked into all the SIASM activities to ensure that their perspective is included [8]. To a large extent SGWTE believe that the science needs required to progress planning and consenting of developing wave and tidal energy are similar to those required for CMSP – and thus they strongly endorse any measures which promote easy access to data for all parties and the further development of decision tools to promote sustainable development of the coastal zone. In addition, the SGWTE essentially agree with the conclusions of the Lisbon workshop supporting the continuation of ICES initiatives for SIASM, not least because of the increasing intensity and frequency of issues arising from trans-boundary and cumulative impacts of development in ICES member nations' coastal zone [8].

The Baltic Fisheries Assessment Working Group (WGBFAS) endorse the work undertaken by the Strategic Initiative Group on Marine Spatial Planning (STIG-MSP) and the conclusions reached at the WKCMSP [12].

The Working Group on the Ecosystem Effects of Fishing Activities (WGECO) reviewed the WKCMSP report and noted that WKCMSP captured the majority of the main issues and data/research gaps surrounding the practical implementation of MSP [2]. They noted that many of the points described in the report represent some of the main challenges facing scientists and managers today. WGECO identifies a number of areas where ICES, with the regional and ecological focus and the networks and logistical capacity of the organisation, is in a unique position to make a substantial contribution to MSP science, development and evaluation. However, WGECO advise that ICES should also acknowledge that WKCMSP is not a starting point for MSP science in general and should ensure that any initiatives are of added value in relation to already mature research and policy processes, and that planned activities are aligned with the expected needs of society and the research communities that are already developing the science related to MSP and related fields.

WGECO recognise that the assessment of cumulative impacts is a general demand in the MSP process and it was identified within the report as one of the key scientific gaps. WGECO also highlights that cumulative impacts are sometimes described as the sum of the number of impacts observed, while the term is also used to describe the combined impact of multiple pressures over space and time, the latter interpretation taking account of interactions between impacts that may have synergistic, antagonistic or additive effects. WGECO highlight that antagonism is a cumulative impact value lower than the sum of individual impacts, and synergy is a value greater than the sum of individual impacts. As a consequence, WGECO has adopted the latter interpretation of the term 'cumulative' [2].

WGECO refer to a recent report by HELCOM in 2010 whereby a well documented approach was presented that, based on the Halpern et al. [20] method, assesses human pressures and impacts on the Baltic Sea marine environment. However, WGECO noted that the work describes additive pressures, i.e. it does not take account of any interactions between these pressures. In practice, they consider that this may result in the development of management measures in the Baltic Sea that do not address the true nature of pressures at sea. Consequently, WGECO state that there is a clear gap in the scientific knowledge base on how to detect and evaluate such interactions between pressures, despite the fact that Darling and Côté [21] conclude that synergistic effects generally are more common than additive ones. The lack of clear separation and definitions of what is meant by cumulative impacts calls for the development of practical guidance for their assessment within MSP.

Often the availability of necessary spatial data is not aligned with ongoing spatial planning initiatives. This is partly due to the planning process, where often scientists, stakeholders and planners are not involved at the same time, but rather consulted when demand arises. WGECO recognizes the potential role of ICES to improve the coordination of provision of spatially resolved data.

The Arctic Fisheries Working Group (AFWG) endorses the work undertaken by the Strategic Initiative Group on Marine Spatial Planning (STIG-MSP) and the conclusions reached at the WKCMSP [18].

4 Pressure Indicators

The Baltic International Fish Survey Working Group (WGBIFS) evaluated the usability of data stored in the DATRAS database for setting pressure indicators that would complement biodiversity indicators.

It is reported that the BITS manual describes all processes during the working up of the catch as well as the parameters which have to be sampled for the different species [6].

It was agreed by WGBIFS that participating countries submit all data in DATRAS exchange format to the ICES Secretariat in Copenhagen.

WGBIFS agreed that the availability of data in the DATRAS database of all species captured during the BITS with at least cpue (number of caught individuals per time) and the length frequency based on subsamples can improve the usability of the BITS in relation to the ecosystem analyses.

WGNAS has reported that they have the capacity to document the spatial locations of Atlantic Salmon rivers as well as information on timing of migrations between rivers and estuaries of specific river stocks throughout the species distributional range [7]. Status of river-specific stocks is

documented annually and this could be used as a pressure indicator that Descriptor 3 of the MSFD. For this, it is noted by WGNAS that reference could be made to the database of Atlantic Salmon rivers in the North Atlantic which has been compiled by North Atlantic Salmon Conservation Organization (NASCO) based on inputs from countries of the North Atlantic. Recently, it is reported that work has been undertaken to rescue and secure tag and recovery data of Atlantic salmon in the North Atlantic, the data being geo-referenced and time stamped [7]. In the next few years, WGNAS note that extensive data on post-smolt migrations and distributions at sea will become available through the SALSEA-MERGE initiative in the Northeast Atlantic.

A scientific perspective on the development of integrated marine management using marine spatial planning

WGECO acknowledge [2] that one of the strengths of MSP is the ability to integrate the management of a diverse range of human activities and hence their associated pressures to achieve the higher-level objectives of healthy ecosystems, sustainable use, and the delivery of ecosystem goods and services.

Furthermore, WGECO cite references where it is highlighted that single sectors and their spatial use conflict with other sectors or marine conservation measures have driven most marine spatial planning initiatives around the world. In practice, they note that ICES reported in 2010 that MSP initiatives that are based on strategic environmental assessments generally result in specialised technical management approaches that lack the environmental context in terms of its contribution to cumulative effects. Thus there are only a few examples such as the Large Ocean Management Plans in Canada (www.dfo-mpo.gc.ca) where ecologically and biologically significant areas have been defined together with social, cultural, and economic overviews for several oceans and coastal management areas. As a means to validate risk-based decision-making, WGECO report that a compendium of ecosystem vulnerabilities, geospatial analysis tools, a definition of ecosystem zone of influence and regional vulnerabilities profiles are being piloted in relevant coastal zones.

In general, risk based decision-making is a process that organises information about the possibility for one or more unwanted outcomes to occur into a broad, orderly structure that helps decision-makers make more informed management choices. WGECO recognises the need to provide the science base such as activity-pressure-state relationships into risk-based decision-making in spatial planning processes.

It is the opinion of WGECO that often one of the main obstacles with regard to integrated marine management is the lack of relevant knowledge, information, and data [2]. However, they do acknowledge that data and knowledge are never complete at the beginning of a MSP process. Nonetheless, WGECO note that thanks to recent advances in spatially explicit tools for mapping and visualization of the distribution of pressures those outputs can be provided to planners. As a marine spatial plan describes the spatial and temporal allocation of resource use, it is crucial to assess the uncertainty associated with the data used. Beyond the issue of incorporating uncertainty in a decision-making process and accounting for the accumulation of the latter, the EG recognise that it is also critical to visualise the uncertainty associated with the outcomes of possible spatial management scenarios. Thus the development of spatial management scenarios to support marine planning requires a spatially explicit framework that incorporates various sources of uncertainty. For

instance, WGECO make reference to Walker *et al*. (2003) who described three sources of uncertainty in any model-based decision support tool. Uncertainty can be related to location (where the uncertainty occurs in the model complex), level (where the uncertainty occurs on the gradient between knowledge and ignorance), and nature (whether uncertainty is due to knowledge gaps or to the variability inherent in the system). Thus the quantification of uncertainty is an important element in a risk-based decision framework [2].

