Options for Delivering Ecosystem-Based Marine Management

Sustainable Use of European Seas and the role of the Marine Strategy Framework Directive

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GLOSSARY

Term	Definition
[GES] Descriptor	Descriptors are used to describe or qualify the ecological characteristics and/or pressure and impacts (associated with human activities), used to define Good Environmental Status (GES) (e.g. Descriptor 1: Biodiversity and Descriptor 10: Marine Litter).
Degree of Impact	The generic severity of the interaction between a pressure and an ecological characteristic in terms of its effects on the characteristic [as used in the ODEMM pressure assessment].
Ecological Characteristic	Ecologically coherent elements of an ecosystem, that group together more disparate taxonomic groups into the minimum number of elements, based on the view that the lower the number of elements, the easier it is to gain a coherent and integrated assessment across the ecosystem.
Ecosystem Goods and Services	The capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly.
Frequency of Occurrence (of a pressure)	The frequency that a pressure associated with a particular sector occurs at, within a given year, where it overlaps with the ecological characteristic being assessed [as used in the ODEMM pressure assessment].
Good Environmental Status	Environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations.
High Level Objectives	The overall objectives set by a particular policy or directive. For the Marine Strategy Framework Directive (MSFD) these are the eleven GES descriptors, whilst for the Habitat's Directive these are the criteria for Favourable Conservation Status.
Impact	The adverse consequence(s) of pressures on any part of the ecosystem where the change is beyond that expected under natural variation given prevailing conditions.
Pressure	The mechanism through which an activity has an effect on any part of the ecosystem. Pressures can be physical (e.g. abrasion), chemical (e.g. introduction of synthetic components) or biological (e.g. introduction of microbial pathogens).
Resilience	The time required by an ecological characteristic to recover after cessation of any further activities causing the particular pressure.
Risk	A function of likelihood and consequence, where highest risk is assumed when a severe consequence is likely.
Spatial Extent	The extent and distribution of the pressure from a sector where it overlaps (in time and space) with a particular ecosystem component.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. To be successful, it requires environmental protection, economic growth and social development.

ABBREVIATIONS

Abbreviation	Title
BSC	Black Sea Commission
BSEP	Black Sea Environmental Programme
CBD	Convention on Biological Diversity
DPSIR	Driver-Pressure-State-Impact-Response
EBM	Ecosystem Based Management
EC	European Commission
EU	European Union
EGS	Ecosystem Goods and Services
FCS	Favourable Conservation Status
GDP	Gross Domestic Product
GES	Good Environmental Status
GEcS	Good Ecological Status
HELCOM	Helsinki Commission
HD	Habitats Directive
HLO	High Level Objective
LME	Large Marine Ecosystem
MAI	Marine Activity Index
MAP	Mediterranean Action Plan
MSFD	Marine Strategy Framework Directive
MSs	Member States
ODEMM	Options for Delivery of Ecosystem-Based Marine Management
OSPAR	Oslo and Paris Commissions
RS	Regional Sea
SEI	Social Economic Index
SPEC	Sector-Pressure-Ecological Characteristic
WFD	Water Framework Directive
UNEP	United Nations Environment Program

Executive Summary

I. Worldwide, the continued and rising demand for ecosystem goods and services has placed the marine environment under threat. The activities and impacts associated with provision of those goods and services have contributed to global decreases in biodiversity and habitat loss, and the global trend of increasing human population places increasing demands on the resource providers. Europe's regional seas are among some of the most threatened in the world with many of their habitats and species at risk of extinction. Without effective management and regulation, it is unlikely that many of those resources will continue to be available in the future.

II. The Marine Strategy Framework Directive (MSFD) is the legal instrument that the European Commission has adopted to promote, clean, healthy, biologically diverse and sustainable seas. Built on the three pillars of sustainability: the environment, economic and social development, the MSFD has been designed to achieve an integrated and holistic approach for the sustainable exploitation of Europe's oceans and seas and requires cooperation between Member States. Eleven aspects of the marine environment (descriptors) were identified by the EC as priorities for sustainable development with the objective of achieving Good Environmental Status (GES) of each by 2020; these are described by a combination of ecological characteristics of the environment, and/or pressures and impacts associated with human activities.

III. As a precursor to 2020, Member States must assess the current state of their marine waters (the initial assessment) and identify targets and indicators for the aspects of GES by 2012. Evaluation of GES for each descriptor is achieved using either information on the status and trends of the ecological characteristic(s), evaluation of the extent of the pressure associated with a specific human activity, the impact of that pressure on an ecological characteristic, or a combination of all three (Chapter 2). Member States will likely rely on existing assessments and monitoring initiatives to describe GES for each descriptor. This approach may be applicable, however, the criteria used in existing (status) assessments and the criteria for GES of each MSFD descriptor must be compared and contrasted to determine if existing assessments can be used to infer status under the objectives of the MSFD. For example, habitats and species under the Habitats Directive criteria are evaluated in terms of pristine (un-impacted) conditions; a baseline considerably different to that of the MSFD where condition is measured in terms of sustainable use.

IV. Here, following an extensive literature review, we present a summary of the information describing status, trends, pressure and impacts that is available to the Member States with relevance to each of the four European regional seas (Annexes I-IV). The variability in the types of information available is demonstrated and how that variation might affect interpretation of GES is discussed. Further, the applicability of available information to GES is demonstrated using an assessment of the linkages between ecological characteristics, pressures, impacts and each GES descriptor. Links were developed by drawing upon the recommendations of the JSR Management group (Cardoso, Cochrane et al. 2010) and guidance from the European Commission, but revised to evaluate direct linkages only to support clearer differentiation between the potential benefits of specific management measures in mitigating the pressures/impacts associated with human activities.

V. For some of the descriptors of GES, it is essential to have information on human activities and their pressures. A pressure assessment approach developed by the ODEMM project was used to evaluate the mechanisms through which human activities have an effect on the marine ecosystem. Pressures can be physical, chemical or biological and the same pressure can be caused by several activities. ODEMM identified 106 activities from 19 sectors, in Europe's regional seas, and attributed 25 specific pressures to those activities including both current and emerging threats to ecological characteristics. A combination of published literature and regional expertise was used to evaluate the extent and frequency of overlap between each sector-pressure (e.g. fishing- abrasion) and predominant habitat type (EUNIS 2 classification) within each regional sea. Each sector-pressure-predominant habitat combination was evaluated using three criteria: (1) degree of impact of the pressure on the habitat, (2) habitat resilience (recovery potential), and (3) the persistence of the pressure beyond cessation of the

activity causing it (approach described in Chapter 2). Highest threat combinations were described using pre-defined combinations of extent, frequency, impact, resilience and persistence scores. High threat combinations that arise from four sectors, namely agriculture, coastal infrastructure, fishing and shipping, were identified as being common to all regional seas (Annexes I-IV).

VI. ODEMM developed a risk assessment approach to determine the likelihood of failure to achieve GES under present conditions. This approach used information collated by regional sea experts that describe the status and trends of ecological characteristics and/or an assessment of the pressure associated with activities occurring within the region and assessed against criteria that described the risk (high, moderate or low) to GES. Risk criteria, in conjunction with a working definition of GES, were developed by the ODEMM project, providing an approach to compare risk among descriptors and regional seas (Chapter 3 and Annex V). Of the 11 GES descriptors, 5 were classified as currently being at high risk of failure in all regional seas, namely: Introduction of non-indigenous species, Commercial fish and shellfish, Foodwebs, Seafloor integrity and Marine litter. The risk assessment framework was also modified to evaluate the Habitats Directive habitats and species and indicated high likelihood of failure to reach Favourable conservation status (FCS) in the Baltic Sea, Mediterranean Sea and NE Atlantic (Nb - the Black Sea has yet to report on FCS under the requirements of Article 17 of the Habitats Directive).

VII. The ODEMM project recognises that the likelihood of failure to achieve GES is not only constrained by ecological characteristics. It is necessary to integrate social and economic growth with the natural environment to understand how GES can be achieved in each regional sea. Member States face a dichotomy of needing to implement programmes of measures to achieve GES for regional seas while concomitantly addressing policies which aim to develop sustainable social and economic growth. ODEMM addresses these issues by proposing a linkage framework which illustrates the connectivity between the natural, social, economic and political components of the marine ecosystem. The linkage framework incorporates the principles of ecosystem-based management (EBM), the three pillars of sustainability and the DPSIR (Driver-Pressure-State-Impact-Response) approach. During project progression, ODEMM will seek to develop linkages between management options, monitoring and review of status and pressures, the overlying governance frameworks and policy drivers, and how climate change links into the full cycle. The linkage framework provides a means to fully evaluate all components and their relationships that can affect our potential to achieve GES in a fully integrated ecosystem assessment in each European regional sea (see Chapter 4).

VIII. To understand the complexities in achieving GES for MSFD descriptors requires an exploration of the relationships between ecological characteristics, economic and socio-cultural components and sector activities. This report explores some of these relationships in Europe's regional seas, through illustrated examples of current and emerging issues associated with high risk of failure to achieve GES for three MSFD descriptors. These illustrated examples explore the MSFD descriptors: Seafloor Integrity, Non-indigenous Species and Marine Litter. Each example describes and explores the issues and their context using trends and other collated information. These examples reveal the numerous relationships and multi-faceted linkages between ecosystem components, highlighting that there is no straight forward solution or method in achieving GES for any one MSFD descriptor.

IX. This report has thus drawn together a huge amount of information useful to those researching and implementing the MSFD in Europe, in addition to presenting the approaches for, and applications of, a number of assessment methods that can be used to assess status and threats to GES as well as explore the linkages between GES descriptors and the natural and human aspects of the regional sea ecosystems. Initially we describe approaches to interpret existing status, trends and pressure data in terms of GES (Chapter 2 and Annexes I-IV). This is followed by an approach to assess the risk of failure to achieve GES of the MSFD descriptors (Chapter 3 and Annex V). In Chapter 4 we present a framework and approach to explore the full array of drivers that can affect likelihood of achieving GES, ODEMM's linkage framework. Finally this information is synthesised and the complexities in achieving GES for three MSFD descriptors explored (Chapter 5).

X. ODEMM will continue to explore, understand and address how society through sectoral activities, and economic and socio-cultural components, interacts, influences and creates complexities and risks in our ability to achieve GES for case studies that consider MSFD descriptors in European regional seas. Each case study will be explored using various management scenarios for each regional sea, to identify issues which will compromise our ability to achieve GES. A risk-assessment framework that identifies the diversity of risk sources associated with meeting GES of MSFD descriptors will be applied in these case studies and a cost-benefit analysis, used to estimate the cost of policy inaction on management options. The costs will be measured in terms of deterioration in provision of ecosystem goods and services associated with various management options. Simultaneously, ODEMM will explore the governance structures, institutional and legal, supporting sustainable and integrated management of the marine ecosystem across Europe's regional seas. Identifying legal and governance constraints will assist in improving implementation of the MSFD ecosystem approach in order to achieve GES across regional seas. These assessments will be synthesised to create a toolkit which will host a suite of techniques to evaluate management scenario options to achieve GES of MSFD descriptors. This toolkit (available in 2013) will be disseminated to a broad range of stakeholders across all European regional seas, and this will be the key output and main achievement of ODEMM. We envisage that ODEMM's contribution will assist in moving forward and addressing Europe's vision of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive.

Chapter 1

Towards Sustainability in Europe's Marine Environment

The International Programme on the State of the Ocean recently described that our oceans are in peril with degradation and destruction to marine life shown to be associated with serious declines in ocean health and resilience around the world (IPSO, 2011). Coastal regions are amongst the most productive ecosystems in the world, providing a wide range of ecosystem goods and services. With one third of mankind living within a 50 km distance of coastlines, many human ocean- and land-based activities take advantage of these services. However, these activities both historically and currently, continue to threaten the marine ecosystem and the resources it provides (Halpern et al. 2007, IPSO 2011).

Europe's wellbeing is inextricably linked with the ocean, with 70,000 km of coastline extending along two oceans and four seas: the Atlantic and Arctic Oceans, the Baltic, the North Sea, the Mediterranean, and the Black Sea. Maritime regions account for some 40% of Europe's GDP (COM 2007) and support a population of ~501 million (Eurostat 2010). As European maritime regions support large populations, and their associated human activities, the surrounding regional seas and oceans are among the most threatened marine ecosystems in the world (Halpern et al. 2007, EEA 2010).

Figure 1.1 The European Marine Regions as described by the Marine Strategy Framework Directive (EC 2008). ODEMM will explore options for delivering ecosystem-based marine management in all four of the marine regions. Shown are the Baltic Sea (dark blue) NE Atlantic (pink, orange and red), Mediterranean Sea (green) and Black Sea (black square).

Humans threaten European marine ecosystems in numerous ways. Impacts of commercial fishing, oil spills and discharges, introduction of non-indigenous species, eutrophication, litter, pollution, habitat destruction and noise pollution, can all be detrimental to the marine environment (Coll et al. 2010, Costello et al. 2010, IPSO 2011). These types of threats are widely accepted as contributing to decreases in biodiversity and habitat loss (Hoekstra et al. 2005, Worm et al. 2006)

Population growth along Europe's coastlines is expected to increase (EEA 2006), and thus, the pressure on marine resources is likely to continue. Whilst Europe must continue to make use of its rich marine resources (COM 2010a), it is now widely recognised that any further development must be sustainable if those resources are to be available for future generations of Europeans.

