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DRAFT Overview of ICES work in relation to Marine Strategy Framework Directive

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1 Marine Strategy Framework Directive Steering Group (MSFDSG) Initiative

1.1 Background information on MSFDSG

The Marine Strategy Framework Directive (MSFD) is a framework within which Member States (MS) shall take the necessary measure to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest [1].

The Marine Strategy Framework Directive (MSFD) is cross-cutting and will have implications for most of ICES work. In March 2011 following a request from the MSFDSG, the Chair of SCICOM and ACOM added the following Terms of Reference (ToR) to all Expert Groups (EGs) during 2011:

- Identify elements of the EGs work that may help determine status for the 11 Descriptors set out in the Commission Decision (available at http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF);
- Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status.

1.2 Scope of Report

The aim of this report is to give an account of the ongoing work being carried out by ICES Expert Groups (EG) and the ICES community that is relevant to Member States implementation of the MSFD. From the responses received from the EGs it appears that there is a substantial body of current and planned work within the ICES network that has a significant potential to contribute to the delivery of the Directive.

Given the broad range of relevant work identified by the EGs, the structure of this overview follows the structure of the Directive i.e. the responses are, as far as possible, attributed to the various Articles and Annexes of the Directive.

1.3 Acknowledgments

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

Specific responses on the MSFD were received from 30EGs groups, see table below for EGs that responded.

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)
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 (Nl) & Martin Lindegren (Denmark)

3 Overview of ICES Work Relevant to the MSFD

3.1 Article 8 – Initial Assessment.

3.1.1 Article 8.1 (a) - Annex III Table 1 - Characteristics

WG Marine Habitat Mapping (WGMHM) [8] refers to the EUSeamap project which is one of the EMODNET Preparatory Actions. The project started in February 2009 and its main phase was concluded in December 2010. After this 22 month period, the project has now entered a maintenance phase for another year or so where the only action will be to maintain the website.

EUSeaMap general objective was to provide broad-scale maps of seabed habitats, using common functional mapping methods, for the Baltic Sea, Greater North Sea, Celtic Seas and Western Mediterranean and to determine what further steps are required to improve their usefulness and coverage.

The key project output is a global map of the physical seabed habitats for the four above mentioned marine regions. The habitats are expressed in the Eunis classification and they span the level 2 to level 4 ranges according to the available data.

In particular, physical habitat maps are expected to be used for the initial assessment of the MSFD. The Incorporation of biological data into the physical map is an idea developed by Ifremer, Vliz and JNCC.

The Commission is still working on EMODNET and is developing portals to access and display marine data. The data is currently undergoing quality checking and the overall project is a work in progress but the pilot portals are accessible at https://webgate.ec.europa.eu/fpfis/iwt/node/1066

Another development is 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. Consequently, the ICES Data Centre (ICES DC) in cooperation with STZ Geoinformatik in Rostock, has developed a web GIS system that promotes increased exchange of spatial data between ICES expert groups and the marine community in general.

The web GIS developments within the ICES DC, is designed to serve all of the ICES community in publishing and sharing map layers and metadata. For example, they are now capable of showing the WGMHM habitat map outlines and metadata. It is a generic application, but it has added functionality for showing habitat map metadata related to a habitat map outline polygon [8]. 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 [9]. The ICES Spatial Facility is accessible at http://geo.ices.dk/index.php and ICES environmental data at http://ecosystemdata.ices.dk/

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. Notwithstanding, the work done on publishing data through the ICES Data Centre and by INSPIRE initiatives is considered 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). The Working Group on Data and Information Management (WGDIM) will monitor the issue of potential data duplication in ICES once the specific data submission activities with INSPIRE and MSFD become clearer [9].

Ecosystem-based management requires more extensive information than single-species stock assessment. Active underwater acoustic methods provide a means of collecting a wealth of ecosystem information with high space-time resolution. Worldwide fisheries institutes and agencies are carrying out regular acoustic surveys covering many marine shelf ecosystems but these data are seriously underused. In addition, more and more acoustics data collected by vessels of opportunity are becoming available. INFREMER are currently involved in acoustics and complementary data collection methods and a review of the current and potential contributions to monitoring population abundance and biomass, spatial distributions and predator–prey relationships. It is also reported [7] that acoustic derived indicators are another neglected field. INFREMER propose indicators for assessing and monitoring zooplankton, fish and other nekton population dynamics and changes in foodweb functioning. Acoustics have the potential to make a strong contribution to ecosystem-based management, but only if a clear understanding of the targets of acoustic measurements can be achieved. This and the development, testing and cross ecosystem comparison of new indicators and suitable reference points is regarded as a current challenge by WGFAST, 2011 [7].

3.1.2 Article 8.1 (b) - Annex III Table 2 - Pressures and Impacts.

Wave and tidal energy activities may exert environmental pressures that influence the achievement of GES, both negatively (e.g. habitat condition and distribution, introduction of underwater noise) and positively (e.g. moderation of fishing pressure by displacement, biodiversity enhancement from introduction of device structures) [16]. However, there has been no specific research undertaken in terms of determining the status of the descriptors or GES with regards to wave and tidal developments. This lack of knowledge has been recognised by the Study Group on Environmental Impacts of Wave and Tidal Energy (SGWTE) [16] and also in the ICES response to the OSPAR request regarding the environmental interactions of wave and tidal energy generation devices [31].

Concerns were expressed that large scale wave and tidal energy developments that may result 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 (Descriptor 1, 4, 7, 11).

Furthermore, SGWTE report that environmental monitoring and adaptive management of wave and tidal energy developments are relevant to determining and controlling influences on GES [16].

Fishery is a main driver of the marine ecosystem and fishery dynamics (multi-fleet) influence directly the ecological (multi-stock) sustainability. 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 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 trade offs of different management options in order to forecast potential consequences on a realistic basis [30].

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 future cross-sectoral and multi-sectoral evaluation and comparison of impact and benefits of various marine activities and management options. 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, Wave, etc.), recreational use and tourism as well as in relation to environmental organizations protective wishes [30].

3.1.3 Article 8.1 (c) - Economic and Social Analysis of the use of those waters and of the cost of degradation of the marine environment

The Working Group for Marine Planning and Coastal Zone Management (WGMPCZM) [2] make reference to the UK Government who has commissioned the preparation of a Handbook for Undertaking Socio-economic Analysis for the Marine Strategy Framework Directive: Practical Guidelines for Applied Analysis. Also of relevance is the OSPAR Regional Economic and Social Assessment for the Marine Strategy Framework Directive– FINAL REPORT [32]. In addition, parallel activities are in place at EU level: Economic assessment of policy measures for the implementation of the Marine Strategy Framework [3].

The Study Group on Integration of Economics, Stock Assessment and Fisheries Management (SGIMM) report that fisheries are economic activities that are dependent on, and interact with, the ecosystem in which they take place. Changes in the ecosystem are of immediate interest to fisheries if these changes affect the resource, i.e. the fish, shellfish or plants harvested by this fishery. Assessment of the resource is just one prerequisite; another is to predict its potential further development. Therefore ecological models are needed to model the ecosystem, the resource and possible future developments. However, in practical terms we manage the human activity, i.e. the fishery, within the ecosystem not the ecosystem itself. Fisheries highly impact the ecosystem based on fisheries behaviour resulting from resource availability, management options, and other options. Thus, economic models are needed to assess and to predict the effect of fishery management options on the ecosystem. The cyclic feedback of changes in the fishery on the ecosystem and the consequences this will have on the development of the ecosystem and the feedback to the fishery again, could only be assessed and predicted using integrated ecological-economic models, which incorporate the necessary complexity of both, the ecosystem and the fishery. This system will be even more complex if not only target species of the fisheries are of concern, but also the ecosystem as a whole, i.e. protected habitat, protected species or ecosystem services like water transparency. Impact assessment on the marine environment and socio-economic cost-benefits of various uses of the marine environment by other sectors compared to fisheries also demands socio-economic and bio-economic management evaluation models in relation to broader marine spatial planning of the multiple claimants to ecosystem services e.g. transport, energy (oil, wind, wave), recreational use and tourism, etc. Economic impact evaluation provides common platform for evaluating impacts of spatial use by different sectors [30].

3.2 Article 9 - Determination of Good Environmental Status

3.2.1 Descriptor 1 – Biodiversity

Time series of phytoplankton and other microbial plankton, together with associated environmental variables in the ICES region are being assembled by the Working Group on Phytoplankton and Microbial Ecology (WGPME) for standardised output to indicate climatologies and multiyear trends for assessment of local, regional, and basin-wide response to natural and anthropogenic forcing [4]. It is reported that the priority is to identify, if such exists, a suite of ecological parameters from these available datasets suitable to indicate good or bad environmental status in the contexts of bio-diversity and ecosystem function. In particular, it is noted that simple ratios such as diatom/dinoflagellate, heterotrophs/autotrophs, picoplankton/nanoplankton, calcifiers/non-calcifiers, phaeophytin/chlorophyll ‘a’, and total bacteria/chlorophyll ‘a’ may provide useful information on the status of the phytoplankton and microbial community, especially if normal conditions can be established from the climatologies of the time series [4].