The use of activity-pressure-state relationships in marine spatial planning

According to WGECO, inherent within the context of MSP is the need for a clear understanding of the relationship between activities, pressures and environmental state (condition), and the spatial distribution of environmental components [2]. Furthermore, pressures arising from human activities in the marine environment have been identified such as offshore renewable, but the relationship between pressures and state is less clear. Changes in state depend on the type of habitat, nature, extent and frequency of the pressure, and the resilience (recovery time) of its characteristic species.

High level objectives focus on the state of the system however management is targeted at the activities and hence WGECO advise that there is a critical need to understand how changes in activity levels brought about by management will result in changes in the state. The total level of pressure is a combination of the pressure arising from each of the sectors. One of the key strengths of MSP is that it provides a framework to combine these effects. Human activities are the only aspect of these ecosystems that can be managed and traditionally management has been applied on a sector by sector basis. Therefore WGECO recommend that the emphasis of MSP should be to integrate spatial management of sectors to take account of cumulative impacts of their activities [2].

WGECO make reference to current EU projects examining cumulative impacts of human activities in the marine environment and the relationship between activity-pressure-state including MESMA and ODEMM in the context of the MSFD. Drawing upon these projects, WGECO note that Figure 1 presents an adapted framework that may be suitable for adoption for MSP within the context of EBM. This framework would allow integration of activity-pressure-state relationships from the different sectors to inform area based management through MSP to achieve high level objectives [2].

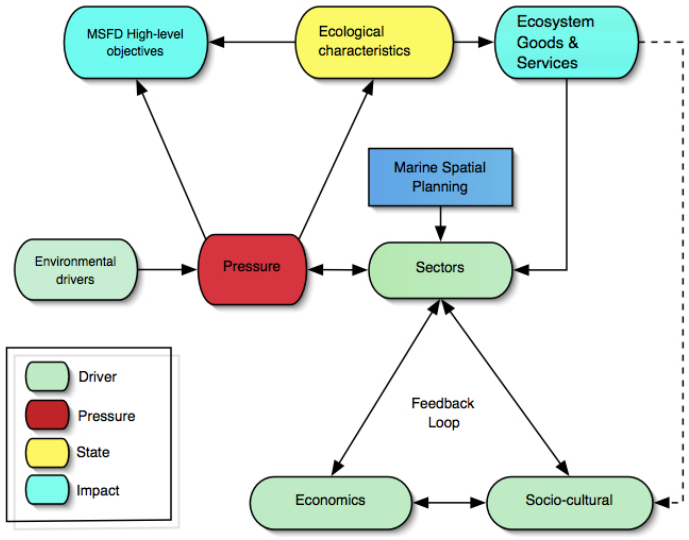

Figure 1: Potential framework for marine spatial planning in the context of ecosystem based management drawing upon the ODEMM Linkage Framework (EU FP7 Project, Grant number 244273). High level objectives (e.g. healthy ecosystems and sustainable use) focus on the state of the system and feed in through MSP (blue box); management measures focus on the sectors (human activities)[2].

The framework acknowledges that linkages between components (human and environmental) are interrelated and multi-directional. State of ecosystem components and the ecosystem goods and services (EGSs) they provide is affected both directly and indirectly by environmental, socio-cultural and economic components. The framework is dynamic and MSP should take account of changes in the strength of contribution to pressures over time. Guidance on the MSP process (e.g. selection, mapping and assessment of ecosystem components and indicators related to operational objectives, evaluation of management effectiveness, adaptative management; MESMA project) could be used to compliment this framework. Emphasis through MSP should be on appropriate spatial management of sectors to take account of cumulative activities and activities. WGECO have developed an example case study of large renewable energy developments to consider potential pressures and associated impacts of these pressures on habitat biodiversity which is referred to in the following section.

4.1 Potential impacts from Renewable Energy Projects

In terms of the potential impacts of renewal energy plans, WGNAS highlight that these have been raised by NASCO with a question to ICES. In the context of Atlantic salmon, WGNAS report that the impacts of renewal energy installations are important and are a growing threat to salmon, and the information provided in their report is a preliminary look at the question [7]. In addition ICES provided advice in response to the OSPAR request regarding the environmental interactions of wave and tidal energy generation devices [22].

WGNAS noted that there was extensive information available on fish pass design and that improving fish passage had contributed to sustaining and recovering wild salmon populations. In addition, the technology available for upstream fish passage is often more advanced than that available for downstream passage. However, scientific evaluation was often absent or inadequate. It was

recognized that fishways are never 100% effective, so a proportion of the migrating population is typically lost at each such structure. In rivers with multiple passes/barriers this can have substantial negative cumulative effects resulting in few spawners reaching the nursery areas and/or few smolts reaching the sea.

The Working Group recognised that careful design, adequate water supply and proper maintenance were crucial to well functioning fishways. Where this was possible, the removal of dams had provided some positive examples of restoration, and complete removal of obstructions offered the best solutions for upstream and downstream movements of aquatic species without delays or mortality. However, WGNAS concluded that there were many more examples of poorly designed and inefficient technical fishways where problems persisted with insufficient studies on the effectiveness of such structures [7].

SGWTE report that SIBAS biodiversity indicators are not currently available, albeit it is possible to identify the main pressure indicators arising from wave and tidal energy developments. This might include the nature of development, how much development is occurring and where, and the amount of energy generated [8].

In this context, it is the opinion of SGWTE that catastrophic outcomes of wave and tidal energy developments might include major changes in tidal amplitudes at coastal locations. Therefore it will be important to identify trade-offs between the magnitude of change and the levels of energy extracted. Changes in the abundance of priority species could occur if energy extraction causes systemic far-field effects on mixing structure and circulation patterns, affecting ecological connectivity and trophic linkages. Direct effects on protected species might also occur through collision, noise and disturbance. In practice, Strategic Environmental Assessments (SEAs), Environmental Impact Assessments (EIAs) and Appropriate Assessments (AAs) should work towards preventing catastrophic outcomes. In accordance with SGWTE, there are, however, weaknesses in these processes in the degree to which trans-boundary effects are addressed. Cumulative effects may occur at an international scale because many species are wide-ranging. Cumulative effects combining across wave, tidal and wind developments are also not properly addressed, highlighting the need for an integrated consideration of marine renewable energy as a whole. In general, SGWTE recognise that interactive and cumulative multisectoral pressures are potentially problematic, but there is scope for trade-offs, enhancements and synergies to be identified [8].

WGECO note that in recent years the rate of development of renewable energy projects has increased. They consider that the major policy driver for development of the renewable energy sector is the EU Renewable Energy Directive (2009). As a result, renewable energy developments will continue to increase in number as MS work to meet individual targets. The scale of proposals, particularly in the offshore wind sector, in terms of size (number of turbines, total area) and energy outputs as a result of technological developments is also increasing. WGECO refer to examples of existing and proposed large renewable energy developments in Denmark, Germany and the UK [2].

All renewable energy projects have the potential to apply pressures on marine components and associated changes in state. Key issues identified for consideration for large-scale proposals include:

- Scale of the proposal (unprecedented size);
- Transboundary impacts (consultation required with other Member States);

- Cumulative impacts with other developments in the area;
- Ecological impacts (construction and operation);
- Construction noise impacts;
- Socio-economic impacts (fishing and other uses/users); and
- Archaeology (disturbance to known/unknown archaeological sites).

WGECO have identified a range of genetic pressures which large renewable developments may exert on the marine environment during construction and operational phases. The main ecosystem components likely to be affected are birds, marine mammals, marine habitats and their characteristic species, functions and processes. Whilst some pressures are common to all offshore renewable activities, e.g. the potential for smothering, substratum loss, siltation and underwater noise during construction, other pressures are activity and phase (construction or operational) specific. WGECO have summarised the potential pressures in Table2 as follows:

Table 1: Indicative list of potential generic pressures associated with offshore renewable activities (wind, WF; wave, W; tidal, T); pressures are common to all activities unless indicated. This table draws upon other research (e.g. ICES 2010; ODEMM) but is not a comprehensive list of pressures. Note that the nature, extent or frequency of pressure is not inferred [2].