Sustainable development was defined by the Brutland Definition – Three Dimension concept (UN 1987), and agreed by all parties in the Rio Declaration on Environment and Development (UN 1992), as:

> "*...development that meets the needs of the present without compromising the ability of future generations to meet their own needs*."

The three-dimension (pillars) concept recognises that sustainable development requires: (1) environmental protection, (2) economic growth, and (3) social development. This definition highlights that humans and the environment are inextricably linked.

The concept of sustainable development for oceans and seas is highlighted in numerous global directives that Europe is a signatory to, including the: Convention on Biological Diversity (CBD) (UN 1992), Agenda 21 (UN 1992), World Summit on Sustainable Development (UN 2002), Convention on the Law of the Sea (UN 1982) and Jakarta Mandate on the Conservation and Sustainable Use of Marine and Coastal Biodiversity to the CBD (UN 1995). All of these directives aim to address the protection of the marine environment while also considering the need for social and economic growth.

To address the loss of marine biodiversity whilst encouraging sustainable use, the European Union (EU) developed a Maritime Policy, describing it as "an all-embracing [maritime] policy aimed at developing a thriving maritime economy, in an environmentally sustainable manner" (COM 2006).

The Maritime Policy was mandated to examine all economic activities in Europe that are linked to impacts on our oceans and seas, and the policies dealing with them. The Maritime Policy is comprised of two pillars. Under the first pillar, the policy aims to stimulate growth and jobs within the EU. This aim was firmly entwined within the Lisbon Strategy and reinforced in Europe 2020. The second pillar aims to maintain and improve ocean status through environmental protection by sustainable development (COM 2006).

The Marine Strategy Framework Directive (MSFD) has been developed as a vital component of the Maritime Policy (EC 2008). The MSFD has been designed to achieve an integrated and holistic approach to exploit the full economic potential of Europe's oceans and seas in a sustainable way. The MSFD is a legal instrument that provides a basis for regulatory action and it has recently been transposed into the national law of European Member States. The over-arching objective is to provide ecologically diverse and dynamic oceans that are clean, healthy and productive, and exploited in a sustainable manner. Assessment of this objective is measured in terms of good environmental status (GES) and must be achieved in Europe's regional seas by 2020. A number of processes define how Member States should achieve GES (Figure 1.2):

- Complete an initial assessment of the current state of marine waters (by 2012)
- Develop targets and indicators to demonstrate GES (by 2012)
- Set up monitoring programmes to assess progress against GES (by 2014)
- Implement a programme of measures to help achieve GES (by 2016).

In this report, we explore current threats to achieving GES across Europe's four regional seas by: (1) compiling relevant information required to interpret the current state of these waters in terms of GES (approach described in Chapter 2 and results given in Annexes I-IV); (2) describing the risk of failing to achieve the different aspects of GES in each regional sea based on current status and usage of those areas (risk assessment approach and results summarised in Chapter 3); and, (3) exploring the diverse issues faced in trying to progress towards GES in the different regional seas including the political, economic, social and environmental drivers acting on those areas (approach described in Chapter 4 and examples given in Chapter 5).

Figure 1.2 A schematic illustrating a generic cycle of status assessment. Under the MSFD, Member States must undertake their initial status assessment by 2010 and this must be compared against the high-level objectives (HLOs) of the MSFD (the 11 GES Descriptors as listed in Section 2.1 below). The Commission has already published a list of indicators and criteria relevant to each Descriptor (COM 2010) and Member States must develop environmental targets for this to assess performance from 2012 through monitoring initiatives. Status will then be assessed again to see if there has been improvement against the HLOs.

Chapter 2

Good Environmental Status (GES) Assessment: Approaches and Interpretation

2.1. Introduction

The Marine Strategy Framework Directive (Directive 2008/56/EC) set out a common framework based on cooperation between Member States to ensure the sustainable use of marine goods and services by current and future generations. It stated that each Member State must achieve or maintain Good Environmental Status (GES) in the marine environment by 2020. GES is defined as:

"Environmental status of marine waters where these provide ecologically diverse and dynamic oceans which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations..." (2008/56/EC)

The MSFD lists 11 qualitative GES Descriptors for the specific areas under which GES must be achieved (Annex I of EC 2008) and guidance on the criteria and methodological standards of MSFD GES within each of the Descriptors has been given by the EC (Commission Decision Document 2010/477/EU; EC 2010).

The 11 GES Descriptors are:

1. 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

2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems
3. 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.

4. 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.

5. 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.

6. 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.

7. Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

8. Concentrations of contaminants are at levels not giving rise to pollution effects.

9. Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.

10. Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

11. Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

2.2. Information relevant to the GES descriptors

Member States (MSs) must assess the current state of their marine waters (the initial assessment) by 2012. In completing the initial assessment, MSs will likely rely on the information already available to them from existing assessments and monitoring initiatives on the ecological characteristics (components of the marine ecosystems), and any other information pertaining to the pressures and impacts listed in Tables 1 and 2, Annex III of the MSFD (EC 2008). To interpret this information with relevance to the High Level Objectives (HLO) of the MSFD (the GES Descriptors), there is a need to understand the linkages between (1) the status and trends in ecological characteristics, (2) pressures and impacts in the regional seas, and (3) the criteria of good environmental status for each GES descriptor[1]. In some cases, Descriptors require information on particular ecological characteristics (e.g. Descriptor 1: Biodiversity), others require information on pressures and their impacts (e.g. Descriptor 10: Marine litter), and others require information on ecological characteristics, pressures and impacts (e.g. Descriptor 5: Eutrophication). In the latter example, the pressure (e.g. introduction of nutrients resulting in eutrophication and reductions in dissolved oxygen) can lead to fish kills (impact) which then can affect the status of the fish community as a whole (fish biodiversity); information on all of these components is therefore useful in assessing the status of Descriptor 5.

Scientific support to the Commission on this matter was provided by Cardoso et al (2010) where the linkages between ecological characteristics, pressures and impacts and the GES Descriptors were listed (Tables 2.1a and b, Cardoso et al 2010). The European Commission further provided guidance on the criteria, attributes and indicators that could be used to evaluate the 11 GES descriptors (Commission Decision Document 2010/477/EU, EC 2010). Thus, for each Descriptor it is possible to extract a list of ecological characteristics and/or pressures and impacts that are relevant, and also to list the types of information on these (the indicators) to allow assessment of the Descriptor(s). ODEMM has drawn upon the recommendations of the management group report (Cardoso et al. 2010) and the Commission Decision guidance (EC 2010) to identify links between ecological characteristics, pressures, impacts and GES Descriptors. However, it was recognised that these recommendations included a combination of both direct and indirect linkages (see linkages in parentheses of Tables 2.1a and 2.1.b of (Cardoso et al. 2010). In ODEMM we have focused on the direct links to inform which types of information are most relevant to the assessment of the status of each GES Descriptor[2], but we have taken note of the indirect linkages in our pressure assessment (see 2.22).

Information relevant to each GES descriptor and currently available from existing assessments and reports is presented in summary in Annexes I-IV for each of the four regional seas. The purpose of the Annexes is to illustrate the availability of relevant information on each Descriptor in each of the regional seas, and also to explore the variability in the types of information available and how this might affect the interpretation of GES. This is explored further below in terms of issues to do with the interpretation of information on: (i) ecological characteristics in Section 2.21, and (ii) pressures in Section 2.22.

Information has also been collated for the high level objectives of the Habitats Directive (the listed habitats and species) where available. Under the Habitats Directive (Directive 92/43/EEC, EC 1992), Member States are obligated under Article 17 to report on the status of their listed habitats and species every 6 yr (e.g. JNCC 2007). The reports cover all habitats and species within a biogeographic region (e.g. Atlantic, Mediterranean Sea, Baltic Sea, but not the Black Sea) and assess the conservation status of those habitats and species. The conservation status assessment is a complex process, with four parts, that are then combined using a format agreed at the European level, to form the overall assessment. Article 17 reports are freely available for download from www.europa.eu. Member States of the EU that border the Black Sea have yet to report on the status of Habitats Directive listed habitats or species. Assessments are currently ongoing and status will be described in the next reporting period under Article 17.

[1]Definitions of an ecological characteristic, pressure and impact are shown in Box 2.1 and a comprehensive list of ecological characteristics and pressures used throughout the ODEMM project is provided in the ODEMM linkage guidance document.

[2]A full description of linkages between all components of the ODEMM framework is provided in ODEMM's Linkage Framework Guidance Document (www.liv.ac.uk/odemm/outputs/guidancedocuments).

Box 2.1. Definitions of Ecological Characteristics, Pressures and Impacts

Ecological Characteristics

Ecological characteristics are ecologically coherent elements of an ecosystem, that group together more disparate taxonomic groups into the minimum number of elements, based on the view that the lower the number of elements, the easier it is to gain a coherent and integrated assessment across the ecosystem. For example, the phyto- and zooplankton are grouped as one ecological characteristic, whilst marine mammals are another.

A list of 17 Ecological characteristics were derived from Table 1 (Annex III) of the MSFD and includes physical and chemical features, habitat types, biological and other (e.g. chemical contaminants) features. A full list of ecological characteristics is provided in Table 3 of the ODEMM's Linkage Framework Guidance Document2.

Pressures and Impacts

A pressure is "the mechanism through which an activity has an effect on any part of the ecosystem". Pressures can be physical (e.g. abrasion), chemical (e.g. introduction of synthetic components) or biological (e.g. introduction of microbial pathogens) and the same pressure can be caused by a number of different activities. For example, both aggregate extraction and navigational dredging cause abrasion, a physical damage pressure that can affect a number of different ecological characteristics. In some fora, 'pressure' is used interchangeably with the terms human activity and/or impact. However, we feel this is misleading, as impacts are the consequence of pressures, and different pressures can result in the same impact. For example, the physical pressure 'abrasion' can result in impacts that include mortality to benthic invertebrates and change in habitat properties (such as particle size distribution, stability etc.), as can the 'smothering' pressure.

A total of 106 activities were attributed to 19 sectors, each of which can contribute one or more human pressures to the marine ecosystem. The MSFD (Directive 2008/56/EC, (EC 2008)) listed 18 pressures; however, this list has been expanded to 25 pressures to encompass current or emergent threats to ecological characteristics. All 25 pressures are described in the ODEMM's Linkage Framework Guidance Document[2].

2.21 Information on ecological characteristics

Many of the ecological characteristics that can be used to describe each GES descriptor are already evaluated in terms of status and/or trends under various directives and/or national or regional initiatives. ODEMM used a wide range of existing assessments and published literature to compile information describing these characteristics in each regional sea. Relevant information is summarised in Annexes I-IV but the detailed records are compiled within the ODEMM Status and Trends database which will be available for download from (www.liv.ac.uk/odemm/outputs/data). The database describes 17 ecological characteristics and links each to the relevant MSFD GES descriptors. Descriptions of each ecological characteristic include the indicator and the criteria used in its assessment, the type of assessment made (status/trend) including interpretation of the assessment, reference points, assessment region (sub-region) and links to source documentation.

Interpreting the information given (status and trends)

Status is a useful approach to evaluate an ecosystem and its components, and can condense multiple assessment criteria into a simple indication of when those criteria have been met. However, status can be described in many ways and can vary between assessment programmes, not just in name, but also in the criteria that are used to evaluate the ecosystem and its component(s). Because of this, the outcomes from the assessments that already exist (under the Regional Sea conventions and the other major directives) cannot be assumed to be equivalent to a status assessment for GES under the MSFD. The information they use may be relevant, but the actual categories applied (e.g. 'poor' status) will need further interpretation to inform GES.

Aside from the differing terminology used in the different assessments (status under the MSFD is referred to as 'Good Environmental Status' (GES), under the WFD as 'Good Ecological Status' (GES) and as 'Favourable Conservation Status' (FCS) under the Habitats Directive), the objectives of the assessment programme may be different and/or there may be differing targets and criteria which make it difficult to use the outcomes from those assessments to infer a result under the MSFD. For example, under the Habitats Directive (92/43/EEC, (EC 1992) the aim is to achieve Favourable Conservation Status where species and habitats are close to pristine conditions, whereas the MSFD aspires to sustainable use, a state which cannot be considered the same as pristine. However, should a component exceed the criteria for 'Favourable' status - a pristine state, the component is therefore also likely to exceed the requirements of 'Good' status under a sustainable use scenario. Thus it is possible to use information from other existing status assessments, but the outcomes must first be interpreted to relate them to GES.

In order to assist this process ODEMM has compiled a comprehensive list of status assessment categories and their criteria required to assess GES in the different regional seas and these are provided in the ODEMM Status and Trends database (www.liv.ac.uk/odemm/outputs/data).

Status information may not always be available to describe the components of an ecosystem and alternatives include trend data which describes changes in a particular indicator over time e.g. population size of seabird species. Trend data is presented on aspects of the environment for several GES descriptors and can be described in one of four ways: (i) decrease, (ii) stable, (iii) fluctuating or (iv) increase. However, we caution that care must be taken when evaluating trend information in terms of what it means for GES. A decreasing (declining/deteriorating) trend does not necessarily indicate that a characteristic is in poor (ecological, environmental or conservation) status. While a decreasing trend may be detected in an indicator, the characteristic may still exceed the criteria required for the indicator to achieve GES. Conversely, an increasing or stable trend may in fact be equivalent to poor status in terms of GES.