In this context, WGPME aim to publish a Cooperative Research Report on Phytoplankton and Microbial Plankton Status in 2012.

In terms of maintaining biological diversity, the Herring Assessment Working Group for the area South of 62 deg N (HAWG) regularly carries out assessments that are linked to the three sub-categories ‘Species Level, ‘Habitat Level’ and ‘Ecosystem Level’ [13]. Related to ‘Species Level’ HAWG assesses/determines annually the following:

- the distributional range and pattern of the various herring and sprat stocks and stock components dealt with in the WG
- the population size and biomass including the status of the recruitment and the spawning stock biomass (SSB)
- the population condition including demographic characteristics (e.g. length size, age class structure, sex ratio, fecundity rates, natural and fishing mortality rates) the population genetic structure to identify stock units

Because of the current single species nature of the HAWG assessments, with respect to 'Habitat level' only marginal work is done to estimate habitat distribution, habitat extent and habitat condition. The work here focuses mainly on detecting the abiotic habitat conditions related to specific herring components and locations during scientific surveys (egg and larvae stages, spawning sites; IHLS, IBTS, etc). Similarly only marginal work is done regarding the ecosystem structure ('Ecosystem level).

At the species level, Working Group on North Atlantic Salmon (WGNAS) [15] provides information on the distributional range and the distributional pattern within the range of Atlantic salmon in the North Atlantic rivers. In a large number of rivers and geographic areas, estimates of population size, population abundance and population demographic characteristics (e.g. body size or age-class structure, sex ratio, fecundity rates, survival/ mortality rates) are available. The descriptions of the population genetic structure are now well known or will be over the next few years.

At the habitat level, the habitat requirements of the species and the availability and quality of the freshwater habitat are well known by WGNAS but such information is not routinely assessed and reviewed by them. Information on habitat requirements at sea and the changes in habitat quality and accessibility are less well known.

At the ecosystem level, the relative abundance of Atlantic salmon in the freshwater fish communities is relatively well known and variations in abundance and characteristics are monitored in a large number of rivers annually but such information is not routinely assessed and reviewed by WGNAS. Similar information is generally lacking for the marine portion of the life cycle, Atlantic salmon being a less abundant fish species (in number and weight) within the pelagic fish community of the North Atlantic.

In terms of the Baltic Region, elements available from Baltic Fisheries Assessment Working Group (WGBFAS) helping to determine status of the 11 descriptors are mostly based on the current stock assessments in the Baltic [24].

Descriptor 1 with the criteria and indicators measured, as shown in the tables below, are available for the 10 stock assessed in WGBFAS with some exceptions: Sole in IIIa, Cod in Kattegat, Cod in SD 22-24, Cod in SD 25-32, Flounder SD 22-32, Sprat in SD 22-32, Herring in SDs 25-27, 28.2, 29 and 32., Herring in SD 28.1 (Gulf of Riga), Herring in SD 30, and Herring in SD 31

Data are accessible in common data formats used for the assessments such as Inter-Catch (http://www.ices.dk/datacentre/intercatch/intercatch.asp) and FishFrame (http://www.fishframe.org/fishframe/(S(i23cklrctsq23kphgigxuibs))/Default.aspx)

1.1 Species Distribution	1.1.1 Distributional range (from commercial catch data)
	1.1.2 Distributional pattern within the latter, where appropriate (from commercial catch data)
	1.1.3 Area covered by the species (from commercial catch data)
1.2 Population Size	1.2.1 Population abundance and/or biomass, as appropriate

1.3 Population condition	1.3.1 Population demographic characteristics (e.g. body size or age class structure, survival mortality rates)

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) regularly carries out assessments that are linked to the three sub-categories “Species Level”, “Habitat Level” and “Ecosystem Level”. Related to “Species Level” WGNSSK assesses/determines annually the following:

- distributional range and pattern of the stocks and stock components dealt within the WG
- population size and biomass including the status of the recruitment and the spawning stock biomass (SSB)
- population condition including demographic characteristics (e.g. length, age class structure, sex ratio, fecundity rates, natural and fishing mortality rates)

Because of the current single species nature of the WGNSSK assessments, WGNSSK contribution to support the work with respect to “Habitat level” and “Ecosystem level” is limited. Input includes mainly data on the hydrographic properties at sampling stations of the surveys and information for the assessed species [28].

The Working Group on Crangon Fisheries and Life History (WGCRAN) indicated that their surveys record species composition and epibenthos. This could contribute to the monitoring of the biodiversity (community) [29].

Research is being conducted by the International Bottom Trawl Survey Working Group (IBTSWG) on improving the quality of historical biological data by i) examination of DATRAS data to identify erroneous records, with a focus on (a) lings: *Molva molva, M. dipterygia* and *M. macrophthalma*; and (b) gobies. Given the reported concern over the accuracy and consistency of some of the data for taxonomically problematic fish species held in DATRAS, IBTSWG is continually trying to improve both historical data and establish methods for improving species identification in ongoing surveys [5].

Of particular concern, the data examined for gobies is seemingly highly problematic, and this has implications as to the suitability of data on DATRAS for use in studies on the wider fish assemblage, including biodiversity and size spectra, which may be undertaken to inform on the Marine Strategy Framework Directive. It is noted that while some species are relatively distinctive, other species and genera are small-bodied and difficult to identify accurately. Notwithstanding, some gobies (e.g. *G. couchi, G. cobitis*) are of conservation importance, and some gobies may be proposed to be included within the biodiversity descriptor. Sand gobies are also a relatively important prey species in inshore areas, and so might be considered for inclusion within foodweb descriptors.

The Benthos Ecology Working Group (BEWG) reported that information is available for various well-studied ecosystem components however such information is largely lacking for the benthic flora and fauna. For instance, BEWG note that although the distribution and extent of several benthic habitats might be known from projects such as MESH, it proved to be extremely difficult to evaluate habitat condition. Furthermore, reliable information on population size and condition of benthic species is largely lacking. It is acknowledged that even if such information would be available, the next problem would then be to evaluate whether the benthos' characteristics are in line with what could be expected: such evaluation necessitates the availability of reference data, but also raises questions related to shifting baselines [26].

Nonetheless, BEWG highlight that information on the benthos might still be useful in a benthos – MSFD context. For example, as it comes to the integration of ecological information regarding the benthos, the Biological Valuation methodology proves useful, as demonstrated in the first European assessment within the MSFD undertaken in the Bay of Biscay, whereas Species Distribution Modelling might help unravelling species-environment relationships and hence habitat and population potential as a measure of extent/size and distribution [26].

WGBAST) [39] compile information and data about the distribution and abundance of salmon and sea trout in rivers flowing into the Baltic Sea, as well as data on returning adults to some of these rivers. The different data sets are used to assess the status of salmon in Main Basin and Gulf of Bothnia on a river-by-river basis, including estimates of spawning stock size, densities of juveniles in rivers, smolt production, natural and fishery induced mortality, and abundance of salmon at sea, including stock projections following different effort scenarios which form the basis for ICES advice about future fishing possibilities. No analytical assessment has yet been developed for sea trout in the Baltic Sea, or for salmon in Gulf of Finland, with the consequence that assessment of status of these stocks is mainly based on trend analyses of juvenile densities in rivers. The population genetic structure of the Baltic salmon is relatively well known, and has been used in combination with other information as a basis for grouping salmon rivers into appropriate assessment units. The population genetic structure of Sea trout in the Baltic Sea is less known, but studies are in progress. Our knowledge about the freshwater habitat requirements for salmon and trout is relatively good and is continuously increasing, but variability in habitat status is not monitored routinely by the working group. There are, however, national initiatives to carry out detailed habitat inventories in rivers, and data already exist for many rivers. To improve assessment of sea trout, a common habitat classification system will be implemented by the working group in the near future to take into account habitat variability in the analysis of data on juvenile densities in rivers (following recommendations from SGBALANST 2011). Our knowledge about habitat requirements for salmon and sea trout during the sea-phase is less known. Information about species composition in rivers is available from electrofishing surveys carried out on an annual basis, but the distribution and abundance of other species than salmon and sea trout is not assessed by the working group. Variation and trends in the distribution and abundance of salmon and sea trout in rivers (both densities of juveniles on spawning and nursery areas, as well as smolt production estimates) could preferably be used as indicators of environmental status for this descriptor. Also area of suitable habitats for salmon and trout could be used as an indicator in the future. Natural at-sea survival may be used as an indicator of good status of the Baltic Sea environment. The number (trend) of self-sustaining wild salmon populations could be used as a more general indicator of status of freshwater and marine ecosystems. Genetic monitoring on a river-by-river basis is currently not routinely carried out by the working group, but could in the future be used as an indicator of biological diversity at the gene level.

WGBFAS suggested are the following: (These can be extracted from FishFrame and are not directly used in the WGBFAS ordinary work)

- Effort by ICES rectangle or SD
- VMS (vessel monitoring system) data to estimate effort at a fine spatial resolution
- WGBFAS notes that the information provided by WGBFAS for the state indicators identified as part of the MSFD work on descriptor 3 could also be a useful complement to assessing impacts of industry on biodiversity [12].

