Options for Delivering Ecosystem-based Marine Management

A review of operational objectives in European Regional Seas

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Deliverable 6: A review of operational objectives in European Regional Seas

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Contents

Glossary of terms

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area
ACOM	ICES Advisory Committee
BAP	Best Agricultural Practice
BD	Birds Directive
BEP	Best Environment Practice
BFR	Brominated Flame Retardents
BS SAP	Black Sea Strategic Action Plan
BS TDA	Black Sea Trans-boundary Diagnostic Analysis
BSAP	Baltic Sea Action Plan
BSBLAP-SAP	Strategic Action Plan for the Black Sea Biodiversity and Landscape Conservation Protocol
BSC	Black Sea Commission
BSPA	Baltic Sea Protected Areas
CBD	Convention on Biological Diversity
CFP	Common Fisheries Policy
CORESET	HELCOM Core Set Indicators Programme
DDT	Dichlorodiphenyltrichloroethane
DG MARE	Directorate General for Maritime Affairs and Fisheries
EcoQO	Ecological Quality Objective
EU	European Union
F	Fishing Mortality
FCS	Favourable Conservation Status
FiB	Fishing in Balance
GES	Good Environmental Status
HCH chemical	Hexachlorocyclohexane
HD	Habitats Directive
HELCOM	Helsinki Commission
HELMEPA	Hellenic Marine Environment Protection Association
HLO	High Level Objective
IAS	Invasive Alien Species
ICC	International Coastal Clean up
ICES	International Council for the Exploration of the Sea
IMARES	Institute for Marine Resources and Ecosystem Studies
IMO	International Marine Organisation
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
LRL	Limit Reference Level
MAC	Maximum Allowed Concentrations
MAP	Mediterranean Action Plan
MARPOL	International Convention for the Prevention of Pollution from Ships (Marine Pollution)
MCSD	Mediterranean Commission on Sustainable Development
MEDITS	Bottom Trawl Survey in the Mediterranean
MIO-ECSDE	Mediterranean Information Office for Environment, Culture and Sustainable Development
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSSD	Mediterranean Strategy on Sustainable Development
MSY	Maximum Sustainable Yield
MTI	Marine Trophic Index

NEA	North East Atlantic
NGO	Non-government Organisation
NIS	Non-indigenous species
ODEMM	Options for delivering Ecosystem-based Marine Management
OSPAR	Oslo Paris Convention/Commission
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
POP	Persistent Organic Pollutants
PSPC	Potential Smolt Production capacity
RAC	Regional Activity Centres
REACH	Registration, evaluation, Authorisation and Restriction of Chemical Substances
SAC	Special Area of Conservation
SALAR	Salmon Atlantic Rivers
SAP	Strategic Action Plan
SAP-BIO	Strategic Action Programme for the Conservation of Biological Diversity
SBL	Safe Biological Limits
SMART	Strategic, manageable, achievable, realistic and time bound
SSB	Spawning Stock Biomass
TAC	Total Allowable Catch
TARGREV	Review of ecological targets for eutrophication for the HELCOM BSAP
TBT	Tributyltin
UN	United Nations
UNEP	United Nations Environment Programme
VTOPIS	Vessel Traffic Oil Pollution Information System
WFD	Water Framework Directive
WSSD	World Summit on Sustainable Development

1. Introduction

1.1 Task 3.3 (Deliverable 6)

This report satisfies deliverable 6 of the ODEMM project. Through task 3.3 we aimed to review regionally specific operational objectives that were of particular use to helping to achieve the high-level objectives set out in the Marine Strategy Framework Directive (MSFD) (2008/56/EC) and the Habitats Directive (HD) (92/43/EEC). For a definition of operational objectives please see section 2. Using the results of the risk assessment (section 1.3), regional teams chose 4 - 5 of the objectives which were assessed as being at high risk of failure for their region (see section 1.4 for full description of what was chosen). Their review would be focused on these. This helped narrow down the review and also allowed teams to focus on issues that were seen to be particularly important in their region. Regional teams were asked to critically review existing operational objectives in their region in terms of status i.e. are they likely to be met, are they under review etc, but also in terms of how they can link to helping achieve any of the MSFD indicators listed in EC (2010). Finally, for each region, gaps were identified where MSFD indicators existed but for which no operational objectives existed for that region. Below we present, for each descriptor, the results of that review by initially discussing European directives and other legislation which are responsible for driving regional operational objectives and then by giving regionally specific operational objectives and the gaps that exist. Finally, we summarise this information in tables which highlight the gaps for each region. The potential use for this information is discussed in the conclusion (section 5).

The operational objectives in this section will be reviewed by descriptor rather than by region, because there are overlaps in relevant information on operational objectives across some or all of the regional seas. For example, the Common Fisheries Policy (CFP) is the main policy framework behind assessing the status and exploitation of commercial fish for all regional seas assessed, and thus many of the operational objectives relevant to Descriptor 3 are the same for all regions due to the development of indicators and targets for the CFP.

1.2 High-level marine objectives

The Marine Strategy Framework Directive (MSFD) (2008/56/EC) and the Habitats Directive (HD) (92/43/EEC) are both key pieces of European marine legislation. They cover EU member states and recognise four European regional seas; the North East Atlantic, the Baltic Sea, the Mediterranean Sea and the Black Sea. The MSFD promotes ecosystem based marine management and requires member states to achieve Good Environmental Status (GES) described by eleven GES descriptors listed in Table 1.

Table1. The eleven GES descriptors by full description along with the shortened name used throughout much of this report

Descriptor number (shortened name)	Full descriptor
Descriptor 1 (Biodiversity)	Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions
Descriptor 2 (Non-indigenous species)	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems
Descriptor 3 (Fish and shellfish)	Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock
Descriptor 4 (Food webs)	All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity
Descriptor 5 (Eutrophication)	Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters
Descriptor 6 (Sea-floor integrity)	Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected
Descriptor 7 (Hydrographical conditions)	Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems
Descriptor 8 (Contaminants)	Concentrations of contaminants are at levels not giving rise to pollution effects
Descriptor 9 (Contaminants in fish and shellfish)	Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards
Descriptor 10 (Marine litter)	Properties and quantities of marine litter do not cause harm to the coastal and marine environment
Descriptor 11 (Underwater noise)	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

These eleven descriptors can be considered high-level objectives of the MSFD. In 2010 the Commission also published a list of attributes and indicators which member states should develop targets for to assess when GES has been achieved. These can be found in EC (2010) and are also given in annex A. Furthermore, the MSFD states that achieving the objectives outlined in the HD will go some way to achieving GES, therefore, the high-level objectives of the HD are also important. The HD aims to achieve Favourable Conservation Status (FCS) for a list of both terrestrial and marine species and habitats. In order to achieve this, member states are required to designate particular sites which have important conservation status for a species or habitat. These sites are called Special Areas of Conservation (SACs) and are both terrestrial and marine (both inshore and offshore). Criteria have been set out by which member states should assess the FCS of these species and habitats every six years and report back to the Commission. It is clear that achievement of the HD is key; in particular for achieving aspects of GES including those descriptors outlined in the MSFD on biodiversity, food webs and sea floor integrity.

1.3 European regional risk assessment

ODEMM task 3.2 required us to assess in regional seas where high-level objectives are not being met. Since MSFD and HD objectives are common across all regions and since the MSFD is currently the main driver of marine conservation and management these were chosen as the high-level objectives to assess. Therefore, we developed a risk assessment whereby criteria were developed using the MSFD indicators, the Cardoso et al. (2010) report and the HD assessment criteria to assess the risk of failing the high-level objectives of the MSFD and the HD. A database containing status and trend information for a list of ecosystem components for regional seas was available to us from previous work carried out within ODEMM (WP1, see summary in Deliverable 1). This also included an extensive database containing information from assessment documents for regional seas. Finally, a pressure assessment had been carried out that assessed the likelihood of overlap between a list of environmental pressures and predominant habitat types and the sensitivity of those habitats to those pressures; from this it was possible to develop criteria to characterise the risk for some of the high-level objectives (e.g. Seafloor Integrity) (see Chapter 3, Deliverable 1). The risk assessment was carried out by experts across sixteen countries from the four European regional seas. The results were used to rank descriptors in terms of importance for a regional sea i.e. the objectives at the highest risk of failure were considered most important for the region. This work has fed into this report by being the starting off point for us to choose regionally important objectives for this review to focus on. See table 2 for a full set of results. For a full description of the risk assessment approach, please see Breen et al. (in prep) (an overview is given in Chapter 3 of ODEMM Deliverable 1). Regionally specific overviews of the risk assessment per region are also given in this report.

Table 2. Complete set of results from the regional risk assessments. NA means no assessment was possible for this objective in this regional sea.

	NEA		MED		Baltic		Black	
	Risk of failure	**Confidence**	**Risk of failure**	**Confidence**	**Risk of failure**	**Confidence**	**Risk of failure**	**Confidence**
Biodiversity-Phyto-zooplankton	Low-moderate	Low-moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Biodiversity-Fish	Moderate	Moderate-high	Moderate	Moderate	Moderate	High	Moderate	Moderate
Biodiversity-Marine mammals and reptiles	Low-moderate	Low	High	High	Moderate	High	Moderate-high	High
Biodiversity-Seabirds	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	High
Biodiversity-Predominant habitat types	Moderate	Low	Moderate	Moderate	High	High	Moderate-high	Moderate
Non-indigenous species	High	Moderate-high	High	High	High	High	High	High
Fish and shellfish	High	High	High	Moderate	High	Moderate-high	High	Moderate
Food webs	High	Moderate	High	Moderate	High	High	High	Moderate
Eutrophication	Moderate	High	Moderate	High	High	High	Moderate	High
Sea-floor integrity	High	Moderate	High	Moderate	High	Moderate	High	Moderate
Contaminants	Moderate	High	Moderate	High	Moderate-high	High	Moderate-high	High
Contaminants in fish and shellfish	Low-moderate	Low-moderate	Low	Moderate	Moderate	Moderate-high	Moderate	Low-moderate
Marine litter	High	Low-moderate	High	High	High	Moderate	High	Moderate
Underwater noise	High	High	High	Moderate	Moderate-high	Moderate	High	Moderate
HD species	High	Moderate	High	High	High	High	NA	NA
HD habitats	High	Moderate	High	High	High	High	NA	NA

1.4 Regional choices of high-level objectives

From the risk assessments, five objectives came out as high risk for all of the four regions. These were non-indigenous species, commercial fish and shellfish, food webs, seafloor integrity and marine litter. To allow an interesting cross regional overview, two of these descriptors (commercial fish and shellfish and food webs) were reviewed for operational objectives by all regional teams. A regionally specific summary of the risk assessment results and other regional choices are given below.

1.4.1 The North East Atlantic

The ODEMM risk assessment for the North East Atlantic (NEA) showed eight objectives to be at high risk of failure. Two of these objectives are the species and habitats listed under the Habitats Directive (HD); the other five are non-indigenous species (NIS), fish and shellfish, food webs, seafloor-integrity, marine litter and underwater noise under the MSFD. All other objectives/descriptors were scored between moderate and low in the assessment. The HD species and habitats have been assessed as overall unfavourable for the majority of species and habitats in many of the sub-regions within the NEA; therefore assessing these at high risk of failure was quite straightforward. The pressure descriptors underwater noise and marine litter describe emerging problems within the NEA particularly in the North Sea. The high level of marine activities, such as shipping activity and the construction of offshore wind farms which emit noise from pile driving, were responsible for the high risk for the underwater noise descriptor and marine litter was found to be at high risk due to information on beach litter levels and the number of fulmars with more than 0.1g of plastic particles in their stomach contents. Non-indigenous species was considered high risk as the number of established non-indigenous species was seen to be increasing in many regions. Stock assessment reports were used to define risk for fish and shellfish of commercial importance. The high levels of declining fish stocks and overfishing resulted in the high risk score. Widespread trawl fisheries also contributed to the high risk score for sea-floor integrity, along with a number of other sectors such as coastal infrastructure and renewable energy. Finally, the high risk assessment for the food web descriptor reflects problems found in other descriptors such as biodiversity (declines of top predators in particular), fish and shellfish and sea floor integrity.

Of the eight descriptors/objectives that were scored at high risk, five were chosen for a review of operational objectives (non-indigenous species, fish and shellfish, food webs, marine litter and HD species and habitats). HD species and habitats were grouped together in one as operational objectives for these were likely to be linked. All other descriptors, apart from underwater noise and sea-floor integrity, were chosen. There is a lack of information on underwater noise and its effects on the marine environment and we also know that there are currently no operational objectives for underwater noise in the NEA, although these are being developed, for the UK at least, as part of the target setting process for the MSFD. Targets for seafloor integrity are also poorly developed and this is an area that will be worked on further in WP4 of ODEMM through an extension of the ODEMM pressure assessment. Under consensus by the regional leads, commercial fish and shellfish and food webs have been reviewed by all regions (see 1.4 for reasoning).

1.4.2 The Mediterranean Sea

The risk assessment for the Mediterranean showed eight objectives to be at high risk of failure. These include the biodiversity components marine mammals and reptiles, the Habitats Directive (HD) listed habitats and species as well as the non-indigenous species, commercial fish and shellfish, food webs, seafloor integrity, marine litter and underwater noise. With the exception of D9, contaminants in fish and shellfish, assessed to be at low risk of failure (as regulatory levels are rarely exceeded in large areas of the Region), all other objectives were assessed to be at a moderate risk of failure. Moderate risk of failure was assigned to D8, contaminants in the environment, as concentrations of some contaminants in biota, sediments and water exceed the relevant Environmental Quality Standards in some sub-regions of the Region. Moderate risk of failure was assigned to D5, eutrophication, as "Undesirable disturbance (including one or more of harmful algal blooms, low dissolved oxygen, associated declines in perennial seaweeds or sea grasses, kills of benthos and fish, dominance by opportunistic macroalgae) caused by eutrophication only occurs at a site or local scale in the region, but it occurs at least once a year". The problem is very common in sheltered marine water bodies such as harbours and semi-enclosed bays mainly in the vicinity of coastal towns and although is reported as worsening the outlook is recorded as moderate (EEA 2006, UNEP 2010). Based on the risk assessment criteria, the only biodiversity component facing a "Continued decline in a genotype, species, habitat or ecosystem type at the regional scale (decline in biodiversity) to the extent that there is a high likelihood of its loss from the region (= extirpation) within the next 10 years" was that of marine mammals and reptiles with 5 out of 9 and 3 out of 3 marine mammals and reptiles respectively considered threatened by IUCN criteria and including several endangered and critically endangered species. The rest of the biodiversity components and descriptors, including plankton, fish, seabirds and predominant habitats, were assessed to be under moderate risk of failure as "New or further decline in extent and/or condition of genotypes, species, habitat types or ecosystem types at the regional scale within the next 10 years". On the contrary, listed habitats and species under HD were assessed to be under high risk of failure as based on Article 17 reporting summary stats, 55% of listed habitats have an overall assessment of unfavorable (27 as unfavorable/inadequate and 27% as unfavourable /bad and 55% of listed marine species that have assessment information available, are shown to be at unfavourable conservation status for at least one of the criteria used to assess them, i.e. population, range and habitat. With at least 25% fish stocks exploited beyond Maximum Sustainable Yield (MSY) (i.e. "over-exploited, depleted or recovering"), 44%-73% of fish stocks outside safe biological limits (SBL), significant numbers of threatened or even commercially extinct species, considerable declines in apex predators and alteration in food webs, D3 and D4 objectives were assigned at high risk of failure. Similarly, with evidence of increasing NIS introductions, a recent faster rate of NIS introductions and indeed evidence for high numbers of established invasive non-indigenous species in many sub-regions, the NIS objective was also assigned at high risk of failure. Pollution is a major issue for the region and this includes noise and litter; both pressures expected to escalate with anticipated increases in maritime traffic and in the proliferation of microplastics in beach and open sea floating litter.

Having reviewed the most relevant and recent assessments/reviews/papers on critical issues for the Mediterranean Sea (Coll et al., 2010, Costello et al., 2010, UNEP/MAP-Plan Blue, 2009, UNEP, 2010) the Mediterranean expert group decided to focus on the objectives of non-indigenous species, marine litter and HD habitats and species. Based on the results of the risk assessment, the risk of failure of these objectives is high and the confidence in these assessments is also high.

1.4.3 The Baltic Sea

Risk analysis carried out for the common list of descriptors revealed that in the Baltic Sea a high risk of failure might be expected for biodiversity, predominant habitats, non-indigenous species, commercial fish and shellfish, food webs, eutrophication, sea-floor integrity, marine litter and HD species and habitats. We decided to continue our analyses for eutrophication and the HD habitats and species in addition to the two common descriptors (commercial fish and shellfish and food webs). Eutrophication is the main problem in the Baltic Sea and as there are already developed functioning operational objectives and data it is possible to compare Baltic Sea Action Plan (BSAP) and MSFD attributes. Eutrophication is traditionally regarded as a major issue in the Baltic Sea region due to high nutrient input, restricted water exchange and considerable load deposited in the sea sediments: the international community has been trying to tackle this since the mid-1970s when the first convention was signed by the then seven Baltic coastal states. The assessment of risk of failure to reach Habitats Directive high-level objectives was made according to HD assessment of conservation status. We selected the high-level objective Habitats Directive habitats and species as there is high risk of failure to reach favourable conservation status and, as the assessment of favourable conservation status has been made, there is some data to make this analysis. Fisheries are usually regarded as one of the major anthropogenic pressures on ecosystems. This is also the case in the Baltic Sea. At present, in the Baltic Sea, only two out of 15 regularly assessed stocks are considered "within safe biological limits". The Baltic Sea food web is relatively simple and there are numerous publications describing the abundance and distribution of the key food web components. The role of top predators, such as seals and harbour porpoise, is still an issue in the Baltic Sea, with some stocks even classified as above or slightly above the Limit Reference Level (LRL). In the HELCOM Initial Holistic Assessment (2010a), nutrient inputs and different methods of fishing, i.e. pressures causing eutrophication and a decline of biodiversity, were rated the top pressures in the Baltic Sea. Most of the pressures leading to inputs of hazardous substances, whether synthetic or non-synthetic, were ranked within the top 25. Numerous pressures causing physical disturbance of the sea bottom or causing noise, mainly impacting biodiversity, were distributed among the pressures with the least overall magnitude. This is associated with the relatively low spatial coverage of these pressures but they can still be highly destructive at the local scale.

1.4.4 The Black Sea

From sixteen descriptors/objectives assessed in the risk assessment for the Black Sea, high risk of failure for GES was noted for seven, fish and shellfish; food webs; sea-floor integrity; marine litter and underwater noise. In addition to commercial fish and shellfish and food webs, contaminants, contaminants in fish and shellfish, and biodiversity - predominant habitats were chosen for subsequent analysis since these are all regarded as important environmental issues in the region. Although three of these five descriptors were not assessed as currently being at high risk, they were assessed as being at moderate or moderate-high risk. Most fish stocks in the Black Sea have been over exploited or are threatened by over exploitation. The structure of catches has shifted from predatory to non-predatory species. Marine living resources have been greatly affected not only by over-fishing but also by alien species introductions and habitats change/deterioration. Ecological modelling studies (Gucu, 2002, Daskalov, 2002, Oguz and Gilbert, 2007, Oguz et al., 2008) and analysis of long-term time series data (Daskalov, 2003 Llope, 2011, Oguz and Velikova, 2010) has shown that the structure of the food web in the Black Sea has undergone significant perturbations over the past 40 years. Operational objectives concerned in regulation of high level objectives such as eutrophication and fisheries are extremely valid and directly related to maintain the quality of the Black Sea food-web (Banaru et al., 2010, Oguz and Velikova, 2010). Due to its inland position, high occupancy of the coastal zone and high specific catchment of the Black Sea, pollution and inflow of hazardous substances (including oil) is a key challenge for the region. Each country has specific "hot spots" with very high concentrations of pollution (pesticides, heavy metals) in sediments (TDA, 2007). Petroleum pollution has continued to be a major problem for the whole sea over the last two decades, taking into account the fact that activity in the Baltic Sea shipping sector tends to increase (BSC SOE Report, 2008b). The concentrations of some substances are in or above the ranges used as Ecotoxicological Assessment Criteria by OSPAR, with illegal dumping/discharges (particularly of agrochemicals) being recognized as a particular problem (BSC, 2010). The highly polluted environment caused the accumulation of pollutants in the biota, which could be dangerous for the human health in case of exceeding the acceptable levels for food (TDA, 2007, BSC SoE, 2008b, Polikarpov and Egorov, 2008, Kayhan et al., 2007, Stanciu et al., 2005, Romeo et al., 2005). Biodiversity decline and habitat destruction are two major issues of the Black Sea that directly affect biodiversity especially for predominant habitats. As shown in TDA (2007), all coastal margin habitats are considered to be in a critical status in at least one country; both types of pelagic habitat (neritic and open sea) are considered critical in at least one country; and 13 of 37 types of benthic habitat are considered to be critical in at least one country.