2.22 Information on pressures - the Robinson et al. Pressure Assessment (in prep)

The MSFD recognises the relationship between pressure and the status of ecological characteristics through explicit inclusion of pressure in some GES definitions. For example, the objective of GES Descriptor 6: Seafloor integrity is "that human pressures do not hinder the ecological characteristics to retain their natural diversity, productivity and dynamic ecological processes (*sic*). Assessment and monitoring needs to be carried out further to an initial screening of impacts and threats to biodiversity features and human pressures" (Commission Decision 2010/477/EU, EC 2010). Thus it is clearly important that information on the pressures from human activities is also available to assess the status of the GES Descriptors in the different regional seas.

For those descriptors that require information on pressures, ODEMM developed a pressure assessment approach to evaluate the mechanisms through which a human activity affects the ecosystem (see ODEMM guidance document for the Pressure Assessment (www.liv.ac.uk/odemm/outputs/guidancedocuments) and Robinson et al. (in prep.). The pressure assessment approach (e.g. Robinson et al. 2008) has been used in several assessments including the Quality Status Report 2010 (OSPAR 2010) and Charting Progress 2 (DEFRA 2010) and these earlier versions have been further improved upon here. This method uses several steps, each reached via expert judgement, to evaluate the effect(s) of human activities on ecological characteristics. Under this framework, increased pressure is expected to result in increased damage to the marine environment, its characteristic species and habitats.

The impact of the pressures associated with activities undertaken by different marine sectors is evaluated using a combination of expert judgment and published literature. A total of five criteria are used to evaluate the pressure, namely: (1) overlap between the pressure and ecological characteristic (extent), (2) frequency of occurrence of the pressure, (3) degree of impact of the pressure on the ecological characteristic, (4)

ecological characteristic resilience (recovery time), and (5) pressure persistence beyond activity cessation. The interaction of each pressure combination is ranked using predefined categories, each indicating a different level of threat to the ecological characteristic being evaluated.

The pressure assessment makes no attempt to directly infer the status of the GES Descriptors being evaluated, but it provides relevant information on pressures and/or impacts on the ecological characteristics. For some descriptors such as Seafloor Integrity, the relationship between the outcome of the pressure assessment and GES is clear. For example, under Descriptor 6: Seafloor Integrity, achievement of GES can be interpreted as occurring when there are no widespread severe impacts affecting a predominant habitat type. Here, severe impacts are interpreted as those adversely affecting the characteristic structures and function of the habitat and its typical species. The pressure assessment indicates where pressures (from human activities) overlap with predominant habitat types and when, either solely or in combination, they represent severe and widespread impacts. Thus it is possible to use this information in assessing status of the GES Descriptor 6, and to also take relevant information for Descriptors 2, 5, 7, 10-11.

2.3 Summary of information available to assess GES and FCS in Europe's regional seas

Information describing status and trends of many of the ecological characteristics identified in the MSFD (Annex III, 2008/56/EC, (EC 2008)) were available in each of the four regional seas. Regional Sea Conventions or Commissions such as OSPAR, HELCOM, UNEP and the BSC collect data in a systematic and coordinated manner for many of the ecological characteristics. The role of each of these conventions is briefly described below. In addition, information is also available from individual Member States (e.g. government research institutes, universities etc), which provides a level of detail that may not be present in the broader Regional Sea assessments.

The regional annexes presented in this deliverable outline the information currently available for assessment of GES and FCS in Europe's regional seas (the HLOs of the MSFD and the HD). This information has been tailored to address the requirements for each HLO and represents the outcome of an extensive literature review undertaken by partners in the ODEMM project. Not all information describing the status, trends, pressures and impacts may be shown, but the sources and broad types of information that will likely be used by Member States in making their initial assessment of their regional seas is represented. Detailed descriptions of the source material collated are available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/data).

Regional Coordination (Secretariats)

Black Sea Commission (BSC) - Black Sea Environmental Programme (BSEP)

The BSEP is an independent secretariat, established to implement the Black Sea convention. Member States include Bulgaria, Georgia, Romania, Russia, Turkey and the Ukraine. BSEP administers the Strategic Action Plan for the rehabilitation and protection of the Black Sea and the programme of the Convention for the Protection of the Black Sea against Pollution including:

- Protocol on Prevention of the Black Sea Marine Environment against pollution from land-based sources;
- Protocol on cooperation in combating pollution of the Black Sea marine environment by oil and other harmful substances in emergency situations;
- Protocol on the protection of the Black Sea marine environmental against pollution by dumping.

Status and trends information on the Black Sea ecological characteristics is presented in several grey literature reports including the BSEP series. Pressures and impacts are less well described and assessments in this report were primarily undertaken using regional expert judgment.

HELCOM

The Helsinki Commission (HELCOM) is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea area (Helsinki convention) and works to protect the marine environment of the Baltic Sea from all sources of pollution. Through intergovernmental cooperation between 9 bordering countries (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden) and the European Community, HELCOM aims to promote a healthy Baltic Sea environment with diverse biological components that function in balance, are in good ecological status and support a wide range of sustainable economic and social activities.

HELCOM performs five primary functions in the Baltic Sea, working as:

- An environmental policy maker who develops common environmental objectives and actions for the region;
- An environmental focal point providing information about (1) the state of/trends in the marine environment; (2) the efficiency of measure to protect it and (3) common initiatives and positions which can form the basis for decision-making in other international fora;
- A body that develops recommendations for the Baltic Sea both of its own and supplementary to other international measures;
- A supervisory body ensuring that the HELCOM environmental standards are fully implemented throughout the region; and
- A coordinating body to ensure a multilateral response during major maritime incidents.

Status and trends information on the Baltic Sea ecological characteristics is presented in several grey literature reports, notably the HELCOM Baltic Sea Environmental Programme (BSEP) series. Pressures and impacts are also well described and much of the information required to undertake a pressure assessment is widely available for the Baltic Sea region. For example, detailed maps of the spatial distribution of marine sectors (e.g. aquaculture facilities) can be downloaded from the HELCOM website in a geo-referenced format. The frequency and impact of specific pressures and the resilience of habitats and species characteristic of the region is also well documented in published literature (i.e. journal articles). Where information was unavailable, expert judgement by ODEMM partners in the Regional Sea and wider European partnership was used to evaluate the frequency and impact of pressures and habitat/species resilience and drew on published literature from surrounding regions.

United Nations Environment Programme (UNEP) - Mediterranean Action Plan (MAP)

The Mediterranean Action Plan (MAP) was originally adopted in 1974 by 16 Mediterranean countries, but has since been adopted by all 21 countries surrounding the Mediterranean and the European Community. UNEP is responsible for the Secretariat of the Convention for the Protection of the Mediterranean Sea against pollution (Barcelona Convention) and its Action Plan, through the Mediterranean Regional Coordination Unit (MEDU) and coordinates a number of Regional Activity Centres around the region. There are five primary objectives of the MAP, three of which are either ecologically focused or relevant to the MSFD as follows:

(1) ensure sustainable management of natural marine and land resources and to integrate the environment in social and economic development and land use policies;

(2) protect the marine environment and coastal zones through prevention of pollution and by reduction and, as far as possible, elimination of pollutant inputs, whether chronic or accidental;

(3) protect nature, and protect and enhance sites and landscapes of ecological or cultural value.

The Secretariat administers several protocols including:

- Protocol for the Prevention of Pollution of the Mediterranean Sea by dumping from ships and aircraft;
- Protocol concerning cooperation in combating pollution of the Mediterranean Sea by oil and other harmful substances in cases of emergency;
- Protocol for the protection of the Mediterranean Sea from land-based sources;
- Protocol concerning Mediterranean specially protected areas; and
- Protocol for the protection of the Mediterranean Sea against pollution resulting from exploration of the Continental shelf and the seabed and its subsoil.

Assessments of ecological characteristics, pressures and impacts in the Mediterranean Sea are described in several reports and a wide range of published literature. These sources are briefly summarised in the Mediterranean Sea regional annex and their relevance to GES descriptors and their contents described in further detail in the database available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/data).

The Oslo Paris Commission (OSPAR)

The OSPAR Convention (OSPAR) provides support for the global obligations and commitments on the protection and management of the sea. Open for signature at the Ministerial meeting for the Oslo and Paris Commissions, it was adopted together with a Final declaration and an Action Plan in 1992 by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden, UK, Luxembourg, Switzerland and the European Community and came into force in 1998. Within the OSPAR, there are five Annexes with the following objectives:

- Annex I: Prevention and elimination of pollution from land-based sources;
- Annex II: Prevention and elimination of pollution by dumping or incineration;
- Annex III: Prevention and elimination of pollution from offshore sources; and
- Annex IV: Assessment of the quality of the marine environment.

At a regional level, OSPAR cooperates with many international organisations and has formal agreements with the North East Atlantic Fisheries Commission (NEAFC), the International Maritime Organization (IMO), the UN Economic Commission for Europe (UNECE) and International Council for the Exploration of the Sea (ICES). This cooperation plays an important role within the NE Atlantic region as OSPAR does not deal with programmes and measures relating to fisheries management and has a preference for issues related to shipping to be directed toward the IMO.

OSPAR recognises that the EU Marine Strategy Framework Directive is an important driver of their future work and through the Quality Status Report (OSPAR 2010) forms a regional contribution to the initial assessment of the NE Atlantic fulfilling their obligations under Annex IV.

2.4. Uses of the information contained in Annexes I-IV

Annexes I-IV collate the available information relevant to assessing state and performance of each of the MSFD's high- level objectives (HLOs) – the 11 GES Descriptors, and the Habitat's Directive (HD) objectives for Species and Habitats for each of the four European regional seas. This includes information on the status and trends of ecological characteristics, impacts on those characteristics, and pressures from human activities. However, the information contained under each HLO in Annexes I-IV cannot on its own tell us the current performance against that objective (e.g. the likelihood of achieving Good Environmental Status for Biodiversity by 2020). This is because the relevant information has come from many different types of assessment which each have their own assessment timescales, aims, indicators, criteria, targets and baseline values. In Chapter 3 an approach is described that allows this information to be interpreted in terms of risk of failure to achieve GES by 2020. The summary information contained in Annexes I-IV is thus not only a useful compendium of all recent status assessments by regional sea, but it can also be summarised in terms of likely risk of failure against the different GES descriptors for the MSFD (see Chapter 3).

Chapter 3

Risk of failure to achieve GES in European Regional Seas by 2020

3.1 Introduction

Under the requirements of the MSFD, Member States are currently working to develop ways in which GES can be assessed for each descriptor by developing targets for indicators relevant to the attributes of the Descriptors, which are listed in the EC Commission Decision Document (EC 2010). Through work undertaken in Work Packages 1 and 3 (led by Cefas) of ODEMM, an approach has been developed that allows users to assess the likely risk of failing to achieve a particular MSFD or HD high-level objective (HLO), using the information already available from existing assessments. Risk can be defined as a function of likelihood and consequence (Woodruff 2005), where highest risk is assumed when a severe consequence is highly likely. In the ODEMM risk assessment approach (developed in WP3; Breen et al., in prep), the consequence in each case is failure to achieve a particular HLO and likelihood of this occurring is evaluated in terms of high, medium and low risk scenarios (see Annex V). To evaluate this risk, relevant information was taken from sources compiled to complete Annexes I-IV and where necessary additional sources were used.

3.1.2 Methodology to assess risk of failing to achieve GES (Breen et al. in prep)

The approach chosen in ODEMM is based on an assessment of the risk of failing to achieve the high level objectives (HLOs) of the MSFD and the HD. The HLOs for the MSFD are based on achieving Good Environmental Status (GES) for the 11 MSFD descriptors (although only 10 were assessed here; hydrographical conditions was left out of the assessment due to lack of information for both the development of suitable criteria and information to support an assessment), and for the Habitats Directive, on achieving Favourable Conservation Status (FCS) for listed habitats and species.

Risk has been assessed for each individual descriptor separately, with Descriptor 1 of the MSFD (biodiversity) being evaluated separately for each of its component parts (Phyto-zooplankton, fish, seabirds, marine mammals and reptiles and predominant habitats). To assess risk of failure, ODEMM has developed a short working description of when GES (or FCS) is achieved, and criteria to assess the likelihood of failing to achieve GES are also given for the three risk scenarios. The wording used for the description of GES and the associated risk criteria was developed for each descriptor from information given in the Commission Decision paper (2010/447/EU, EC 2010), (Cardoso et al. 2010) and where appropriate, the ODEMM pressure assessment criteria (see guidance at (www.liv.ac.uk/odemm/outputs/guidancedocuments)). For FCS of the HD species and habitats the wording was developed from the descriptions by the Joint Nature Conservation Committee (JNCC 2007). The GES/FCS descriptions and risk criteria for each individual descriptor are given in Annex V.

Criteria (given in Annex V) were also developed to assess confidence in the risk score; this was based on the quality of information, the ease at which one could interpret status and trends information into the risk criteria and the agreement within the expert group undertaking the assessment.