3.2.2 Descriptor 2 - Non-indigenous species

Presently, a number of ICES working groups are concerned with the topic of transferring marine organisms. The Study Group on Ballast and Other Ship Vectors (SGBOSV) work on specifically identified vectors of ballast water and hull fouling can provide input on shipping vectors and methods of managing these to reduce risk and may be able to provide some information regarding which species may be transported via these vectors in order to assess the risk associated with each in different areas. The close links the group has with IMO would also mean that information could be provided regarding what new international agreements are being developed to reduce the risk of introducing non indigenous species. There are case studies in Germany on the management and control of invasive species [10].

The Working Group on Introductions and Transfers of Marine Organisms (WGITMO) [11] documents the spread of intentionally imported and/or invasive species introductions via the use of National Reports from many ICES countries. WGITMO's work focuses on the aquaculture vector and what happens when an invasive species is found in a water body (no matter what vector is involved), origin and status of the invasion, potential impacts, options for mitigation and/or eradication, and sharing information with other countries. The WGITMO deals mainly with intentional introductions for e.g. aquaculture purposes, and works to reduce unintentional introductions of exotic and deleterious species such as parasites and disease agents through a risk assessment process and quarantine recommendations.

The Working Group on Environmental Interactions of Mariculture (WGEIM) is examining the potential importance of bivalve culture in the promotion and transfer of exotic species (i.e. alien or introduced) and the resulting implications for bivalve culture and the environment. The WGEIM is also examining management and mitigation approaches for invasive and nuisance species that have been transferred to aquaculture sites [19].

WGITMO [11] noted that recent work completed in the EU MSFD JRC/ICES TG2 Non-Indigenous Species (NIS) Report provides information on: the definition of key terms (non-indigenous species, cryptogenic species, invasive alien species, levels that do not adversely alter the ecosystems); GES in relation to the descriptor; Key attributes of the descriptor (number of NIS recorded in an area, abundance and distribution range of NIS, NIS impact on native communities, NIS impact on habitats, NIS impact on ecosystem functioning); and how are the indicators aggregated to assess GES for the descriptor;

Another project considered beneficial to the descriptor on non-indigenous species is BINPAS - online bioinvasion impact/biopollution assessment system (http://www.corpi.ku.lt/databases/index.php/binpas/). The methodology of bioinvasion impact assessment is based on estimation of the abundance and distribution range of alien species in an assessment area and the magnitude of their impacts on native communities, habitats and ecosystem functioning, all aggregated in a hybrid ranking 'Biopollution Level' (BPL) index [11]. BINPAS collects and stores standardized ecological data on bioinvasion impacts submitted by contributors. The system has been tested and validated on a number of case studies from various ecosystems. It proved to be feasible in integration and sharing of ecological data, providing reliable results for inter-regional comparisons and meta-analysis of the bioinvasion effects on different spatial and temporal scales [11].

In the Atlantic region, the introduction of non-indigenous species in Atlantic salmon rivers and their consequences on populations are frequently documented in WGNAS [15]. Recent examples of these interactions include the impacts of the transfer of parasites (*Gyrodactylus salaris* in Europe), non-indigenous expansions into Iceland of diadromous (sea lamprey) and marine (flounder) species, rainbow trout in Europe, and freshwater predator species (*Esox* sp., *Micropterus dolomuei*) in Canadian and USA waters. Trends in abundance, temporal occurrence and spatial distribution in the wild of some of these species, including in relation to the main vectors and pathways of spreading of such species are information which have been discussed at WGNAS.

WGCRAN has determined that due to the biodiversity monitoring undertaken as part of their survey work, the effects of non-indigenous species would be detected [29].

The BEWG consider that at present, many non-indigenous species have become part of the ecosystem with both positive and negative impacts. In some cases, the invaders play a beneficial role in the ecosystem functioning or for the productivity of commercial resources. Therefore, research should focus on the ecological effect of those species, or in other words, define its function or occupied niche in the ecosystem. This would act as a basis to determine whether a non-indigenous species has to be defined as 'suitable' or not [26].

Another aspect to be taken into account is the economic consequences a non-indigenous species can cause. The economic value of a species can change over time for example as in the shifts in the last century in Europe of the production of the European Flat Oyster, blue mussel and the Pacific Oyster [26].

3.2.3 Descriptor 3 –commercial fish

ICES has started a process (called D3+) leading to a technical/scientific ICES report aiming to support EU Member States (MS) in the implementation of the Marine Strategy Framework Directive (MSFD) with a focus on Descriptor 3 (D3), commercially exploited fish and shellfish. Fisheries related information relevant for the other Descriptors will also be identified and reported on. The first workshop was held in July 2011 and the report is available [33]. A second workshop was held in October and the two workshops will form the basis of a report by the Core group leading this work.

With regards to safe limits for commercial fish, HAWG annually explore the status of herring and sprat stocks in the study area [13]. To achieve or maintain FMSY management plans are already established for some of the herring stocks in the study area and such management plans are increasingly conforming to the MSY approach. The F values are usually estimated from appropriate analytical assessments based on the analysis of catch (taken as all removals from the stock, including discards and unaccounted catch) at age and ancillary information. Where the knowledge of the population dynamics of the stock do not allow to carry out simulations, scientific judgement of F values associated to the yield-per-recruit curve (Y/R), combined with other information on the historical performance of the fishery or on the population dynamics of similar stocks, is used. The value for the indicator that reflects FMSY is determined based on the ICES MSY framework rules which includes the analysis of observed historical trends of the indicator combined with other information on the historical performance of the fishery.

As part of the annual stock assessments performed by HAWG the reproductive capacities of the herring stocks are determined using the Spawning Stock Biomass (SSB). The SSB values are usually estimated from appropriate analytical assessments based on the analysis of catch at age information. Where an analytical assessment allows the estimation of SSB, these values can be compared to appropriate reference points of stock status.

Elsewhere, research is ongoing in relation to the synthesis of information on biological stock structure which aims to improve understanding of the dynamics of fish populations and stocks [17]. This information can also be critical in meeting objectives of fisheries management, such as sustaining yield, avoiding recruitment failure, rebuilding overfished stocks, and conserving endangered species. It is also reported that topical initiatives, such as conserving biodiversity, applying a ‘precautionary approach’, ecosystem-based fishery management, and marine protected areas, place even greater emphasis on understanding the spatial aspects of populations [17]. In recent years there has been a substantial investment in interdisciplinary research to identify and delineate biological structure for ICES stocks. Despite the value of this information and the research investment in this arena, the results of these projects are not always incorporated into the assessment and management of the studied stocks.

The report published following the Workshop on the Implications of Stock Structure (WKISS) summarised the major stock structure identification efforts on ICES stocks and examined whether the results of the synthesis were translated into the assessment or management of the stock [17]. These include:

- Horse Mackerel Stock Identity Synthesis - identification of biological stocks of horse mackerel (Trachurus trachurus) throughout its distributional range, from the Northeast Atlantic to the Mediterranean Sea.
- Sardine Stock Identity Synthesis (SARDYN) - to improve the basis for management advice provided for sardine (Sardina pilchardus) in Atlantic European waters.
- Atlantic Herring Stock Identity Synthesis (WESTHER) - to describe the population structure of herring stocks to the west of the British Isles, to enable the production of a set of improved guidelines for the conservation and management of biodiversity and stock preservation by in-corporating findings into the assessment processes for western herring.
- Redfish Stock Identity Synthesis (WKREDS) - to review exist-ing information on the stock structure of Sebastes mentella in the Irminger Sea and adjacent waters.

- Sandeel Stock Identity Synthesis - No dedicated EU research project has been carried out on sandeel stock structure. However, the EU-FP6 project PROTECT investigated the application of MPAs for sandeel conservation and protection against local depletion.

Other examples of ongoing work on stock structures are detailed in the WKISS 2011 report [17].

Ongoing research includes reviewing and considering the utility of vessel monitoring systems (VMS) and other novel data acquisition systems and how these could be used to improve the utility of CPUE data for assessment purposes. VMS and other electronic monitoring systems are relative new developments and are largely used for compliance purposes. However, arising from a Workshop on the Utility of Commercial CPUE and VMS data in assessment (WKCPUEFFORT) [18] it was reported that the integration of VMS and commercial catch data provides the opportunity to provide fine scale spatial distribution maps of fishing effort and catch distribution maps.

Much of the most recent work has focussed on the interpretation of VMS data to separate fishing from non-fishing activity and integration of VMS with landings data [18]. VMS data, in combination with other data sources such as information from fishery independent surveys are now being used for the evaluation of spatial and temporal closures, but the use of VMS for traditional stock assessment purposes is hampered by the lack of time series and that many assessment techniques lack spatial considerations beyond stock boundary definition.

The use of VMS data has been limited in terms of assessment purposes, nevertheless, the increasing time series and access to VMS and other novel data systems warrants more detailed investigation [18].