1.5 Existing international, European and regional policy frameworks

In 1992 the international community opened for signature 'The Convention on Biological Diversity' at the 'Earth Summit' meeting held in Rio de Janeiro. The convention entered into force in 1993 and required the parties of the convention to commit to the conservation of biological diversity and promote sustainable development (http://www.cbd.int/history/). This widely agreed international convention sets out high-level biodiversity targets. More specific directives also exist at a European level. There have been several European directives which attempt to manage our use of the marine environment. For example; the Birds Directive in 1979 and the Habitats Directive in 1992 both aim to restore important species and habitats back to former conditions. The Water Framework Directive established in 2000 aimed to improve river basin management whilst the Common Fisheries Policy in 2002 has become the driver for fisheries management in European Seas. On a more regional scale, conventions such as the OSPAR convention (NEA); the Barcelona Convention (Mediterranean); the Bucharest Convention (Black Sea) and the Helsinki Convention (Baltic Sea) all gave rise to regional action plans which give specific goals and targets for the regional sea. Figure 1 describes the different levels of policy directives for which objectives will be set. The international and European directives tend to include more high-level goals and aims whilst it is the regional sea action plans which will operationalise many of its high-level goals; however, the extent to which this has been done varies. Although in many cases high-level objectives of both the international and European directives are related to the objectives in the MSFD, this report has focused attention on the regionally specific operational objectives since it is these that will most effectively be used to achieve potential targets member states might develop for the MSFD.

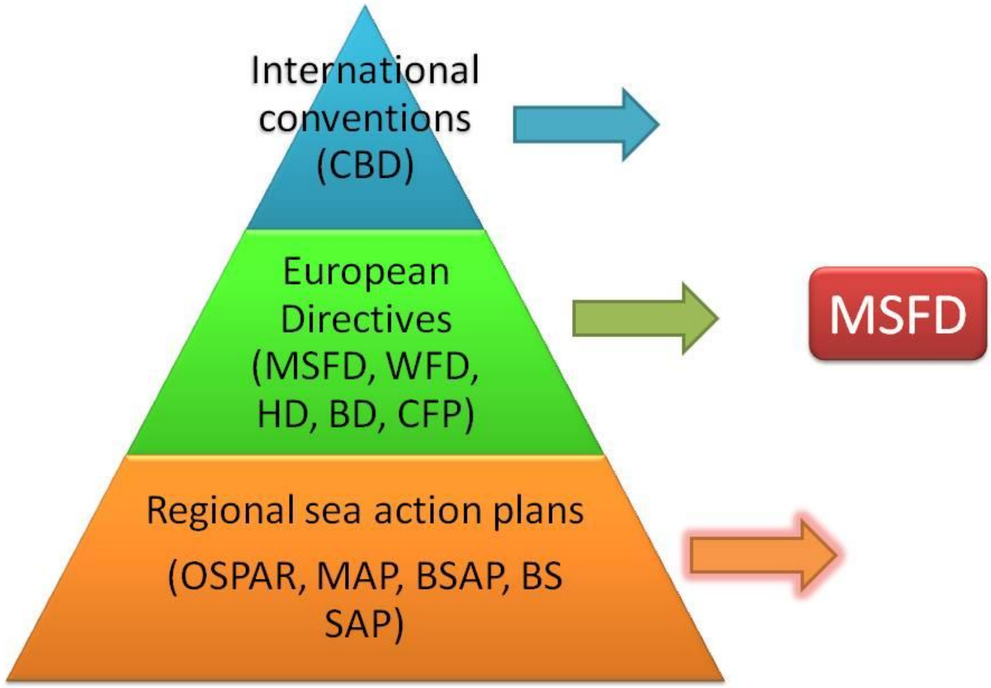

Figure 1. The hierarchy of policy drivers whose objectives can be linked to those of the MSFD. This report will focus on regionally specific examples of operational objectives where possible and how these can be linked to MSFD indicators.

1.5.1 Overview of existing regional policy frameworks

1.5.1.1 The OSPAR convention

The OSPAR Convention was constructed in 1992 to expand and replace the current legislation of regulation of pollution control in the North East Atlantic by the Paris and Oslo convention. Within OSPAR there are fifteen governments working togehter to help protect the marine environment under OSPAR in the North East Atlantic; these are, Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom. OSPAR aims to ensure that all of these contracting parties fulfil their commitments to protecting the North East Atlantic within the 5 OSPAR regions. These regions are, region 1: Arctic Waters, region 2: Greater North Sea, region III: Celtic Sea, region IV: Bay of Biscay and Iberian Coast, region V: Wider Atlantic.

The main aim of OSPAR is to identify the major threats and emerging issues from human impact to the marine environment for the North East Atlantic region, and put together actions and measures to prevent and eliminate these threats. Some of the major threats within this region include shipping, fishing, offshore construction, dumping and pollution.

OSPAR have identified several control measures; these include assessment and monitoring programmes for quality status of each sub-region within the North East Atlantic. Some of these measures and targets include the Ecological Quality Objectives (EcoQOs) for the North Sea. There are several EcoQOs established under OSPAR and several new ones that are currently under development. These EcoQOs are based on indicators of the status of the marine ecosystems within the North Sea and cover a wide variety of aspects within an ecosystem from phytoplankton all the way up the food chain to marine mammals. When the EcoQOs are met, then the status of the ecosystem is thought to be in a healthy state. On the other hand, when the EcoQOs are not met then this indicates that the ecosystem in which this species exists would not be in a healthy condition. Further to this, OSPAR have come up with a list of threatened species and habitats and have identified several Marine Protected Areas (MPA's).

1.5.1.2 The Mediterranean Sea Action Plan

The Mediterranean Action Plan (MAP) (UNEP, 2007) was adopted in 1975 within the Regional Seas Programme of the United Nations Environment Programme and in 1976 the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) was adopted. Seven protocols addressing specific aspects of Mediterranean environmental conservation complete the MAP legal framework. Today, the MAP involves 21 Mediterranean countries and the European Community, all of which are determined to meet the challenges of environmental degradation in the sea, coastal areas and inland, and to link sustainable resource management with development, in order to protect the Mediterranean region and contribute to an improved Mediterranean quality of life. Key MAP priorities for the coming decade are:

- to bring about a massive reduction in pollution from land-based sources;
- to protect marine and coastal habitats and threatened species;
- to make maritime activities safer and more conscious of the Mediterranean marine environment;
- to intensify integrated planning of coastal areas;
- to monitor the spreading of invasive species;
- to limit and intervene promptly on oil pollution;
- to further promote sustainable development in the Mediterranean region.

The Mediterranean Commission on Sustainable Development (MCSD) is an advisory body to the Contracting Parties. It has a unique structure of representatives of the 22 Contracting Parties as well as 15 rotating representatives from local authorities, business community and NGOs, forming, on equal footing, a think-tank on policies for promoting sustainable development in the Mediterranean Basin. The MCSD coordinated the preparation of the Mediterranean Strategy on Sustainable Development (MSSD), which was adopted by the Contracting Parties in 2005. The Programme for the Assessment and Control of Marine Pollution in the Mediterranean Region (MED POL) is the scientific and technical component of MAP. It is responsible for the implementation of the land-based sources, dumping, and hazardous wastes protocols. MED POL assists Mediterranean countries in the formulation and implementation of pollution monitoring programmes, including pollution control measures and the drafting of action plans aiming to eliminate pollution from land-based sources. Six MAP Regional Activity Centres (RACs) are based in Mediterranean countries, each offering its own environmental and developmental expertise for the benefit of the Mediterranean community in the implementation of MAP activities. The Regional Activity Centre for Specially Protected Areas (RAC/SPA) launched the Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean

(SAP BIO). SAP-BIO is currently under review. New targets and objectives are expected in 2011. RAC/SPA recently (April 2011) convened a consultation meeting, bringing together several partners acting in the field of Mediterranean biodiversity conservation, to discuss future orientations after the Nagoya meeting (October 2010) and the decisions adopted by the CBD COP10 (tenth meeting of the Conference of Parties to the Convention on Biological Diversity (COP10). The main objectives were to find the best way to align the activities of RAC/SPA to new priorities, through a revision of the Strategic Action Programme for the Conservation of Biodiversity in the Mediterranean (SAP BIO). The Mediterranean Ecological Vision (Decision IG 17/6, Barcelona Convention 2008) for "a healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations" is the first step towards the development and application of the Ecosystem Approach in the region. With twenty one states with a coastline to the Mediterranean and EU MS being a minority, the implementation of the MSFD will be a challenge with the MAP playing a key role in coordinating the region's efforts to restore the marine environment to a healthy state and achieve GES. The roadmap to the application of the Ecosystem Approach (and the wider implementation of MSFD) includes 7 steps; step 2 is to set 3 common strategic goals a) to protect, allow recovery and where practicable restore structure and function of marine and coastal ecosystems, b) to reduce pollution and c) to prevent, reduce and manage the vulnerability of the sea and the coasts. The on-going step 3 aims at the "identification of important ecosystem properties and assessment of ecological status and pressures and subsequent step 4 at the "development of a set of ecological objectives corresponding to the Vision and Strategic goals".

1.5.1.3 The Baltic Sea Action Plan

The Helsinki Commission, or HELCOM (the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, signed in 1974 and revised in 1992), works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental co-operation between the riparian countries and the EU. The HELCOM Baltic Sea Action Plan (HELCOM BSAP, 2007) is a programme to restore the good environmental status of the Baltic marine environment by 2021. The new strategy is a crucial stepping stone for wider and more efficient actions to combat the continuing deterioration of the marine environment resulting from human activities (HELCOM, 2007).

The HELCOM BSAP addresses all the major environmental problems affecting the Baltic marine environment. It is based on a clear set of 'ecological objectives' defined to reflect a jointly agreed vision of 'a healthy marine environment, with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable human activities'. Targets for 'good ecological status' are based on the best available scientific knowledge. The timeframe for reaching these targets is a political decision. With the application of the ecosystem approach, the protection of the marine environment is no longer seen as an event-driven pollution reduction approach to be taken sector-by-sector. Instead, the starting point is the ecosystem itself, and a shared concept of a healthy sea with a good ecological status. This vision will determine the need for further reductions in pollution loads, as well as the extents of various human activities.

The cross-sectoral plan identifies the specific actions needed to achieve agreed targets within a given timeframe for the main environmental priorities: combating eutrophication, curbing inputs of hazardous substances, ensuring maritime safety and response capacity to accidents at sea, and halting habitat destruction and the ongoing decline in biodiversity. The action plan distinguishes between measures that can be implemented at regional or national level, and measures that can only be implemented at EU level (e.g. Common Fisheries Policy, Common Agricultural Policy, controls over the marketing and use of chemicals) or globally (e.g. the shipping controls defined by the International Maritime Organization).

The HELCOM Baltic Sea Action Plan has involved the active participation of all major stakeholder groups in the region with the aim to ensure that the plan is truly relevant and can be effectively implemented in practice. The HELCOM Moscow ministerial meeting (HELCOM, 2010b) decided to establish, for those HELCOM Contracting States being also EU-Member States, the role of HELCOM as the coordinating platform for the regional implementation of the EU MSFD in the Baltic Sea, including striving for harmonised national marine strategies for achieving good environmental status according to the HELCOM Baltic Sea Action Plan and the EU MSFD.

1.5.1.4 Black Sea Strategic Action Plan

The updated (2009) version of the BS SAP represents an agreement between the six Black Sea coastal states (Bulgaria, Georgia, Romania, the Russian Federation, Turkey and Ukraine) to act in concert to assist in the continued recovery of the Black Sea. The document provides a brief overview of the current status of the Sea, based largely on information contained within the 2007 Black Sea Trans-boundary Diagnostic Analysis (BS TDA), and taking into account progress with achieving the aims of the original (1996) Black Sea Strategic Action Plan (BS SAP). The BS SAP (BSC, 2009) describes the policy actions required to meet the major environmental challenges now facing the Sea, and includes a series of management targets.

The overall vision for the Black Sea region is to enable the population to enjoy a healthy living environment in both urban and rural areas, and to attain a biologically diverse Black Sea ecosystem with viable natural populations of higher organisms, including marine mammals and sturgeons, and which will support livelihoods based on sustainable activities such as fishing, aquaculture and tourism in all Black Sea countries. The Black Sea TDA-2007 reconfirmed four priority transboundary problems expressed in the BS SAP 1996, amended in 2002. These are: 1) eutrophication/nutrient enrichment; 2) changes in marine living resources; 3) chemical pollution (including oil) and 4) biodiversity/habitat changes, including alien species introduction. The SAP was elaborated from consensus reached at a multinational level in relation to a series of proposals that include: Ecosystem Quality Objectives (EcoQOs); short, medium and long term targets; and legal and institutional reforms and investments necessary to solve main environmental problems identified within the 2007 BS TDA.

2. Operational objectives: terms, uses and definitions

Breaking the term 'operational objective' down into its parts; 'operational' is defined in the Oxford English Dictionary as 'able or ready to function', and 'objective' is defined as 'something sought or aimed at' (Oxford University Press, 1984). This suggests than an operational objective is a goal for which it is possible to work towards achieving. In business, an operational objective can be defined as a 'short-term goal whose attainment moves an organisation towards achieving its strategic or long-term goals' (Business Dictionary, 2011).'

ODEMM defines an operational objective as one which has an 'indicator', a 'target' and a 'timeframe', and which is clearly linked to a clearly defined and understood management process or sector. In scientific literature, and particularly in relation to marine management, the term operational objective has had various meanings. Similarly, what can be defined as operational objectives have also been given other terminology for example, target is a commonly used term for operational objectives. Furthermore, significant definition differences exist for terminology to do with objectives (O'Boyle & Jamieson, 2006). Definitions include 'those for which specific, measurable, achievable, realistic and time limited (SMART) targets can be set such that management measures can be fitted and performance can be evaluated' (Stelzenmuller et al., Submitted). Operational objectives are further defined in O'Boyle and Jamieson (2006) as 'the strategies by which conceptual objectives (high level goals) are implemented'. They go on to say that operational objectives provide the link between conceptual aims and the management control and allow an action statement for management (O'Boyle & Jamieson, 2006). In contrast to this Sainsbury and Sumalia (2003) discuss a hierarchical approach to definitions. They define operational objectives as 'An objective that has a direct and practical interpretation, usually for a component'. They then go on to define indicators, reference points and performance measures separately. Similarly, the framework proposed by Rogers et al. (2007) to implement sustainable development in the UK marine environment, proposed that operational objectives are specific to regions, uses and sectors. Management indicators with targets as reference points however, are listed separately all under the main heading of operational delivery. Separation of operational objective terms i.e. indicator and target is common particularly in scientific policies and other studies. For example, a study by Gavaris (2009) looked at ecosystem based management from a fisheries point of view and laid out objectives (a high level goal), strategies (what will be done) and tactics (how it will be done) of how this could be achieved. The high level goal gives the context e.g. do not cause unacceptable reduction of productivity (yield), the strategy gives the indicator and target e.g. keep fishing mortality below 0.2 and the tactic gives some idea of the measures to be used to achieve the objective e.g. catch quota (example taken from Gavaris, 2009). The Baltic Sea Action Plan (BSAP) is a fully integrated action plan which considers all relevant aspects of the marine environment in order to achieve a Baltic Sea in Good Environmental Status (HELCOM, 2007). The BSAP sets out a list of ecological objectives for hazardous substances such as 'All fish safe to eat' which can be considered as a high level goal. Under these objectives indicators and varying levels of target ambition i.e. primary target, intermediate target and ultimate target, are then listed for these. Furthermore, for the nature conservation and biodiversity further ecological objectives are set which again consist of a high level goal and then a set of targets and indicators. Targets in some cases lack a set reference level. An example, taken from the BSAP (HELCOM, 2007), is 'By 2010 to have an ecologically coherent and well-managed network of Baltic Sea Protected Areas, Natura 2000 areas and Emerald sites in the Baltic Sea.' Below this an indicator is given of 'Designated BSPA's, Natura 2000 and Emerald site area as percentage of total sub-region area.' Further explanation of what percentage of the total sub-region would constitute 'an ecologically coherent' network of reserves would be helpful to make this an operational objective using the ODEMM definition. The Mediterranean Action Plan and its Programmes set priority actions, objectives, measures and targets in order to '...significantly reduce pollution in the Mediterranean Sea Area from land-based and other sources and to protect and enhance its marine environment...' (UNEP, 2003), whilst the OSPAR convention (OSPAR, 2009) and the Black Sea Strategic Action Plan (Anon, 2009) both contain lists of EcoQOs which are currently being developed into operational objectives through the development of indicators and targets. An example EcoQO from OSPAR for by-catch of harbour porpoises is 'Annual by-catch levels should be reduced to below 1.7% of the best population estimate' (OSPAR, 2009).

Despite the range of definitions of operational objectives, there is a common understanding in the literature that in order for an objective to be considered operational it must contain an aim, an indicator and a target. ODEMM's use of the term operational objective for the purpose of this review will be used as a broad umbrella term which will encompass objectives, indicators and targets as well as, in some cases, management measures. The report will also come across several different wordings for operational objectives such as 'ecological objectives' and 'ecological quality objectives (EcoQO)'. All essentially mean the same thing and aim to assess the status of the marine environment with the view to managing it sustainably and to achieve a defined high-level policy goal.

3. Review of operational objectives

3.1 Commercial fish and shellfish

Box 1

GES for fish and shellfish is achieved when '*populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock (EC, 2008).*

Attributes and indicators for descriptor 3 fish and shellfish are:

3.1 Level of pressure of the fishing activity

- *Primary indicator: Fishing mortality (F) (3.1.1)*
- *Secondary indicators* (if analytical assessments yielding values for F are not available): *Ratio between catch and biomass index (hereinafter catch/biomass ratio) (3.1.2).*

3.2 Reproductive capacity of the stock

- *Primary indicator: Spawning Stock Biomass (SSB) (3.2.1).*
- *Secondary indicators* (if analytical assessments yielding values for SSB are not available): *Biomass indices (3.2.2).*

3.3 Population age and size distribution.

- *Primary indicators: Proportion of fish larger than the mean size of first sexual maturation (3.3.1)*
- *Mean maximum length across all species found in research vessel surveys (3.3.2)*
- *95% percentile of the fish length distribution observed in research vessel surveys (3.3.3)*
- *Secondary indicator*: *Size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation (3.3.4)*

As previously mentioned, the Common Fisheries Policy (CFP) (2002/2371/EC; EC, 2002)is the main policy driver behind much of the targets set for all four regional seas related to Commercial fish and shellfish (Descriptor 3). The CFP is also the main policy framework determining the status and exploitation of commercial (shell) fish stocks. The CFP underwent reform in 2002 when numerous changes were implemented to improve the management system. These included greater focus on long-term objectives, a move towards fleet-specific management approaches, improved enforcement and greater emphasis on Mediterranean fisheries. The CFP is due for reform in 2012; however, currently the following high level objective applies (Based on Article 2 of the Council Regulation No. 2371/2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy):

"Precautionary approach shall be applied in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing activities on marine eco-systems. It shall aim at a progressive implementation of an eco-system based approach to fisheries management. It shall aim to contribute to efficient fishing activities within an economically viable and competitive fisheries and aquaculture industry, providing a fair standard of living for those who depend on fishing activities and taking into account the interests of consumers".

In order to achieve these objectives the CFP may apply management measures such as Total Allowable Catches (TAC's), quotas and restrictions in mesh sizes of fishing nets or area closures.

When it comes to operationalising these high level objectives the MSFD and CFP (certainly after revision) show very similar approaches; both involving the same indicators, fishing mortality (F) and spawning stock biomass (SSB), and reference levels, i.e. MSY based on the same stock assessments by ICES which is considered the competent authority for this. In addition to this, the MSFD has also put forward a set of indicators that should reflect whether or not the commercial stocks have a "healthy age and size distribution" as well as secondary indicators that can be used for stocks for which no analytical stock assessments are conducted (see annex A for full list of indicators). It is important to note that ICES advice is undergoing a transition to the MSY approach to fisheries management (FMSY) and that biomass target and reference points are not yet available for all stocks under MSY conditions.

Furthermore, an objective has been set by the European Commission towards achieving sustainable use of fisheries resources as part of a requirement from the World Summit on Sustainable Development (WSSD) in Johannesburg 2002. This objective states *"Maximum Sustainable yield (MSY) by 2015. Achieve a population indicative of a healthy stock, through fisheries management with no significant adverse impacts on other stocks, species and ecosystems, in support of achieving Good Environmental Status by 2020, as required under the Marine Strategy Framework Directive"* (EC, 2010). There are two main aims to this target: "improve the management of fished stocks" and "eliminate adverse impacts on fish stocks, species, habitats and ecosystems" (EC, 2010).

Regionally specific operational objectives have also been developed under the various regional sea conventions for which examples are given below per region.

3.1.1 The North East Atlantic

Many fish stocks continue to be overexploited within several sub-regions of the North East Atlantic (OSPAR, 2010c). Some stocks have improved and are thought to be within safe biological limits. These include haddock, saithe, plaice, hake and Norway pout. The majority of other fish stocks are not thought to be within safe biological limits where SSB is below the sustainable or precautionary limit, or the stocks are subject to levels of fishing mortality that exceed Fishing mortality per year. These fish stocks include cod, sole, herring, mackerel and blue whiting. Other stocks that may be at risk include sandeel and horse mackerel (OSPAR, 2009). It has been discussed that a more integrated approach is needed to achieve this objective or to set new objectives along with the EU Common Fisheries Policy and Norwegian fishery policy (OSPAR, 2010b).

Some of the stocks currently overexploited and/or depleted are normally dominant species within the North Sea fish assemblage meaning that changes in their biomass and reproductive capacity can also have repercussions in assemblage structure, diversity and productivity and that these can propagate out through the food web (OSPAR, 2010b).