The assessment was carried out by regional groups of marine experts from 16 European countries at a workshop in February 2011. Regional groups were provided with the list of criteria and information on status and trends as well as the pressure assessment information. Regional groups were asked to use status and trends information and where appropriate the pressure assessment information (see Section 2.2 of this report) to assign a risk score for each of the 16 HLOs being assessed as well as a confidence score for that assessment. In order to provide an audit trail for the assessments regional groups were asked to fill out a 'commentary sheet' which asked specific questions as the assessment was being carried out. In order to ensure consistency in applying the criteria and methods across regional groups several measures were taken. Firstly, all regional teams used the same criteria for all descriptors, secondly, one person each from a core team of people familiar with the approach being taken was assigned to regional teams to guide them through the process and ensure that decisions were made consistent with the outlined approach and interpretation. Finally, after the workshop commentary sheets were collected and thoroughly reviewed for possible

inconsistencies in interpretation. Where any of these arose regional teams were asked to clarify any points further. In some cases the review revealed a problem with the wording of the risk criteria and where these required updating all regional seas were asked to review their outcomes. The criteria listed in Annex V are the final sets of criteria from which the results shown in Section 3.3. were derived.

3.1.3 Summary of risks in Europe's regional seas

Table 3.1 summarises the scores given for risk of failure to meet the HLOs of the MSFD and HD for each of the four European regional seas. Across all regions Non-indigenous species, Commercial fish and shellfish, Food webs, Seafloor integrity and Marine Litter were all assessed to have a high risk of failure to achieve GES by 2020. Non-indigenous species scored as high risk for each region because there is evidence of at least one species causing significant adverse impacts on the ecosystem and increasing numbers of species and/or spread and abundance of established invasive species. All regions have a number of commercial fish and shellfish that are below the acceptable thresholds based on stock assessment information, usually fishing mortality (F) or spawning stock biomass (SSB). Information on some aspects of the food web was hard to find (e.g. on productivity), and the high risk result for food webs was largely due to declines in top predator species that are widely assessed. The results for seafloor integrity were assessed using information in the ODEMM pressure assessment; high risk was scored across all regions due to there being at least one widespread pressure in each habitat that had acute effects on the habitat and/or was frequent enough or persistent enough to lead to chronic effects (both acute and chronic effects result in severe impacts). Marine litter was judged to be high risk in all regions because of evidence of widespread unchanging or increasing amounts of litter (either macro litter found ashore or in the water column, or of micro-particles) and/or evidence of unacceptable levels of plastics in marine species based on existing objectives (e.g. for the NEA the EcoQO on fulmars). FCS for HD species and habitats was at high risk of failing for all of the regional seas where there is information on the HD species and habitats. In addition, Underwater Noise scored high for 3 out of 4 regions assessed. All other objectives were either regionally important (high risk for <3 regions) or between low and moderate for all regions.

Table 3.1. Summary of the results of the Risk Assessment applied in each of the European regional seas broken down by descriptor (and sub-descriptor where relevant, e.g. Biodiversity). Assessment information is not yet available for the HD species and habitats in the Black Sea so these could not be assessed in terms of risk (n/a)

GES Descriptor (and characteristics)	NE Atlantic	Mediterranean Sea	Baltic Sea	Black Sea
Biodiversity - Plankton	Low-moderate	Moderate	Moderate	Moderate
Biodiversity - Fish	Moderate	Moderate	Moderate	Moderate
Biodiversity - Mammals and reptiles	Low-moderate	High	Moderate	Moderate-high
Biodiversity - Seabirds	Moderate	Moderate	Moderate	High
Biodiversity - Predominant habitats	Moderate	Moderate	High	Moderate-high
Non-indigenous species	High	High	High	High
Commercial fish and shellfish	High	High	High	High
Food webs	High	High	High	High
Eutrophication	Moderate	Moderate	High	Moderate
Seafloor integrity	High	High	High	High
Contaminants	Moderate	Moderate	Moderate-high	Moderate-high
Contaminants in fish and shellfish	Low	Low	Moderate	Moderate
Marine litter	High	High	High	High
Underwater noise	High	High	Moderate-high	High
HD Habitats and Species	High	High	High	N/A

A summary of risk and confidence scores for the NEA is shown is Table 3.2. Within the NEA those descriptors which were high across several regions came out as high for the NEA. The high level of fishing activity in the NEA accounted for the risk to D3 Fish and shellfish, this also contributed to the result for seafloor integrity and food webs. Since D4 Food webs describes the state of the ecosystem as a whole the reasons for the high risk result assessed for HD species and habitats (i.e. unfavourable conservation status: population size, range, etc) were also a contributing factor in the overall score for Food webs. Marine litter is an issue in the NEA for which little information is available however beach surveys and information regarding the percentage of Fulmars with 0.1g or more of plastic in their stomach were indicators pointing to a high risk of failing this HLO. Finally, underwater noise was scored as 'high' risk based on the amount of 'noisy' activity in the area as reported in the ODEMM pressure assessment and due largely to shipping and the development of offshore wind farms. Confidence assessments for the NEA were generally between low and moderate. Only where good quality data and information existed was a high score given. This generally was for those descriptors for which there are already regular status assessments in the region (e.g. Fish and shellfish, Eutrophication, Contaminants).

Table 3.2. Summary of risk of failing to achieve GES for each descriptor in the NE Atlantic. Criteria for risk evaluation are described in Annex V after Breen et al. (in prep).

GES Descriptor	Risk Assessment	Risk Confidence
1a. Plankton	Low-moderate	Low-moderate
1b. Fish	Moderate	Moderate-high
1c. Marine Mammals	Low-moderate	Low
1d. Seabirds	Moderate	Moderate
1e. Predominant Habitats	Moderate	Low
2. Non-indigenous species (NIS)	High	Moderate-high
3. Commercial fish and shellfish	High	High
4. Food webs	High	Moderate
5. Eutrophication	Moderate	High
6. Seafloor Integrity	High	Moderate
8. Contaminants	Moderate	High
9. Contaminants in Fish and Shellfish	Low	Low-moderate
10. Marine Litter	High	Low-moderate
11. Energy (Underwater noise)	High	High
12. Habitats Directive Habitats and Species	High	Moderate

Beside those HLOs that were high across all regions, there was also high risk for biodiversity- predominant habitats, Eutrophication, and HD species and habitats in the Baltic Sea regional assessment. Eutrophication is a well known risk for the region, which has also contributed to the high risk of failure of FCS for HD species and habitats and the biodiversity of predominant habitats. The risk results and confidence scores for all descriptors are shown in Table 3.3.

Table 3.3. Summary of risk of failing to achieve GES for each descriptor in the Baltic Sea. Criteria for risk evaluation are described in Annex V after Breen et al. (in prep).

GES Descriptor	Risk Assessment	Risk Confidence
1a. Plankton	Moderate	Moderate
1b. Fish	Moderate	High
1c. Marine Mammals	Moderate	High
1d. Seabirds	Moderate	High
1e. Predominant Habitats	High	High
2. Non-indigenous species (NIS)	High	High
3. Commercial fish and shellfish	High	Moderate-high
4. Food webs	High	High
5. Eutrophication	High	High
6. Seafloor Integrity	High	Moderate
8. Contaminants	Moderate-high	High
9. Contaminants in Fish and Shellfish	Moderate	Moderate-high
10. Marine Litter	High	Moderate
11. Energy (Underwater noise)	Moderate-high	Moderate
12. Habitats Directive Habitats and Species	High	High

Regional Risk Assessment: Black Sea

Table 3.4 shows the complete risk result and the confidence assessments for the Black Sea. Beside those HLOs that were high across all regions, there was also high risk for Biodiversity-seabirds and Underwater Noise in the Black Sea regional assessment. The increase in shipping activity contributed largely to the score for both Marine litter and Underwater Noise, whilst fishing activity and run off from land waste were also thought to contribute to the 'high' score for marine litter. Contaminants in the Black Sea is also known to be an issue with a 'moderate-high' risk result with 'high' confidence in this assessment. This result was based largely on available information on the concentration on contaminants in the water column, mainly petroleum hydrocarbons which exceed the Maximum Allowed Concentrations in nearly all regions of the sea. The habitats directive species and habitats are not assessed in the Black Sea.

Table 3.4. Summary of risk of failing to achieve GES for each descriptor in the Black Sea. Criteria for risk evaluation are described in Annex V after Breen et al. (in prep).

GES Descriptor	Risk Assessment	Risk Confidence
1a. Plankton	Moderate	Moderate
1b. Fish	Moderate	Moderate
1c. Marine Mammals	Moderate-high	High
1d. Seabirds	High	High
1e. Predominant Habitats	Moderate-high	Moderate
2. Non-indigenous species (NIS)	High	High
3. Commercial fish and shellfish	High	Moderate
4. Food webs	High	Moderate
5. Eutrophication	Moderate	High
6. Seafloor Integrity	High	Moderate
8. Contaminants	Moderate-high	High
9. Contaminants in Fish and Shellfish	Moderate	Low-moderate
10. Marine Litter	High	Moderate
11. Energy (Underwater noise)	High	Moderate
12. Habitats Directive Habitats and Species	N/A	N/A

Table 3.5 shows the risk result and confidence scores for the Mediterranean Sea. Half of the HLOs scored in the risk assessment were considered to be at 'high' risk of failure. In addition to the five descriptors which were found to be at high risk throughout all regions, biodiversity-marine mammals, underwater noise and HD species and habitats were also all considered to be at 'high' risk of failing GES or FCS. Marine litter has been scored 'high' due to amounts and increasing trends in beach litter mainly associated with tourism and recreation activities, and a prevalence of plastics/microplastics in floating and seabed litter attributed mainly to land-based sources. Underwater noise is scored 'high' due to high shipping activity in the region as demonstrated by its share in global activity (15% of global shipping activity by number of calls), traffic (30%) and oil transport (25%) as well as expected further increases. Non-indigenous species again are a major issue in the region, with continuously increasing numbers of NIS and indeed invasive NIS, and sufficient information to score this result with 'high' confidence. Studies have looked at the increasing abundance and numbers of NIS in the region caused by shipping and mariculture, whilst the Suez Canal has been a major pathway of tropical NIS moving northwards into the Mediterranean for decades.

Table 3.5. Summary of risk of failing to achieve GES for each descriptor in the Mediterranean Sea. Criteria for risk evaluation are described in Annex V after Breen et al. (in prep).

GES Descriptor	Risk Assessment	Risk Confidence
1a. Plankton	Moderate	Moderate
1b. Fish	Moderate	Moderate
1c. Marine Mammals	High	High
1d. Seabirds	Moderate	Moderate
1e. Predominant Habitats	Moderate	Moderate
2. Non-indigenous species (NIS)	High	High
3. Commercial fish and shellfish	High	Moderate
4. Food webs	High	Moderate
5. Eutrophication	Moderate	High
6. Seafloor Integrity	High	Moderate
8. Contaminants	Moderate	High
9. Contaminants in Fish and Shellfish	Low	Moderate
10. Marine Litter	High	High
11. Energy (Underwater noise)	High	Moderate
12. Habitats Directive Habitats and Species	High	High

Chapter 4

Integrated Ecosystem Assessment of European Regional Seas

4.1 Introduction

Chapter 1 highlighted that in order to achieve the three pillars of sustainability, it is necessary to integrate objectives for management of the natural environment with social and economic growth. It is clear from the available information that the risk of failing to meet Good Environmental Status (GES) in Europe's Regional Seas by 2020 is high for many GES descriptors based on the current strains and human usage of these seas (Chapter 3 and information in Annexes I-IV). By 2016, Member States will need to implement programmes of measures that act to reduce some of the pressures on their regional seas such that there can be improvement in terms of GES by 2020 (see Chapter 1). As we can only manage our human activities (see Box 4.1) the programmes of measures will consist of management options on those activities shown to be causing the greatest threats to GES. However, at the same time there are policies that aim to develop social and economic growth in Europe (EC 2004) and EU Directive for Renewable Energy (EC 2009) and there are likely to be conflicts in the needs to meet all objectives.

Box 4.1 Incorporating the Principles of Ecosystem-based Management

ODEMM's approach incorporates EBM principles by proposing effective and sustainable resource management options by synthesizing and applying knowledge from economics, and the social and natural sciences. EBM bases its principles on sustainable development, whereby the goal is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need (Mcleod and Leslie 2009). ODEMM's approach incorporates EBM principles by recognising (Levin, Fogarty et al. 2009; Mcleod and Leslie 2009; Rosenberg and Sandifer 2009):

- humans are an integral part of our ecosystems;
- the need to account for the complexity in natural ecosystem components;
- that pressures contributing to the degradation of our marine resources are most likely associated with multiple human activities; and
- and that we can only manage these human activities, and not the ecosystem itself.

Improving the likelihood of achieving GES requires an understanding of the linkages between all of the drivers that affect our marine ecosystems. To understand these interactions, the ODEMM project has developed a linkage framework to illustrate the connectivity between the natural, social, economic and political components of the ecosystem.