A recent EU funded project "Development of tools for logbook and VMS data analysis" concluded that the common data format proposed should be used to ensure data and exchange compatibility. The results of this project available at the time were reviewed by the Study Group on VMS data, its storage, access and tools for analysis (SGVMS) [34]. The project looks at how VMS data can be used in conjunction with logbook data to spatially identify strata where linked VMS and logbook data was used to spatially refine commercial LPUE indices. Indices can be biased if the spatial distribution of fishing effort changes over time. Identifying strata based on homogenous, spatially refined catch composition data, can be used to provide unbiased LPUE trends, contrasting stratified LPUE and non-spatially refined LPUE for some species shows marked differences. As time series of VMS data increases, spatially refining commercial tuning fleets using such approaches should be considered during stock benchmarks. Recognising that species distribution is strongly influenced by habitat type, it was considered at WKCPUEFFORT that the data types required to generate standardised abundance indices not only based on spatial distribution, but also to incorporate habitat type.

In terms of providing guidelines on when to use commercial catch data, it was concluded at WKCPUEFFORT [18] that the decision to include or exclude commercial catch data is one best left to individual stock coordinators and that many of the issues are compliance rather than scientifically related. Other uses of VMS include how new monitoring systems could be useful in terms of providing better estimators of effort and how more systematic and widespread data collection of fishing gear parameters would help refine effort metrics. For example, instead of estimating effort in terms of time, trawl sensors could be used to quantify swept volume or area.

The Baltic Fisheries Assessment Working Group (WGBFAS) has reported that elements of their research available to determine status of the MSFD descriptors are mostly based on the current stock assessments in the Baltic. Data are accessible in common data formats used for the assessments such as Inter-Catch and FishFrame. WGBFAS have stated that they have data available on fishing mortality, the ratio between catch and biomass, spawning stock biomass and biomass indices [24].

Atlantic salmon status is assessed relative to defined conservation limits (limit reference point) and management of fisheries is based on management objectives of achieving conservation limits in individual rivers. The status of Atlantic salmon in the North Atlantic is assessed relative to these conservation limits annually by WGNAS. Conservation limits for sea age groups are also defined to guide management for age structure and population diversity [15].

HAWG studies the dynamics of important forage fish, herring and sprat. Thus it provides important data on the dynamics of populations relevant to the ecosystems around Denmark, the North Sea and the waters around the UK and Ireland [13].

The primary indicator is fishing mortality F with the aim to achieve FMSY or better. The North Western Working Group (NWWG) [25] follows the WKFRAME [35] protocol outlined for assessments under the MSY framework, so that all analytical assessments contribute to this first level primary indicator.

The secondary indicator is the catch/biomass ratio as indicator for stocks without analytical assessment. This is a trend based indicator and as such is in accordance to the protocol outlined by WKFRAME. However, NWWG has noted that the Commission Decision also applies this secondary indicator in a MSY context. In turn, WKFRAME considers that in situations where no analytical assessment is available or for stocks with a poor data situation, calling this Maximum Sustainable Yield advice is potentially misleading [25]. In these circumstances, the advised exploitation rates are compatible with sustainable exploitation (SE) and not a narrowly defined maximum sustainable yield. NWWG state that it is also important to stress that for these stocks, the approach is considered adaptive, where provisional targets are used and long term targets are periodically updated [25].

For stock productivity and reproductive status the primary level indicator is SSBMSY, and the secondary indicator is survey biomass trends. NWWG follows the WKFRAME protocol outlined for assessments under the MSY-framework. Within this framework, SSBMSY is not estimated and stock status is defined with respect to biomass reference points, i.e. Btrigger [25].

NWWG considers a need for further evaluation and testing in particular for population age and size distribution (3.3.1), (3.3.2) and (3.3.3) [25]. For the proportion of fish larger than the mean size of first sexual maturation (3.3.1), in stocks with highly variable recruitment one could observe high proportion of immature fish because of big incoming year classes and at the same time the SSB might be well above safe biological limits. The index would show low value when the stock might be in a healthy state. Similarly a recruitment failure on some years in row and the SSB is below safe biological limits the index might show high value. An example given by NWWG is that the 95%-percentile in the German Greenland groundfish survey and in the Iceland bottom trawl surveys spring/autumn seems not specifically responsive to stock trends, which is the basis for the secondary first level indicator. In the German Greenland groundfish survey, the 95%-percentile reflects the presence of large cod, but does not follow the trend of this stock, i.e. despite considerably lower survey index values after 2006 the 95%-percentile is higher than in the period of large biomass in the 1980's. Despite considerable variability in survey indices for abundance and biomass from the Icelandic shelf, the 95%-percentile shows a rather stable pattern after it dropped from 1994 to 1995. Hence, in accordance with NWWG, the indicative value of this index for the Greenland ground fish survey is unclear [25].

The Working Group on the Assessment of Southern Shelf stocks of Hake, Monk and Megrim (WGHMM) acknowledge that work deployed during assessment working groups is one of the best annually compilations in relation to data and knowledge on population dynamics and fishing activity [27]. This knowledge is most of the time used for giving advice in managing stocks. Parameter calculated define the current status of the most important stocks species commercially exploited in Europe through a series of indicators. These indicators are traditionally used to state population status in relation to some reference points (fishing mortality, recruitment and spawning stock biomass levels).

The WGHMM research involving data and population dynamics can be straight applied to the following indicators - fishing mortality, catch/ biomass ratio, spawning stock biomass, biomass indices, proportion of fish larger than mean size of first sexual maturation and 95% percentile of the fish length distribution observed in research vessel surveys [27].

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) annually explores the status of demersal stocks. It is assessed what the fishing mortality (F) is in relation to FMSY and Ftarget for the stocks where management plans are implemented. The F values are in most cases estimated from analytical assessments. Where the knowledge of the population dynamics of the stock do not allow to carry out analytical assessments, yield-per-recruit curve (Y/R) analysis, combined with other information on the historical performance of the fishery or on the population dynamics of similar stocks, is used. For some Nephrops stocks in the North Sea, information from dedicated TV surveys are utilized to estimate harvest rates in relation to MSY. As part of the annual stock assessments the reproductive potentials of the stocks are determined in relation to reference points as Bpa (still kept at the default MSY Btrigger) using the Spawning Stock Biomass (SSB) as proxy [28]

In order to qualify the state of the *Crangon Crangon* stock, the size distribution is monitored by WGCRAN [29]. WGCRAN also recommend examining the share of egg-bearing females (per size class) preferably in winter and spring. The status of the fishery will be assessed using a Y/R simulation model that was specifically developed for the *C.Crangon* fishery. This new tool will be used to explore the potential of the MSY and F0.1 concepts. Alternatively the potential of seasonal effort reductions to maximise the reproductive out will be investigated [29].

IBTSWG reported [5] that they were asked to prepare methods for delivery of information to assessment working groups in 2012. IBTSWG stated that the data required for the suggested indicators are available on either DATRAS and/or from the national laboratories. There are, however, some important issues that should be considered, in terms of stocks and species, what length at maturity is most appropriate, what should be done for species which may have a pronounced sexual dimorphism in the size at maturity, and species selection. Until there is clarification and scientific consensus on how such issues are approached, there is little point in IBTSWG preparing methods for the delivery of the data required for such metrics. It should also be noted that existing surveys were designed originally to inform on the distribution and relative abundance of juvenile fish, and providing information on recruitment pulses as an important element of the survey. Whereas it can be considered important for managers to try to ensure that the full length and age range, sex ratio and maturity stages of fish and shellfish are present in exploited ecosystems, the proposed metrics may not be useful on informing on this. The process requires further work to select and define indicators and associated reference levels that respond to changes in the populations subject to fishing. Simulation studies are required to ensure that such indicators provide suitable sensitivity in the time-scales required for management and that they are robust to variation in natural processes, such as recruitment variability and regional and seasonal variation in the spatial distribution of juveniles/adults of small and large species.

Regarding mean size at first sexual maturation, IBTSWG [5] suggested that there may be a rationale for using the size (or age, if available) at 50% maturity as a more consistent metric. A single incorrect allocation of an immature fish as mature on any one survey may affect a metric based on the length at first maturity, whereas the length at 50% maturity is based on a more comprehensive range of data, and so will be a more robust indication of the size at which fish are mature. Such data can be calculated for all stocks for which biological sampling is undertaken. In addition Sexual dimorphism in body size can influence this indicator. Some fish species can have pronounced differences in the size at maturity. If such species have heavily skewed sex ratios in trawl surveys, then this has potential implications for metrics. For example, spurdog often aggregate by sex and size, and females mature at a larger size than males. Another issue identified by IBTSWG relates to Recruitment Pulses. The proposed indicators often include metrics based on proportions. This will potentially introduce bias due to recruitment pulses. For example, even if there was no change in the relative abundance of the mature stock, a strong recruitment event will reduce the proportion of mature fish. Hence, the proposed metric is affected by environmental conditions and natural stock dynamics.

Whereas indicator 3.3.1 can be applied to the species/stocks of interest, the decision document is less clear for other indicators and 3.3.2 is ambiguous, as it states “mean maximum length across all species found in research vessel surveys”. Is this all commercial species or all species? Is it just finfish or does it include shellfish?. If this is viewed as ‘all’ fish (commercial and non-commercial), any survey (by nation or year) in which improved taxonomic resolution is available for non-target fish (which are often small-bodied) risks reducing a metric of the "mean maximum length across all species found in research vessel surveys".