As described above, the CFP is the main policy framework determining the status and exploitation of the commercial (shell) fish stocks in Europe. Within the North East Atlantic region the status of commercial fish stocks is assessed annually by the International Council for the Exploration of the Sea (ICES), providing the scientific advice used for the management of fisheries in this region. The MSFD, Task Group 3 explained that the term 'Within *safe biological limits'* is used to assess status of commercial fish stocks by ICES and is defined by two attributes: Firstly 'exploited sustainably consistent with high long-term yields' (assessed in terms of F), and secondly 'have full reproductive capacity' (assessed in terms of SSB) (Piet et al., 2010).

3.1.1.1 Review of existing operational objectives

As described above, operational objectives already exist (and are assessed by ICES) under the Common Fisheries Policy that are consistent with the high level objectives of the MSFD that states that *"Populations of all commercially exploited fish and shellfish are within safe biological limits…".* Targets on the objectives for SSB and F are available for single stocks and thus it will be necessary to look at how the assessments can be interpreted relative to the MSFD's regional (or sub-regional) sea boundaries.

OSPAR has a commercial fish objective that has been established within the OSPAR Ecological quality objective (EcoQO) framework to assess the status of commercial fish stocks. The current EcoQO relates to the indicator 'spawning stock biomass' under the EU Commission Decision. The EcoQO states *"Maintaining the spawning stock biomass above precautionary reference points for commercial fish stocks where those were agreed by competent authority for fisheries management".* This EcoQO was developed to help maintain healthy and safe levels of fish stocks and to keep fish stocks above their precautionary limits (OSPAR, 2010b). The overall objective here is to have both spawning stock biomass and fishing mortality (F) and the majority of fish stock, i.e. 50-100%, within precautionary limits. This precautionary limit is normally achievable when fishing morality (F) is kept below sustainable levels (OSPAR, 2010b).

3.1.2 The Mediterranean Sea

As with other data areas in the Mediterranean, there are significant regional differences in data coverage. Most commercial fish and shellfish data originate from the western part of the Mediterranean. Existing demersal stock assessments suggest that fishing mortality should be reduced significantly, in many areas, sometimes by a large amount, as some of these stocks may be approaching a critical state. While "significantly" cannot always be quantified, the "reference direction" to follow for the Mediterranean demersal fisheries is clear: fishing mortality should be decreased (Piet et al., 2010). Demersal stocks remain outside safe biological limits (EEA, 2006). Key commercial demersal species such as hake, red mullet, common pandora and picarel continue to be overexploited to various degrees in most assessed areas. Key shellfish species, such as the rose shrimp, scampi and red shrimp, are fully exploited to over-exploited depending on species and assessment area (Piet et al., 2010). Of the demersal species hake, red mullet and the deep water rose shrimp are in an alarming state as a result of over-fishing (UNEP/MAP-Plan Blue, 2009). Likewise, large pelagics are exploited beyond levels that support MSY. The assessment of Mediterranean swordfish indicates that the stock is below the level which can support MSY and that current fishing mortality exceeds FMSY (ICCAT 2009a). The bluefin tuna assessment results indicated that the spawning stock biomass (SSB) has been declining rapidly in the last several years while fishing mortality (F) has been increasing rapidly, especially for large bluefin tuna. The under-reporting of catches until 2007 combined with the lack of reliable historical information for several fleets, and for the Mediterranean as a whole, means the stock could not be monitored with confidence and, therefore, severe depletion could easily go undetected. Continuing fishing at the 2007 fishing mortality rates is expected to drive the spawning stock biomass to very low levels; i.e. to about 18% of the SSB in 1970 and 6% of the unfished SSB. This combination of high F, low SSB and severe overcapacity, as was estimated in the 2008 assessment, results in a high risk of fisheries and stock collapse (ICCAT, 2009b). Small pelagic stocks exhibit large-scale fluctuations, but are not fully exploited anywhere, except for anchovy and pilchard in 2 areas (EEA, 2006).

3.1.2.1 Review of existing operational objectives

In order to contribute to achieving the World Summit on Sustainable Development (WSSD) targets concerning maintaining fish stocks to MSY levels, establishing Marine Protected Areas, and time/area closures for the protection of nursery grounds, SAP-BIO has set various priority actions, objectives and targets relevant to commercial fish. Priority Action 21 (objectives a-i) aims to maintain or restore fishery stocks to levels that can produce the MSY on an urgent basis for depleted stocks and where possible not later than 2015. With key demersal and pelagic stocks outside safe biological limits and a few depleted and/or facing risk of collapse, this objective can be seen as currently failing. In addition, a large number of stocks remain un-assessed, and of the assessed stocks only a few stocks are assessed routinely and systematically, and MSY targets for SSB and F are not available for most stocks. Priority Action 10 aimed to attain the protection of 20% of the coast as marine fishery reserves by 2010 and the establishment of representative networks of MPAs by 2012. This again can be seen as failed since Mediterranean MPAs (including the high-sea Pelagos Sanctuary) cover only 4% of the Sea so far, the existing network is regionally unbalanced and not coherent and a large number of MPAs are still essentially "paper parks" (Abdulla et al., 2008). Additionally SAP-BIO included a long list of measures-based objectives aimed at improving selectivity of gear and fishing practices, improving fishing statistics and developing Mediterranean strategies for the conservation and suitable management of vulnerable fish and invertebrates. Progress has been made but significant challenges remain ahead, for example drift netting, once widely used throughout the Mediterranean targeting swordfish is now banned, however illegal drift netting still occurs in the region (e.g. by Morocco, Turkey, Algeria and others).

3.1.3 The Baltic Sea

For the Baltic Sea stocks the appropriate source of information is the regular assessments done by ICES Assessment Working Groups reporting to Advisory Committee (ACOM).

Only two out of eight regularly assessed stocks are currently considered “within SBL” (eastern Baltic cod and Bothnian Sea herring stocks). For many stocks there are still insufficient data to assess the current status precisely. It is even more complicated when the present “regime shift” state of the Baltic Sea is considered which requires revising most of the existing reference points (Piet et al., 2010).

For Baltic salmon stocks the F and SSB targets do not apply. For the evaluation of the current state of the wild salmon stocks, the smolt production relative to the level of natural smolt production capacity on a river-by-river basis is used and this should be used in the evaluation of GES as well. Presently from the 27 assessed rivers, 10 are likely to reach the 75% target in 2010, 11 rivers are uncertain and 6 rivers are unlikely to reach the 75% targets. The reference points of the natural production capacity are more likely to be met in productive rivers, especially in the Northern Baltic Sea area, while the status of less productive wild stocks is poor (Piet et al., 2010).

3.1.3.1 Review of existing operational objectives

There is a consensus in the Baltic Sea to use Potential Smolt Production Capacity (PSPC) relative to the 75% level of the natural production capacity on a river-by-river basis. There is also consensus that in order to evaluate the effects of fisheries in 2010 we must assess the smolt production in 2015 (i.e. spawned 2010, hatching 2011, 2-3 years in the river plus one year in the sea makes year 2015). Again the criterion PSPC being relative to the 75% level of the natural production capacity will apply. Reaching at least 75% of the PSPC has been suggested by ICES if the plan is to recover salmon populations to the MSY level. The PSPC estimates therefore form the basis of the current reference points for the assessment of the Baltic salmon stocks. The salmon stocks are considered very likely to reach the reference point where the probability is more than 90%. They are likely to reach the reference point where the probability is between 70% and 90% and uncertain when the probability lies between 30% and 70%. When the probability of reaching the reference point is less than 30%, it is considered unlikely (Piet et al., 2010).

The Baltic Sea Action Plan addresses all the major environmental problems affecting the Baltic marine environment. Status of commercially exploited fish populations is analysed among the factors affecting objectives associated with the FCS of Baltic Sea biodiversity. Relevant actions include the rapid implementation of the existing long-term management plans for both cod and eel to improve their distribution size/age-range, no later than by 2012. Member States agree to make a joint submission, in consultation with the Russian Federation, with the view to ensure that fisheries are managed in a sustainable manner compatible with the environmental objectives of the HELCOM Baltic Sea Action Plan, to the 2012 review of the EU CFP.

According to the BSAP, coastal fish constitute an imperative part of the Baltic Sea total biodiversity and have a structuring role in coastal food webs. A substantial part of the coastal fish community of the Baltic Sea consists of freshwater species, only managed at a national level.

Preliminary operational objectives developed under the BSAP, referring specifically to commercially exploited fish populations, are as follows:

- Spawning stock biomass of western Baltic cod and eastern Baltic cod compared to precautionary level (Bpa) as advised by ICES and/or defined by EC management plans,
- Fishing mortality level of western Baltic cod and eastern Baltic cod, compared to precautionary level (Fpa) as advised by ICES and/or defined by EC management plans.

This work, however, will be coordinated by ICES whereas HELCOM intention is to focus mostly on the coastal fish community indicators. The list of core indicators proposed by the HELCOM CORESET Biodiversity 3/2011 report includes four referring to coastal fish:

- Fish abundance index
- Fish size index
- Fish species demographic index
- Fish species diversity index

Two more were suggested as candidate indicators:

- Salmon smolt production capacity
- Sea trout parr density.

Target levels for those indicators are presently under development.

3.1.4 The Black Sea

Fish stocks of the Black Sea have been the most drastically fluctuating components of the region over the second half of the 20th century, of which consequences are still in effect. The fish species in the Black Sea are under continuous risk of overexploitation by the fisheries. The mean trophic level of the catch decreased substantially from 1950s to 2000s (www.seaaroundus.org). Once abundant pelagic piscivorous fish; bonito, bluefish and mackerel, and demersal fish; red mullet, whiting and turbot, almost disappeared from catches (Oguz and Gilbert, 2007). The fisheries yield consists mostly of small pelagic fish; i.e. anchovy and sprat. There is no sign of recovery of once abundant demersal and pelagic piscivorous fish. Further, the stocks of small pelagic fish encountered significant oscillations over time (BSC SoE, 2008b) so as to lead to the collapse of the fishery in the early 1990s. High level objectives target to increase the biodiversity of commercial fish species and the chances of recovery of their stocks. In order to be able to achieve the sustainable management of fish stocks, multinational management measures, because of the complicated life histories of most of the fish species whose biological development take place across the whole Black Sea basin, should be undertaken regarding the fisheries of the Black Sea countries. Such development of strategies could be achieved relatively readily in EU member states; however, involvement of non-EU countries is necessary considering the fact that Turkey is responsible for almost more than 70% of the catch in the region. Such possible impediments should be overcome by strengthening the Black Sea Regional Cooperation under the umbrella of the Black Sea Commission.

3.1.4.1 Review of existing operational objectives

The Black Sea Strategic Action Plan (BS SAP) 2009 has an EcoQO that relates to descriptor 3, commercial fish and shellfish, (Preserve commercial marine living resources: a - Sustainable use of commercial fish stocks and other marine living resource; b - Restore/rehabilitate stocks of commercial marine living resources), which is being developed into an operational objective.

The operational objective "to increase the overall biomass by 30% for demersal fish stocks by 2019" aimed to match fishing effort to stocks. This operational objective is related to MSFD attribute/indicator: "Reproductive capacity of the stock: Biomass indices" (box 1). To restore the demersal fish stock it is planned to introduce quota regime for turbot and other demersal fish stocks by 2014. The quota regime has been introduced for turbot only for Bulgaria (BG), Romania (RO) and Ukraine (Piet et al., 2010). The implementation of the operational objective in the Black Sea requires international agreement in the special legislation/policy. In accordance with the BS SAP (2009) regional agreement for fisheries and conservation of living resources of the Black Sea is to be adopted and implemented in all countries by 2019. This objective is "on target"; the legal binding document draft has already been prepared.

In correspondence with the MSFD attribute "Level of pressure of fishing activity" (box 1) in the BS SAP (2009) there is an operational objective: to decrease by-catch level by 2014 (%-age is not specified). This operational objective requires: to establish regionally agreed minimum permitted length of commercial fish and minimum mesh sizes for target species (by 2014).

In correspondence with the MSFD attribute/indicator “Population age and size distribution” (box 1) the following operational objective is planned in BS SAP (2009): to increase the recruitment of fish by 2019 (%-age is not specified), which aims for the protection of juvenile commercial fish. Planned measures for the implementation of this objective are: a) to identify and introduce closed nursery areas (by 2014); and b) to establish and introduce closed seasons for demersal fish (by 2019).

As well as the specific measures outlined above to help achieve operational objectives, further measures have also been planned. Measures are planned for the protection of the benthic environment (BS SAP, 2009) as follows: to ban non–precautionary fishing technologies in force (notably dredging and bottom trawling). This measure is directly related to the MSFD attribute “Reproductive capacity of the stock” (box 1) because improved habitats result in an increase of reproduction of demersal fish. Furthermore, national legislation/policy tools/measures in the fisheries sector are in place in all states. Complete ban and periodic ban on commercial fishing are applicable. Total allowable and permissible catches (TAC) are not applicable in Turkey. Minimum admissible size, prohibited fishing gears and allowable mesh size for nets are also applicable in all the countries, whereas information on fishing free zones needs further clarification and improvement. A National Strategic Plan for Fishing and Aquaculture is available in Bulgaria and Romania for 2007-2013; they also implement the European Common Fisheries Policy. Release of young commercial fishes into the Black Sea is in place in Bulgaria and was in place in Turkey up until 2002. Aquaculture is well developed in all states and it is expected to reduce the stress on natural populations.

3.2 Marine food webs

Box 2

GES is achieved when *'All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity* (EC 2008)

Attributes and indicators for food webs (EC 2010)

4.1. Productivity (production per unit biomass) of key species or trophic groups
To address energy flows in food webs, adequate indicators need to be developed further to assess the performance of the main predator-prey processes, reflecting the long-term viability of components in the part of the food web that they inhabit, based on the experience in some sub-regions in selecting appropriate species (e.g. mammals, seabirds).

- Performance of key predator species using their production per unit biomass (productivity) (4.1.1).

4.2. Proportion of selected species at the top of food webs
To address the structure of food webs, size and abundance of components, there is a need to assess the proportion of selected species at the top of food webs. Indicators need to be further developed, based on the experience in some sub- regions. For large fish, data are available from fish monitoring surveys.

- Large fish (by weight) (4.2.1).

4.3. Abundance/distribution of key trophic groups/species

- Abundance trends of functionally important selected groups/species (4.3.1).
  It is necessary to identify changes in population status potentially affecting food web structure. Detailed indicators need to be further specified, taking account of their importance to the food webs, on the basis of suitable groups/species in a region, sub-region or subdivision, including where appropriate:
- groups with fast turnover rates (e.g. phytoplankton, zooplankton, jellyfish, bivalve molluscs, short-living pelagic fish) that will respond quickly to ecosystem change and are useful as early warning indicators,
- groups/species that are targeted by human activities or that are indirectly affected by them (in particular, by-catch and discards),
- habitat-defining groups/species,
- groups/species at the top of the food web,
- long-distance anadromous and catadromous migrating species,
- groups/species that are tightly linked to specific groups/species at another trophic level.

Food webs are recognised as the transfer of food energy from one organism to another; they are complex, diverse and constantly changing (Rogers et al., 2010). Food webs change according to the habitats in which they live, some are very discrete and some are larger. Food webs are split into several trophic levels; these tend to consist of producers, consumers and decomposers. Some food webs consist of a bottom-up system; this is where the food web is controlled by primary producers, whereas others consist of top-down system where the food web is controlled by the predators. Further to this, there are food webs that tend to be controlled by a dominant species within that ecosystem and this is called a 'wasp-waist' food web.

The main factors that affect food webs are removal of key species such as fish and mammals by fishing and by-catch. Assessments for the overall status of food webs are hard to define due to the complexity of several interlinking species over several different habitats. Assessments can be made by monitoring the population size, structure and abundance at several trophic levels; this information can tell us something about the current state of the ecosystem and its food web. For example, an increase in a population on the top of the food chain such as marine mammals can result from an increase in their food source, and on the other hand a decrease in their food source could result in a decrease of the marine mammal, particularly if they have high diet-specificity. These so-called trophic cascades can be good indicators of what is happening within an ecosystem and there are well recognised examples of such phenomena.

Current development on the MSFD targets and indicators will focus on achieving GES where all elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity (Box 2)

3.2.1 The North East Atlantic

Currently many species of marine life, which include invertebrates, birds, mammals, fish and reptiles, are in a declining or unfavourable status in the North East Atlantic (OSPAR, 2010b). Many of these species are top predators or species that can at least tell us something useful about the state of food webs in the ecosystem. The main threats that can affect these types of species include over exploitation of fish stocks and by-catch caused by fishing which contributes to the loss of key species from the food chain.

Assessments of the overall status of food webs and, therefore, ecosystems are difficult to define. Currently there is not an overall assessment to assess the status of food webs but there are several monitoring programmes in place that assess population size, structure and abundance from species at several trophic levels which can tell us something about the state of the ecosystem and its food web. At the top level, declining populations of species can be an indication of loss of a food source at the lower level. A good example of this is the Black-legged kittiwake that feeds on sand eels as their main food source. Studies have shown that breeding success of this bird is dependent on sand eel abundance (OSPAR, 2009a).

3.2.1.1 Review of operational objectives

OSPAR proposed several EcoQOs that could help achieve improved status for several key species, which are relevant to food webs. Two of these could be related to indicator 4.1 (Box 2) which includes population trends in seals and sea birds. The EcoQO for grey seals states "Taking into account natural population dynamics and trends, there should be no decline in pup production of grey seals of ≥10% as represented in a five-year running mean or point estimates (separated by up to five years) within any nine subunits of the North Sea". The EcoQO for harbour seals states "Taking into account natural population dynamics and trends, there should be no decline in harbour seals population size (as measured by numbers hauled out) of ≥10% as represented in a five-year running mean or point estimates (separated by up to five years) within any of eleven subunits of the North Sea" (OSPAR, 2010a).

Within the North East Atlantic, the EcoQO for grey seals has been met under the 5 year assessment (up to 2006) for the North Sea. There has even been an increase in grey seal pup recruitment during this period (OSPAR, 2010b). The areas under assessment include: Orkney, Jjorholmane (Rogaland), Firth of Forth, Farne Islands, Donna Nook, Netherlands coast, Heligoland and Schleswig-Holstein's Wadden Sea (OSPAR, 2010b). There was a lack of data for two areas under assessment at the French Channel coast, therefore it is impossible to know whether this objective has been met in that area.

The EcoQO for harbour seals has not been met for several areas under assessment; these include Orkney, Shetlands, Greater Wash to Scroby Sands, North and East Scotland (Montrose to Cape Wrath), South East coast of Scotland (Montrose to Berwick upon Tweed), West coast of Norway and Limfjorden. There has been a decrease in populations of harbour seal populations in these areas and this is thought to be a more than 10% decrease (OSPAR, 2010b). However there are several areas where the EcoQO has been met, these areas include Kattegat, Skagerrak and Oslofjord, Heligoland, Wadden Sea and Netherlands Delta (OSPAR, 2010b). The main threats to harbour seals are thought to include disease (Phocine distemper virus), by-catch through fishing, and competition with grey seals (ICUN, 2010).

This current EcoQO covers the North Sea region of the North East Atlantic. However the assessments were carried out over a large area of the North Sea, concluding quite a comprehensive assessment for seal populations. It is suggested that this EcoQO may not be met in the Outer Hebrides where a 13% decline was reported for harbour seals. Further to this a 30% decline was reported in Iceland between 2001-2006 and there is evidence of declines of 13% between 2000-2003 and 30% between 2001-2006 for grey seals off Iceland (OSPAR, 2010a). Monitoring in other sub-regions of the North East Atlantic may be needed to determine whether this EcoQO has been met.

In addition OSPAR have set a draft EcoQO for seabirds which is currently under development which also could relate to indicator 4.1 (Box 2). This EcoQO states that "Changes in breeding abundance should be within target levels for 75% of species monitored in any region or their sub-divisions".

OSPAR have also set up an EcoQO for minimizing by-catch of harbour porpoises. Harbour porpoises are on top of the food chain and changes in trends in abundance and population may indicate changes at lower levels of the ecosystems. The EcoQO states that "Annual by-catch levels of harbour porpoises should be reduced to levels below 1.7% of the best population estimate". It is difficult to distinguish the status of the by-catch of harbour porpoises as the current assessment is done on best estimates with very high levels of uncertainty. There is a need for fishing vessels to observe and record by-caught harbour porpoises to gain a better understanding of by catch rates (OSPAR, 2005).

The target indicator for large fish (by weight) under the Commission decision (Box 2) is covered under the OSPAR EcoQO which states "Over 30% of fish (by weight) should be greater than 40cm in length based on ICES Quarter 1 International Bottom Trawl survey (ICES Q1 IBTS) series". The overall aim of this objective is to increase the amount of early maturing fish to support an overall increase in fish yields and healthy fish populations. This objective has currently not been met, although there has been an increase in larger fish (those above 40cm) to 22%. Measures to help achieve this target include management of the intensity of fishing effort and spatial and temporal distributions (OSPAR, 2009b).

Black-legged kittiwakes are found in coastal areas of the British Isles. This sea bird is shown to be under threat in OSPAR regions I and II, populations have declined by as much as 50% since 1990 (OSPAR, 2010b). The main threats to these birds are thought to be predation, such as by the Great Skuas (Shetlands) and the White-tailed Eagle (Norway) and/or loss of key food species which in turn results from over fishing (OSPAR, 2010b). OSPAR has developed an EcoQO to assess the indicator "Performance of key predator species using their production per unit biomass (productivity)" (EC, 2010). This EcoQO states that "Breeding success of black-legged kittiwake should exceed (as a three-year running mean) 0.6 chicks per nest per year of each of the following coastal segments: Shetland, north Scotland, east Scotland, and east England". This EcoQO was developed to assess the availability of their primary food source, sand eel, and their success to breed. The relationship showing that if sand eels are low in abundance, the success rate in breeding will also be low or visa versa. The EcoQO only covers coastal areas of the North Sea and is still currently under development. The EcoQO could be used to look at areas of high risk and protected areas for birds around the coasts on the North Sea.