	Phase	
Pressure type	Construction	Operational
Physical	Smothering Substrata loss (or change) Siltation Abrasion Underwater noise	Siltation (W, T) Underwater noise
Hydrological		Changes in water flow rate
Biological	Death/injury through collision	Barrier to species movement Death/injury through collision
Other	Introduction of synthetic and non-synthetic compounds	Electro-magnetic changes (WF, W) Salinity changes (T)

Therefore a degree of change in habitat biodiversity will be one of the main results of the use of renewable energy projects. Physical habitats respond to human pressures in a fundamentally different way to the biotic components of the system. *In extremis* a biological species can be extirpated, with consequences for community composition and biodiversity measures, but in general affected biotic components retain an ability to recover (resilience).

WGECO use a hypothetical example to illustrate the complexity of trying to link pressures and changes in habitat biodiversity [2]. As a result, they conclude that for any given spatial planning initiative the amount of change in pressures and related impacts on the habitat is regulated to meet the defined operational objectives. High-level management goals need to be translated into operational objectives to allow the elaboration of specific targets, limits and measures. Operational objectives are defined as those for which specific, measureable, achievable, realistic and time limited (SMART) targets can be set such that management measures can be fitted and performance can be

evaluated. Operational objectives aim to implement the overall goal of the spatial plan such as e.g. the promotion of offshore renewables.

In summary, WGECO highlights the need to develop and incorporate activity-pressure-state relationships in operational objectives for MSP to support risk-based decision-making. Based on the activity-pressure-state relationship, pressure indicators in relation to renewable energy developments incorporate the magnitude, spatial extent and frequency of the underlying activities. WGECO recognizes that the acceptable level of change in such pressure indicators and the related combined impacts on biodiversity indicators such as habitat biodiversity may be able to be estimated locally based on current scientific knowledge. However, the extent to which known activity-pressure-state relationships at a local scale can be extrapolated to a regional level is not clear. Integrated marine management using MSP facilitates a holistic assessment of activity-pressure-state relationships within a planning area [2].

The Benthos Ecology Working Group (BEWG) suggest that the Red List that has been developed by many countries for their marine areas should be used for assessing which species or habitats need protected. An initiative is planned by BEWG to prepare a Red List for the whole North Sea [13]. In the Baltic Sea it is reported that Helcom started a similar project already where some BEWG members contribute (to be finalized in 2012).

The BEWG has not investigated species or habitats that need protection, key indicators or carrying capacity analysis for assessing the effects of large renewable energy plans on benthic systems yet. The BEWG will initiate a workshop on the topic of impact on benthos by the upcoming large renewable energy plans.

Nonetheless, BEWG highlight that from the MESMA project, a paper is being prepared, related to habitats and MSP:

> Salomidi, M., S. Katsanevakis, Á. Borja, U. Braeckman, D. Damalas, I. Galparsoro, R. Mifsud, S. Mirto, M. Pascual, C. Pipitone, M. Rabaut, V. Todorova, V. Vassilopoulou, T. Vega Fernández (in preparation). *Goods and services, vulnerability, and conservation status of European seabed biotopes: a stepping stone for ecosystem-based marine spatial management*. Mediterranean Marine Science [13].

Elsewhere, the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) could provide catch (by rectangle and quarter) and VMS (geo-referenced at different time intervals) data comprising information from fishing activities that can be used to set pressure indicators [15].

The Working Group on Fisheries Acoustics, Science and Technology (WGFAST) report that acoustics is particularly suited to do non intrusive sampling, and WGFAST have several contributions on using acoustics to address the effect of marine protected areas and the effect of hydro kinetic power plants. WGFAST added explicitly the need for contributions to further address this topic at their next 2012 meeting in Brest, France from 8–11 May 2012 [3]. Therefore they propose that at this meeting, in response to the ICES strategic plan 200–2013, WGFAST will document how acoustic and complementary methods will contribute to the goals of an ecosystem approach with benthic and pelagic observations to improve assessment and management of living marine resources,

understanding mechanisms and processes of change and stability, and parameterize and evaluate models of ecosystem structure and function.

It is the opinion of the Working Group on Crangon Fisheries and Life History (WGCRAN) that due to large renewable energy plans no catastrophic effects are expected for shrimps [16].

5 Spatial Data

WGBIFS will report on a request from WKCATDAT/WGISUR concerning the evaluation of the prioritized catalogue of potential data needs for the EAFM (Eco-system Approach to Fisheries Management at the next meeting. In addition it is noted that Latvia will prepare analyses of the hydro acoustic surveys according to the following issues and will present the results during the meeting of WGBIFS 2012 [6].

- Data on distribution of sprat and herring separately for different age groups (t=0;1,t ≥ 2);
- Data on spatial distribution of herring fishery for periods (months or sea-sons);
- Data on location of herring spawning grounds and nursery areas (such a data owns specialists from Lithuania);

The results can support the planning of further investigations for the development of rational fishery's methods, in order to avoid a negative impact on spawning grounds and nursery areas for juvenile fish [6].

WGNAS has reported that they have the capacity to document the spatial locations of Atlantic Salmon rivers as well as information on timing of migrations between rivers and estuaries of specific river stocks throughout the species distributional range [7].

SGWTE noted that data exists on the spatial extent of development and leasing areas and could be collated alongside other types of spatial data if required. There are also data model outcomes on the distribution of wave and tidal energy resources; such data tends to exist for large spatial scales, there being a lack of high quality information on the fine-scale distribution of resources at a site level [8].

The Working Group on Marine Shellfish Culture (WGMASC) has expertise on spatial planning of aquaculture: e.g. how to define the best locations to grow shellfish and ensure that planning applications are processed efficient and effectively (GIS based tools as an aid in the development of management areas). Furthermore, WGMASC confirm that case studies can be provided dealing with the relation between aquaculture and coastal and marine spatial planning. WGMASC recommends that SCICOM discuss this with SICMSP [9].

WGMASC also recognises the work of WGMPCZM, particularly in relation to sustainability indicators and Marine Protected Areas.

In their 2010 report WGMASC gives an overview of the information they have gathered over the years that is relevant to MSP and CZM including the publication 'An Ecosystem-Based Framework for

the Integrated Evaluation and Management of the Impacts of Shellfish Aquaculture Activities in the Coastal Zone'.

Future contributions of WGMASC can be providing examples and case studies to the SICMSP. In addition, expertise of the group can be used when information is needed on where shellfish can be grown and what the environmental impacts of those activities are. Updating available knowledge on decision support tools that can be used in spatial planning of aquaculture areas is another contribution [9].

The Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS) anticipates that it is unlikely that large offshore renewable energy plans will significantly impact the vast oceanic spawning areas of either mackerel or horse mackerel. WGMEGS produces spatially (and temporally) resolved data for both mackerel and horse mackerel spawning and has done this every three years since 1977 [11]. In addition, WGMEGS report that some environmental parameters such as sea surface temperature and salinity have often been obtained concurrently. In more recent years full CTD profiles are obtained at most sampling positions. On occasion various other parameters such as Chlorophyll 'a' fluorescence, turbidity, light attenuation and nutrient concentrations are also measured, which could help to describe the spawning habitat favoured by these species [11].