MSFD indicators that inform on "the relative abundance of large fish" are required, although there is no clarification of what is meant by a large fish. This has been discussed in the reports of the Working Group on Fish Ecology, and large fish may be viewed as

- All specimens of fish caught that are above a defined length, irrespective of species. Although this is easily calculated, it does mean that a juvenile of a large-bodied species that is below a nominal cut-off is not considered 'large'.
- The relative abundance of all those fish species that are considered 'large' species in the fish assemblage(s) sampled, based on their maximum reported length (Lmax), irrespective of the lengths observed in the survey that year.
- The largest observed size of each fish species depends on their Lmax. For example, if a species has an Lmax of only 10 cm, a specimen of 10 cm is still considered large.

IBTSWG state that there are incorrect data on DATRAS that are yet to be checked and corrected by national institutes, and the data reupl oaded to DATRAS. For example, Research being carried out by IBTSWG concluded that the data examined for gobies is highly problematic, and this has implications as to the suitability of data on DATRAS for use in studies on the wider fish assemblage, including biodiversity and size spectra, which may be undertaken to inform on the Marine Strategy Framework Directive.

IBTSWG identifies a number of examples of potential limitations and caveats in the implementation of the Descriptors

- Spurdogs in the Irish Sea:-Biological studies have indicated that male spurdog can start to mature at 55 cm, with 50% maturity at about 59.5 cm. In contrast, female spurdog first mature at about 69 cm, with 50% maturity at 74 cm and 100% maturity at 86 cm. Although it is acknowledged that such sexual dimorphism in length at maturity is not as pronounced in other fish species, it may be an issue for the calculation and interpretation of the 'proportion of fish larger than the mean size of first sexual maturity'. Furthermore, for species which have aggregating behaviours such as spurdog (which aggregate by sex and size), research vessel catches can be sporadic and heavily skewed to one particular life history stage in any one year.

- Haddock in the North Sea:- Preliminary studies were undertaken on data from the Q3 North Sea IBTS to highlight the potential impacts of a strong year class. The raised numbers of fish at length were extracted from DATRAS, and the total numbers of fish <20cm and ≥20 cm calculated. The 1999 year *cl*ass when graphed has a major impact on a proportional ratio, as did the 2005 and 2009 year classes. A metric that can be heavily influenced by recruitment pulses (which may be related more to natural environmental conditions than human activities) is no*t* appropriate for informing on the status of older individuals in the stock. Given that data on the catch rates of older fish are available, it would be preferable not to develop proportional indices that are heavily influenced by the catches of recruiting fish.

- North Sea herring assessment:- Despite many studies into environmental drivers of stock productivity leading to much improved understanding of the cause of variability in production, at present the potential to include this understanding into the provision of management advice it limited. HAWG considers that information on the environmental drivers of productivity of the stocks is very patchy, and mostly lacking [13]. HAWG acknowledges that this area requires targeted research efforts.

- WGBAST [39] assess status of salmon populations by evaluating the probability that individual rivers reach smolt production objectives corresponding to 50% and 75% of the potential smolt production capacity. The 75% objective is based on the Maximum Sustainable Yield (MSY) framework. Work is in progress to improve assessment of sea trout so that it will be possible to evaluate status by comparing densities of juveniles in rivers to predicted optimal densities taking habitat quality into consideration. The current status of individual salmon and sea trout populations is the natural indicator for this descriptor.

An example of how the knowledge and experience of the assessment Working Groups experts is used in the context of the Marine Strategy Framework Directive was presented at WGHMM. The aim is to integrate the scientific and advisory work for implementing an ecosystem approach based on qualitative descriptors, and give a coordinated and integrated assessment of sea environmental status, a copy of this working paper is available at http://www.ices.dk/reports/ACOM/2011/WGHMM/Annex%20S%20-%20%20New%20ToRs%20on%20Marine%20Strategy%20Framework%20Directive%20and%20Coastal%20and%20Marine%20Spatial%20Planning.pdf

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 xx

- *Tablexx:: 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.*
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		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	0.690	0.194	0.066	0.285	0.478	0.159	0.342
	2006	0.065	0.598	0.543	0.331	0.343	0.780	0.170	0.046	0.234	0.411	0.166	0.297
	2007	0.004	0.603	0.442	0.248	0.265	0.810	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	0.740	0.266	0.087	0.233	0.399	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	27235	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%	61%	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%	19%		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

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Also, data available from the International Council for the Exploration of the Sea (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. Results are not presented here as the relevance for this short communication is the readily data availability from ICES data bases.

The conclusions of the discussions in WGHMM were that assessment working group experts are owner 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 un-der the ecosystem based approach. It is worth to mention that in the MSFD and moving towards a 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 use-ful data to experts working on these issues. Also, the experience gain after years of work of assessment scientist in relation to bridging management with advice should be considered.

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3.2.4 Descriptor 4 –food webs

The MSFD requires an assessment of the marine food web in the determination of GES. In some instances the numbers and breeding success of higher trophic levels (mammals, birds, large fish) in the marine food chain have been suggested as possible indicators of the state of the food web [20]. ICES group members have previously reported impacts of harmful algal blooms on marine mammals and birds. The toxin groups and impacts on these higher levels of the food web in the ICES region will be identified by the Working Group on Harmful Algal Bloom Dynamics (WGHABD) [20].

The WGHMM note that their research involving data and population dynamics can be applied to the following indicators 4.1.1 performance of key predator species using their production per unit Biomass, 4.2.1 Large Fish by weight and 4.3.1 abundance trends of functionally important selected groups/ species [27].

WGNSSK studies the dynamics of the important forage fish sandeel and Norway pout, and their main predators (cod, whiting, haddock, saithe). Thus it provides important data on the dynamics of populations relevant to the eco-systems in the North Sea. Information on predation mortalities from the multi species model SMS is being provided by ICES WGSAM, and is used in the assessment of North Sea cod and North Sea whiting. Latest estimates could be provided also for Norway pout, sandeel, haddock and herring [28].

WGCRAN note that survey data provide information on the diversity of the species. Those data can be used by WGBIODIV. Using those data spatial and temporal patterns in the distribution of the shrimps can be analysed and trends could be detected. From the commercial fishery VMS data are available. From those LPUEs are calculated. A trend within the LPUEs might also give evidence for changes in the shrimps' abundance [29].

To specify the role of the shrimps within the food web, WGCRAN indicate that an intensified examination of stomach analyses is aspired. Due to a modelling approach, conclusions on a population level might be deduced from the stomach analyses. The abundance of shrimps in space and time is monitored by surveys. From the fisheries activities LPUEs are calculated [29].

It is the opinion of the BEWG that indicators focusing on the lower levels of the food web and inter-level interactions are lacking. In this regard, they believe that knowledge about the basis of the food web is important to define 'sustainability' or 'carrying capacity' of the ecosystem for the top levels of the food web [26].

The Large Fish Indicator (LFI) was proposed as an indicator for the state of foodwebs by the ICES/JRC task group dealing with descriptor 4. It is also being used within the CFP to help support the ecosystem approach to fisheries management. This indicator has been developed by WGECO and WGFE over several years. The process focuses on two aspects that need to be considered in order to assess whether the Ecological Quality Objective (EcoQO) for the fish community is achieved:

- Indicator selection, i.e. which metric would be the best state indicator; and
- Setting of target level, i.e. how might the management target, the EcoQO, be set for this indicator.

In researching the best indicator, the LFI emerged as the best option. After selection, this indicator was further developed to improve its signal to noise ratio. This was achieved by setting the “large fish” threshold as >40 cm (rather than 30 cm) and determining the indicator based on the proportion of the total fish biomass, rather than numbers, exceeding this threshold. This excluded much of the noise caused by stochastic recruitment-driven variation in the juvenile fish. Then a reference level was established based on historical levels when exploitation was considered to be sustainable and the target level was set accordingly.

3.2.5 Descriptor 5: Human-induced eutrophication

WGBAST [39] suggested that the abundance of salmon and sea trout in freshwater ecosystem is affected by water quality, and changes in abundance of the species could be a sign of changes in the water quality due to e.g. eutrophication. However, the group does not routinely assess water quality, but relevant information and data is gathered within electrofishing programmes in freshwater. How salmon is affected at sea by e.g. algal blooms due to eutrophication is less known. WGNAS [15] opportunistically reviews reports of Atlantic salmon populations impacted by human-induced activities, but assessment of eutrophication or water quality is not a generic term of reference for WGNAS. Abundance of salmon and trout, as well as composition of the total fish community in freshwater streams could be used as indicators of water quality.

3.2.6 Descriptor 6 – seabed integrity

Research work is being carried out by the Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT)[21]. In this context, a general pattern of reduced amounts of extracted marine sediments across member countries was identified by WGEXT, likely as a result of the economic climate. In terms of tools and policies to control the extraction of marine sediments, it was described that little in the way of change was reported across member countries either in their national control measures or in the use of the WGEXT 2003 Guidelines [21]. However, WGEXT are content that in the context of appropriate consent regimes which provide for rigorous environmental assessment and evaluation of each proposal to extract sediment, these impacts may be considered to be within environmentally acceptable limits and therefore not adverse. These assessments are recommended to take account of the 2003 “ICES Guidelines for the Management of Marine Sediment Extraction”, as adopted by OSPAR, which provide for the adoption of appropriate extraction site locations, and implementation of mitigation and monitoring programmes [21].