4.2 The ODEMM Linkage Framework

The ODEMM linkage framework is a conceptual tool to describe the relationships between the High Level Objectives (HLOs) of the MSFD, the ecological characteristics of the natural environment, socio-cultural and economic characteristics and ecosystem goods and services (EGS) (Figure. 4.1). The framework builds on the DPSIR approach (Driver-Pressure-State-Impact-Response) (EEA 1998) that uses cause-and-effect interactions to assess which management responses might help to reduce impacts on the state of the environment (See Box 4.2 on applications of the DPSIR approach).

The ODEMM approach (Fig. 4.1) moves beyond DPSIR so that the aspirations of the Marine Strategy Framework Directive (MSFD) in particular can be considered. This requires that:

- The state of the ecosystem can be interpreted in terms of impacts on the high level objectives (Good Environmental Status (GES) as described under 11 Descriptors) of the MSFD;

- The state of the ecosystem can be interpreted in terms of impacts on the provision of Ecosystem Goods and Services (EGSs) (which is essential if managers are to be able to weigh up the costs and benefits of particular management responses; a requirement under the MSFD);

- The wide-range of interactions between ecological, economic and social-cultural factors can be considered in terms of the likelihood of failing to achieve MSFD high-level objectives for GES.

ODEMM's group of experts identified the broad links (both direction and connectivity) between all components (Fig. 4.1). Many of these components have been further disaggregated into sub-components, for example, 'Pressures' has been broken down to 25 individual pressures, and the EGS component is comprised of four groupings: provisioning, regulating, habitat and cultural services, with each service consisting of a number of characteristics[3].

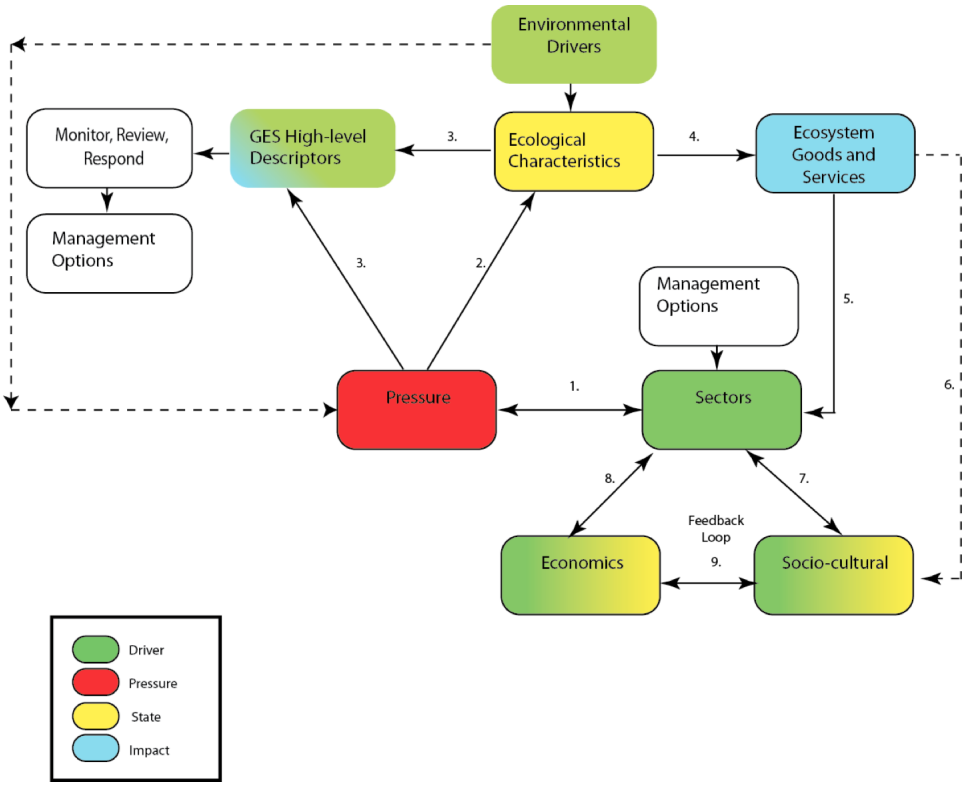

Figure 4.1 The different components of the framework are each described as either: driver (green), pressure (red), state (yellow) or impact (blue), or a combination of several categories. The interactions between the different components are shown by arrows where there is either an effect of one component on the other (a one-way arrow), or the potential for both components to affect each other (a two-way arrow). Economic and Socio-Cultural components can be interpreted as either a measure of state or as a driver on each other or directly on Sectors. The GES High Level Descriptors is an impact and a driver depending on the flow of the framework. The response loop will be developed further in later stages of the ODEMM project. This framework does not yet take into account other Regional or National Policies.

[3] A full description of the ODEMM Linkage Framework (the linkage framework guidance) and the tables underlying some of the linkages can be downloaded at www.liv.ac.uk/odemm/outputs/guidance documents

Future work within the ODEMM project will develop the linkage framework, to build in the links between management options, monitoring and review of status and pressures and the overlying governance frameworks and policy drivers. We will also work more on the interactions with environmental drivers and how climate change links into the full cycle.

European Projects applying the DPSIR approach

The DPSIR framework has been widely adopted and used by the European Environment Agency (EEA) as a way to enable feedback to policy makers on environmental status, which in turn will inform policy decisions. For example, the framework enables an assessment of risks to Good Ecological Status in the Water Framework Directive (WFD) (Borja 2006) and can be used to understand and represent the various steps of the MSFD (EC 2010). The DPSIR framework has been applied by Regional Sea Conventions (e.g. OSPAR) and has been used by a number of EU MS (Turner et al. 2010) and various European projects in their assessment.

The European Lifestyles and Marine Ecosystems (ELME) project, completed in 2007, was designed to explore the relationship between European human lifestyles and the future of Europe's regional seas (Langmead, McQuatters-Gollop et al. 2007). The ELME project used a conceptual model to integrate existing knowledge on environmental state changes, sectoral pressures and social and economic drivers. Within their conceptual model, the DPSIR framework was adopted to organise information relating to each environmental issue.

ELME focussed on the D-P-S parts and its outputs flowed into the EU 7 Framework Programme, specifically the Knowledge-Based Sustainable Management For Europe's Seas (KNOWSEAS) project. KNOWSEAS adapts the DPSIR approach by replacing impact (I) with welfare (W) to become DPSWR. This change emphasises the importance of coupled social and ecological systems. The welfare component in the KNOWSEAS model measures change (the 'costs') to human welfare as a result of state changes. Using DPSWR, the KNOWSEAS project examines and emphasises the cost-benefit tradeoffs between the social and ecological systems.

The 7FP Water bodies in Europe- Integrative Systems to assess Ecological status and Recovery (WISER) project is aiming to support the implementation of the WFD by developing tools for the integrated assessment of the ecological status of European surface waters. WISER introduced the DPSIRR scheme, adapting it from DPSIR by extending it with Recovery components. These Recovery components are the return of the structural and functional characteristics of the organism groups due to restoration. Recovery is expected in consequence of appropriate response measures and activities.

4.3 Summary

By incorporating the principles of EBM, and building on approaches used in European Programmes (e.g. DPSIR), ODEMMS's linkage framework provides a means to fully evaluate all components that can affect our potential to achieve GES in a fully integrated ecosystem assessment. The linkage framework identifies that economic, socio-cultural, and sector components, and their associated costs and benefits, play an important role in achieving GES. The ODEMM linkage framework proposes one way to explore these relationships, whilst highlighting that management options and governance frameworks will vary between Regional Seas. As many risks to achieving GES of the MSFD Descriptors are related to human activities, Chapter 5 will explore, describe and illustrate some of these issues.

Chapter 5

Understanding the complexities in achieving GES for MSFD Descriptors

5.1 Introduction

As described in Chapter 4, reducing the risk of failure against the objectives of the MSDF (the GES descriptors) and the Habitats' Directive, requires an understanding of the economic, cultural, and social context of our regional seas. Chapter 4 described ODEMM's approach, and the linkage framework that allows users to explore which environmental, economic, social and cultural drivers should be considered in examining the potential to achieve particular MSFD and HD objectives. The purpose of Chapter 5 is to illustrate the complexities faced in trying to achieve particular aspects of GES by examining the European and specific regional context in terms of sector activities, economic and socio-cultural components and the major policy drivers that can influence particular aspects of GES (e.g. marine litter).

Chapter 3 presented the current risk of failing to achieve GES (and FCS) and how this varies between European Regional Seas. It is clear from this that there is a high risk of failing to achieve GES by 2020 for many Descriptors in Europe's regional seas. In the regional annexes (Annexes I-IV), the sectors that currently exert the highest threats to Europe's regional seas based on their extent, frequency and the nature of their pressures and associated impacts were identified and related to a number of GES descriptors (see summary in Table 5.1). Based on these outputs, three descriptors have been chosen to illustrate current and emerging issues associated with high risk of failure to achieve GES across the regional seas. These examples are: Seafloor Integrity, Non-indigenous Species and Marine Litter.

Achieving GES is influenced in many ways by the demands of the human population. Understanding how this is distributed and changing around Europe's regional seas is key to considering the issues faced in trying to achieve any one GES descriptor. Section 5.2 summarises trends in human population around Europe and this is then referred to where relevant in the examples given in Section 5.3.

The examples illustrated below will highlight how socio-cultural and economic characteristics, sector activities, and various policy arrangements can influence the risk of failing to achieve GES. Each example will describe the issues and their context, as related to the MSFD descriptor, by using trends and other information where available. This process will highlight gaps in current knowledge. The ODEMM project team has collated economic, sectoral and socio-cultural information across all European Regional Seas where available. For example, traditional maritime sectors such as fisheries, shipping, and seaports have historical information in most regions. Yet, data availability relating to some activities such as collecting and harvesting is not available or perhaps inaccessible. Similarly, information paucity exists for socio-cultural and economic characteristics due to a lack of, or unreported, data. The ODEMM project also recognises that the collated information often covers different time periods, or time steps, in terms of data collection and reporting. This can limit understanding of how current trends may influence our ability to achieve GES.

The capacity of individual countries and regions to meet the aspirations of sustainable development and achievement of GES can also be assessed in terms of activity indices. Section 5.4 explores the economic and resource capacity of Member States in their potential for applying marine management strategies to achieve sustainable development based on their marine activity intensity and the human development index (HDI). The combined values generate the Marine Activity Index (MAI) which assists in identifying Member States that have a decreased capacity in implementing marine management strategies. The MAI index, coupled with other economic, cultural, legal and political complexities (highlighted in Section 5.3) will influence our ability to meet GES. Section 5.5 describes these complexities and their application in moving forward in ODEMM.

Table 5.1 The sectors which exert widespread pressures to marine ecological characteristics as identified through the ODEMM pressure assessment and summarised in the regional annexes (Annexes I-IV), and the MSFD descriptors which are at high risk of failing GES for each European Regional Sea (as detailed in Chapter 3).

Regional Sea	Sectors Exerting Widespread Pressures to Marine Ecological Characteristics	MSFD Descriptors at High Risk of Failing GES
Baltic Sea	Agriculture, Coastal Infrastructure, Fishing, Shipping, Tourism and Recreation.	Non–indigenous species, Commercial Fish and Shellfish, Food Webs, Seafloor Integrity, Marine Litter, Biodiversity–Predominant habitat, Eutrophication, Contaminants, HD habitats and species.
Black Sea	Agriculture, Coastal Infrastructure, Fishing, Shipping, Tourism and Recreation, Waste Water Treatment.	Non–indigenous species, Commercial Fish and Shellfish, Food Webs, Seafloor Integrity, Marine Litter, Biodiversity–seabirds, Contaminants, Underwater Noise.
NE Atlantic	Agriculture, Aquaculture, Coastal Infrastructure, Fishing, Military, Non-renewable Energy (oil & gas), Research, Shipping, Telecommunication.	Non–indigenous species, Commercial Fish and Shellfish, Food Webs, Seafloor Integrity, Marine Litter, Underwater Noise, HD habitats and species.
Mediterranean Sea	Aggregates, Agriculture, Aquaculture, Coastal Infrastructure, Fishing, Navigational dredging, Non-renewable energy (oil & gas), Shipping, Tourism & Recreation and Waste Water Treatment.	Non–indigenous species, Commercial Fish and Shellfish, Food Webs, Seafloor Integrity, Marine Litter, Underwater Noise, HD habitats and species, Biodiversity – marine mammals and reptiles.

5.2 Member State Population in European Regional Seas

European populations concentrate in coastal regions of many Member States (NUTS3) (Figure 5.1) (EEA 2006). During the census period 1991-2001, there were a total of 140 million coastal inhabitants in 18 EU[4] countries, and this figure is predicted to increase (EEA 2006). Since 1991, Europe's coastal population has grown by 3.44%, which on average is 0.5 million per year. There are 281 EU coastal cities with populations greater than 50,000 inhabitants, with only 10% of these coastal cities having populations greater than 0.5million (EEA 2006). The remaining 90% are divided equally between 50-100 and 100-500 thousand inhabitants (EEA 2006). It is important to note that some Member States have larger spatial coastline extent compared to smaller member states which will influence coastal population number, for example Greece compared to Belgium.

[4] EU coastal Member States not included (EEA, 2006) were: Bulgaria, Germany, Greece, Lithuania, Malta, Poland and Turkey.