WGBFAS recognizes that the FishFrame data framework should in principle be the primary source for obtaining fisheries data (catch and effort) by country and at the spatial resolution of ICES rectangle or SD [12]. These can be extracted from FishFrame and are not directly used in the WGBFAS ordinary work. Other spatially-resolved data, from surveys, can be provided by WGBIFS or directly by ICES Data Centre.

WGBFAS also noted that individuals within the EG and their respective institutes may be able to identify and potentially provide a range of spatial data (catch and biological data) not directly connected to the formal assessments undertaken in WGBFAS, but to other national and international projects. A list of data could be provided, upon request, at the next year EG [12].

WGECO has identified gaps in availability and analysis of spatially resolved data which ICES has the potential to develop to support MSP. In identifying gaps WGECO explain that it is important for ICES to note that the marine planning arena brings together a wide spectrum of disciplines and the MSFD has made certain types of data (e.g. commercial fish and fisheries) relevant to a wider range of clients and stakeholders. As a result, outputs which might be perceived as simple or obvious to traditional ICES audiences may be considered extremely useful by these new audiences.

Gaps in availability and analyses of spatially resolved data are identified in Tables 8.3.1 and 8.3.2 included in the Appendix [2]. The tables comment on the scope and provision of such data and suggest the degree to which ICES could contribute to their development. Most of the gaps identified have relevance for the CFP, MSFD, N2K and MSP. These policies and processes all require spatially resolved data related to ecological components and processes as well as the distribution of activities and associated pressures.

The importance of having data at the appropriate scale is recognized. The resolution of data required for MSP will depend on the scale for which spatial management is applied. For instance, fishing effort data at the scale of ICES statistical rectangles would be appropriate to analyses on a

regional or subregional scale, while the resolution might be too low to be useful for spatial planning in smaller areas. Temporal scale is also of importance, as the particular natural processes and human activities may vary greatly over time and at different rates. Estimation of uncertainty in relation to spatially resolved data is a key gap in data from MSP.

Many of the gaps identified by WGECO are related to further development and new analyses of data held within ICES DataCentre. WGECO recommends that these data integrated more effectively and made available and disseminated in appropriate formats useful to data customers, and promoted to relevant stakeholders. WGECO also recommend that ICES could establish the links between data needs of MSP and the data collected via the DCF with the purpose of highlighting needs for further integration [2].

In relation to spatial data in the Barents Sea, the AFWG noted that many spatial resolved data sets exist [18]. In general they note that most data are available at the national institutes IMR and PINRO, but some data are also collected by other organisations (such as National fishing authorities, ICES and other national and international data centres).

Moreover, AFWG report that the most relevant data sets are derived from spatial sampling/reporting; from the fishing fleet (catches, effort, etc) and from data from scientific surveys (temperature, salinity, fish catches by length groups and derived parameters, as well as ecosystem parameters such as whales, seabird, pollution, zooplankton). In addition, satellites data are interesting spatial data sets (sea surface temperature, phytoplankton abundance etc).

Spatial data are also generated by reanalyses, numerical models and aggregated datasets. In particular AFWG report that IMR have just launched an aggregated spatial database for eco-system datasets in the Barents Sea, presently called “the FishExChange database”, with an open service mapping generator (see http://www.imr.no/fishexchange/fishexchangedatabase/nb-no). Status and survey reports also show the variety of spatial datasets (e.g. Stiansen *et al*. 2009, Aglen *et al*. WD03) show examples of the wide span of spatial available data.

Next year (2012) AFWG plan to start on a list of available spatial datasets, and where they are stored [18].

With regards to habitat maps, at present, to the knowledge of the BEWG, there are no such habitat maps available. However, the BEWG has formulated a group with the general goal of species distribution modelling and many ongoing projects are involved in the production of relevant maps [13].

The generation of such habitat maps will involve several steps including the following as recommended by BEWG:

- Identification of the relation between habitat and bottom community distribution including abundance, biomass and functional groups.
- Identification of the connection between fisheries pressure and impact on bottom community with focus on resilience and vulnerability of species and communities [13].

In addressing spatially resolved data WGNSSK has confirmed that they could provide the following information:

- IBTS data that contain spatially resolved survey catch data; the IBTS also includes information on hydrodynamic properties at the sampling stations. Nursery areas and spawning areas could be identified.
- It should possible to provide additional spatial information on effort, catches and discards utilising Logbook and VMS data. WGMIXFISH is one possible group that could deal with preparing a data call for this issue, given that international information for the North Sea is already being collected at the scale of the ICES division. A data workshop was to be organised by WGMIXFISH on August 30th 2011, where this may have been discussed more directly.
- Acoustic data originating from various surveys in the study area of WGNSSK can also help to map spawning aggregations [15].

The Working Group on the Assessment of Southern Shelf stocks of Hake, Monk and Megrim (WGHMM) noted the relevance of introducing spatial and ecosystem aspects in stock assessments. WGHMM is already using some stock assessment models (like Stock Synthesis or Gadget) that permit, *e.g.*, the incorporation of different spatial areas with movement between them, separate fish by sex, consider different growth patterns and, in the case of Gadget, predator-prey interactions. However, the assessments currently performed by this WG with those models do not yet incorporate these features, as doing so is complex, both in terms of methodological skills and data needs [14]. Until this happens, it is unlikely that this group can produce maps of *e.g.* spawning or recruitment areas, different from those coming originating directly from surveys, which should generally be better known to survey working groups (such as IBTSWG).

WGHMM noted that the type of 'more unique' knowledge it possessed in this area was probably in relation to fishing activity and, therefore, it was decided to provide a list of documents publicly available and known to WG members [14].

In Borja et al. (2011) population indicators of main commercially-exploited fish in ICES Division VIIIc were revised in relation to the level of pressure of the fishing activity. Fishing mortality is one of the traditionally precautionary limits in commercial fiac assessment. Spawning stock biomass and population age and size distribution are used also as indicators, to measure the health of the stock. These population variables are annually and routine calculated at the assessment WG. In this analysis, twelve of the higher commercial value stocks of the Bay of Biscay, over a period of 80 years, were studied. The results of the revision are presented in Table 3, in the Appendix.

Also, WGHMM refer to the data available from ICES, for bottom trawl surveys (http://datras.ices.dk/Data_products/EUIndicator.aspx), corresponding to the EVHOE (Evaluation Halieutique de l'Ouest de l'Europe) survey undertaken within the framework of the International Bottom Trawl Survey (IBTS), was used to calculate the proportion of large fish present [14].

WGHMM conclusions were that, even though several WG members have experience in the spatial information, there was no time to tackle these aspects within WGHMM . The WG considered that it was more realistic that those scientists could provide their contributions by participating in other meetings or workshops rather than through WGHMM itself. The relevance of introducing spatial and ecosystem aspects in stock assessments was highlighted as an important objective and WGHMM is already using some stock assessment models (like Stock Synthesis or Gadget) that permit, *e.g.*, the incorporation of different spatial areas with movement between them, separate fish by sex, consider

different growth patterns and, in the case of Gadget, predator-prey interactions. However, the assessments currently performed by this WG with those models do not yet incorporate these features, as doing so is complex, both in terms of methodological skills and data needs. Until this happens, it is unlikely that this group can produce maps of *e.g.* spawning or recruitment areas, different from those coming originating directly from surveys, which should generally be better known to survey working groups (such as IBTSWG). WGHMM noted that the type of "more unique" knowledge it possessed in this area was probably in relation to fishing activity and, therefore, it was decided to provide a list of documents publicly available and known to WG members. This list compiled during the meeting follows:

Abad E., A. Punzón, I. Preciado and R. Somavilla. 2008. Using GAMs to identify factors that affect *Eledone cirrhosa* CPUE of North Spanish bottom trawlers. Poster presented at the *XV Simpósio Ibérico de Estudos de Biologia Marinha*, Funchal, Madeira, Portugal, 9-13 September 2008.