WGEXT suggest that in defining ‘adverse’ it should be accepted that direct changes to the physical structure of the seabed will result from the extraction of marine sediments. Defining ‘adverse’ as being no environmental change from existing (pre-dredge) conditions would, in the opinion of WGEXT, be inappropriate and detrimental to the continued ability of member countries to extract marine sediments from their seabed [21].

The WGHMM note that data and population dynamics can be applied to the following indicators – type abundance, biomass and areal extent of relevant biogenic substrate; extent of seabed significantly affected by human activities for different substrate types; presence of particularly sensitive and/ or tolerant species; and multi-metric indices assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species. [27].

Demersal fisheries often result in a considerable impact on the sea bed. Spatial distribution of demersal fishing effort is available per rectangle. Many WGNSSK EC members participate also directly to the work of the STECF for the evaluation of effort management, where EC effort distribution by gear and ICES rectangle is collected and mapped (STECF (2011), available at https://stecf.jrc.ec.europa.eu/reports/effort. In addition, most national labs hold VMS data with a finer spatial resolution, which can be linked to logbooks information providing very detailed mapping of effort and catches (cf review in [18]). Tools have been developed by a group including some WGNSSK members to estimate the DCF Indicators 5 (Distribution of fishing activities), 6 (Aggregation of fishing activities) and 7 (Areas not impacted by mobile bottom gears) based on standardised VMS data [28].

Shrimp-fishes' activities are monitored using VMS data, so the quantity of the disturbance of the sea-floor can be approximated by the analysis of those data. Additionally WGCRAN may contribute strategies to minimize the impacts on the Sea-floor [29].

The BEWG acknowledge that the WFD methods and approaches to define the good ecological status of the benthic ecosystem are also valuable in the MSFD context. Therefore they recommend that it is not necessary to develop new ones, but to invest in the existing ones (e.g. stressor-response) and improve them to better assess structural and functional benthic aspects [26]. To define the structure and function of benthic systems are not trivial tasks, especially when, for such systems, the definition and understanding of function is still in its beginnings. The BEWG state that sound tools are required to provide an accurate assessment of these benthic ecosystems, so EGs can begin to underpin processes that can be directly related to function [26].

The use of a static sensitivity/tolerance list of species in assessment tools around the world to define the ecological status of waters (using flora and fauna) is common. These lists are useful tools and were improved in the last decade (adding of species worldwide, revisions of autecology), but caution is required as specified by BEWG [26]. This due to the fact that, for some/many species a change of life history strategy or its autecology requirements and consequently its sensitivity along distinct environmental gradients is expected.

3.2.7 Descriptor 7 – Alterations of Hydrographical Conditions

WGBAST [39] considered that alterations of hydrographical conditions in rivers have large impacts on salmon and trout populations. Construction of migration obstacles and dams, as well as historic dredging for timber floating, are examples of especially problematic alterations affecting these species because migration possibilities are affected negatively and spawning and nursery areas are destroyed. In many salmon and trout rivers, habitat restoration programmes are ongoing, and there is much research and practical work to open up migration routes for migratory fish species by e.g.

construction of fish passages. Estimates of losses of suitable salmonid (and other migratory species) freshwater habitats due to alterations of flow regimes and construction of migration barriers would function as an indicator of environmental status for this descriptor.

Atlantic salmon during their life stages residing and migrating through estuaries and in freshwater are particularly vulnerable to alterations in hydrographical conditions in freshwater and estuaries. There is a large amount of scientific literature on the impacts of barrages on Atlantic salmon populations, including extirpations of populations and on technological approaches to facilitate fish passage. The description of threats to Atlantic salmon from modified flow regimes and fish passage have been terms of reference considered by WGNAS but not on an annually recurring basis [15].

3.2.8 Descriptor 8 – Contaminants giving rise to pollution effects

The work of the Study Group on Integrated Monitoring of Contaminants and Biological Effects (SGIMC)[12] is very directly relevant to status assessment under Descriptor 8. In particular,

- The philosophy of integrated monitoring, as outlined in the draft Guideline for OSPAR (Annex 21, SGIMC, 2011). [12]
- The schemes for integrated monitoring of contaminants and effects in water, sediment and biota.
- The assessment criteria developed for biological effects, which have been incorporated in a large number of Background Documents, and are summarised in Annexes 22 and 23, SGIMC, 2011 [12].
- The proposed scheme for integrated assessment of contaminants and their effects described in Section 8 ii) and Annex 25 of SGIMC, 2011.
- The Technical Annexes for biological effects that have been updated by SGIMC and WKIMON over the last few years and are included as Annexes to the reports.

> In 2011 ICES completed a 3-year work programme on the development of guidance on integrated monitoring and assessment of chemicals and biological effects. A Guideline for the integrated monitoring and assessment of contaminants and their effects provides concept and strategy, Background Documents provide description of available methodology and references, and Technical Annexes contain a detailed description of methods and advice on how to understand the measurements. The table below shows the Biological effect techniques relevant to the ecosystem components for integrated monitoring and assessment of chemical and biological effects data and the status regarding availability of Background Documents, Assessment Criteria, and Quality Assurance.

Biological effect technique	Background document	Assessment Criteria	Quality Assurance
Oyster and mussel embryo test	X	X	A
Sea urchin embryo test	X	X	B
Copepod test (*Tisbe*)	X	X	A
Whole sediment bioassays	X	X	A
Sediment pore-water bioassays	X	X	A
Sediment sea water elutriates	X	X	A
DR-LUC	X	X	B (in future)
PAH metabolites	X	X	C, D
Cytochrome P4501A activity (EROD)	X	X	A, B, F
Vitellogenin	X	X	E
Acetylcholinesterase	X	X	B, E
Comet assay	X	X	E
Micronucleus formation	X	X	B, F
DNA adducts	X	X	
Metallothionein	X	X	A (fish), F (mussels)
Lysosomal stability (Cytochemical and neutral Red)	X	X	B (fish), B, F (mussels)
Liver histopathology	X	X	A
Macroscopic liver neoplasms	X	X	A
Intersex in fish	X	X	B (in future)
Mussel histopathology (gametogenesis)	X	X	B (in future)
Imposex/ Intersex in gastropods	X	X	C
Stress on Stress (SoS)	X	X	not required
Scope for growth	X	X	B
Externally visible fish diseases	X	X	A
Reproductive success in eelpout	X	X	A

A: BEQUALM; B: Between particular independent laboratories; C: QUASIMEME; D: BEAST; E: WGBEC; F: MEDPOL.

ICES advice to OSPAR available at:
http://www.ices.dk/committe/acom/comwork/report/2011/Special%20Requests/OSPAR%20Guidance%20on%20integrated%20monitoring.pdf

In determining what GES might be for descriptors, SGIMC agreed that GES should be related to the assessment criteria for effects and contaminants that have been variously developed by OSPAR and ICES over recent years. These are Background Concentrations, Background Assessment Concentrations (BAC), and Environmental Assessment Criteria (EAC) for contaminant concentrations, and their analogues for biological effects measurements [12]. SGIMC consider that GES should be related to concentrations and the intensity of effects being less than EACs.

An integrated assessment scheme that combines chemical and biological effects data through the coherent set of assessment criteria have been developed by ICES/OSPAR, including those for biological effects developed by SGIMC (Section 8 ii) and Annex 25 of the SGIMC 2011 report) [12].

The scheme describes how measurements of various parameters in various environmental matrices at various stations can be progressively summarized into simple visual representations of status at different degrees of data aggregation. At the highest level, data for both contaminant concentrations and their effects can be represented at MSFD Regional level by a single three colour 'traffic light'. SGIMC consider that the critical boundary for GES assessment is the green–red boundary, representing comparisons with EACs. SGIMC recommend that GES be expressed as some high percentage compliance with this boundary.

SGIMC consider that 100% compliance is impractical, as it amounts to a 'one out all out' approach, and is therefore highly susceptible to perturbations by a small number of errors in sampling, analysis or data handling, or short-term variations in environmental quality. SGIMC therefore suggest that 95% compliance at the highest level of data aggregation would be an appropriate threshold for GES compliance.

SGEH [22] supports the integrated monitoring approach depicted in SGIMC 2011 as currently being the most appropriate approach available for determining GES for Descriptor 8. SGEH/HELCOM has now transferred the approach and guidelines to the Baltic Sea region.

WGNAS would not routinely assess or report on contaminant levels leading to pollution. However, Atlantic salmon have been revealed to be susceptible to non-acute exposure to various chemicals whose levels in the environment can be at low concentrations but that can affect salmon developmental states, particularly for the vulnerable stages transitioning between freshwater and the marine environments. Such interactions are documented in literature and discussed at WGNAS on an ad hoc basis [15].