3.2.2 The Mediterranean Sea

Marine resources in the Mediterranean remain impacted, overexploited and understudied at various degrees and aspects. Nevertheless, existing knowledge shows that directed fisheries have caused stock collapse/local expirations for some species, with increasing evidence that fishing activities are also conspicuous at the systemic level. The latter includes the massive ecological footprint of fishing and the marked effects on the food web structure altering its internal functioning and displaying patterns of ecosystem degradation (Tudela, 2004, Coll et al., 2008)

Increased fishing intensity and efficiency of fishing methods (including expansion to previously inaccessible or deep areas) along with detrimental fishing practices have increased the depletion of top-predators such as monk seals, sharks, tunas, swordfish and groupers. It has also targeted spawners of several long-lived species (Malak et al*.,* 2011). A large proportion of target, non-target and past-target species, including several emblematic species of conservation concern, are at risk of extinction or indeed threatened (Cuttelod et al., 2008).

Fishing down of marine food webs has been documented in Mediterranean using trophic indicators, like the "Marine Trophic Index" (MTI), the "Fishing in Balance" index (FiB) and the Pelagic/Demersal index (P/D) (EEA 2006). The mean trophic level of Mediterranean catches has declined by about one trophic level during the last 50 years. Following an increase up to the mid-80's and the end of the fisheries expansion phase (especially offshore), the mean trophic level has declined (www.seaaroundus.org). The decrease of the FiB index and the rising of the P/D index may be interpreted as a result of a decrease in abundance of high trophic level species in the Mediterranean ecosystems and impaired food web functioning (Pennino, 2011).

3.2.2.1 Review of operational objectives

Although changes have occurred and some data (especially for the EU MS are collected) and could be seen to be indirectly addressing the issue, currently there are no operational objectives that are directly related to the MSFD indicators for food webs. The EC and the General Fisheries Commission for the Mediterranean (GFCM) are aiming to increase data collection (species assessed, types of data collected, indicators etc) as well as data accessibility in the Mediterranean region. Substantial but partial data collection for 39 species and 8 biomass and length based population indicators is covered under the Mediterranean Bottom Trawl Survey (MEDITS) and annual summer monitoring surveys since 1994. These surveys cover all suitable trawling locations over the shelves and the upper slopes from 10 to 800m depth (Bertrand et al., 2000). Till now, the surveys have mainly occurred in the North of the Mediterranean Sea from Gibraltar to the eastern Aegean Sea. The MEDITS group is currently developing a set of community indicators which can be elaborated from the data collected so far to contribute to the population and community indicators identified in the EU-Data Collection Framework and the MSFD. The proposal is to update the MEDITS website, presently devoted only to population indices, to cover all the MEDITS area with the same set of indicators. Concurrently, SAPBIO is under revision and new indicators (in line with 11 MSFD descriptors) and targets are expected in 2011 for the Mediterranean.

3.2.3 The Baltic Sea

According to HELCOM (HELCOM 2009b, HELCOM 2010a), the balance among the trophic levels has been disturbed and the zooplankton and benthic fauna at the second trophic level are subject to pressures both from above and from below. On the one hand, the zooplankton and benthic fauna can no longer control the abundance of phytoplankton, benthic algae and vascular plants at the first trophic level in many areas of the Baltic, where excessive nutrients have caused accelerated plant growth and eutrophication. At the same time, the zooplankton and benthic fauna are impacted by growing numbers of hungry perch, sprat and herring. These, in turn, are thriving well because their predators, including larger fish, seals, harbour porpoises and white-tailed eagles (at level four), have been reduced owing to human pressures. Although the abundance of seals has increased in northern parts of the Baltic Sea, the status of the populations of marine mammals is still poor in most of the Baltic Sea south of the Gulf of Bothnia.

Food-web models suggest that the co-occurrence of a weakened predation pressure by fewer mammals and large fish and increased primary productivity at level one have caused a complex series of changes in the Baltic Sea. As many as three regime shifts seem to have occurred in the Baltic Sea during the 20th century (Österblom et al., 2007). Although some of the observed changes are considered to have been influenced by climatic variation, reduced top predation pressure and excessive nutrient loading are likely to be the other causative factors (Möllmann et al., 2007). The first of the three changes in the Baltic food web structure took place in the early 20th century, when increasing cod populations signalled the decline of seal and harbour porpoise populations due to hunting. The second change in the food web structure was caused by increased nutrient loading from the catchment area, which led to an increased productivity in the sea. The development of a large-scale fishing industry in the Baltic in the latter half of the 20th century caused the third change in the food web structure, leading to prospering prey fish populations. During this shift, the cod population plunged and decreased sevenfold, while the sprat population benefited and multiplied eightfold.

The cascading effects of decreased predation and increased resources may also bring about eutrophication effects, including blooms of blue-green algae and nuisance short-lived macroalgae (Vos et al., 2004, Heck and Valentine, 2007). Support for such a scenario has been recently found in the Baltic marine environment (Casini et al., 2008). The changes in the food web structure have mainly been seen in the pelagic areas of the Baltic Sea, but increasing evidence shows that similar phenomena can also be observed in the coastal areas (Korpinen, 2008, Eriksson et al., 2009). The consequences of increased resource availability and decreased top-down control not only cause altered population abundances, but also changes in species composition and size spectra. The cascading effects of cod predation have been suggested to cause changes in the zooplankton species composition, leading to reduced growth of the Baltic herring (Rönkkönen et al., 2004). The side effects of eutrophication such as reduced water clarity and increased sedimentation of organic matter have benefited some algal species while perennial species such as bladderwrack have declined; this has caused changes in the invertebrate community (Korpinen and Jormalainen, 2008). In coastal bays and lagoons, a similar shift from macrophyte dominance to phytoplankton dominance has occurred (Dahlgren and Kautsky, 2004).

There are promising signs that the abundance of top predators is increasing in the Baltic Sea. The recovery of seals and predatory birds from hunting and contamination pressures has increased their population sizes during recent decades. The high fishing pressure on cod has been reduced to a sustainable level with the EU long-term management plan for cod which is expected to further enhance the cod stocks in the near future.

3.2.3.1 Review of operational objectives

Status of the food web is analysed directly and indirectly among the factors affecting ecological objectives associated with eutrophication and especially nature conservation and biodiversity. According to the BSAP, ecological objectives for nature conservation and biodiversity will be described by the following preliminarily selected indicators which can be associated to the food web:

- Trends in the number of threatened and/or declining species,
- Abundance, trends and distribution of Baltic seal species compared to the safe biological limit (limit reference level) as defined by HELCOM HABITAT,
- Abundance, trends, and distribution of Baltic harbour porpoise,
- Number of rivers with viable populations of Baltic sturgeon,
- Spawning stock biomass of western Baltic cod and eastern Baltic cod compared to precautionary level (Bpa) as advised by ICES and/or defined by EC management plans,
- Fishing mortality level of western Baltic cod and eastern Baltic cod, compared to precautionary level (Fpa) as advised by ICES and/or defined by EC management plans,
- Trends in numbers of discards and by-catch of fish, marine mammals and water birds,
- Number of entangled and drowned marine mammals and water birds,
- Number of salmon rivers with viable stocks,
- Trends of salmon smolt production in wild salmon rivers.

BSAP also suggests a set of targets; however, some may be regarded as high level objectives or goals when considering the ODEMM definitions. Few should also be treated as "administrative" goals: e.g. establishing closures of fisheries (by 2012), development of appropriate breeding and restocking activities for salmon and sea trout (by 2009), ensuring the successful eel migrations from the Baltic Sea (by 2008), or establishing the re-introduction programme for Baltic sturgeon (by 2015).

There are in some cases, however, operational objectives using the ODEMM definition. These are as follows:

- By 2009 illegal, unregulated and unreported fisheries are close to zero,
- By 2015 to reach production of wild salmon at least 80%, or 50% for some very weak salmon river populations, of the best estimate of potential production, and within safe genetic limits, based on an inventory and classification of Baltic salmon rivers,
- By 2015, to achieve viable Baltic cod populations in their natural distribution area in Baltic proper,
- By 2015 by-catch of harbour porpoise, seals, water birds and non-target fish species has been significantly reduced with the aim to reach by-catch rates close to zero,
- By 2015 discards of fish are close to zero (<1%).

Of those listed above some seem to be not achievable (e.g. by-catch of harbour porpoise, illegal, unregulated and unreported fisheries, and discards of fish, all to be close to zero), some would be extremely difficult to fulfil (production of wild salmon in all the salmon rivers), and finally some of them are already partly achieved (i.e. eastern Baltic cod stock condition is within the safe biological limits whereas its distribution is still limited to the southern part of the Baltic Sea).

Even where defined operational objectives do not exist, measures and management programmes have been undertaken to restore the Baltic Sea food web. For example, the re-introduction of Baltic sturgeon in Odra River, the collection of information on the status of Baltic salmon and sea trout populations and their spawning rivers, the HELCOM SALAR project has provided recommendations for habitat restoration in certain prioritised rivers. Other measures include improvement in the selectivity of fishing gears to reduce by-catch.

3.2.4 The Black Sea

Over the past fifty years, the species structure of pelagic and benthic communities in the Black Sea has undergone essential changes. It was expressed in the shift of abundance of functionally important groups of plankton, nekton and benthos. In particular, significant reduction of the populations of large predatory fish and mammals occurred. Food web dynamics in the Black Sea was considered in some ecological modelling studies (Gucu, 2002, Daskalov, 2002, Oguz and Gilbert, 2007, Oguz et al., 2008) and long-term time series data analysis (Daskalov, 2003, Oguz and Velikova, 2010). It was shown that with the removal of apex predators and demersal fish by overexploitation and along with increased eutrophication, anchovy and jellyfish became the dominant groups in the Black Sea. This shift transferred the Black Sea food web from a demersal-pelagic integrated system into a pelagic-only system. While the production of small pelagic fish transferred into other trophic levels, the absorbed system energy by jellyfish ended up in detritus. This increased the detritivory of the Black Sea food web which caused greater loss of the system's primary production in the dead-end trophic organisms like jellyfish, which had no natural predators in the Black Sea ecosystem. Further, introduction of an alien species in 1980s into the Black Sea; i.e. *Mnemiopsis leidyi*, significantly changed the dynamics of the food web.

Following all the perturbations and manipulations, the Black Sea food web maintained a new balanced state in the 2000s. This new state is characterised by the dominance of pelagic species sharing an important portion of the system production, and with increased flows to detritus through trophic dead-end organisms. However, there is still risk of substantial transformations of the Black Sea ecosystem under the influence of anthropogenic and climatic drivers. It is not possible to manipulate the dynamics of the Black Sea food web to end up in a sustainable marine system, however, it is possible to remove the anthropogenic stress so as to increase the resilience of the Black Sea ecosystem against impacts which might be caused by climatic drivers and intra-dynamic species competition in the future.

To achieve this, operational objectives concerned in regulation of high level objectives as eutrophication and fisheries are extremely valid and directly related to maintain the quality of the Black Sea food web.

3.2.4.1 Review of operational objectives

In the Black Sea there are no current operational objectives that relate specifically to food webs. However, there are high level objectives that are indirectly related to food webs which aim to preserve several important species and habitats. These include two EcoQO from the BS SAP 2009, the first EcoQO also relates to descriptor 3 fish and shellfish. The EcoQO are as follows:

EcoQO 1: Preserve commercial marine living resources: a - Sustainable use of commercial fish stocks and other marine living resources; b - Restore/rehabilitate stocks of commercial marine living resources.
EcoQO 2: Conservation of Black Sea Biodiversity and Habitats: a - Reduce the risk of extinction of threatened species; b - Conserve coastal and marine habitats and landscapes; c - Reduce and manage human mediated species introductions.

Further to this there are several other operational objectives under the BS SAP which include the following:

- To increase, in biomass, demersal fish stocks by 30% by 2019.
- To decrease by-catch level (%-age is not specified) by 2014.

These operational objectives can be related to the MSFD attribute "Abundance/distribution of key trophic groups/species". Based on these targets, special measures are also to be implemented: a) to introduce quota regime for turbot by 2014; b) to limit and ban the fishery endangered sturgeons and demersal fish species by 2009.

Turbot (*Psetta maxima*) is the one of the most important demersal fish species in the Black Sea with high market demand and prices. The TAC's and quotas for turbot in 2009 and 2010 and quotas allocation to the Member States were introduced according to Council Regulations (EC) No 1137/2008 and No 1287/2009. Both for Bulgaria and Romania quotas of 50 t in 2009 and 48 t in 2010 for each country were permitted. Turbot exploitation in Ukraine has been regulated by TACs since 1996. In Turkey there is no TAC regulation of turbot catches. Despite the recently low TACs, the fishing mortality remains at a level certainly higher than the proposed reference point (F0.1=0.15) with no sign of reduction. The exploitation of turbot in the Black Sea should be kept at the lowest possible level in order to allow the stock to recover (Piet et al., 2010).

The operational objective “decrease by-catch level” is aimed to restore population of marine mammals, which are classified as endangered, such as harbour porpoise, short-beaked common dolphin, bottlenose dolphin and extinct species such as the Monk seal in the Black Sea. There is a lack of comprehensive information and data on commercial species, health of populations of marine mammals and human stress on the Black Sea cetaceans and this is the major gap for the implementation. The ACCOBAMS Conservation Plan for BS Cetaceans, as a whole, is a great contribution towards the implementation of the Biodiversity Protocol concerning the issues with marine mammals. The Black Sea Commission initiated national consultations on the adoption of the ACCOBAMS Conservation Plan for BS Cetaceans as a Plan for all Black Sea coastal states (the Russian Federation and Turkey are not Contracting Parties to ACCOBAMS), but negotiations are in progress.

Within the Black Sea, one of the main reasons for drastic changes within the food web is removal of species due to overfishing. Therefore the operational objectives (according to the BS SAP, 2009) are: ‘to match fishing efforts to stocks by 2012-2016.’ This operational objective can be linked with the MSFD indicator “Abundance/distribution of key trophic groups/species” and indirectly with the indicator “Proportion of selected species at the top of food webs”. This objective is “on target” and a draft of the legally binding document for Fisheries and Conservation of living resources of the Black Sea has already been prepared.

To restore and sustain fish stocks and their biodiversity several measures and targets have been outlined:

- to harmonise, improve and agree methodologies for assessment of the all commercially important fish stocks at a regional level and for the collation of fisheries statistic data by 2015;
- to adopt and implement in all countries Regional agreement for fisheries and conservation of living resources of the Black Sea by 2019.

The introduction of NIS can also contribute to changes within the food web. In the Black Sea the invasion of *Mnemiopsis leidyi* (a comb jelly) contributed to a catastrophic decline in fish productivity in the late 1980s/early 1990s. Due to declines in fish species, the food web can be altered considerably. The BS SAP aims for limitation of species invasion by several measures; these include: a) to identify actions towards ratification of the Ballast Water Management Convention in the BS region Road map to reduce the risk of alien species invasion by 2016; and b) to enhance control of transfer of alien species with ballast waters (by 2014). These measures could be considered under food webs attributes. These measures are currently under review.

3.3 Biodiversity- Predominant habitats

Box 3

GES for biodiversity is achieved when *'biological diversity is maintained. The quality and occurrence of habitats are in line with prevailing physiographic, geographic and climatic conditions.'*

Attributes and indicators for the habitats level of the biodiversity descriptor are:

1.4Habitat distribution

- Distributional range (1.4.1)
- Distributional pattern (1.4.2)

1.5 Habitat extent

- Habitat area (1.5.1)
- Habitat volume, where relevant (1.5.2)

1.6 Habitat condition

- Condition of the typical species and communities (1.6.1)
- Relative abundance and/or biomass, as appropriate (1.6.2)
- Physical, hydrological and chemical conditions (1.6.3)

3.3.1 The Black Sea

At the Convention on Biodiversity (June 5, 1992, Rio de Janeiro, Brazil) the World Summit on Sustainable Development (WSSD) adopted a range of important decisions, regarding research and study of the marine environment and defined a target of halting the loss of biodiversity by 2010. In Johannesburg, in 2002, European Environment Ministries adopted a Protocol on Strategic Environmental Assessment, as well as an Environment Strategy for countries of Eastern Europe, Caucasus and Central Asia in Kyiv, Ukraine. In 2003 the Strategic Action Plan for the Black Sea Biodiversity and Landscape Conservation Protocol (BSBLCP-SAP) was established. These conventions can all be related to the conservation of predominant habitat types.

The Habitats Directive was enlarged to encompass Member States located in the Black Sea in 2007 and status is yet to be reported for those countries. Existing estimates of the Black Sea habitats status are based on regional criteria outlined in TDA (2007). Changes in aquatic coastal habitats vary and are dependent on the intensity of environmental pressures at the sub-regional level. The Danube Delta and the Bulgarian coastal wetlands probably continue to experience diversity decline and impaired ecological status compared to the 1960s. This is despite the considerable reduction in habitat degradation due to the designation of extensive protected areas and the implementation of management plans aimed at biodiversity and water quality restoration. The Dnipro Delta and the Turkish coastal aquatic habitats have continued to decline due to eutrophication and pollution. Often, habitat degradation can only be inferred from increased anthropogenic pressures rather than systematic studies. A lack of research and knowledge on Georgian coastal habitats and the Dniester Delta, as well as difficulties in obtaining national data, have weakened this assessment of changes in the ecological status and diversity of the Black Sea.

Benthic habitats show local signs of recovery but overall are still degraded compared to the pristine pre-eutrophication state of the Black Sea (TDA, 2007).

The Black Sea has a rich and, to some extent, unique biodiversity resulting from its semi-enclosed geography and inputs from several major rivers. Until recent times, this biodiversity underpinned a highly productive ecosystem that provided, among other benefits, abundant fishery resources. Unfortunately, wild species and their habitats have been, and continue to be, under massive human pressure. After a long period of economic depression in the majority of Black Sea countries, the rate of economic growth is steadily increasing, especially after Bulgaria and Romania joined the EU. The human impact on Black Sea biodiversity is consequently rapidly growing, including transformation of natural shore areas for resorts/recreation areas, pollution due to shipping of oil from the Caucuses to the West and encouragement of exotic species such as the veined whelk (*Rapana nervosa)*. Effective measures for the conservation of natural resources are now urgent, not least the establishment of an adequate network of Marine Protected Areas. However, representation of marine protected sites in the Black Sea countries as a whole, and especially in the offshore zone, is poor, although this reflects the global situation (BSC, 2008).

3.3.1.1 Review of operational objectives

In the BS SAP 2009 high-level objectives (EcoQO), that relates to descriptor 1 Biodiversity: Predominant habitats were outlined as follows: Conservation of Black Sea Biodiversity and Habitats: a Reduce the risk of extinction of threatened species, b Conserve coastal and marine habitats and landscapes, c Reduce and manage human mediated species introductions

Further to this there are several operational objectives under the BS SAP which include the following:

- to reduce number of threatened species and increase in their abundance (%-age is not specified) (by 2014). It is related to the MSFD indicators “Habitats conditions: Relative abundance and/or biomass, as appropriate” (Box 3);
- to reduce number and area of critical habitats(%-age is not specified) (by 2014). It is related to the MSFD indicators – “Habitats extent; Habitat conditions” (Box 3).

There are measures aimed to achieve EcoQO - to conserve and prevent extinction of threatened coastal and marine species:

- to assess endangered species abundance, distribution and threats (by 2014);
- to update Red list of species and BS Red Data Electronic Book (every 5 years).

There are several measures planned by the BS SAP for the protection of habitats these include:

- inventory and classifying of coastal and marine habitats completed and published (by 2014);

- to update list of the BS threatened habitats on the web page of the BSC regularly (every 5 years).

There are also several measures for the protection of coastal and marine areas from the negative effect of human activities by implementation of Marine Protected Areas (MPAs). The following measures are included: To increase number and total area of marine and coastal PAs (by 2014) and to list recommended areas for designation as protected (by 2014). These measures aim to achieve the high level goal of improving the state of the protected areas (by 2014);

For implementation, the following measures are required: to adopt a regional conservation plan for Black Sea endangered species and develop national action plans for all countries of the region (by 2014-2019).

In order to track progress with the establishment of an ecologically coherent network of MPAs in the Black sea, the following indicators could be used:

- Area of Black Sea coastal and marine habitats included in the MPA network (target: at least 10% and up to 30% of each one by 2015)
- Focal species of the Black Sea maintained in favourable conservation status across the MPA network (target: 100% by 2015)
- MPAs have an approved management plan and a governing body/administration in place (target: 100% by 2012 or within 3 years of establishment)
- MPA management effectiveness score (target: not less than 80% in any year)

Finally, given the urgency of making progress towards setting up an MPA network, it is noted that Black Sea countries can already take a number of significant steps, including:

- Designating as legally protected areas, all internationally important coastal / marine wetlands in the Ramsar List;
- Designating conservation areas in their inshore waters (territorial seas) known to be important for fish spawning, nutrient recycling (mussel beds, algae fields), migration routes of pelagic species and so on;
- Banning the use of damaging fishing techniques that result in unacceptable levels of by-catches or destroy seabed habitats;
- Preventing pollution from land based sources or from shipping, with improved enforcement measures for those guilty of breaches;
- Preventing recreational development in sensitive areas.