Abad E., A. Punzón, J. Castro and J. Landa. 2007. Geographical distribution and seasonality of métiers targeting Monkfish in Northern Spain. Poster presented at the *ICES Annual Science Conference*, Helsinki (Finland), 17-21 September de 2007.

Abad, E., J. M. Bellido, A. Punzón, N. Pérez and M. A. Ámez.2005. Analysis of the trawl fleet spatial distribution during and post Prestige oil spill by GIS simulations and real data. Cantabrian and Spanish northwestern fisheries. Poster presented at the *ICES Annual Sci-ence Conference*, Aberdeen (UK), 20-24 September de 2005.

Abad, E, J. M. Bellido, A. Punzón. 2010. Transfer of fishing effort between areas and fishery units in Spanish fisheries as side effects of the prestige oil spill management measures. Ocean and Coastal management, 53: 107-113.

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Castro, J., Marín, M., Pierce, G.J. y Punzón, A. 2011. Identification of métiers of the Spanish set-longline fleet operating in non-Spanish European waters. *Fisheries Research*, 107: 100-111.

Castro, J., Marín, M., Costas, G., Abad, E., Punzón, A., Pereiro, J. y Vázquez, A. 2011. *ATLAS de las flotas de pesca españolas de aguas europeas atlánticas*. Temas de Oceanografía, nº 4. Instituto Español de Oceanografía. Ministerio de Ciencia e Innovación. 215 pp.

Iriondo A., Quincoces I., Santurtun, M., and Gonzalez, I. 2006. Northern hake landings per unit effort and abundance indices of Basque fleets operating in Sub-areas VI, VII and divisions VIIIa,b,d, in the period 1993-2005. Working Document presented at the WGHMM in Bil-bao (España).

Iriondo, A., Prellezo, R., Santurtún, M., García, D., Quincoces, I. Mugerza, E. 2010. A multivariate approach for metier definition: A case study of Basque Country trawlers. *Revista de Investigación Marina*, 17(6): 139-148

Lucio, P., Artetxe, A. and Santurtún, M. 2000. Deep-sea Fisheries in the Basque Country (Spain) in 1998-1999. Working document presented in the ICES Study Group on the Biology and Assessment of Deep-Sea Fisheries Resources. Copenhagen 4-10 February 2000

Lucio, P., Diez, G., Iriondo, A., Santurtun, M., Prellezo, R., Artetxe, A., and Quincoces, I. 2004. The deep-sea fisheries in the Basque country (Spain) in 2002-2003. Working document for the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources Copenhagen (Denmark). 18-24 February. 2004.

Lucio, P., Iriondo, A., Santurtún, M., Quincoces, I. and Artetxe, I. 2003. Notes on the spatial distribution of the Northern Hake catches by the Basque fleets in Sub-areas VI, VII and Divisions VIIIa,b,d in 1998-2002. Working Document for the ICES Working Group on Hake, Monkfish and Megrim. Copenhagen,14-23 May, 2003

Lucio, P., Quincoces, I., Iriondo, I., Santurtún, M. and Artetxe, I. 2003. Revision and update of the Northern Hake and Anglerfish landings per unit effort and abundance indices of the Basque fleets in Sub-areas VI, VII and Divisions VIIIa,b,d for the period 1993-2002. Work-ing Document for the ICES Working Group on Hake, Monkfish and Megrim. Copenha-gen,14-23 May, 2003.

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Lucio, P., Santurtún, M., Quincoces, I., Díez, G., Artetxe, I., and Iriondo, A. 2002. Overview on the Deep-sea fisheries in the Basque Country (Spain) in 1999-2001. Working Document for ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources. (Horta (Azores. Portugal), 4-10 April 2002.

Lucio, P., Santurtún, M, Quincoces, I., Iriondo, I. and Artetxe, I. 2003. The Basque Fishery on Sea Bass (*Dicentrarchus labrax*) in the Northeastern Atlantic waters in 2001-2002. Working Document for the ICES Study Group on Sea Bass. Lowestoft (England.UK), 18-22 August, 2003.

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Prellezo, R., Lazkano, I., Santurtun, M. and Iriondo, A. 2009. A Qualitative and Quantitative Analysis of Selection of Fishing Area by Basque Trawlers. *Fisheries Research*, 97.1-2.

Punzón, A., Trujillo, V., Castro, J., Perez, N., Bellido, J.M., Abad, E, Villamor, B. Abaunza, P. and Velasco, F. 2008. Closed area management taken after the 'Prestige' oil spill: effects on industrial fisheries. *JMBA2 - Biodiversity Records*, 10 pp.

Santurtún, M. Sagarminaga, Y., Lucio, P., Galparsoro I., Quincoces & Iriondo, A. 2004. Interan-nual trends in catches of squid (*Loligo* spp.) in the Bay of Biscay (ICES Div. VIIIa, b, d) dur-ing 2000 in relation to oceanographic features. ICES CM 2004/CC. Poster presented at the ICES Annual Scientific Conference in Vigo, September 2004.

WGFAST suggests that a training course in geostatistics is a powerful technique for analysing spatial data [3].

In the last decade the Working Group on Marine Habitat Mapping (WGMHM) acknowledge that the need to support marine spatial planning and integrated area based science has been steadily growing [4]. This development, they report, is also promoted by the implementation of the INSPIRE Directive (2007/2/EC), establishing the spatial infrastructure in Europe and the Marine Strategy Framework Directive (2008/56/EC) that necessitates an integrated, area based ecosystem approach.

In order to support the developments towards marine spatial planning and integrated area-based science, WGMHM report that the ICES Data Centre (ICES DATA CENTRE) in cooperation with STZ Geoinformatik in Rostock, has developed a web GIS system that can capture spatial layers including metadata and make them discoverable and accessible for all users. The web GIS developments within the ICES Data Centre are now capable of showing the WGMHM habitat map outlines and metadata. The ICES web GIS is a generic application designed to serve all of the ICES community, but it has added functionality for showing habitat map metadata related to a habitat map outline polygon. The ICES web GIS system was shown as a prototype system at the WGMHM 2011 meeting and was to be officially launched in June 2011.

WGMHM explains that the integrated viewer has some added functionality for habitat maps making it possible to select a polygon in one of the three layers generated for habitat maps (Modelled habitat maps, Surveyed habitats maps and Substrate maps) and display the related metadata. It has been important to use best practices and widely accepted standards in the system. The metadata are stored in the ISO19115/19139 format, but the required information has been kept to a minimum due to the wide scope of layers and uses expected in the system [4].

In addition WGMHM refers to progress on a number of international mapping programmes including:

- PREHAB – Spatial PREdiction of benthic HABitats in the Baltic Sea: incorporating anthropogenic pressures and economic valuation
- Swedish offshore bank survey
- National programme report for the Netherlands (MESMA)

- National programme report for UK-England [Regional Environmental Characterization Surveys (REC)]
- Predictive modelling of Laminarian kelp forests within the temperate waters of Brittany
- Seabed habitat mapping in support of marine renewable energy developments and Marine Protected Areas in Scottish waters

The WGCRAN report that spatially resolved data on the distribution of shrimps are available by various surveys. The fisheries activities can be approximated using the VMS data. Furthermore it is reported that additional spawning ground maps could be provided [16].