3.2.9 Descriptor 9 – Human Consumption

Not within the working field of ICES

3.2.10 Descriptor 10 – Marine Litter

With regards to marine litter, IBTSWG have been collecting marine litter information in most of the surveys in the North Sea and the Western and Southern areas. They have stated that those responsible for MSFD descriptor 10 are to contact survey leaders of IBTS. In the case of UK (Cefas) this contact was done before the survey and the spreadsheet/Form used to do the data logging was filled up on all hauls. The form and the protocol will be used as the standard marine litter data collection procedure in the IBTS surveys.

3.2.11 Descriptor 11 – Introduction of energy (e.g. noise)

HAWG acknowledges recent studies on the effect of marine noise on pelagic fish. It cannot provide expertise on this matter but pelagic fish have been studied with regards to this matter [13].

WGEXT recognises that extraction of marine sediment does generate underwater noise, however the impacts of this on the marine ecosystem are currently being investigated [21].

WGEEL [37] shares the view that it is very difficult to assess the impact of renewable energy on the eel. Despite the existence of scientific evidence showing that eels can use electromagnetism for orientation when migrating to reproduce. Currently it is not possible to quantify the impact of electromagnetic fields on marine species.

3.2.12 All Descriptors – General comments

In January 2011, the Workshop on Cataloguing Data Requirements for Surveys for the Ecosystem Approach to Fisheries Management (WKCATDAT) [36] developed a table of actual or potential data products from fishery surveys, the type of survey where it can be collected and their relevance to the ten of the eleven descriptors of the MSFD.

IBTSWG [5] reviewed the table and made a number of comments which will help inform WKCATDAT on updating the table.

Some of the comments given by this group are;

- The need for additional resources for data collection during ichthyoplankton surveys might differ for those on fish trawl surveys
- The need for additional laboratory facilities after the survey to analyse samples depends on the lab: a lab might not have any room for more analysis, so this should always be checked.
- Post-survey database developments for new data collection is not taken into account and should be included.

The Working Group on the Ecosystem Effects of Fishing Activities (WGECO)[6] was also asked to review the work of WKCATDAT. Please refer to Table 6.5.1 of WGECO 2011 Report [6] for further details. WGECO note that no survey tasks were identified which would provide information on the eleventh descriptor, Energy and Noise. Furthermore it was determined that the members of WKCATDAT were pre-dominantly data providers and it was felt that input was also needed from data users such as WGECO.

Members of WGECO reviewed the table, and indicated priorities for data collection, provided comments on the spatial and temporal resolution of the data and provided an indication of the immediacy of the data requirement (some tasks could be highly relevant to a research priority but may not be needed immediately to inform indicators for the MSFD descriptors). Scores from 0 (no value) to 3 (high value) were provided for each survey task. The survey tasks were then ranked according to their perceived priority within each of the eight Task Categories (Table 6.5.1, WGECO, 2011).

The Baltic International Fish Survey Working Group (WGBIFS) [14] considers the use of spatial information in future work within ICES to be important. The group stresses that the production and delivery of this information should be automated by ICES. For the Bottom Trawl Survey the DATRAS data-base and the new ICES EcoSystemData could be used for this purpose for standardizing the procedures. For BIAS and BASS surveys (Acoustic Surveys), ICES is strongly recommended to create a database as platform for the analysis and delivery of such information.

Relevant information that can be extracted by the surveys coordinated by WGBIFS includes the following:

BITS survey (demersal trawling)

- Maps of cod and flounder distribution and average size, total or by age. 1st and 4th quarter.
- Maps of prespawning cod and flounder distribution and average size. Catch combined with maturity stage information. 1st quarter.
- Maps of the distribution of other species caught in the trawls.

- Habitat mapping for cod (oxygen >1.5 ml/l, salinity at bottom). CTD measurements.

BIAS and BASS surveys (acoustic and pelagic trawling)
- Maps of sprat and herring distribution and average size at feeding period. Autumn.
- Maps of sprat distribution and average size at spawning time. Spring.
- Maps of the distribution of other species caught in the trawls.

In 2010 a study by WGBIFS was initiated relating to the biodiversity in the Baltic Sea based on the data of Baltic International Trawl Surveys (BITS). A sub-group of WGBIFS members evaluated the usability of data stored in the DATRAS database for this issue.

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.

The international coordinated trawl surveys are directed to the demersal species i.e. cod and flounder and other flatfish in the Baltic Sea. Besides target species, all other fish are analysed with lower intensity of recorded data to support ecosystem analyses. Length distribution should be recorded for all main fish species caught, at least for cod, flounder herring, sprat and flatfish. Age, sex, mass and maturity estimates are at least required for the main target species cod and flounder. However, same data should be sampled for herring, sprat and flatfish when capacities are available.

It was agreed by WG BIFS 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. Therefore, it is recommended that from quarter 4 BITS in 2011 onward all countries sample and submit data of all species sampled during the BITS.

Additional data related to all species captured during BITS are available in the national databases or on protocols. The group agreed that data stored in the national databases should be uploaded as fast as possible to make the information available for analyses of the biodiversity and studies related to the ecosystem approach. [14]

3.3 Article 9 - Defining GES and Article 10 - Targets and Indicators

3.3.1 Characteristics to be taken into account for setting GES and Targets and Indicators.

Many of the EGs have realised that GES is a broad and complicated subject that is not yet fully understood and that it may be some time before we can manage human activities in a way that could result in GES. [14]. For example, the Baltic International Fish Survey Working Group (WGBIFS) report [14] that in order to determine and describe a GES scenario for the Baltic Sea, it is important to understand that the changes undergone by the fish populations, which have had a big impact on the ecosystem, have mainly been caused by intensive fishery pressure. Additionally the measures related to the control and continuous assessment of the fishing efforts is probably the quickest accessible tool available and a key factor in the achievement of the desired GES.

Historical data show dramatic changes in both the spatial distribution and abundance of species, as well as in the size distribution of many of the species. Historical data series might provide a good clue for the establishment of health indices to be reached as a goal for a GES. Using these historical series, a general objective might be phrased as the need to recover the status of fish populations to levels of earlier times. In a more specific way, the managers should work within a multistep process that will be flexible and mainly concern the species that are managed and evaluated by any of the current ICES workgroups [14].

Once more, it is of key importance to understand that GES cannot be attained without a focus on modifying the current commercial fishing practices and allowances. In particular, WGBIFS noted [14] that very little can be done in the specific case of the Baltic Sea through the modification of other environmental factors, so a set of measures restricting the fishing pressure might be the only way to reach the status demanded by the 11 descriptors of the Marine Strategy Framework Directive.

Additionally to improve GES, there are management tools which are available today but are currently underused, mainly because of economical management reasons. One example is Multi-frequency Acoustics, a tool that can add important information. Compared to survey costs it is a relatively small expense, especially if the additional information achieved is considered. Other tools and data collecting procedures have similar potential also which should be considered.

WGNAS informed by their own work on North Atlantic Salmon, and recommend that variations in abundance and distribution of Atlantic salmon and the relative abundance of salmon within the freshwater fish communities would be an appropriate indicator of biological diversity [15].

WGECO [6] have referred to their own experience and expertise in the biodiversity indicators specifically linked to fishing effects. Themes discussed by WGECO included the following:

- the extent to which current monitoring activity and routinely available national data were influencing the selection of indicators and the confidence with which targets were being set.

In some cases it was apparent that lack of data, and the high cost of initiating new dataseries, was limiting the enthusiasm for choosing new indicators.

- the selection of indicators themselves and the consistency with which MS were interpreting them, and the extent to which common targets and reference points were being selected.
- MS are taking different account of the management measures necessary to achieve the targets. Such assessment is necessary for the cost benefit analysis that will be required in the Initial Assessment. Economic consequences can either be evaluated once targets have been set, or can be used as an integral part of the target setting process, influencing the outcome. Under each of these scenarios the final targets selected may be different.

In particular WGECO has been prominent in developing the Driver Pressure State Impact Response (DPSIR) approach, and identification of indicators and reference levels [6]. It has also been prominent in developing the Integrated Ecosystem Assessment approach used in the OSPAR QSR process in 2010, often referred to as the 'Robinson et al.' approach. The specific issue of fishery impacts on the ecosystem has also been regularly addressed, and this is of particular importance for the establishment of GES in the context of descriptors 1, 3, 4 and 6. Within this, there has been work on the impacts of different fishing gears, and fishing methods, and guidance on the development of indicators of fishing activity and effort. Specific work was directed at the development of the Large Fish Indicator, now stipulated in the EU Data Collection Framework (DCF) as an indicator of fish community structure and in the MSFD as a key indicator in descriptor 4 on foodwebs.

In WGECO (2010) there is a review of methods to define GES. In this review suitability of methods from other directives, i.e. Water Framework Directive (WFD) (2000/60/EC), and the Habitats Directive (HD) (92/43/EEC), are considered and an attempt was made to place the MSFD in the context of these directives. Additional information was collected from these directives that could help defining GES.

Compared to other marine species, the European eel might not be the best candidate for assessing progress towards GES of marine waters because good biological indicators to evaluate the ecological status of a specific area should preferably use more sedentary species with a short life span, provided good knowledge on their life cycle exists, which is not the case for the eel. Nevertheless, the analysis of the descriptors listed in the MSFD and the evaluation of the available information on the species for those descriptors allowed the WGEEL to consider the species for assessing GES of marine waters [37].