3.4 Non-indigenous species

Box 4

GES is achieved when *"non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem"* (EC 2008)

Attributes and indicators for non-indigenous species (EC 2010)

2.1. Abundance and state characterisation of non-indigenous species, in particular invasive species

- Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species (2.1.1)

2.2. Environmental impact of invasive non-indigenous species

- Ratio between invasive non-indigenous species and native species in some well studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species) (2.2.1)
- Impacts of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible (2.2.2).

Non-indigenous species (NIS) introduced by humans can have both an ecological and economic impact. Two of the main forms of introduction are by shipping through ballast water and fouling and also through mariculture. A third very important vector of NIS introduction is through canals; the Suez Canal in the Mediterranean is responsible for the majority of alien species introductions (Galil, 2009). NIS can be both invasive (Invasive Alien Species (IAS)) and non-invasive. Those that are invasive tend to reproduce fast and successfully and can have various negative effects such as destruction of habitats and depletion of native species either through competition for food or through predation. Due to an increase in vessel traffic over time, NIS is an emerging issue for many regional seas and continues to threaten many indigenous species. Management measures implemented by the International Marine Organisation (IMO), e.g. the Ballast Water Convention, have helped to reduce the risk of introduction of more species. Regional conventions stepped up efforts and have taken measures consistent with the Johannesburg World Summit 2002 objectives. Further to this, development of targets and indicators within the MSFD will help to achieve GES for this descriptor with the overall aim that "non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem (Box 4). The Convention on Biological Diversity (CBD) have also developed targets for its 2010 biodiversity target setting exercise and these may also be applicable as operational objectives for implementation of the MSFD's HLO on NIS. In 2010 these targets were revised and now state that *'By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment'.* This target is still under revision. To help achieve this target, optional milestones have been drafted by the CBD. These include: "By 2014, potential pathways for invasive alien species are identified using a risk assessment framework, and lists of the most harmful invasive species are developed"; Furthermore it states "By 2014 action plans are developed and relevant legislation is reviewed"; In addition, "By 2016, actions have been taken to address the most important introduction pathways and the most serious invasions"; Finally, "By 2020, the measures which have been put in place have been assessed to determine their impact".

3.4.1 The North East Atlantic

It is difficult to determine the number of NIS in a region and even more difficult to determine whether these species have had or will have adverse effects on the environment. Not all NIS are harmful and can live in harmony within the environment they establish in. Currently in the OSPAR region 160, NIS have been identified, but the real numbers are thought to be higher (OSPAR, 2010b). NIS are present in most sub-regions with 30 NIS species found in two or more of these sub-regions (as identified by ICES) and this is thought to be increasing (OSPAR, 2010b). Currently the main source of introduction of NIS into the NEA region is through maricultures and ballast water from ships. Within this region NIS were mainly introduced before any management measures were implemented. One example of an introduced species is the Pacific oyster, which was introduced to replace the already declining native oyster. Due to the oyster's tolerance to several temperatures it has spread and established itself in many areas; this has caused irreversible changes to native ecosystems (OSPAR, 2010b). Another example is the Chinese mitten crab which was introduced unintentionally through ballast water. Again this species is able to tolerate a wide range of temperatures and salinities. The mitten crab has caused destruction to river banks within the Thames estuary and poses a threat to the native white clawed crayfish.

3.4.1.1 Review of operational objectives

For the North East Atlantic, there are currently no targets or indicators that are specific to levels or impacts of invasive alien species in the marine environment. However, there are management measures in place to restrict further impact from NIS. These include the IMO Ballast Water Convention on the regulations on ballast ship water as discussed above. It is hard to know whether this management measure is truly effective and therefore more monitoring is needed. Further measures are also needed to help implement regulation of control for already established NIS. There is still a lot of uncertainty regarding true abundance and numbers of NIS due to lack of data and misidentification and it is therefore hard to give a true impact assessment. Further monitoring is need to help gain a more complete picture of the impacts of NIS and to come up with targets to help mitigate against this problem.

Although there are no descriptors and indicators for NIS as such under the MSFD, descriptor 1: biodiversity, can be indirectly related to the aims of achieving GES for NIS. Biodiversity action plans exist which are required under the CBD. Species for which action plans exist include the native oyster and the pink sea fan. There are also selected grouped species action plans for some important commercial fish stocks such as cod. These individual species action plans could be used as a tool for determining the impact of NIS on several species under threat by the introduction from human activities.

3.4.2 The Mediterranean Sea

The Mediterranean is the most invaded regional sea of the world with the phenomenon reaching epic scales (Galil, 2008, Costello et al., 2010). Tropical species originating from the Indo-Pacific, Red Sea or Indian Oceans have been entering the Mediterranean through either the Suez Canal (*Lessepsian* migration) or the Strait of Gibraltar for decades. The means of introduction differ greatly among the phyla and the basins of the Mediterranean with the majority of aliens in the eastern Mediterranean entering through the Suez Canal, whereas mariculture and shipping are powerful means of introduction in the North-western Mediterranean and in the Adriatic Sea (Galil, 2008). The temporal records of the alien species reflect political crises, economic development and scientific interest in studying the phenomenon (Galil, 2009).

Almost a thousand alien species are known in the Mediterranean and estimations on the number of NIS is continuously increasing. The vast majority of them having being introduced in the Eastern Mediterranean and nearly half of them have established populations in at least one area (Coll et al., 2010). Though no extinction of a native species is known, sudden decline in abundance, and even local extirpations, concurrent with proliferation of aliens, had been recorded (Galil 2007). Over one hundred species are classified as invasive or potentially invasive in the Mediterranean (Zenetos et al., 2010).

3.4.2.1 Review of operational objectives

For the Mediterranean Sea, there are currently no operational objectives related to descriptor 2, NIS. However, there are current measures in place to contribute to achieving the WSSD targets concerning significant reduction by 2010 in the current rate of loss of biological diversity. SAP-BIO (UNEP 2003) has set various priority actions and management measures relevant to control and mitigation of the introduction and spread of alien species; these are as follows:

- Controlling and mitigating the introduction and spread of alien and invasive species by a) developing appropriate institutional measures to fight against particular sources of alien species, b) implementation of a regional coordination network to mitigate introduction and spread of alien species and c) filling in existing gaps in knowledge about alien species. [Activity 15 (Priority Actions), Objectives a, b, c, by 2006.] Although the knowledge base is increasing, with continued new records of NIS these measures have certainly failed
- Assessing the potential impact of threats on Mediterranean coastal and marine biodiversity by a) creating an inventory of biodiversity elements and/ or areas likely to be impacted by a number of threats to biodiversity including the spread of non-indigenous species threat on biodiversity. [Activity (Priority Action) 13, objective a, by 2008.] This too, has failed, as mapping of biodiversity and priority and critical areas is still far from complete or coherent.
- Controlling and regulating of aquaculture practices, Activity 20 (Priority Actions), Objectives b & c: Develop and adopt measures to minimise the impacts of aquaculture and aquariology on the marine and coastal environment, by 2010. Awareness has certainly increased with characteristic examples and some progress has been made.

Although awareness has increased considerably (partly due to specific efforts and through attention generated around the introduction of toxic fish), effective management measures are largely still lacking. A Mediterranean Action Plan has been designed to constitute a Mediterranean strategy to face up to the problems posed by the introduction of non-native marine species and to strengthen the Mediterranean countries' capacities to develop coordinated measures to prevent control and monitor the bio-invasion effects. The final version includes the Action Plan on Introductions of Species and Invasive Species, the Guidelines for controlling the vectors of introduction into the Mediterranean of non-indigenous species and invasive marine species and a Guide for risk analysis assessing the impacts of the introduction of non-indigenous species (www.rac-spa.org).

3.5 Eutrophication

Box 5

GES is achieved when *'Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters'.* (EC 2008)

Attributes and indicators for eutrophication (EC 2010)

5.1. Nutrients levels

- Nutrients concentration in the water column (5.1.1)
- Nutrient ratios (silica, nitrogen and phosphorus), where appropriate (5.1.2)

5.2. Direct effects of nutrient enrichment

- Chlorophyll concentration in the water column (5.2.1)
- Water transparency related to increase in suspended algae, where relevant (5.2.2)
- Abundance of opportunistic macroalgae (5.2.3)
- Species shift in floristic composition such as diatom to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities (5.2.4)

5.3. Indirect effects of nutrient enrichment

- Abundance of perennial seaweeds and seagrasses (e.g. fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency (5.3.1)
- Dissolved oxygen, i.e. changes due to increased organic matter decomposition and size of the area concerned (5.3.2).

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services. These changes may occur due to natural processes; management concern begins when they are attributed to anthropogenic sources. Additionally, although these shifts may not be harmful in themselves, the main worry concerns 'undesirable disturbance': the potential effects of increased production, and changes of the balance of organisms on ecosystem structure and function and on ecosystem goods and services.
(Cardoso et al., 2010)

3.5.1 The Baltic Sea

Eutrophication is a major problem in the Baltic Sea. Excessive nitrogen and phosphorus loads coming from land-based sources are the main cause of the eutrophication of the Baltic Sea. About 75% of the nitrogen load and at least 95% of the phosphorus load enter the Baltic Sea via rivers or as direct waterborne discharges. About 25% of the nitrogen load comes as atmospheric deposition (HELCOM, 2009a).

3.5.1.1 Review of operational objectives

The Baltic Sea Action Plan has a priority to address the issue of eutrophication in the Baltic Sea. To do this, the BSAP has defined a clear set of ecological objectives which specifically relate to eutrophication.

The Baltic Sea Action Plan's ecological objectives for eutrophication include:

- Winter surface concentrations of nutrients reflecting the ecological objective "Concentrations of nutrients close to natural levels"
- Summer Secchi depth reflecting the ecological objective "Clear water"
- Chlorophyll *a* concentrations reflecting the ecological objective "Natural level of algal blooms"
- Depth range of submerged vegetation and status of invertebrate communities reflecting the ecological objective "Natural distribution and occurrence of plants and animals"
- Area and length of seasonal oxygen depletion reflecting the ecological objective "Natural oxygen levels".

Specific targets are being developed currently.

The transparency of seawater integrates many of the concrete effects of eutrophication and has been chosen as the primary ecological objective with summertime (June-September) using Secchi depth as an indicator. The other indicators can be regarded as supportive indicators to give additional information on whether good environmental status has been achieved and are dealt with elsewhere. Each objective is reflected by one or more HELCOM Core Set Indicators for eutrophication. In HELCOM (2007, 2009a), sub-region specific reference conditions and targets for each indicators are presented. Currently a HELCOM project (HELCOM TARGREV, http://www.helcom.fi/projects/on_going/en_GB/targrev/) is developing the eutrophication indicators further. Comparing MSFD attributes and BSAP objectives of eutrophication, it can be seen that they are quite well fitted. To reach the objectives of BSAP and to reach good environmental status of the Baltic Sea, HELCOM has agreed on the principle of identifying maximum allowable inputs of nutrients. These input ceilings have been estimated through ecosystem modelling, using the environmental targets as the starting point. The maximum allowable inputs of nitrogen and phosphorus have been estimated by sub-region and country (HELCOM, 2007).

To make the eutrophication segment of the HELCOM BSAP operational, HELCOM has adopted several recommendations on:

- more stringent requirements for phosphorus-removal from municipal wastewater treatment plants (above 10,000 p.e.) and introduction of requirements for wastewater management for small- and medium- sized municipalities (300-10,000 p. e.);
- improvement of on-site wastewater treatment of single-family homes, small businesses and settlements up to 300 p.e.;
- measures aimed at the substitution of phosphorus in detergents,

3.6 Contaminants

Box 6

GES is achieved when *'Concentrations of contaminants are at levels not giving rise to pollution effects'.* (EC 2008)

Attributes and indicators for contaminants (EC 2010)

8.1. Concentration of contaminants

- Concentration of the contaminants mentioned above, measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC (8.1.1)

8.2. Effects of contaminants

- Levels of pollution effects on the ecosystem components concerned, having regard to the selected biological processes and taxonomic groups where a cause/effect relationship has been established and needs to be monitored (8.2.1)
- Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil and oil products) and their impact on biota physically affected by this pollution (8.2.2).

Contaminants can be both natural and man-made; contaminates that arise from human activities have been becoming an increasing problem in some places and can have adverse effects on marine life. Within the marine environment the main sources and pathways of man-made contamination arise from discharges and emissions from industrial, residential and agricultural activities. Industrial chemicals include those such as organohalogens, metals, pharmaceuticals, organometals, phenols and polycyclic aromatic hydrocarbons. Residential contamination includes sewage and other household wastes. Agricultural sources includes pesticide and biocides that are added to the aquatic environment by land run off. Concentrations of contaminants tend to be higher around coastlines where the main forms of human activities are based. Large amounts of nitrogen and phosphorus are discharged from rivers into the sea giving rise to eutrophication in many places which can give rise to an increase in phytoplankton blooms. Another source of pollution comes from shipping. Ships previously used antifouling paints such as Tributyltin (TBT) to protect their hulls. TBT has been deemed to be toxic to aquatic life and can cause biological effects such as imposex within the dogwhelk. Under current measures TBT is banned for the use on ships and, since the ban, levels of TBT in marine organisms have dropped. High levels of contaminants have been thought to contribute to disease outbreaks seen within some species and in general a reduction in overall health of species. Contaminants are not only found in marine organisms but also within the water column and sediments. Sediments act as sinks for contaminants; tiny particles of contaminants can adhere to sediment particles in which they can stay for many years. These sediments are disturbed by the natural and human induced activities such as dredging and trawling; the contaminants are then released and transported to other areas. Although in some regions contamination is thought to have fallen, levels are still thought to be above precautionary levels in many cases. There are several EU directives and conventions that are in place to regulate, restrict or ban the release of contaminants to the marine environment. These include the EU regulation, evaluation, authorisation and restriction of chemical (REACH) (EC No. 1907/2006).

3.6.1 The Black Sea

Chemical pollution in the Black Sea is caused by human activities in marine and land-based sectors: these activities include shipping/harbour operations, agriculture, industrial discharges and municipal discharges. Concentrations of most toxicants (heavy metals, pesticides, oil-pollution, radionuclides) are typically greater in sediments than in water. The production, sale and usage of persistent organochlorine pesticides (e.g. DDT, HCHs) or herbicides (e.g. aldrin, endrin, dieldrin) has been prohibited in the Black Sea catchment for many years. For example, in Romania the application of DDT was originally banned in 1972 and "drins" (aldrin, dieldrin, etc.) from 1995. However, such substances have a long half-life (over 30 years), so the effect on the marine environment is very much a long-term issue. Dumping of wastes, particularly persistent organic pollutants, directly into the Black Sea, whether legally or illegally is a continuing problem in some countries. The scale of this dumping/illegal discharge is not known. There has been a historical problem of illegal dumping in all countries surrounding the Black Sea, but the extent to which this has been dealt with is not known.

The main environmental impacts of chemical pollution can be summarized as follows:

- Increased frequency/severity of hypoxic events;
- Sand/beach contamination by polluted waters including accumulation of heavy metals and POPs (persistent organic pollutants) in sediment and biota;
- Degradation of aquatic ecosystems/habitat loss;
- Reduced fish stocks;
- Pollution of ecosystems, particularly coastal wetlands;

3.6.1.1 Review of operational objectives

The BS SAP 2009 has an EcoQO that relates to descriptor 7 contaminants. The EcoQO is as follows:

EcoQO 4: Ensure Good Water Quality for Human Health, Recreational Use and Aquatic Biota:
Reduce pollutants originating from land based sources, including atmospheric emissions;
–and reduce pollutants originating from shipping activities and offshore installations.

Although no specifically related operational objectives have been defined for contaminants in the Black Sea, several policies and management measures have been developed to help achieve this EcoQO. In according with BS SAP, 2009 it is planned to develop, introduce and disseminate the concept of BAP (Best Agricultural Practice) and BEP (Best Environment Practice) as a tool for encouraging farmers to deliver the highest level of non-farm pollution control. The BAP and BEP concept is to be adopted by relevant governmental institutions and then practically implemented by farmers. It is required to develop/adopt environmental legislation on a national level (in each BS country) to: establish a list of most polluting industries; to agree a priority list of industrial sites; to implement BAT and BEP. In order to decrease the number of pollution sources and reduce pollutant emission there are the following operational objectives:

a) to increase P-free detergent sales (%-age not specified); b) to increase the number of farmers applying BAP (%-age not specified); c) to increase the number of installations using BAT (%-age not specified). They are to be implemented by 2019 but the percentages of the increasing of these indicators are not specified. These measures are related to MSFD indicator "Concentration of the contaminants mentioned above, measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC".

In the Black Sea region there are problems with insufficiently treated sewage, which pose a threat to public health and in some cases pose a barrier to the development of tourism and aquaculture. The measure (BS SAP, 2009) to 'reduce loads of nutrients by 2019' is related to MSFD attribute "Concentration of the contaminants mentioned above, measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC". The implementation of this measure is planned by continue/improve rehabilitation/construction of wastewater treatment plants (WWTP).

A real problem of pollution in the Black Sea is related with oil pollution. According to the Black Sea SAP, 2009, the Sea Contingency Plan to the Protocol on Cooperation in Combating Pollution of the Black Sea by Oil and Other Harmful Substances in emergency situations (Part I – Response to oil pollution; Part II - Chemical Plan) is to be developed by 2012; and to be adopted at national levels by 2017.

For reduction of the pollution in sediment there is an objective based measure in place (BS SAP, 2009): to 'decrease number of official deposits for dredged sediments in appropriate location by 2015'. This measure is related to MSFD attribute "Concentration of the contaminants mentioned above, measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC". This regulation of dumping activities is to lead to reduced pollutant emission to the sediment. But to achieve GES regarding the contaminants in sediment it is necessary to focus the objectives on the reduction of the pollutants concentration in sediment.

In the Black Sea there is serious problem with illicit chemical and solid waste discharges in the ports. The BS SAP (BSC, 2009) aims to solve this problem by the implementation of the following measure: 'to increase disposal and treatment of ship-generated wastes and cargo residues in full compliance with MARPOL 73/78 by 2019'. The VTOPIS or equivalent systems is planned to be implemented and operational in all Black Sea countries to support national governments in surveillance of vessels/traffic and in reducing/eliminating the pollution originating from vessels, including off-shore installations.

3.7 Contaminants in fish and other seafood for human consumption

Box 7

GES is achieved when '*Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards'.* (EC 2008)

Attributes and indicators for contaminants in fish and shellfish (EC 2010)

9.1. Levels, number and frequency of contaminants

- Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels (9.1.1)

- Frequency of regulatory levels being exceeded (9.1.2).

Contaminants induced by human activities can make their way into the marine environment. These contaminants enter into the water column and larger particles sink to the sea bed in which they adhere to the sediment particle. Marine life ingests contaminants that are readily available within the environment. It is therefore necessary to monitor the levels of contaminants within edible tissues such as fish and shellfish. This is carried out to make sure that contaminants within seafood consumed are at safe levels for consumption. Contaminants found within edible tissues have included polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCB's) heavy metals, mercury, dioxins, brominated flame retardants (BFRs) and phthalates. Some of these contaminants can be highly toxic and contaminants such as PCB's and PAH's may pose carcinogenetic risk at higher exposures. Overall, contaminants can contribute to a variety of negative effects such as shell thinning in bird eggs, reduced fecundity or reproductive impairment, increase susceptibility to disease, endocrine disruption and death. There is currently some monitoring and assessments carried out to assess concentrations of contaminants within edible tissues. As discussed above under the contaminants section, there are several EU directives and conventions in place to help regulate, control and mitigate the release of human induced contamination.

3.7.1 The Black Sea

High levels of contaminants in water and sediments within the Black Sea have been linked to decreased quality in seafood; this is thought to be due to bioaccumulation of toxic substances which poses a risk to human health when consumed. The high pollution in water and sediment of the Black Sea is related to a decreased quality of seafood caught in the Black Sea, due to bioaccumulation of toxic substances; and increased risks to human health.

Maximum allowed concentrations (MAC) exist in both EU policy and in national policies. For some contaminants and radionuclides in shellfish species, contamination levels were 400 times lower for EU MAC but they exceeded the Ukrainian MAC by 400% (Polikarpov and Egorov, 2008). There are fragmented data for radionuclides accumulation in the different species of the sea-grass, crustacean, shellfish and fish (Polikarpov and Egorov, 2008), but insufficient data on accumulation of pesticides/DDT in species.

Oil is an almost inevitable pollutant for seas. Oil enters in to the marine environment from many sources such as shipping traffic, oil production, pipeline breaks, illegal discharge of tanker ballast water, tanker accident, refinery and from air, incompletely burned fuel, automobile exhausted gas, wood-burning etc. Oil pollution, especially polyaromatics (PAHs), are very dangerous. Contamination of marine water by petroleum causes acute or chronic toxicity for marine organisms. The consumption of sea food contaminated by oil derived carcinogens, PAHs is a human health risk.

3.7.1.1 Review of operational objectives

Member States are to monitor wild caught fish, crustaceans, molluscs, echinoderms, roe and seaweed harvested in the different (sub) regions, destined for human consumption, for substances for which maximum levels contained within products destined to human consumption are established at EU, regional, or national level, and/or referred to contaminants, for which the predicted or measured environmental concentration is above the level where no biological effects appear.