Baltic Sea

Population trends of countries bordering the Baltic Sea have fluctuated in the last decade (Table 5.2). Countries such as Finland, Sweden and Denmark have experienced population growth, whilst Poland, Estonia, Latvia and Lithuania saw a decrease in population (Eurostat 2011a). On the Nordic coast of the Baltic Sea, coastal populations increased in line with EU trends (by 3.3 %), specifically in urban spots such as Helsinki and southern regions of Sweden (EEA 2006). Poland, Estonia and Latvia's decrease in coastal population reflected the declining national population trends (EEA 2006).

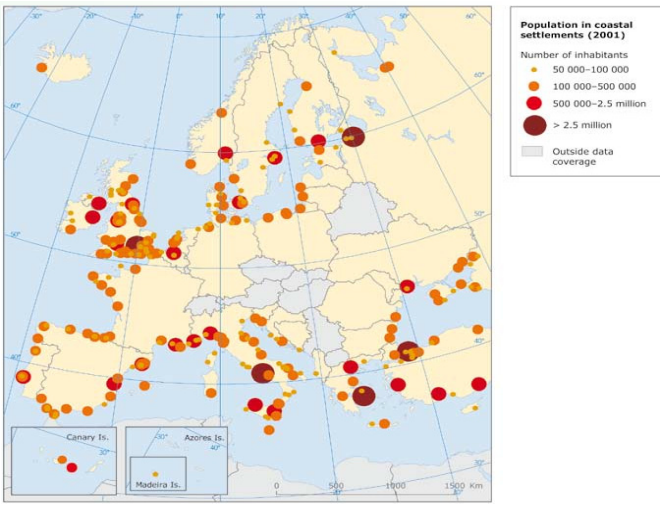

Figure 5.1 European populations in coastal settlements between 1991-2001 (EEA 2006).

Table 5.2 A comparison of total population number in the Baltic Sea for 2000 and 2010. Total population is counted as of 1 January for any given year. Population number is based on data from the most recent Eurostat census and adjusted by the components of population change produced since the last census, or, based on population registers. Trends in general population change is presented by ↑ and ↓ for increasing and decreasing populations respectively (Eurostat 2011a).

Country	Population in 2000	Population in 2010	Trend	Proportional Change in National Population (%)
Denmark	5,330,020	5,534,738	↑	3.8
Estonia	1,372,071	1,340,127	↓	-2.3
Latvia	2,381,715	2,248,374	↓	-5.6
Lithuania	3,512,074	3,329,039	↓	-5.3
Poland	38,653,559	38,167,329	↓	-1.3
Finland	5,171,302	5,351,427	↑	3.5
Sweden	8,861,426	9,340,682	↑	5.4

Mediterranean Sea

Mediterranean Sea countries which experienced national population growth between 2000-2010 include: Cyprus, Greece, Israel, Italy and Malta (Eurostat 2011a) (Table 5.3). Croatia experienced a decrease in its national population. There were fluctuations in coastal populations of EU Member States during this same time period. Italy decreased in coastal population, specifically in areas such as Corsica and Sardinia (EEA 2006). Conversely, France experienced an increase in coastal population during the same time period (EEA 2006).

A heavily populated coastal town in Crete (Photo: A. Delaney)

Table 5.3 A comparison of total population number in the Mediterranean Sea for 2000 and 2010. Total population is counted as of 1 January for any given year. Population number is based on data from the most recent Eurostat census and adjusted by the components of population change produced since the last census, or, based on population registers. Trends in general population change is presented by ↑ and ↓ for increasing and decreasing populations respectively (Eurostat 2011a).

EU Member State	Population in 2000	Population in 2010	Trend	Proportional Change in Population (%)
Greece	10,903,757	11,305,118	↑	3.7
Spain	40,049,708	45,989,016	↑	14.8
France	60,545,022	64,714,074	↑	6.9
Italy	56,923,524	60,340,328	↑	6.0
Cyprus	690,497	803,147	↑	16.3
Malta	380,201	412,970	↑	8.6
Portugal	10,195,014	10,637,713	↑	4.3
Croatia	4,497,735	4,425,747	↓	-1.6

The Black Sea has limited information for population trends between 2000-2010, with data only available for Romania, Bulgaria and Turkey at the national level (Table 5.4). Turkey and Romania experienced national population growth, whilst Bulgaria experienced a decrease in national population with the exception of its coastal communities (Eurostat 2011a; Palazov and Stanchev 2006). Overall, the Black Sea coastline experienced a population decrease of 1.6% between 1991-2001 (EEA 2006).

There is evidence that the Bulgarian coastal population has increased substantially. After the recent census data reported by the National Bulgarian Statistical Institute, 14 coastal municipalities, which covers 5.21 % of the country territory, has 8.85 % of the entire country population concentrated in these regions (BSERP 2007). For the period 1934-2001, the total population in these municipalities has increased by 146%, which is almost six times higher than that for the entire country (Palazov and Stanchev 2006). The increase in Turkey's coastal population is especially noticeable in Istanbul contributing to its status of a "coastal mega-city", due to an estimated population of 15 million people (BSERP 2007). This will cause impacts in this region of the Black Sea, with further implications in other areas if more stringent management of coastal and marine resource uses and better control of pollutant emissions from land do not occur (BSERP 2007).

Increasing trends in global human population size is leading to greater demand for coastal resources (Photo: M. Goren)

Table 5.4 A comparison of total population number in the Black Sea, for 2000 and 2010. Total population is counted as of 1 January for any given year. Population number is based on data from the most recent Eurostat census and adjusted by the components of population change produced since the last census, or, based on population registers. Trends in general population change is presented by ↑ and ↓ for increasing and decreasing populations respectively (Eurostat 2011a).

EU Member State	Population in 2000	Population in 2010	Trend	Proportional Change in Population (%)
Bulgaria	8,190,876	7,563,710	↓	-7.7
Romania	22,455,485	21,462,186	↓	-4.4
Turkey	66,889,425	72,561,312	↑	8.5

Broadly, North East Atlantic countries have experienced increasing populations over the past 50 years. However, Germany experienced an opposite trend with a decreasing national population (Table 5.5). Ireland, UK, Belgium, France and Spain experienced increasing national populations (Eurostat 2011a). In NE Atlantic coastal areas, populations increased between 1991-2001 but at a slower rate then the general population (EEA 2006). There was a 6.4% population increase on the Atlantic coast, specifically in EU Member States of France, Ireland and the UK (EEA 2006). It is not clear if population increase was even for the French coastline of the Mediterranean Sea as compared to the NE Atlantic. Belgium and the Netherlands also experienced an increase in coastal populations during the same period, but comparatively at a slower rate then national population levels (EEA 2006).

A crowded beach on the French coast (Photo: B. Visbeek)

Table 5.5 A comparison of total population number in the NE Atlantic, for 2000 and 2010. Total population is counted as of 1 January for any given year. Population number is based on data from the most recent Eurostat census and adjusted by the components of population change produced since the last census, or, based on population registers. Trends in general population change is presented by ↑ and ↓ for increasing and decreasing populations respectively (Eurostat 2011a).

EU Member State	Population in 2000	Population in 2010	Trend	Proportional Change in Population (%)
Belgium	10,239,085	10,839,905	↑	5.9
Denmark	5,330,020	5,534,738	↑	3.8
Germany	82,163,475	81,802,257	↓	-0.4
Ireland	3,777,763	4,467,854	↑	18.3
Netherlands	15,863,950	16,574,989	↑	4.5
UK	58,785,246	62,008,048	↑	5.5
Iceland	279,049	317,630	↑	13.8
Norway	4,478,497	4,858,199	↑	8.5

5.3 Illustrated examples to understand the complexities in achieving GES for MSFD Descriptors

Example 1 - Descriptor 6: Seafloor Integrity

Seafloors in all European Regional Seas support a diverse range of ecosystem structures and functions, contributing to complex food webs. As defined by the ODEMM project, seafloor i ntegrity is disaggregated into two components:

1. seafloor represents predominant habitat types, for example, intertidal rock or subtidal sediments, and

2. integrity is the characteristic which describes the functioning of natural ecosystem processes in relation to its spatial scale.

Together, the achievement of GES for seafloors requires that the structures and functions of the ecosystem are safeguarded and benthic ecosystems, in particular, are not adversely affected[4].

A number of sectors outlined in the ODEMM project are dependent on functioning habitats (e.g. fishing, tourism and recreation); however, many of their activities create pressures which can alter the integrity of those habitats. In addition, there are other sectors (e.g. land-based industry) that may not themselves depend on the functioning of marine habitats, but cause pressures (e.g. contamination in riverine runoff) on some of them, detrimentally impacting their structures and/or functions. The links between sector activities and pressures on seafloor habitats have been identified by ODEMM, and the 'severity' of those pressures in predominant habitats evaluated. In all regional seas there are several high threat combinations of sectors and pressures on the different predominant habitats and the sectors contributing at least one high threat pressure on regional sea habitats are listed in Table 5.1.

In proposing management measures that could help to reduce the threat to seafloor integrity from human activities, and thus improve the likelihood of achieving GES by 2020 for that descriptor, Member States and regional seas will almost certainly be faced with conflicts of interest due to their obligations to other policy drivers (national and international), and social and economic development in their regions. These conflicts will be considered here in terms of potential risks that could contribute to failure in achieving GES for seafloor integrity, using the example of the Renewable Energy sector.

This sector is regarded to be an emerging issue within the ODEMM project, specifically in the regions of the Baltic Sea, NE Atlantic and Mediterranean Sea. In December 2008, the EU adopted a climate change and energy package which commits the EU-27 countries to increasing the share of renewable energy to 20% of Europe's total energy production by 2020 (EEA 2010). Production rates (in thousand tons of oil equivalent) and number of businesses in the Renewable Energy sector in Europe have increased over the past 10 years and specifically, growth in offshore wind energy production increased rapidly during the late 1990's and early 2000's (Stenzel et al. 2003). However, in 2009, the Renewable Energy sector accounted for only 4.8 % of the EU's total electricity consumption, thus reaching the 20% in 2020 target, requires a substantial expansion in activities. The 4.8 % figure is expected to at least triple by 2020 as EU Member States try to meet their commitments. This could imply an annual expansion in wind farms, both onshore and offshore, of more than 10 GW per year until 2020 ((Stenzel, Foxon et al. 2003); (EEA 2010)). Currently, offshore wind farms are primarily located in the North East Atlantic and Baltic Seas where wind energy potential is at its greatest (EEA 2010). Even with the availability of other renewable energy, and different national priorities of EU Member States, wind energy is likely to grow in most, if not, all countries (EEA 2010).

Algal harvesting on the north coast of France (Photo: A. Delaney)

[4] Refer to MSFD Descriptors and their definitions of GES in Annexes I-IV.

An increase in Renewable Energy sector activities will cause pressures on the ecological characteristics of predominant habitats, increasing the risk of failing to achieve GES for Seafloor Integrity. This will be an emerging issue for all EU Member States, particularly for those whose continental shelves support the highest capacity for renewable energy generation (i.e. the UK and other northern European countries). There are a range of pressures associated with the renewable energy sector (Figure 5.2), but not all of them occur throughout the operational phase of the various installations, and some have low severity effects on habitats (e.g. changes in siltation). Some of the pressures (e.g. changes in siltation, abrasion, smothering) will only occur during the construction phase, but others (e.g. substrate loss) will remain continuously unless the structures are removed and the areas restored. The major ecological threat to seafloor integrity from wind farms is the loss of natural substrate caused by the footprint of the turbines. Where substrate loss is widespread this could affect habitat function and process which will in turn influence the ecosystem goods and services provided by the affected habitats (e.g. disturbance alleviation, waste assimilation, seafood production), which human populations also depend on.

This sector does therefore provide an interesting duality between needing to achieve policy for both sustainable development and environmental protection. The EU needs to meet the emergent energy demands of growing populations (see Section 5.2) by renewable technology; yet, this may come at a cost to the seafloor integrity of European Regional Sea ecosystems. Conversely, implementing the EU Directive for Renewable Energy (EC 2009) will address global conventions, such as the World Summit on Sustainable Development (UN 2002), which in turn, underpins the broader rationale for the MSFD itself. There is a direct conflict in needing to achieve GES for Seafloor Integrity and meeting international directives and regional policies for producing energy in a sustainable manner.