The Working Group on Data and Information Management (WGDIM) discussed the potential risks of data duplication in relation to the INSPIRE directive. Those routes, however, are often national, and within the 34 themes in the 3 annexes of the INSPIRE directive, there is considerable overlap with data that are routinely submitted to ICES. As a consequence of the potentially multiple routes of exchanging data at ICES, INSPIRE national portals and ultimately MSFD, there is an increased risk of the duplication of data. It is the opinion of WGDIM that individual datasets can become part of larger collections (e.g. through submission to one of the data systems as ICES), but may also be required to be submitted at a national level. Hence, when a dataset is submitted like this, it may be a major challenge to identify duplicates [5].

However, the work done on publishing data through the ICES Data Centre and by INSPIRE initiatives is considered by WGDIM to be more important than the issue of duplication (e.g. it is better to get data “out there” and run a risk of some duplication). WGDIM will monitor the issue of potential data duplication in ICES once the specific data submission activities with INSPIRE and MSFD become clearer.

The web GIS developments within the ICES Data Centre (ICES DC), is designed to serve all of the ICES community in publishing and sharing map layers and metadata. The ICES web GIS system was demonstrated as a prototype system at the WGDIM 2011 meeting and was to be officially launched in June 2011 [5].

6 General Comments and Recommendations from Expert Groups

The Working Group for Marine Planning and Coastal Zone Management (WGMPCZM) reported [1] that in 2009, UNESCO published a widely referenced step-by-step guide for MSP [19] which describes a series of steps designed to operationalise the MSP process. These steps were developed on the basis of a review of MSP initiatives from around the world. In this regard WGMPCZM extracted ‘good practice’ from the documented success and failure of practical international MSP experience. The proposed steps for MSP include:

- Establishing context and authority for marine spatial planning;
- Obtaining financial support for marine spatial planning;
- Organizing the process for marine spatial planning;
- Organizing stakeholder participation for marine spatial planning;
- Defining and analyzing existing conditions for marine spatial planning;
- Defining and analyzing future conditions for marine spatial planning;
- Preparing and approving the spatial management plan;

- Implementing and enforcing the spatial management plan;
- Monitoring and evaluating performance of the spatial management plan;
- Adapting the marine spatial management process.

WGMPCZM has identified [1] a number of relevant projects and case studies where MSP is being trialled. These projects include:

- Coastal Futures (2004–2010)
- MESMA (2009–2013)
- MASPNOSE (2010–2012)
- PLAN BOTHNIA (2011–2012)
- BaltSeaPlan (2009–2012)
- COEXIST (2010–2013)

And while a lot of good work is ongoing, WGMPCZM identified the following challenges:

- Legal challenges – MSP is subject to the legal limitations of the EEZ (as defined by UNCLOS); fisheries management is often not sufficiently addressed.
- Binding instruments are based on the sectoral approach - the lack of umbrella instruments can delay integration.
- Fragmented and/or overlapping jurisdiction in coastal and marine space is constraining the development of coherent policy.
- There is a lack of coordinated governance related to MSP in the EU.
- A purely spatial view of the sea is frequently applied - zoning alone cannot solve all of the issues to be addressed by MSP.
- Major weaknesses related to participation in the MSP process include transparency and representativeness.
- Conceptual limits – there is a significant amount of terminology associated with MSP which is subject to multiple interpretations (i.e. ecosystem approach, marine vs. maritime spatial planning).
- The link with ICZM is not strong enough.
- Lack of baseline information.
- Critical thresholds (or guidelines) are difficult to define.
- Science-policy gap (i.e. academic and policy systems are not compatible for information sharing, scientists and decision-makers often have different timelines).

Other case studies were reviewed including Canada and some European countries such as the UK and Scotland, Sweden etc.

It was decided by WGMPCZM to hold a joint session between WGMPCZM and STIG-MSP at the ASC 2012 and conduct a workshop on simulating the development of MSP for large scale hypothetical wind farm development as discussed within STIG-MSP during the Lisbon workshop to be held 2-4th November 2011.

MESMA

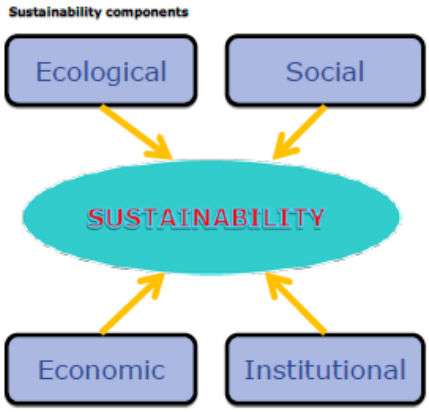
The Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) make reference to [10] the MESMA (Monitoring and Evaluation of Spatially Managed

Areas). This is a project funded under 7th EU Framework Program (www.mesma.org), started 1st November 2009. MESMA has 18 partners from 12 EU countries. MESMA focuses on marine spatial planning and aims to produce integrated management tools (concepts, models and guidelines) for monitoring, evaluation and implementation of Spatially Managed Areas (SMAs). The project will support the formalisation and implementation of EC policy and will also support integrated management plans for designated or proposed sites with assessment methods based on European collaboration [10].

MESMA covers all EU marine waters, including the ICES area. Within the project a number of case studies will be conducted to different human pressures such as fisheries, renewable energy, shipping, aquaculture and aggregate extraction. Both the information on aggregate activities as well as the stakeholder network build up within WGEXT will be of great interest to MESMA. Some partners of WGEXT are involved in the MESMA project and will play an important role in the transfer of information of the WGEXT into the project.

In terms of different multi-disciplinary types of sustainability, the Study Group on Integration of Economics, Stock Assessment and Fisheries Management (SGIMM) highlight that several directives indicate integrated approaches and integration into wider marine management. This includes taking into consideration other directives such as the EAFM (EU Ecosystem Based Approach to Fisheries Management) the Bird and Habitat Directive, the Water Framework Directive (WFD) and the MSFD. In this context SGIMM deem it necessary to define sustainability in a broader context considering different disciplines and to differentiate levels of sustainability (e.g. stock / ecosystem). Management objectives and reference points from e.g. international conventions needs to be transformed into operational management objectives and management strategies which again needs to be transformed into concrete management-strategy-reference-points for specific status-indicators with respect to defined sustainability in order to use models for MSE in relation to those. Ideally, the EG suggest that the full system of sustainability should be evaluated to ”dress” managers to make informed decisions based on a full overview so that they can politically choose between tradeoffs in a framework of different types of sustainability [17].

Biological Sustainability Criteria, according to SGIMM, used in ICES advice are nearly exclusively on the basis of single species and often on a single stock level. The criteria and reference points were related to stock size (SSB) and single stock fishing mortality (F) under the precautionary approach and are still in the new MSY framework. The criteria in relation to mixed fisheries are the same indictors and sustainability criteria (reference points) as for single species and stocks (which can be conflicting in mixed fisheries) without considering fleet and economic criteria. On the ecosystem level, SGIMM consider the criteria to be vague (even though Ecological Quality Elements and ECOQO’s are defined, Reference Points are most often not specifically defined, settled or made operational). However, there is work intensely done in ICES to define such indicators with the help of several external (e.g. EU) funded research projects [17].



SGIMM report that with respect to economical and sociological sustainability and criteria for this the current management (and associated advice) is in general not build up around fisheries economical and sociological advice. There are no well-defined operational management objectives in force and any well-defined management criteria and indicators set. The advice and management reference points and measures of performance are not well defined - and not implemented. At present the EU STECF mainly evaluates bio-economic consequences of different scenarios for traditional biological based sustainability on single species and single stock level. SGIMM highlight that some progress in EU STECF (e.g. SGMOS) and ICES (e.g. ICES WGMIXFISH) has been made in relation to exploratory modelling and evaluation but output from here is not fully implemented in advice and management.