The presence of the contaminants above is to be assessed against regulatory levels set for human consumption. This includes the performance of a trend analysis when either environmental concentration levels or biological effect levels are still in the process of being set. Progress towards GES will depend on whether the contaminants are subject to surveillance and are at levels below the levels established for human consumptions or showing a downward trend (for the contaminants for which regulatory levels are in the process of being set).

In the BS SAP, 2009, there are no ecological objectives specially formulated for the descriptor "Contaminants in fish and shellfish". However, there are several EcoQO's (high level objectives) that can be indirectly related to this descriptor which aim to decrease and prevent release of contaminants to the environment; these include EcoQO 4: Ensure Good Water Quality for Human Health, Recreational Use and Aquatic Biota a) Reduce pollutants originating from land based sources, including atmospheric emissions; b) Reduce pollutants originating from shipping activities and offshore installations.

3.8 Marine litter

Box 8

GES is achieved when '*Properties and quantities of marine litter do not cause harm to the coastal and marine environment'*. (EC 2008)

Attributes and indicators for marine litter (EC 2010)

10.1. Characteristics of litter in the marine and coastal environment

- Trends in the amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source (10.1.1)
- Trends in the amount of litter in the water column (including floating at the surface) and deposited on the sea-floor, including analysis of its composition, spatial distribution and, where possible, source (10.1.2)
- Trends in the amount, distribution and, where possible, composition of micro-particles (in particular micro- plastics) (10.1.3)

10.2. Impacts of litter on marine life

- Trends in the amount and composition of litter ingested by marine animals (e.g. stomach analysis) (10.2.1).

Marine litter is a global issue and is solely caused by human activities. It is found everywhere, on coastlines, on the surface of the ocean, floating in the water column and on the sea bed. A lot of marine litter is made up of plastics which take a long time to break down and in a lot of cases the plastic will remain in the marine environment forever. The main sources of litter come from shipping, from illegal dumping at sea, discarded fishing gear or accidental loss, extraction and offshore mining. Litter from rubbish tips and dump sites on land also makes its way into the sea. Tourism and recreation is often linked to beach litter. Other sources of marine litter include natural disasters such as flooding and hurricanes.

Although no systematic regional measurements of amounts of marine litter are available for most regions, the available latest reviewed information on effects and impacts of marine litter point to no common denominator: it can spoil, foul and destroy the beauty of the oceans and the coastal zone (UNEP, 2009). Sea birds, marine mammals and fish can become entangled in discarded fishing lines and plastics, leading to injury and death in a lot of cases. Fishing nets lost from fishing vessels can continue to capture marine life, fish, birds and sometimes marine mammals may be caught; this is known as ghost fishing. Larger pieces of plastic can cause smothering to sea beds and pose threats to benthic communities. Benthic life tends to be slower moving and so have an increased risk of exposure. Plastic is also broken down into smaller particles which can be ingested by marine life, these can pose several problems. Ingested particles may lead to individual deaths, but its effects will persist throughout the entire food web. There is a lot of uncertainty surrounding the effects of small plastic particles (micro plastics) and their ability to cause harm, through ingestion leading to toxicity or bioaccumulation.

The vast amount of marine litter in our oceans today is largely there due to poor management and practices, and a lack of infrastructure and awareness. At an international level the International Maritime Organisation (IMO), have implemented a no garage policy for ships which support the 'clean ships' concept MARPOL Annex V 'Regulations for the prevention of pollution by garbage from ships' 1973. The London and Basel convention have also implemented measures for marine litter that include the prevention of marine pollution by dumping of waste and other matter (London convention 1972) and the trans-boundary movement of hazardous wastes and their disposal (Basal convention 1992). These measures have been further strengthened by the EU directive on port waste, and further measures are currently being developed. Current development on the MSFD targets and indicators will focus on achieving GES where properties and quantities of marine litter do not cause harm to the coastal and marine environments (Box 8). This would be achievable where there was a significant reduction in marine litter from the baseline (Set as 2012).

3.8.1 The North East Atlantic

The main sources of litter in the North East Atlantic include land-based activities (rubbish tips and dump sites), shipping, discarded fishing gear, illegal dumping at sea, and offshore mining and extraction. In the North Sea the biggest contribution to marine litter comes from shipping and it is considered one of the sub-regions where effects of marine litter are highest.

Birds, mammals and turtles are prone to entanglement and injury in lost fishing gear and ingestion of smaller littler particles (OSPAR, 2010b). These smaller particles composed mostly of plastic are an increasing problem for marine organisms in the pelagic zone. The plastic is broken down into smaller particles (micro particles) which are then consumed by marine taxa such as sea birds and filter feeding organisms (OSPAR, 2010b). It is also thought that marine litter can help the spread of some NIS by providing a raft for specimens to attach themselves.

This high level objective would be achieved where there was a significant reduction in marine litter from the baseline (set as 2012). This high level objective has several aspects; it is difficult to assess the amount of litter that would cause harm, and therefore operational objectives will need to be set for both the assessment of the amount of 'harm' e.g. plastic particles ingested by marine life and the amount of litter. Furthermore, although marine litter may be reduced, many litter items take many years to degrade in the environment (OSPAR, 2010b) and thus, even with control of additions, the current litter in the environment will not reduce quickly. So long term monitoring is needed for assessment of the source and the amount of litter.

3.8.1.1 Review of operational objectives

There is currently only one existing operational objective related to descriptor 10 (marine litter) for the North East Atlantic Region, which has been established within the OSPAR Ecological Quality Objective (EcoQO) process. The EcoQO states that 'there should be less than 10% of northern fulmars having more than 0.1g plastic particles in the stomach in samples of 50 to 100 beach-washed fulmars found from each of 4 to 5 areas of the North Sea over a period of at least five years' (OSPAR, 2008). This EcoQO relates to indicator 10.2.1 'Trends in the amount and composition of litter ingested by marine animals' (e.g. stomach analysis) (Box 8).

The monitoring of fulmar stomach analysis is lead by the Institute for Marine Resources & Ecosystem Studies (IMARES) in the Netherlands. Fulmars are a good indicator species for this regional sea as they are found throughout the North Sea. The analysis of fulmar stomach contents for plastic only indicates presence and absence and the underlying complexities including bioaccumulation of toxins by ingesting plastics and the overall affect on the food chain are unclear (i.e. whether it is actually causing harm). It is thus difficult to make a direct evaluation of progress towards achieving GES for descriptor 10 based on this operational objective alone.

The OSPAR EcoQO is currently only assessed for the North Sea and therefore this should be viewed as a sub-regional objective. Currently, this target has not been met in any of regions in the North Sea under assessment. Studies carried out during the period of 2002 to 2006 showed that out of 1098 fulmars analysed within the region 45% to >60% of these had 0.1g of plastic particles in their stomachs failing the target considerably (OSPAR, 2010b).

3.8.2 The Mediterranean Sea

In the Mediterranean Sea, land based and ship-borne pollution is an issue of concern since the 1970's. The impacts of marine litter, beyond studies indicating high frequency of occurrence of debris in sea turtle stomachs, and anecdotal finds of fish and larger invertebrates 'necklaced' with debris, on the 'non-emblematic' Mediterranean biota are poorly documented (Galil, 2006). A recent review (UNEP/MAP, 2011) has confirmed previous deductions that most of the Mediterranean marine litter is from land-based sources, rather than ships. All vessels above 400 tons or carrying more than 15 persons are obliged to implement garbage management plans in accordance with international maritime law. Additionally, as of 2009, the Mediterranean has a 'Special Area' status of MARPOL Annex V and the disposal into the sea of the following is prohibited: all plastics, including but not limited to synthetic ropes, synthetic fishing nets and plastic garbage bags; and all other garbage, including paper products, rags, glass, metal, bottles, crockery and packing materials. Problems still exist in relation to the operation and use of port reception facilities although the availability of reception facilities in the major Mediterranean ports has also improved in recent years. Abandoned, lost, discarded, floating and sunken fishing gears also remain a problem.

Marine litter on the beaches is mostly linked to shoreline and recreational activities and smoking-related activities. A proliferation of lighter smaller items has been seen recently, for example in the continued increase of marine litter during 2002 to 2003 and 2005 to 2006 despite the considerable decrease in the numbers of volunteers participating in the ICC campaigns in Mediterranean countries during the same timeframe. Whereas the number of litter items per volunteer increased in the long run, the weight of collected litter per volunteer had a decreasing trend. Marine litter items in the Mediterranean, include primarily plastics (52% in beach litter), aluminium and smoking-related litter, as opposed to (previously seen) heavier items from dumping activities such as household appliances, construction materials, tires, etc (UNEP, 2009). Ocean based and waterway activities account for a smaller part of marine litter in the region, with floating (by about 83%) and seabed litter dominated by plastics as well. The MED Expedition 2010/2013 highlights an alarming phenomenon in the Mediterranean - the presence of a quasi-invisible pollution likely to enter food chains: pollution by floating plastic microdebris. The first set of analyses made by Ifremer (France) and the University of Liege (Belgium) estimates that about 250 billion floating microplastics contaminate the surface of the Mediterranean (http://www.expeditionmed.eu/petition/index.php?lg=en).

3.8.2.1 Review of operational objectives

In the Mediterranean Sea there are currently no operational objectives that relate specifically to descriptor 10, marine litter. However, there are increasingly more awareness campaigns, and NGO efforts in surveying and cleaning beaches and the sea and providing information on the volume and types of litter existing in the Mediterranean with the aim to significantly reduce it (UNEP, 2009). Most of the countries are undergoing a series of policy reforms relating to marine litter, covering the whole range from waste prevention practices all the way to environmentally sound disposal of waste, with a view to involving a wide range of stakeholders. Administrative coordination, budget allocation, technical capacity and weak enforcement remain the main obstacles. On the up-side, there is a clear indication that private sector involvement is increasing. No country has any kind of cross-border collaboration scheme on the issue of marine litter management (UNEP, 2009, UNEP/MAP 2011). The Mediterranean Action Plan (MAP) has been instrumental in the Region's efforts to tackle marine litter pollution with a number of landmark activities since the late 1980's (UNEP, 2009). These include the Review Meeting on the Persistent Synthetic Materials Pilot Survey held in 1989, A Comprehensive Bibliography on Marine Litter containing 440 references and an Assessment of the State of Pollution of the Mediterranean Sea by Persistent Synthetic Materials, which can Float, Sink or Remain in Suspension published by UNEP/MAP in 1991. Further, a Consultation Meeting on Marine and Coastal Wastes in the Mediterranean held in 1999 outlining a project and a questionnaire about litter management in coastal zones of the Mediterranean later sent to Mediterranean countries and the responses analysed, and in 2003, UNEP/MAP, in cooperation with WHO, prepared Guidelines for Management of Coastal Litter for the Mediterranean Region (MAP/UNEP/MED POL, 2004). In 2006, the MAP with the support of the Regional Seas Programme of UNEP, developed a medium-term public awareness and education campaign on the management of marine litter in the Mediterranean working with NGOs of the region, namely the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE), the Hellenic Marine Environment Protection Association (HELMEPA) and Clean Up Greece, in the context of a project entitled "Keep the Mediterranean Litter-free Campaign".

3.9 Habitats Directive listed habitats and species

The Habitats Directive (HD) (92/43/EEC) was established in 1992 to 'promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements' (EC, 1992). The HD aims to achieve Favourable Conservation Status (FCS) for which a number of indicators have been established.

For a habitat, FCS is defined when:

- the natural range or area of the habitat is stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future.

For species, FCS is defined when:

- there is a population dynamic which indicates that it is able to maintaining itself on a long-term basis as a viable component of its natural habitat,
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The Habitats Directive required Member States identify and designate special areas of conservation (SACs) to protect the listed habitats and species. These SAC's (terrestrial, aquatic and marine) initially provided protection to 189 habitats and 788 species of conservation importance, however these annexes have been added to, and as of 2006, there are 218 habitats and 887 species. The Directive also requires the Commission to periodically review the progress and contribution of SACs towards the aim of maintaining or restoring biodiversity and the conservation of natural habitats and species. The Commission should prepare a report based on reports submitted by Member States on the progress and results of the measures undertaken in order to achieve the goal set out by the Directive.

3.9.1 The North East Atlantic

Currently many species in the North East Atlantic are in a declining or unfavourable status as defined by the HD. OSPAR have identified 30 species, which include invertebrates, birds, mammals, fish and reptiles, that are currently under threat or declining in the OSPAR region and the real number is thought to be possibly higher (OSPAR, 2010b). The main threats to habitats and species include destruction of habitats and ecosystems through human activities such as fishing, offshore infrastructure, dredging, contamination and introduction of non-indigenous species, and the removal of target species mainly through fishing (OSPAR, 2010b). For example, within the greater North Sea, it has been reported that there has been a significant reduction in the breeding populations of some sea birds; this may be due to a combination of loss of key food source and the effects of climate change (OSPAR, 2010b). There has also been significant damage to some sediment habitats and reefs due to the effects of trawling and extraction (OSPAR, 2010b).

3.9.1.1 Review of operational objectives

The main objectives which exist in the NEA for HD species and habitats are those that are outlined under section 3.9 for FCS. Within the NEA these have been defined further by JNCC (2007) who have carried out the 6 year reviews on species and habitats.

Although there are no descriptors and indicators for HD habitats and species as such under the MSFD, descriptor 1: biodiversity, descriptor 4: food webs and descriptor 6: sea floor integrity are indirectly related to the aims of the HD. In particular article 6 of the MSFD states that achievement of the aims of the Habitats Directive is an important '...contribution to the achievement of GES under the MSFD.' Biodiversity action plans exist which are required under the CBD. Species for which action plans exist include, the native oyster and the pink sea fan. There are also selected grouped species action plans for some important commercial fish stocks such as cod. Habitat action plans (HAPs), for sublittoral and littoral rocks, sediments, chalk, sands and gravels also exist.

Within the North East Atlantic, OSPAR has a biological diversity and ecosystem strategy in which a list of habitats and species are prioritised for protection. A list of these species and habitats are outlined in OSPAR List of Threatened and/or Declining Species and Habitats (2008-6). In addition OSPAR has an overall objective for biodiversity and ecosystems which states "Protect and conserve the ecosystems and the biological diversity of the maritime area which are, or could be affected as a result of human activities, and restore, where practicable, marine areas adversely effected". In order to achieve this high-level objective OSPAR have designated 63 Marine Protected Areas (MPAs) in their region. These should help to support operational objectives on HD protected species and habitats in the NEA regional sea area.

OSPAR have several EcoQO's that relate indirectly to the HD listed species and habitats. These operational objectives can be used to support achievement to FCS for some selected species. The grey seal, harbour seal and harbour porpoise are all currently listed under the HD. These three species have also individual EcoQO to assess status. These EcoQOs can be related to descriptors 1 (biodiversity) and descriptor 4 (food webs) under the EU Commission Decision. The EcoQO for grey seals has been met. This is shown by the increase in pups over the period of 5 years (2002-2006) in the areas in the North Sea under assessment (OSPAR, 2009b). However, some areas lack data and therefore could not be sufficiently assessed. The EcoQO for harbour seals has not been met for 7 out of the 11 areas under assessment in the North Sea. These areas include Orkney, Shetlands, Greater Wash to Scroby Sands, North and East Scotland (Montrose to Cape Wrath), South East coast of Scotland (Montrose to Berwick upon Tweed), West coast of Norway and Limfjorden (OSPAR, 2010b). Areas for which the objective has been met include Kattegat, Skagerrak and Oslofjord, Heligoland, Wadden Sea and Netherlands Delta. The EcoQO for harbour porpoises states that "Annual by-catch levels of harbour porpoises should be reduced to levels below 1.7% of the best population estimate". Currently it is not possible to assess whether this objective has been met because the current assessments comprise very high variability (OSPAR, 2005). As discussed in the review of food webs, the EcoQO for black-legged kittiwakes could also be related to HD habitats and species. The EcoQO states that "Breeding success of black-legged kittiwake should exceed (as a three-year running mean) 0.6 chicks per nest per year of each of the following coastal segments: Shetland, north Scotland, east Scotland, and east England". This objective has not been met (see food webs section 3.2). These EcoQOs have not been set with the specific aim of achieving the objectives of the HD. However, in the cases presented here they can be indirectly linked to achieving favourable conservation status for some of the HD listed species (OSPAR, 2009a).

OSPAR are currently developing three further EcoQOs which will relate more directly to listed habitats and species. One of these aims to assess the current state of threatened species and to assess the impact caused by human activities in order to put into place adequate management measures to help mitigate problems and move towards GES. The second EcoQO assesses benthic quality, structure and function with the aim of working towards an ecosystem approach to management. Finally the third objective relates to seabirds and can be directly linked to indicator 4.1 of the MSFD (EU commission Decision). This draft EcoQO states that “Changes in breeding abundance should be within target levels for 75% of species monitored in any region or their sub-divisions”.

3.9.2 The Mediterranean Sea

For the loss of biodiversity in Mediterranean, a number of issues continue to be of general concern (i.e. coastal infrastructure, pollution, degradation and fragmentation of habitats, overexploitation of marine resources and invasive introduced species), which along with the exacerbating effects of climate change are recognized as the main drivers of biodiversity changes (Cuttelod et al., 2008; Abdulla et al., 2008). Almost 20% of the known Mediterranean species are threatened both locally and worldwide. The HD listed species includes several charismatic emblematic and threatened marine species including the monk seal, sea turtles and cetaceans. The Mediterranean emblematic monk seal is one of the 10 most endangered species in the world and has been classified by the IUCN as being at critical risk of extinction. Similar is the case for cartilaginous fish, with 42% of shark species threatened with extinction. 63% of the fish and 60% of the mammals listed in the protocol concerning Special Protected Areas and Biological Diversity have endangered status. These numbers are probably underestimated considering the fact that almost one-third of Mediterranean native marine fishes and three-quarters of the deep-water species are still unknown or assessed as “Data Deficient” (UNEP/MAP-BLUE PLAN, 2009; Costello et al., 2010). At least 55% of marine species and marine habitats listed in the Habitats Directive have been assessed as being in 'unfavourable conservation status' (i.e. unfavourable inadequate or unfavourable bad) (EEA, 2010). Indicative of the continuous degradation and habitat loss is the case of *Posidonia oceanica*, a HD priority habitat for the region that has been decreasing progressively during the last 30 years, particularly near urbanised coastal areas (Airoldi and Beck 2007, EEA, 2010). In addition, while *Posidonia* has been the subject of over 1000 publications and in spite of a well-known theoretical spread and an area estimated at 35000 km^2, in some Mediterranean states only a tiny stretch of coastline has been inventoried or mapped (UNEP/MAP-BLUE PLAN, 2009) with most seabed mapping exercises focusing so far in the Western Mediterranean.

3.9.2.1 Review of operational objectives

In order to contribute to achieving the WSSD targets concerning significant reduction of current biodiversity loss by 2010, the SAP-BIO (UNEP, 2003) has set various priority actions, objectives and targets relevant to listed species. These include making a complete and integrated inventory of Mediterranean coastal, wetland, and marine sensitive habitats, completing checklists of species associated with sensitive habitats, implementing actions to conserve threatened and endangered coastal and marine species and the development and validation of adequate biological and socio-economic indicators to assess the ecological health of sensitive habitats and species by 2010. Progress has been made but significant challenges remain. for example, with mapping of priority and sensitive habitats still far from complete or coherent. Priority Action 1 (Objective a) aims towards the description and GIS based mapping of the spatial distribution of sensitive habitats by 2010 which has clearly failed. However, a new EU DG MARE project (MAREA), aims to map and model sensitive and essential habitats in the Mediterranean. Other relevant actions include WSSD targets concerning the establishment of

MPAs, with the aim to attain the protection of 20% of the coast as marine fishery reserves by 2010 and the establishment of representative networks of MPAs by 2012. This can be seen as failed since Mediterranean MPAs (excluding the high sea Pelagos Sanctuary) cover only 0.4% of the Sea. So far, "no-take' zones are less than 0.1% and the existing network is seen as geographically biased and not representative (Abdulla et al., 2008). Finally, high on the regional environmental agenda is the assessment of the potential impact of threats on Mediterranean coastal and marine biodiversity, as for example seen in Priority Action 13 of SAP-BIO 2003 for an "Inventory of biodiversity elements and/or areas likely to be impacted by the threats of biodiversity: pollution; fisheries and other resource exploitation; introduction and spread of non indigenous species; uncontrolled recreation at activities; changes in land use; effects of water management schemes by 2010". This is also part of the on-going step 3 of the region's roadmap to the implementation of the Ecosystem Approach, namely the "identification of important ecosystem properties and assessment of ecological status and pressures", while step 4 aims at the "development of a set of ecological objectives corresponding to the Vision and Strategic goals".

3.9.3 The Baltic Sea

Compared to other aquatic ecosystems, only relatively few animal and plant species live in the brackish ecosystems of the Baltic Sea. Despite this limited biodiversity, the Baltic Sea is home to a unique mix of marine and freshwater species adapted to the brackish conditions, as well as a few true brackish-water species. Where salinity levels are low in the Baltic's northern and eastern waters, fewer marine species can thrive, and marine habitats are dominated by freshwater species, especially in estuaries and coastal waters.

The limited number of species involved in Baltic Sea food webs means that each individual species has a special importance in terms of the structure and dynamics of the whole ecosystem. The disappearance of a single key-species could destroy the functioning of the whole system and it is these ecosystems which are considered to be very vulnerable to external disturbances.