Currently there is no spatially resolved database of eel catch, fisheries or survey data that is available relevant to MFSD. Recruitment time series data are spatially linked, usually to either an estuary, or a fixed point at or near the tidal interface of a river. The Workshop on Baltic Eel, however, has made initial attempts to collate spatial fisheries data for the whole of the Baltic Region. It is envisaged by WGEEL, through improved DCF for eel and some planned data exchange and reporting under the EU Regulation (commencing in 2012) that an eel database will be established and this may support the analysis of spatially resolved eel data. The European eel is classified as threatened by OSPAR and HELCOM conventions. This species can be used as a candidate species to evaluate the status of marine regions in the implementation of the MSFD. However, because it is a diadromous species with a wide distribution and with a life cycle that is not completely understood as such some caution has to be taken when selecting the phase of their life (glass eel, yellow eel or silver eel) to assess the environmental status of marine regions as they can incorporate pressures occurring in all the habitats they occupy during their life-span.

Despite the existence of other (sedentary) species that can be used as better indicators of certain pressures in the marine regions it can be concluded that the European eel can be used to assess the environmental status for descriptors D1 and D3 and D9, especially for the Baltic Sea and the North Sea.

3.3.2 Selection of Indicators

Past work by WGECO is presented in ICES Cooperative Research Report No. 272 [40], where an extensive overview is given of the conceptual background and practical implementation of ecological quality objectives, reference points and fishing effects. This is effectively the definitive background document for the development of the OSPAR/ICES Ecological Quality Objectives (EcoQOs). The report further elaborates metrics for evaluating the ecosystem effects of fishing including data based community metrics, mass-balance models and changes in life history.

In 2011WGECO made a comprehensive overview of their previous work with particular focus on the relevance to the MSFD [6]

One crucial quality that an indicator requires for it to be useful in a management context is the signal to noise ratio. Managers risk losing credibility and resources if they respond to noise rather than to signal. For this reason WGECO report that it is essential to have accurate information on the time required to detect changes in indicators, the strength of signal associated with a change in indicator value, or to account for error when setting Targets and Limits. Information on power to detect change and the extent to which indicators are informative can be achieved by signal detection theory and power analysis.

3.3.3 The setting of reference levels

In order to set a reference level for pristine conditions it is considered necessary to have some idea of what state the indicator would have been in, at a time where human activities were not impacting the parts of the ecosystem measured by the indicator. This can be identified based on a time (or area) without human impacts or if this information is lacking then some scientifically sound method will be required to project backwards what value the indicator would have had prior to human impacts. This can be done through process-based models supported by adequate data [6].

When setting reference levels for an indicator that reflect “sustainable use”, it is necessary to apply a line of consistent ecological reasoning regarding the level of alteration that is not sustainable, then set reference levels to avoid this. According to WGECO, there has been substantial scientific debate about appropriate benchmarks for the boundary between sustainable and unsustainable use, and the appropriate ways to deal with uncertainty and natural variation in this boundary condition. The reasoning was developed most fully in building the fisheries advisory frameworks, and although ICES is changing that framework to accommodate a new EU policy objective for fisheries, this rationale remains a useful guide to setting reference levels associated with sustainable use. Additional guidance on standards that are being accepted by both science and policy communities as benchmarks for sustainability can be found in the work of high-level intergovernmental marine agencies such as FAO and CBD. Although the reasoning applied in the fisheries advisory frameworks was developed for populations, WGECO has already argued that the same general approach can be followed to estimate reference levels associated with impairment of capacity to recover for other ecosystem attributes.

ICES advice to OSPAR in 2010 [41] suggested caution on the issue of thresholds. Ecosystems are never static, but are influenced by variations in natural forcing, including long term climate fluctuations, and human activities. Ecosystem status is a continuum and variations are not always a result of human activities. It is therefore difficult to establish what is good or what is not good against such natural fluctuations. The use of multiple levels (good, moderate and poor) made this process even more difficult. While the specification of threshold values between levels of status can facilitate policy application and communication, the thresholds should be interpreted with caution since they are arbitrary points on a continuum of changes in all ecosystem components. When managing human activities and defining Good Environmental Status (GES), account needs to be taken of such variations. The Utrecht approach used thresholds that were based on existing regulatory limits (e.g. Habitats Directive) and this should be avoided.

When considering reference conditions against which thresholds should be defined ICES recommends:

- *the use of reliable data to provide information on the ecosystem status at a time when it was unimpacted or when it was used sustainably,*
- *the use of process based models to hindcast to when the ecosystem status was unimpacted or when it was used sustainably;*
- *the use of unimpacted areas for ecosystems attributes that are relatively stationary in space;*
- *in situations when the above is lacking, the use of observed data with sufficient contrast (i.e. range of conditions) in statistical models to extrapolate to when the ecosystem was less impacted;*
- *use of expert opinion where appropriate;*

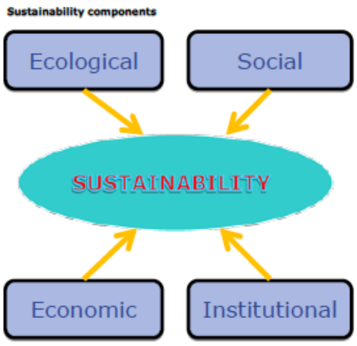
ICES Advice to OSPAR is available from :
http://www.ices.dk/committe/acom/comwork/report/2010/Special%20Requests/OSPAR%20Extending%20marine%20assessment%20and%20monitoring%20framework.pdf

WGMPCZM [2] reported that whilst the ecosystem service concept is increasingly mentioned in environmental (including coastal and marine) policy frames, it still is not a fully operational concept and much debated within science. Debated issues include, for example, the practical measurement of and the 'currency' in which to measure ecosystem services and societal benefits. In particular, the role of monetary vs. non-monetary measures and how to deal with intangibles like many cultural services such as land and seascape aesthetics. Another much debated question is how to establish clear and if possible quantifiable relations between ecosystem functions and processes with human benefits and sea uses and with human well-being. Establishing such relations is highly relevant if the concept of ecosystem services should be able to support decision making in spatial planning.

Several directives point at integrated approaches and integration into wider marine management taking also other sectors than the fishing sector into consideration such as the EAFM (EU Ecosystem

Based Approach to Fisheries Management) the Bird and Habitat Directive, the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). In this context it is 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, for example international conventions, need to be transformed into operational management objectives and management strategies. These then need to be transformed into concrete management-strategy-reference-points for specific status-indicators with respect to defined sustainability. Ideally, 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 [30].

Biological Sustainability Criteria 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 the criteria are 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 worked ongoing in ICES to define such indicators with the help of several external (e.g. EU) funded research projects.



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. 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.

3.3.4 Approaches to Descriptors 1, 3, 4, 6

Details on the UK and German approaches to Descriptor 1,3,4,6 are provided in the main WGECO, 2011 report as well as an overview of the work done by Borja et al. and a case study of Options for Delivering Ecosystem-based Marine Management (ODEMM), an FP7 project [6].

In terms of commercial salmon population WGNAS consider that conservation limits and the compliance of stocks in individual rivers is an appropriate indicator [15]. WGNAS also suggests that monitoring juvenile salmon abundances and the fish communities could be used to assess water quality and eutrophication states of the freshwater environment. Indicators of environmental quality that relate to Atlantic salmon are defined in relation to the EU Water Framework Directive. With regards to hydrographical conditions, WGNAS recommend that indicators would include estimates of habitat loss due to barrages and modified flow regimes, number of rivers impacted by barrages, progress in removing deterrents or improving access to salmon to habitat, are all potential indicators of environmental status for these descriptors [15].

4 Article 11- Monitoring Programme

The Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS) has identified elements which could be incorporated into their work which might contribute to a broader 'ecosystem approach' [23]. Similar to the outcomes of the Workshop on Cataloguing Data Requirements from Surveys [36] WGMEGS have also drafted a table of where their research may contribute to determining MSFD descriptors. This table is provided in the working group report.

WGMEGS notes that any additional tasks required in determining the status of the MSFD Descriptors are likely to impact the existing surveys (e.g. break in phytoplankton and trawl survey time series) unless sufficient additional resources (staff, ship time, equipment) become available.

5 Regional cooperation – Article 6

5.1 Transboundary Effects

With regards to wave and tidal energy developments, in practice, Strategic Environmental Assessments (SEAs), Environmental Impact Assessments (EIAs) and Appropriate Assessments (AAs) should work towards preventing catastrophic outcomes such as major changes in tidal amplitudes or changes in the abundance of priority species [16]. There are, however, recognised 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 do not seem to be properly addressed, highlighting the need for an integrated consideration of marine renewable energy as a whole. In general, interactive and cumulative multi-sectoral pressures are potentially problematic, but there is scope for trade-offs, enhancements and synergies to be identified [16].

6 References

[1] *Council Directive (EC) 2008/56/EC of 17 June 2008 on Establishing a Framework for Community Action in the field of Marine Environmental Policy (Marine Strategy Framework Directive), Article 1.*

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