Fishery is a main driver of the marine ecosystem (e.g. North Sea, Baltic Sea, Biscay, Mediterranean, NW Atlantic, etc) and fishery dynamics (multi-fleet) influence directly the ecological (multi-stock) sustainability. SGIMM suggest that fishery dynamics are very much based on economic considerations, e.g. in relation to levels of fleet capacity, dynamics in relation to revenues and costs, fleet and fisheries specific harvest patterns – e.g. mixed fisheries, behaviour patterns of different fisheries with respect to targeting and effort allocation associated to resource availability and reactions to regulations as well as other economic dynamics of fisheries. In existing ICES management advice fishing mortality, F, is mostly integrated as one overall parameter in stock evaluation not considering fleet specific partial F dynamics (fleets/fisheries/area/season). It is necessary, WGIMM advise, to analyse these at the fishery level and to evaluate their different impacts as integrated activities influenced by biology/ecosystem, economy, sociology and politics (regulations) in order to perform a holistic and integrated evaluation of tradeoffs of different management options in order to forecast potential consequences on a realistic basis.

When developing integrated approaches it is necessary to involve the main drivers influencing the dynamics of the system and to identify units and indicators as well as to establish functional relationships of the dynamics, and estimate parameters for the main drivers and indicators. This, SGIMM observe, is a multi-disciplinary exercise (biology, economy, sociology) that will call for use of integrated evaluation frameworks, tools and models capable of evaluating the integrated drivers and their parameters in multi-disciplinary context. Also, it will be necessary to involve parameters in advice enabling also future cross-sectoral and multi-sectoral evaluation and comparison of impact and benefits of various marine activities and management options. Consequently, EGIMMT advise that this should be done in relation to spatial planning, broader marine management issues and necessary risk assessment of different activities and options (Marine Strategy Framework Directive).

Here the economic parameters seems to be the platform for comparison of impacts - also to enable integration of stakeholder perspectives and their incentives – across sectors such as marine fishery, transport, energy (Oil, Wind-energy, Wave-energy, etc.), recreational use and tourism as well as in relation to environmental organizations protective wishes [17].

7 Overlap with Marine Strategy Framework Directive Terms of Reference

WGDIM report that the web GIS developments within the ICES Data Centre (ICES DC), are designed to serve all of the ICES community in publishing and sharing map layers and metadata. The ICES web GIS system was demonstrated as a prototype system at the WGDIM 2011 meeting and officially launched in June 2011.

WGDIM highlight that in the last decade the need to support marine spatial planning and integrated area based science has been steadily growing [5]. This development is also promoted by the implementation of the INSPIRE Directive (2007/2/EC), establishing the spatial infrastructure in Europe and the Marine Strategy Framework Directive (2008/56/EC) that necessitates an integrated, area based ecosystem approach.

WGMHM note that the use of habitat maps is beneficial both for the MSFD and MSP. In this context it is proposed that at the next WGMHM meeting to be held in 2012 in Germany, a review of practise about the use of habitat maps, and more specifically 'Mapping for the MSFD and marine spatial planning' will form part of their TOR [4].

WGHMM noted that assessment working group experts are owners of a large knowledge on population dynamics and manage data of fisheries and stocks highly useful for other purposes than stock assessment. Ecological status could be the next step to be undertaken under the ecosystem based approach. In this regard, WGHMM state that it is worth mentioning that in the MSFD and moving towards Marine Spatial Planning, fishing activity is still one of the main activities affecting the status of the ecosystems. Thus, there is a need of taking into account all knowledge deployed by assessment experts and put effort in offering useful data to experts working on these issues. Also, the experience gained after years of work of assessment scientist in relation to bridging management with advice should be considered [14].

As noted previously in the report, it is the opinion of SGIMM that when developing integrated approaches it is necessary to involve the main drivers influencing the dynamics of the system and to identify units and indicators as well as to establish functional relationships of the dynamics, and estimate parameters for the main drivers and indicators. This is a multi-disciplinary exercise (biology, economy, sociology) that will call for use of integrated evaluation frameworks, tools and models capable of evaluating the integrated drivers and their parameters in multi-disciplinary context. Also, it will be necessary to involve parameters in advice enabling also future cross-sectoral and multi-sectoral evaluation and comparison of impact and benefits of various marine activities and management options. This, SGIMM recommend, should be done in relation to spatial planning, broader marine management issues and necessary risk assessment of different activities and options (Marine Strategy Framework Directive). Here the economic parameters seems to be the platform for

comparison of impacts - also to enable integration of stakeholder perspectives and their incentives – across sectors such as marine fishery, transport, energy (Oil, Wind-energy, Wave-energy, etc.), recreational use and tourism as well as in relation to environmental organizations protective wishes [17].

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[2] ICES Advisory Committee (2011). *Report of the Working Group on the Ecosystem Effects of Fishing Activities (WGECO)*. ICES CM 2011/ACOM:24. [Online] Available at: http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=23. (Accessed: 26 August 2011)

[3] SCICOM Steering Group on Ecosystem Surveys Science and Technology (2011). *Report of the Working Group on Fisheries Acoustic Science & Technology (WGFAST)*. ICES CM 2011/SSGESST:12. [Online] Available at: http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=141. (Accessed: 29 August 2011)

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[7] ICES Advisory Committee (2011). *Report of the Working Group on North Atlantic Salmon (WGNAS).* ICES 2011/ACOM:09 [Online] Available at: http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=35 (Accessed: 08 September 2011)

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9 Appendix

Table 1: Gaps in availability of spatially resolved data identified by WGECO.

Category of spatially resolved DATA	Subcategory	Comments/scope for ICES
Fish habitats	Spawning & nursery areas	ICES could produce species "fact sheets" and downloadable GIS files to provide state-of-the-art spatial information on the spawning and nursery areas of fish species at the highest possible spatial resolution. Novel approaches may need to be explored to improve existing data, incl. gathering of knowledge from fishing sector, etc. Numerous ICES WGs have previously dealt with mapping of spawning and nursery areas for different species and in different marine areas, e.g. SGRESP (Petitgas, 2010). This SGRESP approach is useful to MSP and ICES could make valuable contribiutions to MSP by expanding this work to other species and making products readily available online (i.e. as files independent of reports, GIS files, etc.).
	Location of known fish habitat types incl. pelagic habitats	Biological characterization/definition and mapping of common habitat types of commercial fish species in the ICES area, combined with maps of known distribution of such habitats (e.g. from regional/national mapping projects and initiatives) would be a valuable planning tool for integrated spatial management in relation to MSFD. In particular such products would be useful in planning of MSFD protected area site selection (MSFD Art. 13, 4–6). Such an analysis could include pelagic habitats (e.g. Planque *et al.*, 2006) which may be relevant in development of MSP, vertical spatial zonation, definition of biological characteristics e.g. reproductive volume (MacKenzie *et al.*, 2000).
	Migratory pathways	Mapping of known migratory pathways of marine species would be useful and is often an overlooked component in marine planning on a larger scale. Such maps would require novel approaches to analysing existing data, gathering of knowledge from fisheries stakeholders, etc.
Species	Commercial fish and shellfish species	State-of-the-art species distribution maps for commercial fish species in the ICES area are currently available in the ICES FishMap website http://www.ices.dk/marineworld/ices-fishmap.asp. This online tool could be expanded to include information on different life stages of focal species, providing the planning process with spatial information on stock structure, etc. It should be the aim to provide maps at the highest possible resolution. Examples of such mapping initiatives can be seen in the following websites http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/map.aspx and http://www.nero.noaa.gov/hcd/index2a.htm. In addition, numerous ICES WGs have dealt with mapping of commercial fish species, e.g. SGRESP (Petitgas, 2010).
	Sensitive species	Maps showing the known spatial distribution of species that may be considered "sensitive" in marine ecosystems (e.g. in the context of CFP, red lists, etc). The identification of relevant species can be extracted from ICES WG reports.