Baltic Sea habitats and species are threatened by eutrophication and by elevated amounts of hazardous substances entering the sea as a result of long-lasting human activities in the surrounding catchment area and at sea. In addition, biodiversity is affected by fishing, hunting and shipping.

One of the requirements under the HD is to establish a network of SAC's for the protection of Annex i species and Annex ii habitats. The protection efficiency of the BSPA network of protected areas in the Baltic Sea has increased since the adoption of the BSAP (2007) as the BSPAs currently cover 10.3% of the total Baltic Sea marine area. With this figure the Baltic Sea has reached the 10% target for the area conserved within a regional sea as has been set by the UN CBD COP7 and recently reiterated by COP10. In many HELCOM countries new designations of offshore protected areas have been made in 2009-2010 related to the Habitats directive. Seven Natura 2000 MPAs have been designated in Latvia (436 582 ha, i.e. 34% of territorial waters) partially overlapping with BSPA (HELCOM, 2010b).

3.9.3.1 Review of operational objectives

The Baltic Sea Action Plan aims at aligning the goal "favourable conservation status of marine biodiversity" with corresponding goals and objectives of already existing regulations which also address biodiversity and nature conservation.

In order to reach favourable conservation status of biodiversity, HELCOM has adopted ecological objectives covering topics referring to:

- restoring and maintaining sea floor integrity at a level that safeguards the functions of the ecosystems;
- that habitats, including associated species, show a distribution, abundance and quality in line with prevailing physiographic, geographic and climatic conditions; and
- a water quality that enables the integrity, structure and functioning of the ecosystem to be maintained or recovered.

In accordance with the CBD, HELCOM's overall goal of a favourable conservation status of Baltic Sea biodiversity is described by three ecological objectives:

- natural marine landscapes (referring to ecosystem level)
- thriving and balanced communities of animals and plants
- viable populations of species.

The need for further research to reach the targets and objectives associated with the favourable conservation status of the Baltic Sea biodiversity and therefore HELCOM BSAP included targets to increase knowledge on and protection of Baltic Sea marine habitats, communities and species. For example, by 2011 by updating a complete classification system for Baltic marine habitats/biotopes and by 2013 by updating HELCOM Red lists of Baltic habitats/biotopes and biotope complexes, and producing a comprehensive HELCOM Red list of Baltic Sea species (for a full list of these measures see BSAP). Furthermore, a tentative set of indicators describing status of biodiversity is currently being developed in the HELCOM CORESET project, and will be presented during 2011

Since regulation of fisheries is not a mandate of HELCOM, HELCOM has addressed the competent fisheries authorities in co-operation with the Baltic RAC and HELCOM to take immediate actions. Many of these actions are measures based, however one 'to develop a suite of indicators with region-specific reference values and targets for coastal fish as well as tools for assessment and sustainable management of coastal fish by 2012' could be useful to the requirements under the HD.

Beside these lists of actions, measures taken to address eutrophication and food webs will also be useful to the achievement of FCS.

4. Regional discussion of gaps in operational objectives related to the proposed MSFD indicators

4.1 Gaps general discussion

Throughout the course of reviewing operational objectives related to MSFD descriptors (section 3) it became clear that the level of match of regionally specific operational objectives to MSFD attributes or indicators differed significantly between regions. We have, therefore, included a section outlining the major gaps where there are currently no operational objectives in the region which can be directly or indirectly linked to an MSFD indicator. The summary table below shows clearly where these gaps lie in each region and for each descriptor (Table 3). Following this table we have included a regional discussion on the information shown in the table which tries to highlight, with examples from the descriptors reviewed in section 3, the major areas where further development of operational objectives are needed and where measures-based targets or actions exist which could be used to support an indicator where currently no operational objective exists.

Table 3. A regional comparison of operational objectives to support MSFD indicators. 'Y' indicates that there is an existing operational objective which can be linked to that indicator, 'N' indicates that there is no operational objective that exists which can be linked to that indicator and therefore where a 'gap' is known to exist and 'U' indicates that there is at least one member state in that region that is currently developing targets (operational objectives) for that indicator, but which are not yet complete. Finally, blank cells indicate an unknown situation or that these indicators haven't been reviewed in section 3 therefore operational objectives and/or gaps might exist. This scoping exercise has been carried out looking at nationally and regionally defined operational objectives and therefore where a letter occurs this indicates an objective existing or underdevelopment or where a gap exists at the national or regional scale.

Descriptor	**Indicator**	**Region**			
		NEA	**MED**	**BALTIC**	**BLACK SEA**
Biodiversity	1.1.1 Distributional range	**U**		**U**	
	1.1.2 Distributional pattern within the latter, where appropriate			**U**	
	1.1.3 Area covered by the species (for sessile/benthic species)			**U**	
	1.2.1 Population abundance and/ or biomass, as appropriate	**U**		**U**	
	1.3.1 Population demographic characteristics (e.g. body size or age class structure, sex ration, fecundity rates, survival/mortality rates			**U**	
	1.3.2 Population genetic structure, where appropriate				
	1.4.1 Distributional range	**U**			**N**
	1.4.2 Distributional pattern				**N**
	1.5.1 Habitats area	**U**		**N**	**Y**
	1.5.2 Habitat volume, where relevant			**N**	**N**
	1.6.1 Condition of the typical species and communities	**U**		**U**	**Y**

	1.6.2 Relative abundance and/or biomass, as appropriate			U	Y
	1.6.3 Physical hydrographical and chemical conditions			Y	N
Non-indigenous species	2.1.1 Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species	**N**	**U**	**U**	
	2.2.1 Ratio between invasive non-indigenous species and native species in some well studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species)	**N**	**U**	**U**	
	2.2.2 Impacts of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible	**N**	**U**	**U**	
Fish and shellfish	3.1.1 Fishing mortality (F)	**Y/U**	**Y?**	**Y/U**	**N**
	3.1.2 Ratio between catch and biomass index (hereinafter 'catch/biomass ratio')	**Y**	**N**	**Y/U**	**N**
	3.2.1 Spawning Stock Biomass (SSB)	**Y/U**	**Y?**	**Y/U**	**N**
	3.2.2 Biomass indices	**N**	**N**	**U**	**Y**
	3.3.1 Proportion of fish larger than the mean size of first sexual maturation	**N**	**N**	**U**	**Y**
	3.3.2 Mean maximum length across all species found in research vessel surveys	**N**	**N**	**U**	**N**
	3.3.3 95% percentile of the fish length distribution in research vessel surveys	**N**	**N**	**U**	**N**
	3.3.4 Size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation	**N**	**N**	**U**	**N**
Food Webs	4.1.1 Performance of key predator species using their production per unit biomass (productivity)	**U**	**N**		**N**
	4.2.1 Large Fish (by Weight)	**Y**	**?U**	**U**	**N**
	4.3.1 Abundance trends of functionally important selected groups/species	**Y/U**	**N**	**U**	**Y**
Eutrophication	5.1.1 Nutrients concentration in the water column	**U**		**Y**	

	5.1.2 Nutrient ratios (silica, nitrogen and phosphorus), where appropriate	**N**		**Y**	
	5.2.1 Chlorophyll concentration in the water column	**U**		**Y**	
	5.2.2 Water transparency related to increase in suspended algae, where relevant	**N**		**Y**	
	5.2.3 Abundance of opportunistic macroalgae	**U**		**U**	
	5.2.4 Species shift in floristic composition such as diatom to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities	**U**		**U**	
	5.3.1 Abundance of perennial seaweeds and seagrasses (e.g. fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency	**U**		**Y**	
	5.3.2 Dissolved oxygen, i.e. changes due to increased organic matter decomposition and size of the area concerned	**U**		**U**	
Sea floor integrity	6.1.1 Type, abundance, biomass and areal extent of relevant biogenetic substrate	**U**			
	6.1.2 Extent of the seabed significantly affected by human activities for the different substrate types	**U**			
	6.2.1 Presence of particularly sensitive and/ or tolerant species	**U**		**U**	
	6.2.2 Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic sensitive species	**U**		**Y**	
	6.2.3 Proportions of biomass or number of individuals in the macrobenthos above some specified length/size	**U**		**N**	
	6.2.4 Parameters describing the characteristics (shape, slop and intercept) of the size spectrum of the benthic community	**U**		**N**	
Hydrographical conditions	7.1.1 Extent of area affected by permanent alterations	**U**			
	7.2.1 Spatial extent of habitats affected by the permanent alteration	**U**			
	7.2.2 Changes in habitats, in particular the functions provided (e.g. spawning, breeding and feeding areas and migration routes of fish, birds and mammals), due to altered hydrographical conditions	**U**		**U**	

Contaminants	8.1.1 Concentration of the contaminants mentioned above, measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC	**U**		**Y**	**Y**
	8.2.1 Levels of pollution effects on the ecosystem components concerned, having regard to the selected biological processes and taxonomic groups where a cause/effect relationship has been established and needs to be monitored	**U**		**U**	**N**
	8.2.2 Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil and oil products) and their impact on biota physically affected by this pollution	**N**		**Y**	**Y**
Contaminants in fish and shellfish	9.1.1 Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels	**U**		**U**	**N**
	9.1.2 Frequency of regulatory levels being exceeded	**U**		**U**	**N**
Marine litter	10.1.1 Trends in the amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where	**U**	**N/U?**	**U**	
	10.1.2 Trends in the amount of litter in the water column (including floating at the surface) and deposited on the sea- floor, including analysis of its composition, spatial distribution and, where possible, source	**U**	**N/U?**	**U**	
	10.1.3 Trends in the amount, distribution and, where possible, composition of micro-particles (in particular micro- plastics)	**N**	**N/U?**	**U**	
	10.2.1Trends in the amount and composition of litter ingested by marine animals (e.g. stomach analysis)	**Y**	**N**		
Underwater noise	11.1.1 Proportion of days and their distribution within a calendar year over areas of a determined surface, as well as their spatial distribution, in which anthropogenic sound sources exceed levels that are likely to entail (in dB re 1µPa 2 .s) or as peak sound pressure level (in dB re 1µPa peak) at one metre, measured over the frequency band 10 Hz to 10 kHz (significant impact on marine animals measured as Sound Exposure	**U**			
	11.2.1 Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1µPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate	**U**			

4.2 The North East Atlantic

In 2008 OSPAR and their EU member states started the process of implementing the directive to facilitate the MSFD; work is still ongoing with the ultimate aim of putting in place measures to achieve GES by 2020. This work will include developing environmental targets with their associated indicators to achieve GES within the marine environment in the NEA consistent with that of the MSFD. In September 2010, the North East Atlantic Environmental Strategy was adopted. This Strategy adopts a similar concept to that of the MSFD for delivering ecosystem based management for both the ecological and socio-economic environment. OSPAR has developed a joint OSPAR/MSFD road map which will be used as a tool to continue to implement and develop their strategy within a certain time frame achieving this by 2020. OSPAR will also continue to work on tackling emerging issues caused by human activities; this will include development of monitoring methods, again in line with those of the MSFD. Therefore the situation in the NEA is a positive one. However, there are varying degrees of development of operational objectives between the GES descriptors.

Within the NEA adequate operational objectives exist for commercial fish species especially for fishing indicators such as *fishing mortality* and *spawning stock biomass,* and in many cases these can be linked to the suggested indicators for the commercial fish and shellfish descriptor (Box 2). Gaps still remain, however, for these indicators. Only a small proportion of stocks are actually assessed and certainly at present, the required reference levels are only available for a small proportion of these stocks. This applies even more so for commercial shellfish than for fin fish. A recent scoping study for 116 stocks in the NEA showed that reference levels for F were only available for 32 and reference levels for SSB for 31 stocks, while for only 24 stocks both were known. Of those stocks for which reference levels were known 38% fulfilled the F-based criterion, 48% the SSB-based criterion while only 25% fulfilled both (ICES, 2010). The assessment undertaken for the 2010 Quality Status Report by OSPAR only used 15 stocks, which they estimated to account for approximately 20% of landings (OSPAR, 2010b). As well as these limitations, there are also issues pertaining to data requirements: the main (primary) indicators (F and SSB) are based on analytical stock assessments which are completed on a yearly basis for some of the main stocks in the NEA but not for all. The other indicators should be based on data from monitoring programs (i.e. RV Surveys) done as part of the Data Collection Framework (DCF). The monitoring programs are comprehensive and cover the North Sea well, but this may apply to only some sub regions within the NEA. This will be an issue that has to be considered when assessing the status of commercial (shell) fish for the whole regional sea area.

There have been other attributes for fish and shellfish which have come under scrutiny, for example the GES requirement that all stocks should have a "healthy" age and size distribution for which a number of indicators have been suggested; however, there are some concerns as to how appropriate these indicators are. For example, the indicator "mean maximum length across all species found in research vessel surveys" is essentially an indicator describing the species composition in a fish assemblage consisting of both commercial and non-target species, thus it is not very specific to commercial species. It may be more appropriate as an indicator that could be used to support an operational objective on biodiversity of fish under Descriptor 1. Furthermore, there is still work required to determine targets for any operational objectives based on indicators that describe the age and size distribution of commercial species before they can actually be described as operational. This is also true for the secondary indicators proposed (Box 2) for biomass and fishing mortality where information on SSB and F are not known.

Whilst gaps remain even in well developed descriptors, other descriptors have fewer operational objectives which can be linked directly to any of the indicators suggested in the Commission Decision Document (EC, 2010). Within the NEA, a good example of this is in the food webs descriptor. Whilst there is a direct link between the indicator '4.2.1 large fish by weight' and the OSPAR EcoQO 'large fish by weight', the EcoQO only accounts for predominantly demersal fish species. In order for the development of further operational objectives for food webs there is need for a better understanding of the interactions between trophic levels and the human and environmental pressures that affect them. Where there is lack of knowledge in areas which have been assessed, more comprehensive data sets are needed to determine current status of key species in the food web. Furthermore, there needs to be better understanding and knowledge of the decline in populations of several key predator species which can be used as indicators of the health of the food web. For example in the NEA, information on harbour seals which may include trends in the disease outbreaks from the Phocine distemper virus with the combination of other pressures such as competition with grey seals would be useful for target development in this area.

NIS and marine litter are other examples where there are large gaps in indicators. Marine litter has a directly related EcoQO in the fulmars' objective; however, that is as far as this goes for these descriptors. The development of state based operational objectives for NIS and marine litter is difficult since there are large gaps in knowledge and evidence for which to base targets on. For example, indicator 10.1 under Descriptor 10 for Marine Litter looks at *"Characterisation of litter in the marine and coastal environment":* looking at trends in the amount, composition, spatial distribution and source of litter washed up or deposited on beaches and the water column (surface to sea bed). This indicator also looks at trends in the amount, distribution and composition of micro-particles with emphasis on micro-plastics. More information is required on the source of litter and whether the contents of plastic in organisms actually comes from the marine environment or is of terrestrial origin (Rubbish tips and dump sites). A large amount, approximately 80%, of litter that is found in the marine environment tends to come from terrestrial origin (EC, 2010). Therefore further measures may need to be implemented on land before a measurable reduction of litter in the marine environment can be achieved. Similarly, indicator 10.2 under Descriptor 10 for Marine Litter is focused on *"Impacts of marine litter on marine life"*: looking at trends in the amount, distribution and composition of marine litter ingested by marine animals through stomach analysis. It is widely understood that marine litter is a prevalent problem in the North East Atlantic, with high proportions of fulmars in the North Sea that were assessed having pieces of plastic in their stomachs (OSPAR, 2010b). However, there is limited monitoring of stomach contents of birds, and much information is reliant on volunteers sending dead birds in for analysis. The number of birds sent for analysis is small and therefore it is difficult to draw conclusions on the broader levels of harm from marine litter across the regional sea. More monitoring is required to gain a more comprehensive picture of the extent of the problem of marine litter. IMARES are currently helping other organisations to set up similar monitoring programmes with other indicator species. Yet, since the coverage of monitoring is restricted to the North Sea, any increase in information will be confined to the sub-regional level. There might be the need to either carry out the same analysis on the same indicator species in other sub-regions within the NEA, or if that indicator species is not abundant in that sub-region, then other indicator species may be chosen for stomach analysis (EC, 2010).

There are other cases, particularly with the pressure-based descriptors such as marine litter and underwater noise, where scientific knowledge and understanding is limited; however the need to take action against these threats is still clear. In these cases assigning measures-based targets rather than state-based targets is a useful option and our review of operational objectives has highlighted that this is the case for many descriptors. For example, in the NEA there are currently no operational objectives specific to non-indigenous species, although the revised targets set by the CBD seem relevant to the overall GES objectives for NIS. In particular, the target to put in place management plans that could control or eradicate what they describe as “priority species” could be revised to more specifically focus on invasive alien NIS as those “priority species”. The second component of the CBD’s target on NIS is more focused on the identification and control of pathways that will introduce more NISs. This could also be adapted as a practical management-focused operational objective that would help to reduce any increase in new invasions and thus ultimately improve the likelihood of achieving GES under Descriptor 2. Further measures-based options are the high level objective in place for ballast water and sediments by the IMO Ballast Water Management Convention which would also help to support achievement of an operational objective set on reducing introductions or spread. For marine litter there are similar measures in place. Although one operational objective for the NEA exists there is still a need for further development of these. Measures and regulations however are in place to help control the input of litter into the marine environment. MARPOL annex V ‘*Regulations for the prevention of pollution by garbage from ships’,* for example, has implemented a no garbage policy for ships which supports the ‘clean ship’ concept. This is further strengthened by the EU directive on post waste reception facilities. Several member states have implemented ‘Fishing for litter’ schemes, an idea which originated from a pilot scheme in the Netherlands and which is now also being implemented in the UK. The initiatives encourage fishing boats to collect marine litter found in their nets and deposit them in large bags which can be left in port for collection. What the examples described here demonstrate, is that although operational objectives which describe the state of a descriptor can be difficult to develop, and hence have been shown here as a ‘gap’, measures can still be taken which can help GES to be achieved.

As discussed above, currently in the UK, along with other member states, we are in the process of the implementation of the MSFD. This work involves development of methods for monitoring and development of targets and their indicators that are in line with the MSFD. Work is ongoing to develop these proposed indicators further and defines, in so far as it is possible, targets based on these indicators. The summary Table 3 shows for which indicators targets are currently being developed. The UK approach combines the biodiversity, food web and sea floor integrity descriptors together and developed common indicators and targets based on these. Targets for other descriptors are at varying stages of development. OSPAR aim to fully implement targets and indicators which support those in the MSFD by 2020.

That the majority of countries bordering the NEA are member states makes the process of developing regionally specific operational objectives that are related to the MSFD much more attractive to all countries involved. OSPAR has recognised the need to align their work with the requirements under the MSFD and has in several cases developed clear operational objectives for several of the MSFD indicators. However, these still tend to focus on the North Sea sub-region and at present do not extend to other NEA sub-regions. Much of the gaps that have been presented in this section relate closely to areas where we have a gap in current knowledge which would allow us to define scientifically robust indicators and targets. In order for this to be achievable, more resources are needed for monitoring programmes which will not only provide evidence for the development of targets but also allow us to evaluate the state of those indicators in relation to the defined targets at a later date. Further development is also needed regarding indicator species and targets for non-commercial fish species since these not only are affected by the fish and shellfish descriptor but are also important components in biodiversity and food webs. Although the situation in the NEA could be viewed as more advanced, perhaps, than other regional seas we are still only starting to develop sufficient indicators and targets in order for us to successfully implement the MSFD and more importantly assess whether or not GES has or will be achieved.

4.3 The Mediterranean Sea

Major outstanding issues and emergent threats are well known and include loss and habitat degradation (through urbanisation, industrialisation, coastal infrastructure, shipping and tourism), pollution (including litter), invasive species, overexploitation of marine resources, fisheries related impacts (unsustainable fishing practices, by-catches and discards, illegal fishing) as well as climate change (Coll et al., 2010, Costello et al., 2010, UNEP/MAP-Plan Blue, 2009, UNEP, 2010). The main pressures (e.g. continued commercial trawling over sensitive habitats, high by-catches and discards through illegal gears and unselective fisheries), sources (e.g. land based & ship borne marine litter types) and important pathways (e.g. NIS introduction) are also well known for the Mediterranean. However, with the exception of management-related objectives and measures (e.g. 7 Action Plans for endangered species and habitats including for example: the monk seal, the NIS or the Coralligenous & other Calcareous Bio-concretions), as well as the ongoing alignment of MAP by the 2010 CBD COP10 decisions and the revision of the Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean (SAP BIO), there are currently no regional operational objectives strictly mapping to the MSFD descriptors.

Some measures-based objectives exist related to the use of MPAs and these could be relevant to a number of the MSFD and HD High level objectives. However, despite being valuable conservation tools, Mediterranean MPAs lack a scientific basis for the selection (location, habitats included, depth range, etc.) and design (size, shape, number, proportion of total surface protected, etc.) and appropriate monitoring and evaluation of the effectiveness of MPAs based on sound sampling designs. There is also lack of empirical evidence for potentially complex effects of MPAs, e.g. indirect effect on ecosystems, effects on larval replenishment of commercially and/or ecologically important species, genetic effects etc. (Abdulla et al., 2008, Coll et al., 2010). Thus even existing objectives related to MPAs will certainly still require some further work to make them truly operational.