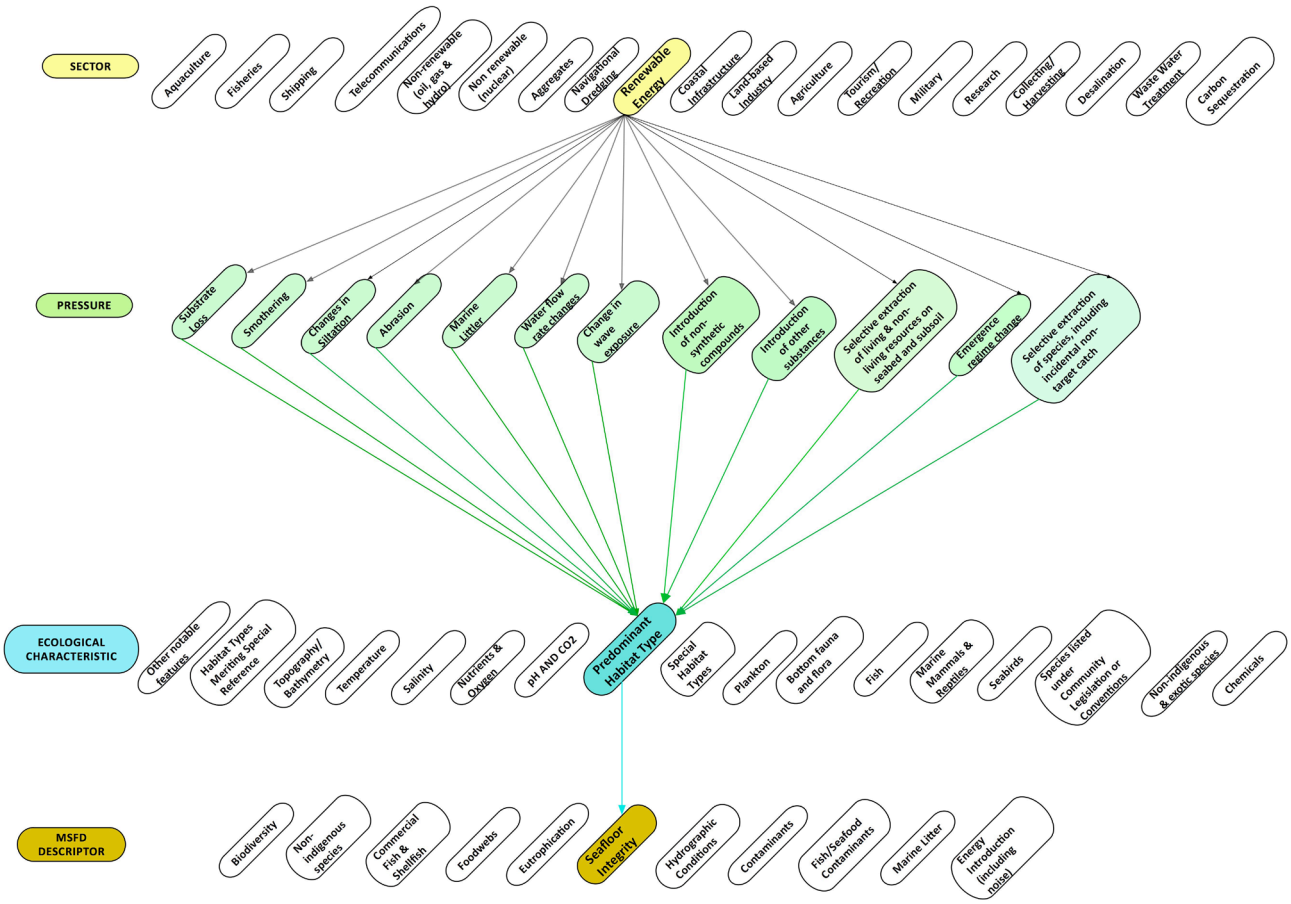

Figure 5.2 This figure illustrates how the Renewable Energy Sector (yellow) exerts a number of pressures (green) on to the Ecological Characteristic (blue), *Predominant Habitat Type*. This influences the ability to achieve GES for the MSFD Descriptor *Seafloor Integrity* (brown). The lines with directional arrows are the linkages between the four components as described in Figure 4.1 of this report[5].

[5]Further infomation describing the linkages between components can be found in the ODEMM Linkage Framework Guidance Document and associated tables (www.liv.ac.uk/odemm/outputs/guidancedocuments)

Against this broader backdrop of the conflicts in policy objectives that can influence seafloor integrity through priorities related to the renewable energy sector, there are also a number of other social, cultural and economic issues that increase the complexity in making decisions on managing the pressures related to this sector (Figure 5.3). There are potentially positive economic and social outcomes from increased employment and household income for those employed in this specific marine sector and the growth in the number of businesses in this sector will promote growth in industries related to the associated technology for renewable energy. This in itself may have a flow on effect to an increase in education levels specifically associated with technologies in renewable energies. GDP may also ultimately be positively affected in those countries where the major renewables companies are based and this may then also influence the decision making process.

Conversely renewable energy installations located within sight of the coast can create conflict for coastal communities who value the aesthetic and health and wellbeing benefits from living on the coast. In Europe, more than 80% of the population live in coastal locations (EEA 2006) and summary in Section 5.2). Coastal communities often have a strong sense of identity due to their association with the coast and marine environment. If such a community feels that these values will be compromised, and they have political capacity to lobby government, their sense of stewardship for this area may influence the approval process. This outcome can only occur for coastal communities who have lobbying capacity and ability (Box 5.1) which may be greater where a high degree of community cohesion and identity are found. In addition, the chosen locations for installations and their spatial extent can cause conflict with other sectors, such as Fisheries and Tourism and Recreation (due to the loss in fishing grounds and recreational areas).

Member State governments may therefore be placed into a conflicted political field of needing to meet policy objectives for renewable energy targets and GES for seafloor integrity over the same timescale, whilst also having to consider the different needs of their communities who ultimately will re-elect them into power at the end of their parliamentary term. Decisions can cause risk to a party's political integrity, influencing confidence in government decision-making processes and policy actions (Box 5.2).

In short, the relationship between the increased need for growth in wind farms and the location and extent of their footprints (and thus pressures on Europe's seafloor habitats) is not straight forward! All of these issues could affect the capacity for Member States in European Regional Seas to achieve GES for Seafloor Integrity.

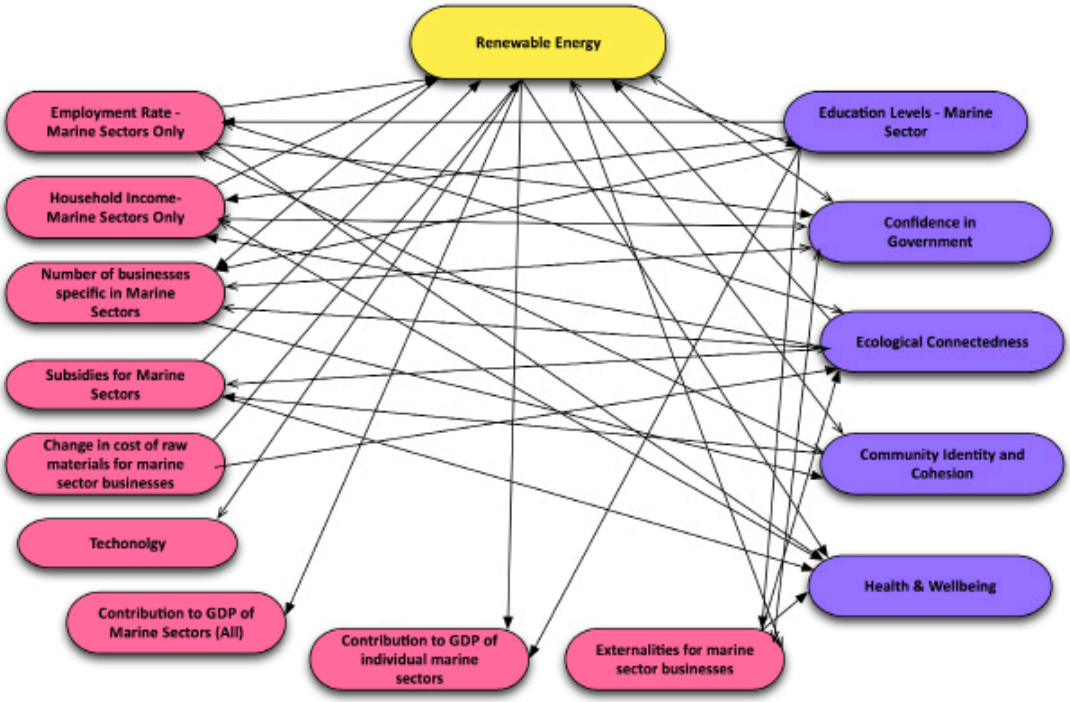

Figure 5.3 The linkages between the Renewable Energy Sector and the economic (pink) and socio-cultural (purple) components. The arrows indicate the direction of the linkage relationship, e.g. Education Levels – Marine Sector (socio-cultural) has a direct relationship to Employment Rate – Marine Sectors Only (economic). A double - headed arrow indicates that the linkage relationship is bidirectional, that is, both characteristics influence each other, for example, Ecological Connectedness (socio-cultural) and Employment Rate – Marine Sectors Only (economic) influences one another. The linkages between the Sector, Socio-cultural and Economic components are based on the ODEMM linkage framework (Figure 4.1) and illustrate the complex relationships between component characteristics.

Box 5.1 The capacity of a Community to Influence Renewable Energy Planning and Development

Nearly half of planned wind farms in the British country-side are rejected by local communities who do not want wind farm installations in their 'back yards'. Rejection rate for wind farms has risen from 29% in 2005 to 48% in 2010, with most communities disputing the visual impact of wind turbines in their local area (Smith and Prosser 2011). This raises complex issues in regards to the UK Government achieving their Green Energy policy to meet the 2020 renewable energy target. Economically, the high rejection rate has cost 1.3 billion in lost investment (Smith and Prosser 2011). Although this example is of land based wind farms, coastal communities can have the same capacity to influence renewable energy planning decisions.

Box 5.2 Confidence in Government

To better understand the social realities of European Union citizens, the European Commission launched a special Eurobarometer survey in 2006 to gauge the many dimensions of social life in the European Union. This survey highlighted the declining trend of public trust in political institutions (EC 2007). This decreasing trend applied to the following political institutions: the National Government, the Parliament, political parties and city or village council. The more distant the connection between the survey respondent and the political entity, less trust was perceived.

A decrease in public trust can be associated with disappointment in specific targets or objectives not being met, or not being met within the required timeframe, by political institutions. When targets are not being met within the prescribed time period, the public loses trust in the capacity of political institutions to fulfill their obligations.

Example 2 – Descriptor 2: Non-indigenous Species Introduced by Man

The introduction of non-indigenous species (NIS) through human activities can have severe and detrimental impacts on marine ecosystems. An example of this was the introduction of the invasive comb jelly species, *Mnemiopsis leidyi*, which is notorious due to its detrimental effect on the pelagic food web and fisheries collapse in the Black Sea (Mee et al. 2005; Langmead et al. 2007; Knowler 2007; BSERP 2007; Mee et al. 2008; Langmead et al. 2009). Similarly, invasive seaweeds and invertebrates have been entering the Mediterranean Sea since 1863 (Galil 2008). In particular, invasive NIS seaweeds have contributed to the decline in Mediterranean Sea seagrass meadows, impacting their ecosystem functions, and compromising their restoration (Mooney & Cleland 2001; Boudouresque and Verlaque 2002 and 2005; Williams 2007). The decline of native seagrass meadows, an important nursery habitat for fish, can cause wider implications for the Mediterranean fisheries sector and thus, as illustrated in both the Black Sea and the Mediterranean, the failure to achieve GES for NIS (Descriptor 2) also has ramifications for several other descriptors including: Biodiversity, Seafloor Integrity, and Commercial Fish and Shellfish. The ability of NIS to rapidly change the dynamics and processes of marine ecosystems over potentially large spatial scales is both a current and future concern for all European Regional Seas.

ODEMM defines that in order for GES for NIS to be achieved, significant adverse effects on environmental quality from NIS need to be avoided. This includes no elimination or extinction of sensitive and/or rare populations, alteration of marine communities, seasonal dominance of algal blooms, or

or alteration of water chemistry which includes oxygen, nutrient content, pH and transparency. Based on this definition, invasive NIS pose a great concern and risk in achieving GES. This is due to the potential of invasive NIS to spread rapidly, having adverse biological effects on native species and habitat processes and functions. NIS introductions originate from a number of sources such as the shipping and aquaculture sectors, and trade in aquarium and ornamental species (Padilla and Williams 2007). This example will focus on the conflicts in trying to achieve GES for NIS particularly in relation to introductions via the shipping sector due to forecast growth for this industry.

Shipping and Non-indigenous species

The shipping sector is one of the predominant industries causing translocations and introduction of NIS in all European Regional Seas. Invasive NIS in larval form can be easily transported in ship ballast water, or in adult form, on ship hulls. Representatives from many different taxonomic groups have been shown to be introduced by ships (see linkages in Figure 5.4).