Category of spatially resolved DATA	Subcategory	Comments/scope for ICES
	Key species (foodweb)	Maps showing the known spatial distribution of species that may be considered "key" in marine ecosystems (e.g. species that perform key functions as top predators, prey species, etc). The identification of relevant species can be extracted from ICES WG reports. Such spatial data would be of relevant to MSP in light of MSFD. The ICES website (www.ices.dk) is currently home to the EcoSystemData Online Warehouse, which provides spatially resolved data on fish stomach sampling, contaminants in sediments, aggregated trawl-survey data, etc. This website could be expanded to include key and sensitive species and habitats and other spatial layers. ICES should make planners more aware of the availability of these data sources. ICES currently publishes zooplankton status reports (e.g. O'Brien *et al.*, 2008) which could be made available as downloadable GIS files to provide spatially resolved data for use in analyses of primary and secondary production.
Physical / Ecological processes	Spatio-temporal resolution of upwellings, fronts, etc.	Fronts, upwellings, etc. can be characterized/identified/modelled and mapped by relevant WGs based on existing data. Such spatial maps would be useful in planning for identifying ecological units, potential productivity hot spots, etc. ICES is currently involved in these areas e.g. WGOOFE oceanography group and ICES Reports on Ocean Climate.
	Productivity hot spots	Areas of high productivity can be characterized/identified/ modelled and mapped by relevant WGs. Maps could have relevance for sectoral spatial planning (e.g. identifying valuable fishing grounds, conservation planning).
	Biodiversity hot spots	Areas of high biological diversity can be characterized/identified/ modelled and mapped by relevant WGs. Maps could have relevance for MSP in general and for conservation planning in particular.
Anthropogenic activities	Fishing activity by vessels <15m (w/out VMS)	High resolution spatial data are currently available for fishing effort of vessels larger than 15 m. However, only low resolution data or very few data are available for smaller vessels. Since fishing vessels without VMS data make up the majority of the fleet in some countries, it would be of great value for MSP if ICES could develop methods/standards/services for making existing spatial data for smaller vessels as useful as possible and make those data available in highest possible resolution.
	Discard observations	Develop methods and maps to make discard observations more useable in spatial management. In order to make such data as ecologically relevant as possible, mapping of total catch (landings and discards) should distinguish between areas where species are extracted (mortality) and areas where discards are dumped (food supply). Mapping and analysis of discarding patterns in EU fisheries is one of the objectives of the EU project BADMINTON (http://83.212.243.10/badminton.html).

Table 2: Gaps in availability of spatially resolved analyses identified by WGECO

Category of spatially resolved ANALYSES	Subcategory	Comments/scope for ICES
	Development of system of smaller statistical units within ICES	ICES should aim to present data at higher spatial resolution as existing ICES statistical units are too large for use in planning within smaller marine areas. WGECO recommends that appropriate spatial scale requires further discussion within the ICES community (see also ICES 2008).
	Spatial overlap analysis of fish habitatvs.existing MPAs, spatial plans	Maps and analyses of the spatial overlap between fish habitats and existing protected areas (e.g. Natura 2000) are relevant in MSP and MPA designation. These analyses can help to optimize spatial allocation of activities or marine conservation areas (e.g. MPAs).
	Spatial extent of fishing activities	Develop aggregated maps of fishing activities (and associated pressure footprints and intensity) using modelling approached (incorporating point data) to provide spatial coverage at appropriate resolution. These data should be aggregated at métier, species or temporal scales.

Table 3: Indicators used in the assessment of qualitative descriptor 3 (exploited find), for 12 stocks within the southern part of the Bay of Biscay. Key: F: fishing mortality; SSB: spawning stock biomass;MSY: maximum.

		Engraulis encrasicolus	*Lophius budegassa*	*Lophius piscatorius*	*Lepidorhombus boscii*	*Lepidorhombus whiffiagonis*	*Merluccius merluccius*	*Sardina pilchardus*	*Trachurus trachurus*	*Scomber scombrus*	*Micromesistius poutassou*	*Thunnus alalunga*	*Thunnus thynnus*
Fishing mortality (F) (primary indicator) for all species, except for *E. encrasicolus*, which is Catch/biomass ratio (secondary indicators)	2005	0.068	0.554	0.601	0.281	0.214	0.650	0.194	0.066	0.245	0.478	0.159	0.342
	2006	0.065	0.598	0.543	0.331	0.345	0.780	0.170	0.046	0.234	0.411	0.166	0.297
	2007	0.004	0.603	0.442	0.248	0.263	0.830	0.184	0.050	0.263	0.436	0.131	0.345
	2008	-	0.352	0.424	0.226	0.206	0.750	0.267	0.065	0.236	0.476	0.129	0.311
	2009	-	0.198	0.380	0.272	0.098	0.748	0.266	0.087	0.233	0.359	0.129	0.208
	Reference F	Undefined	F msy = 0.44	F msy = 0.26	Fmsy= 0.18	Fmsy=0.17	Fmsy =0.26; Fpa = 0.4	Undefined	Undefined	Fmsy=0.22; Fpa= 0.23	Fmsy=0.18; Fpa= 0.32	Fmsy (2007) = 0.442	Fmsy=0.09 (HR) Fmsy=0.15 (LR)
	> F reference		3	5	5	4	5			5	5	0	5
	< F reference		2	0	0	1	0			0	0	5	0
Spawning Stock Biomass (SSB) (primary indicator)	2005	17110	1492	6523	4316	848	11100	369000	2356290	2290881	6210258	169151	36092
	2006	27190	1779	5707	4896	861	12700	586000	2251270	2409602	5932354	173444	39079
	2007	37080	2066	5164	5020	756	15200	566000	1955010	2540759	4631475	188885	39006
	2008	37255	2296	5436	5326	728	16000	420000	2095550	2709395	3255375	200863	34571
	2009	22000	3157	5707	4716	728	20100	316000	2276680	2978321	2097420	200806	33399
	Reference SSB	MSY & Bpa= 33000 t	MSY & Bpa= ND	MSY & Bpa= ND	MSY & Bpa= ND	MSY & Bpa= ND	MSY & Bpa= ND	MSY & Bpa= ND	MSY & Bpa= ND	MSY= 2.2 t, Bpa= 2.3 t	MSY= 2.25 t, Bpa= 2.25 t		
	> SSB reference	1	-	-	-	-	-	-	-	5	4		
	< SSB reference	4	-	-	-	-	-	-	-	0	1		
Proportion of fish larger than the mean size of first sexual maturation (primary indicator)	2005	100%	57%	63%	100%	32%	8%		42%	77%	100%		
	2006	100%	20%	44%	100%	40%	9%		44%	65%	-		
	2007	Fishery is closed	17%	55%	100%	44%	18%		62%	73%	100%		
	2008	Fishery is closed	75%	61%	100%	43%	39%		37%	74%	100%		
	2009	Fishery is closed	62%	57%	100%	55%	29%		34%	88%	93%		
Size at first sexual maturation (secondary indicator)		9.2 cm (range 4-12.5 cm)	M&F: 44.7 cm	M&F: 61.84 cm	17 cm	26.6 cm	M&F: 43.68 cm	14.8 cm	23.9 cm	28.6 cm	15 cm	85 cm	97-110 cm