UNEP/MAP is tasked with the implementation of the Ecosystem Approach and MSFD in the Region, which will be a major challenge as this involves 21 very different states, the majority of which are not in the EU. The new strategic goals for the Mediterranean (Decision IG 17/6, Barcelona Convention 2008) are: a) to protect, allow recovery and, where practicable, restore the structure and function of marine and coastal ecosystems thus also protecting biodiversity, in order to achieve and maintain good ecological status and allow for their sustainable use; b) to reduce pollution in the marine and coastal environment so as to minimize impacts on and risks to human and/or ecosystem health and/or uses of the sea and the coasts; and c) to prevent, reduce and manage the vulnerability of the sea and the coasts to risks induced by human activities and natural events. The development of a set of (operational) ecological objectives with indicators and target levels based on the 11 MSFD descriptors and GES and corresponding to the Vision for "a healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations" and the Strategic goals is pending.

4.4 The Baltic Sea

The Baltic Sea Action Plan is translated at the regional scale with local conditions for the goals of those high level international commitments. However, in many aspects this work is still in progress and further work is needed to ensure that the BSAP is fully aligned with the work being undertaken for the MSFD.

Operational objectives of BSAP for descriptor 5, eutrophication, cover the MSFD attributes well. However, there are some indicators missing. This has been recognised by HELCOM and the indicator development work is in progress. It seems that most of the work to develop operational objectives is still needed for the Eutrophication indicators 5.2.3 Abundance of opportunistic macroalgae, 5.2.4 Species shift in floristic composition such as diatom to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities and 5.3.1 Abundance of perennial seaweeds and seagrasses adversely impacted by decrease in water transparency.

Operational objectives of BSAP for habitats and species related to the Habitats Directive suit quite well the HD attributes and these might also be useful for MSFD descriptor 1, biodiversity. The main problem in assessing the status of habitats is that there are no long-term data available allowing an analysis of trends in the status of the habitats of the Baltic Sea. Therefore the development of monitoring programmes would also be useful in this case.

In terms of descriptor 3, fish and shellfish, there are still insufficient data to define reference point for many stocks. This is where the biggest gaps remain. Already established management plans are revised regularly, some of which resulted in the relatively quick and positive response of the stock (Eastern Baltic Cod) but the others (e.g. Western Baltic Cod) are changing stock condition pretty slowly. The European Commission has decided to develop options for a new management plan for Baltic salmon but options for a new management plan had not been presented so far. No specific objectives were adopted for the other stocks. The new MSY system is based on a single species approach. In our opinion MSY targets, especially for species closely located in the food chain, should consider multispecies interactions. As stated in the Commission Decision on criteria and methodological standards on good environmental status of marine waters (notified under document C(2010) 5956) further research is needed to address the fact that a SSB corresponding to MSY may not be achieved for all stocks simultaneously due to possible interactions between them. Operational objectives developed for MSFD are well justified based on long term data series. Those suggested by HELCOM CORESET put more emphasis on coastal fish communities. A substantial part of those species are managed at national level. Further cooperation is needed in this respect. Furthermore, BSAP is stressing the urgent need to develop and implement management plans for the key commercial offshore and coastal stocks.

Finally, whilst the Baltic Sea food web is relatively simple there are still numerous gaps regarding the quantitative knowledge about particular elements of the food web and its response to the specific anthropogenic pressure. In BSAP, the status of the food web is analysed directly and indirectly among the factors affecting objectives associated with the nature conservation and biodiversity. A discussed and suggested list of BSAP core indicators is still under development; however, it covers many of the food web elements. To fulfil the MSFD requirements, further work should focus on those organisms which are crucial for the whole food web functioning (e.g. proportion between the key copepod species).

4.5 The Black Sea

The Black Sea Strategic Action Plan (Anon, 2009) contains lists of EcoQOs which are currently being developed into operational objectives through the development of indicators and targets. However, not all of these can be related to the MSFD attributes and indicators outlined in the Commission Decision Document (EC, 2010). Where development work is on-going serious problems relate to the availability and suitability of data for development of the indicators and estimation of reference levels (BSC, 2010).

For example, there is a lack of comprehensive information on fishing activity, stock catch and composition. The current annual reports have serious gaps and the analysis of fish stocks are far from the desired level of accuracy. The data exchange at regional level is not yet systematic and regular and further efforts are needed to achieve cooperation between the responsible authorities. Furthermore, most of the stocks are not assessed (sprat and turbot are the only assessments available for the whole Black Sea), or separate assessments exist between bordering countries.

For predominant habitats, insufficient data exists to support the indicators for microalgae communities in the BSIS or lack (unreported in BSIS) data of seagrassess (BSC, 2010). Although several MPAs for the protection of predominant habitats have been created along the Romanian coast and around The Black Sea (http://www.salix.od.ua/BlackSeaMPAmap.htm) there is still a lack of international coordination and harmonisation of approaches to efficiently establish a network of MPAs in the region. Further work is also needed on the economic costs and values of MPA networks.

Finally, there is a need for development of, and improvement in, the existing monitoring system used for contaminants in the Black Sea. An improvement should provide comparable data sets for pollutant loads (from direct discharges and river inputs) and for other parameters. The acceptance of standardised methods by all countries is also an important issue which needs to be addressed as well as funding for suitable equipment and staffing. Operational national quality assurance programmes for the inter-comparison / inter-calibration of chemical concentration and flow data from point sources is also needed.

In cooperation between the Black Sea Commission and the EEA the status of national monitoring systems is being thoroughly analysed and existing problems identified against the requirements of the MSFD. This shows movement towards the alignment between the BS SAP and the MSFD, however the following comments were obtained from the EEA: '*There are no consistent data sets in the Black Sea Commission data base, the time series are with large differences in the determinants measured by the countries, the number of stations and years covered. Therefore, the data sets are not suitable for indicator-based reporting*.' This comment highlights the need for further development of monitoring and data quality before the Black Sea can fully align to the requirements of the MSFD.

Despite the need for improvement in data and monitoring, through the review of operational objectives, we have identified several areas where operational objectives already exist which can be directly linked to indicators of the MSFD. For example, for the fish and shellfish descriptor, operational objectives in the BS SAP (BSC, 2009) can be linked to the indicators 3.2.2 biomass indices ('to increase the overall biomass by 30% for demersal fish stocks by 2019') and 3.3.1 Proportion of fish larger than the mean size of first sexual maturation ('to decrease by-catch level by 2014, %-age is not specified'). Other gaps however, exist for indicators 3.1.1 Fishing mortality and 3.2.1 spawning stock biomass.

Further examples include predominant habitats where the BS SAP has defined operational objectives such as 'to reduce number of threatened species and increase in their abundance, %-age is not specified (by 2014)' and 'to reduce number and area of critical habitats, %-age is not specified (by 2014)'. These can be related to MSFD indicators 1.6.2 'relative abundance and/or biomass, as appropriate' and 1.5.1 'habitat area' respectively. Gaps, however, still exist in other indicators related to habitat distribution and habitat condition. Finally, the existing regional operational objectives for contaminants in accordance with the BS SAP (BSC, 2009) link with the MSFD attribute 8.1 'concentration of contaminants'. These are measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under the Water Framework Directive (2000/60/EC) and in accordance with Article 6 of the MSFD (EC, 2008).

For food webs, there are currently no operational objectives specifically related to the indicators outlined in the Commission Decision Document (EC, 2010) for the Black Sea. However, operational objectives which aim to restore descriptor 3, commercial fish and shellfish, and those already outlined for descriptor 1, biodiversity of predominant habitats, could also be used indirectly to assess the status of descriptor 4, food webs, as a whole. However, the development of operational objectives which allow assessment of the indicators for food webs (e.g. 4.1 Productivity (production per unit of biomass) of key species or trophic groups) is crucial to achieve GES for food webs.

Finally, where problems exist and where data is insufficient to fully develop an operational objective for this, a range of measures have been listed which could help to achieve GES even if assessment of status using targets or references points is impossible. For example, in order to achieve sustainable fisheries in the Black Sea, proper fisheries management policies (i.e. Adoption of the Fisheries Convention) need to be implemented and fishing effort needs to be adjusted to the status of the stocks. For contaminants, measures-based improvement of port reception facilities would be useful even though the numbers of reception facilities have increased in the region since 2001. Furthermore, better enforcement of rules and regulations would also help.

5. Conclusion

The work that has been carried out here is an initial review which will be further developed through work package 4 of ODEMM. Work package 4 is about management measures for achieving FCS or GES. Task 4.2 will select operational objectives (indicators and where possible targets) on particular GES Descriptors/HD objectives to take through the rest of the project in a series of case studies which will help focus work in further work packages. This report provides a starting off point for which more detailed selection of appropriate indicators and targets can now be carried out which will then be linked to management measures necessary to achieve these targets.

Looking closely at existing operational objectives, which can in some way be linked to requirements under the MSFD, gives an understanding of the current situation in each regional sea and the work that still needs to be done in order to fully implement the MSFD in that region. One of the clear conclusions from this work is that although each regional sea has a clear action plan or convention which aims to develop operational objectives for that region (NEA: OSPAR convention; Mediterranean Sea: Mediterranean Sea Action Plan; Baltic Sea: Baltic Sea Action Plan; Black Sea: Black Sea Strategic Action Plan) there is variation in the ease at which operational objectives developed under these can be addressed through the MSFD.

The work being done in the North East Atlantic by OSPAR, in particular in the North Sea region, has developed clear EcoQOs which can be directly linked to descriptors such as fish and shellfish and marine litter. For example, there is an EcoQO which states *'Maintaining the spawning stock biomass above precautionary reference points for commercial fish stocks where those were agreed by competent authority for fisheries management;'* this is of direct use to the MSFD indicator relating to SSB. Similarly,, a further EcoQO states that *''there should be less than 10% of northern fulmars having more than 0.1g plastic particles in the stomach in samples of 50 to 100 beach-washed fulmars found from each of 4 to 5 areas of the North Sea over a period of at least five years';* this again can be directly used to assess some of the indicators listed for marine litter.

The situation in the Baltic Sea in terms of operational objective development is good for eutrophication. Although targets are still under development, objectives include *"Concentrations of nutrients close to natural levels"* and *"Clear water"* which directly relate to MSFD attributes and indicators. The situation for fish and shellfish in the Baltic Sea is a little more unclear, however, since indicators for assessing fish stocks in the Baltic differ slightly to what is suggested under the MSFD. In terms of the Black Sea however, the BS-SAP has listed EcoQOs which are more like high level objectives than operational objectives. No operational objectives exist for fish and shellfish in terms of the primary indicators 'F' and 'SSB' or for any of the contaminants indicators, although the high level EcoQO '*Reduce pollutants originating from land based sources, including atmospheric emissions; –and reduce pollutants originating from shipping activities and offshore installations'* has been listed.

Furthermore, it is clear from Table 3 that whilst the Baltic Sea and the NEA have both got at least one Member State developing targets for descriptors, the review we were able to undertake suggests that this is not yet happening for the Black Sea or the Mediterranean. This variation might be related to the number of EU Member States which border the regional sea.

For instance, almost all countries surrounding the NEA are EU Member States whilst in the Black Sea only 2/7 are EU Member States.

One of the difficulties faced, however, between linking existing operational objectives for use under the MSFD is knowledge about the aims and aspirations behind their development. This could differ from the aspiration of sustainability outlined under the MSFD. The achievement of GES under the MSFD for instance differs from the achievement of FCS under the HD since the HD aspires towards pristine conditions whilst the MSFD aspires towards sustainability. This is something that was addressed through the risk assessment carried out under this ODEMM work package (see Breen et al., in prep). This issue has not been addressed throughout this review; however, it is an important issue which much be considered in more detail through the choosing of operational objectives for the case studies to be carried through the rest of the ODEMM project.

Work carried out through WP2 (Governance) in ODEMM looked at institutional ambiguity between regional sea conventions and the MSFD. Institutional ambiguity is defined in the resulting paper (van Leeuwen et al., in prep) as 'the ambiguity that results from different institutional settings coming together in new policy practices'. Institutional ambiguity depends on the mismatch between the definitions of environmental quality between the regional conventions and the MSFD i.e. aspiration of the regional conventions versus the definition of GES. It also depends upon the number of member states bordering a regional sea since the higher the number of countries obliged to implement the MSFD the more urgency is felt within the regional convention to align itself to MSFD implementation. The results of this paper found that similar to what we have shown through this work, the Black Sea had high institutional ambiguity whilst the Baltic Sea and the North Sea (NEA) had low institutional ambiguity. Furthermore, the Mediterranean and the Black Sea have a significant proportion of their surrounding countries which are not Member States whilst this proportion is lower for the Baltic and the NEA. These factors might to some extent explain the variation between member states in the development of operational objectives which are fully aligned to MSFD indicators. It might also explain why both the NEA and the Baltic are already developing MSFD targets whilst the Black Sea has yet to begin this process.

The section in this report which looks at gaps has highlighted several areas where future development is needed for a full implementation of the MSFD. The need for better quality data for which targets and reference levels can be developed is clearly important, as well as information on the effects of pressures on marine ecosystem components which would be very useful for some descriptors, e.g. underwater noise and marine litter. In order to provide this, effort should be placed on increased monitoring which is more targeted towards providing information specifically for the MSFD indicators and providing funding for projects which will help better understand the effects of human pressures on the marine environment.

From reviewing operational objectives in the regional sea action plans, it is clear that whilst gaps may exist in terms of operational objectives often management measures have been implemented which will deal with the issue. For example, the improvement in port reception facilities to improve the contaminants descriptor, the IMO Ballast water Convention on the regulations on ballast ship water aims to improve the status of non-indigenous species (see section 3 for further examples). The advantages of having both an operational objective and management measures is that the operational objective can be used to assess the effect of the management measure and to evaluate if it is appropriate and working therefore the two should be used where possible in conjunction with each other. The MSFD acknowledges this by requiring member states to develop 'targets' for GES descriptors and to implement a programme of measures to ensure that GES is achieved (EC, 2008). Therefore, further to operational objectives some of the measures listed in the regional sea action plans could be used to help achieve GES and specific objectives that relate to achievement of GES should be developed to be placed on those management measures.

The work and reviews that have been carried out in the report relate only to those descriptors that were chosen to be reviewed for links to regional operational objectives through the risk assessment carried out in work package 3 of ODEMM. The MSFD lists 11 descriptors which must achieve GES; therefore those descriptors which have not been covered here will also have varying degrees of existing work and further work needed. For example, there are little or no known operational objectives for underwater noise whilst the issues in biodiversity will be much better documented and some objectives and targets might exist. Further, more measures will exist for some of the biodiversity components in the form of species-specific action plans etc.

In summary, what is presented in this report provides a useful review of existing operational objectives in regional seas. Further to this, we try, where possible, to show a link where these could be used by member states as 'targets' for further development under the MSFD. Finally, we discuss where gaps exist in terms of knowledge, monitoring or development for the MSFD attributes and indicators outlined by the Commission Decision Document (EC, 2010). We juxtapose these as separate regional reports in order to highlight differences in the work being carried out between the regional seas.

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Annex A

Descriptor	Attribute	Indicator
Biodiversity (Species level) *(Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions.)*	1.1 Species distribution	– *Distributional range (1.1.1)*
		– *Distributional pattern within the latter, where appropriate (1.1.2)*
		– *Area covered by the species (for sessile/benthic species) (1.1.3)*
	1.2 Population size	– *Population abundance and/or biomass, as appropriate (1.2.1)*
	1.3 Population condition	– *Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates) (1.3.1)*
		– *Population genetic structure, where appropriate (1.3.2)*
Biodiversity (habitats level) *(Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions.)*	1.4 Habitat distribution	– *Distributional range (1.4.1)*
		– *Distributional pattern (1.4.2)*
	1.5 Habitat extent	– *Habitat area (1.5.1)*
		– *Habitat volume, where relevant (1.5.2)*
	1.6 Habitat condition	– *Condition of the typical species and communities (1.6.1)*
		– *Relative abundance and/or biomass, as appropriate (1.6.2)*
		– *Physical, hydrological and chemical conditions (1.6.3)*
Biodiversity (Ecosystem level) *(Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions.)*	1.7 Ecosystem structure	– *Composition and relative proportions of ecosystem components (habitats and species) (1.7.1).*
Non-indigenous species (*Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem.)*	2.1 Abundance and state characterisation of non-indigenous species, in particular	– *Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non indigenous*

	invasive species	*species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species (2.1.1)*
	2.2 Environmental impact of invasive non-indigenous species	– *Ratio between invasive non-indigenous species and native species in some well studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species) (2.2.1)*
		– *Impacts of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible (2.2.2).*
Fish and shellfish (*Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.)*	3.1 Level of pressure of the fishing activity	*Primary indicator* – *Fishing mortality (F) (3.1.1).*
		Secondary indicators (if analytical assessments yielding values for F are not available): – *Ratio between catch and biomass index (hereinafter catch/biomass ratio) (3.1.2).*
	3.2 Reproductive capacity of the stock	*Primary indicator.* – *Spawning Stock Biomass (SSB) (3.2.1).*
		Secondary indicators (if analytical assessments yielding values for SSB are not available): – *Biomass indices (3.2.2).*
	3.3 Population age and size distribution.	*Primary indicators.* – *Proportion of fish larger than the mean size of first sexual maturation (3.3.1)*
		– *Mean maximum length across all species found in research vessel surveys (3.3.2)*
		– *95% percentile of the fish length distribution observed in research vessel surveys (3.3.3)*
		Secondary indicator: – *Size at first sexual maturation, which may reflect the extent of undesirable genetic effects of exploitation (3.3.4)*

Food webs (*All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.)*	4.1 Productivity (production per unit biomass) of key species or trophic groups	– *Performance of key predator species using their production per unit biomass (productivity) (4.1.1)*
	4.2 Proportion of selected species at the top of food webs	– *Large fish (by weight) (4.2.1)*
		– *Abundance trends of functionally important selected groups/species (4.3.1).*
Eutrophication (*Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.)*	5.1 Nutrients levels	– *Nutrients concentration in the water column (5.1.1)*
		– *Nutrient ratios (silica, nitrogen and phosphorus), where appropriate (5.1.2)*
	5.2 Direct effects of nutrient enrichment	– *Chlorophyll concentration in the water column (5.2.1)*
		– *Water transparency related to increase in suspended algae, where relevant (5.2.2)*
		– *Abundance of opportunistic macroalgae (5.2.3)*
		– *Species shift in floristic composition such as diatom to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities (5.2.4)*
	5.3 Indirect effects of nutrient enrichment	– *Abundance of perennial seaweeds and seagrasses (e.g. fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency (5.3.1)*
		– *Dissolved oxygen, i.e. changes due to increased organic matter decomposition and size of the area concerned (5.3.2).*
Sea-floor integrity (*Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.)*	6.1 Physical damage, having regard to substrate characteristics	– *Type, abundance, biomass and areal extent of relevant biogenic substrate (6.1.1)*
		– *Extent of the seabed significantly affected by human activities for the different substrate types (6.1.2).*
	6.2 Condition of benthic community	– *Presence of particularly sensitive and/or tolerant species (6.2.1)*

		– *Multi-metric indexes assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species (6.2.2)*
		– *Proportion of biomass or number of individuals in the macrobenthos above some specified length/size (6.2.3)*
		– *Parameters describing the characteristics (shape, slope and intercept) of the size spectrum of the benthic community (6.2.4).*
Hydrography (*Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.)*	7.1 Spatial characterisation of permanent alterations	– *Extent of area affected by permanent alterations (7.1.1)*
	7.2 Impact of permanent hydrographical changes	– *Spatial extent of habitats affected by the permanent alteration (7.2.1)*
		– *Changes in habitats, in particular the functions provided (e.g. spawning, breeding and feeding areas and migration routes of fish, birds and mammals), due to altered hydrographical conditions (7.2.2).*
Contaminants (*Concentrations of contaminants are at levels not giving rise to pollution effects.)*	8.1 Concentration of contaminants	– *Concentration of the contaminants mentioned above, measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC (8.1.1)*
	8.2 Effects of contaminants	– *Levels of pollution effects on the ecosystem components concerned, having regard to the selected biological processes and taxonomic groups where a cause/effect relationship has been established and needs to be monitored (8.2.1)*
		– *Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil and oil products) and their impact on biota physically affected by this pollution (8.2.2).*
Contaminants in fish and shellfish (*Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.)*	9.1 Levels, number and frequency of contaminants	– *Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels (9.1.1)*
		– *Frequency of regulatory levels being exceeded (9.1.2).*
Marine litter (*Properties and quantities of marine litter do not cause harm to the coastal and marine environment.)*	10.1 Characteristics of litter in the marine and coastal	– *Trends in the amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution*

	environment	*and, where possible, source (10.1.1)*
		– *Trends in the amount of litter in the water column (including floating at the surface) and deposited on the sea-floor, including analysis of its composition, spatial distribution and, where possible, source (10.1.2)*
		– *Trends in the amount, distribution and, where possible, composition of micro-particles (in particular micro-plastics) (10.1.3)*
	10.2 Impacts of litter on marine life	– *Trends in the amount and composition of litter ingested by marine animals (e.g. stomach analysis) (10.2.1).*
Underwater noise (*Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.)*	11.1 Distribution in time and place of loud, low and mid frequency impulsive sounds	– *Proportion of days and their distribution within a calendar year over areas of a determined surface, as well as their spatial distribution, in which anthropogenic sound sources exceed levels that are likely to entail significant impact on marine animals measured as Sound Exposure Level (in dB re 1μPa^{2}·s) or as peak sound pressure level (in dB re 1μPa$_{peak}$) at one metre, measured over the frequency band 10 Hz to 10 kHz (11.1.1)*
	11.2 Continuous low frequency sound	– *Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1μPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate (11.2.1).*

SEVENTH FRAMEWORK PROGRAMME

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