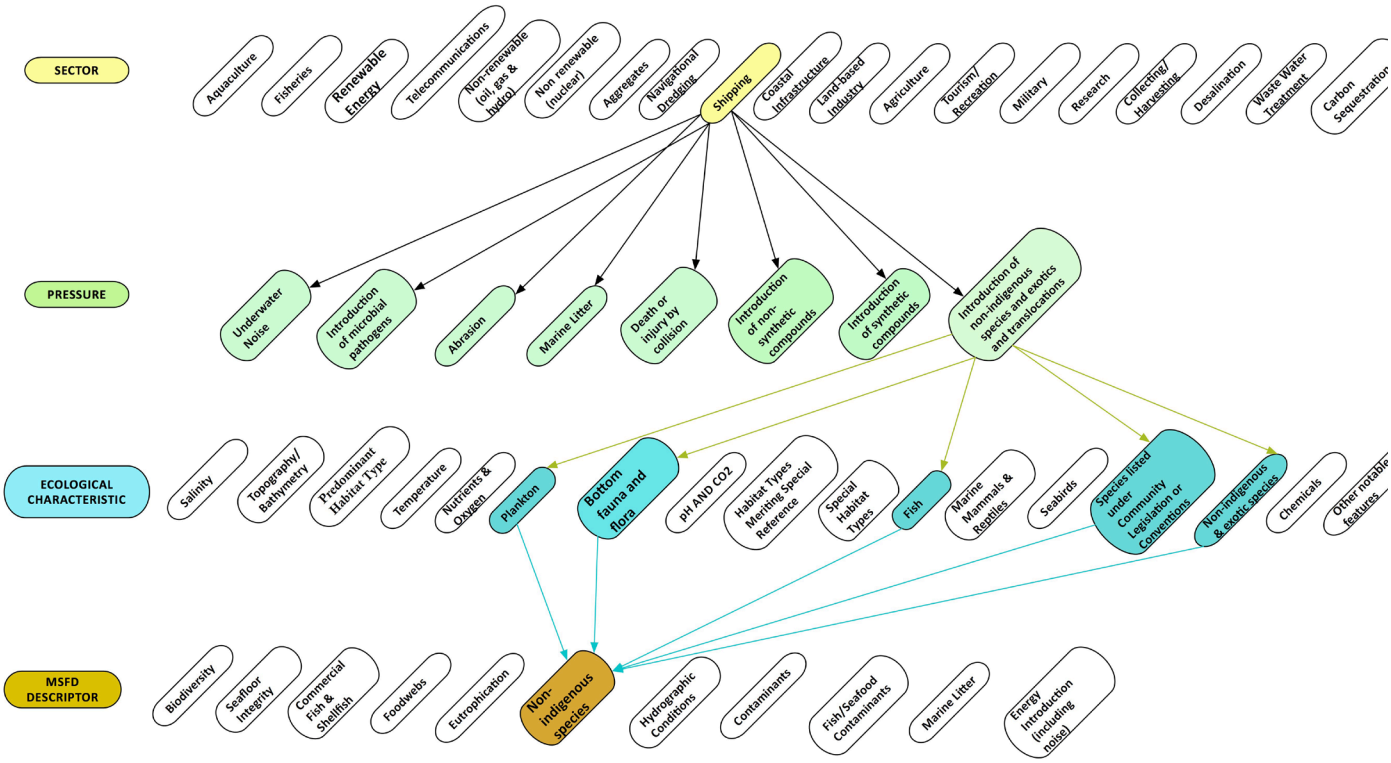

Figure 5.4 This figure illustrates how the Shipping Sector (yellow) exerts a number of pressures (green) to the Ecological Characteristics (blue), Bottom Fauna and Flora. This in turn influences the ability to achieve GES for the MSFD Descriptor Non-indigenous species (brown). The lines with directional arrows are the linkages between the four components as described in Figure 4.1 of this report[7].

[7]Further information describing the linkages between components can be found in the ODEMM Linkage Framework Guidance Document and associated tables (www.liv.ac.uk/odemm/outputs/guidancedocuments).

The growth of shipping in European Regional Seas has been rapid during the first decade of the 21st century, with total seaborne trade increasing from six to more than 8000 million tonnes during 2000-2008, corresponding to an increase of around 36% (HELCOM 2010). With future predictions of further growth of the sector, this raises concern for the increased spread of invasive NIS.

The International Marine Organisation's (IMO) Marine Environment Protection Committee (MEPC) first became aware of the problems, associated with the translocation of invasive NIS, in the 1980's due to Canada and Australia being amongst the first countries to experience large-scale environmental problems with NIS translocations. In 1992, the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, also recognized the issue of invasive NIS and noted it as a major international concern within the conference proceedings.

This issue was further highlighted in the Convention on Biological Diversity (CBD), where ''invasion of exotic species'' is one of the five main categories of the anthropogenic impact on marine and coastal biota (www.bio-div.org). The IMO MEPC adopted Guidelines in 1997 to address invasive NIS in the form of "*Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens*" as one way to minimise and prevent the spread of NIS (MEPC resolution A.868(20) (http://www.emsa.europa.eu/implementation-tasks/environment/ballast water.html).

The IMO continued to adopt and review guidelines, and released the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) in 2004 (EMSA 2008). The guidelines stipulate that the exchange of ballast water needs to proceed in the open ocean to reduce the risk of transferring harmful species. The intent of this guideline was to tie into the four European Regional Sea Conventions (HELCOM, the OSPAR Commission, REMPEC/Barcelona Convention and the Black Sea Commission), whilst meeting the European Commission's Communication and Biodiversity Action Plan.

In addition to the BDM Convention, the following EC Directives also have a direct impact on treating ballast water (EMSA 2008):

- Marine Strategy Framework Directive 2008/56/EC;
- Marine Equipment Directive 96/98/EC – as amended by 2002/84/EC;
- Biocide Directive 98/8/EC;
- Port State Control Directive 95/21/EC;
- Port Waste Reception Facilities Directive 2000/59/EC, and
- the emerging European policy on invasive species (the recent EC communication "Towards an EU Strategy on Invasive Species").

Although there are a number of EU Directives and Conventions which discuss the treatment of ballast water, there are no current targets which are specific to the levels or impacts of invasive NIS in the European regional seas. This will create difficulties for the shipping sector in their attempt to be part of the process in achieving GES for the NIS descriptor.

Shipping lanes are becoming increasingly busy. Photo (Reuters)

Box 5.3 Shipping Sector Trends for European Regional Seas

Baltic Sea

The intensity of shipping activities and related environmental impacts have increased very rapidly over the last decade within the Baltic Sea and are expected to increase considerably in the future. There are around 2000 ships on the Baltic Sea any one moment in time, accounting for 15% of the world's cargo transportation (HELCOM 2010). Every day 150 – 200 large tankers filled with oil are harboured in 20 ports around the Baltic Sea. By 2015 oil transportation is forecast to increase by a further 40% to 160 million tonnes a year (HELCOM 2010). Additionally, 30,314 heavy cargo ships passed through the Kiel Canal in 2009, which links the Baltic Sea with the North Sea (HELCOM 2010). The total amount of cargo handled in the ports surrounding the Baltic Sea was 822.4 million tonnes in 2008, which is 3% more than in 2006, but 0.4% less than 2007 (HELCOM 2010).

Mediterranean Sea

The Mediterranean Sea is characterized by being a maritime area of load and unload, but also being a trans-shipment and transit area (UNEP 2011). Marine transport in the Mediterranean sea has grown by over 50% between 1997 and 2006, specifically with container ship traffic increasing by 71%, due to the increase in trade with Asia (UNEP 2011). There is a predominance of energy (24%) and non-bulk products (36%) transported. Ship size has increased due to the growth in transport of goods, supporting larger volumes of traded goods.

Black Sea

During 2008, Ukraine commercial ports alone handled over 132 million tonnes of cargo, with a 6.8 % rise from numbers in 2007 (Skourtos et al. 2010). In 2009, approximately 58 million tonnes of goods passed through EU ports only in the Black Sea, with 62% in Romanian ports and 38% in Bulgarian ports. The main EU ports in the Black Sea basin are Constanta (RO) (50%) and Burgas (BG) (23%) (Eurostat 2011c).

From 2008 to 2009, the gross weight of goods handled in these Black Sea ports fell sharply by 25.0% (18.0% for Bulgarian ports and 28.0% for Romanian ports). This was much more than the gross weight of goods handled in the European Union as a whole, which fell by 12.4%. In contrast, from 2007 to 2008, this figure had increased by 4.3%, while it fell by 0.5% in the European Union ports as a whole (Eurostat 2011c). This decrease in trend during 2008-2009 can be attributed to the global economic crisis which affected the shipping sector across the globe.

NE Atlantic

The UK had the highest share of goods handled (15%) in all EU-27 ports, which is equivalent to 501 million tonnes. This was closely followed by the Netherlands (Eurostat 2011b). Rotterdam, Antwerpen and Hamburg maintained their positions as the three largest EU ports in terms of both gross weight of goods and volume of containers handled during 2009. Most of the cargo handling in Rotterdam involves bulk goods such as oil, chemicals, coal and ores, and is Europe's largest container port. Rotterdam plays an important role in the transport of products, in both directions, to intercontinental partners (Eurostat 2011b).

The shipping sector supports a range of economic and socio-cultural characteristics identified within the ODEMM project (Figure 5.5). Current and future predictions of growth within this sector will support new specific businesses in the marine sector, such as shipbuilding, and other associated businesses such as cargo transport and logistic. This will stem from the new *Motorways of the Sea* model created by the EC (EC 2004). This EC decision is a value adding exercise to support community development through creation of employment opportunities and a cohesive trans-European transport network. The new model is to increase the European maritime logistic chain in an attempt to reduce road traffic and congestion due to increasing use of heavy good vehicles. Although there was a decline in the late 1990's to 2000 in the shipbuilding industry, attributed to mechanised processes replacing human labour, and the lack of interest by school and university graduates in that industry (EC 2006), the new model will hopefully reinvigorate shipping sector employment.

The routes in the proposed *Motorways of the Sea* model will allow transport of goods, specifically to countries previously not on major shipping channels. Thus increased levels of shipping and new shipping routes will almost certainly have further economic and social benefits by boosting growth of businesses in areas that were previously not well connected to the wider world by shipping. In the Black Sea this will likely lead to the creation of new markets and the economic and social growth of communities living in port towns. Wherever it occurs, increased activity can positively affect household income for those directly associated with the shipping sector, and indirectly for those who live in coastal communities which support shipping logistics such as ports and land-based transport. Education levels for those involved in the shipping sector have the potential to increase, for example with additional training in ship piloting. Overall, there are likely to be economic benefits at the level of the individual family working in businesses related to the sector, right up to effects on GDP. These benefits from shipping sector activities contribute to the community value adding aspect of the *Motorways of the Sea* model

Although the IMO have created impetus for bilateral and regional commitments for ballast water treatment through the Ballast Water Convention in 2004, the costs, benefits and risks associated with different management options for minimising the spread of NIS from ships, and enforcement and regulation of these, will have to be considered. At the same time, changing sea temperatures and other physio-chemical characteristics due to climate change have been linked to increases in the natural movement of NIS from areas outside of European Regional Seas. This problem is particularly prevalent in the Mediterranean Sea where species are moving north through the Suez Canal and translocating into various marine basins across the region (Galil 2007; Collet al. 2010). The coupling of climate change and introduction via shipping can cause potential devastating impacts to native habitats and species. However, only the introductions via human activities (i.e. shipping) can be directly managed. Given the clear social and economic benefits associated with growth in the shipping sector, it may be hard for Member States to force the implementation of possibly expensive procedures to reduce spread of NIS from ships when there is the backdrop of climate change and the associated movements of species occurring at the same time.

However, it is clear that the continued introduction and spread of NIS will impact on other marine sector businesses (e.g. aquaculture, fisheries, recreation and tourism) and also reduce the likelihood of being able to achieve GES for not only Descriptor 2 (NIS) but also GES for Biological Diversity, Commercial Fish and Shellfish, Food Webs, and Seafloor Integrity. As described already it will only be possible to reduce introductions where humans can control the source. Shipping is without doubt a sector where this could be achieved (or at least improved upon) and affordable solutions that can be implemented (and enforced) will be even more important as Europe seeks to fulfill the EC's decision for increasing shipping sector activities through the *Motorways of the Sea* model.

Example 3 – Descriptor 10: Marine Litter

Similar to Example 2 (NIS Introduced by Man), Marine Litter is an MSFD pressure descriptor. Thus achieving GES for these descriptors is related to the reduction of the pressure described. According to the MSFD, GES for Marine Litter is achieved when the properties and quantities of Marine Litter do not cause harm to the coastal and marine environment (EC 2010). The only way that GES can be achieved is if there is a measurable and significant decrease in Marine Litter from 2012 (baseline figures) to 2020. These measurements will be based on the impact of Marine Litter on marine life across all European Regional Seas.

Marine Litter is widespread across all European Regional Seas due to multiple sector activities (see Descriptor 10 in Annexes I-IV). Marine Litter can be washed ashore, found floating in the water column and on the seafloor in shallow and deep waters. It originates from numerous sources and consists of different materials including: plastics, metal, glass, rubber, wood and cloth (EEA 2010). Large scale accumulations of marine litter have been observed in large areas of ocean causing detrimental impacts, for example, in the central Pacific Ocean known as the "Great Pacific Garbage Patch" (EEA 2010).

As a pressure, Marine Litter can cause detrimental and long-term effects on the following ecological characteristics as described in the ODEMM project (Figure 5.6): bottom flora and fauna, fish, marine mammals and reptiles, seabirds, and species listed under community legislation or conventions. The introduction of marine litter causes physical disturbances in marine and coastal habitats in addition to entanglement, ingestion, suffocation and general debilitation of marine fauna (EEA 2010). Currently, marine mammals, reptiles (turtles for example) and seabirds are used to evaluate levels of marine litter by measuring the amount of ingested material. The impact which marine litter inflicts on these top predators can have repercussions at various levels of the food chain. This causes implications for achieving GES in other MSFD descriptors such as Food Webs and Biodiversity, in addition to causing economic and socio-cultural issues for various sectors.

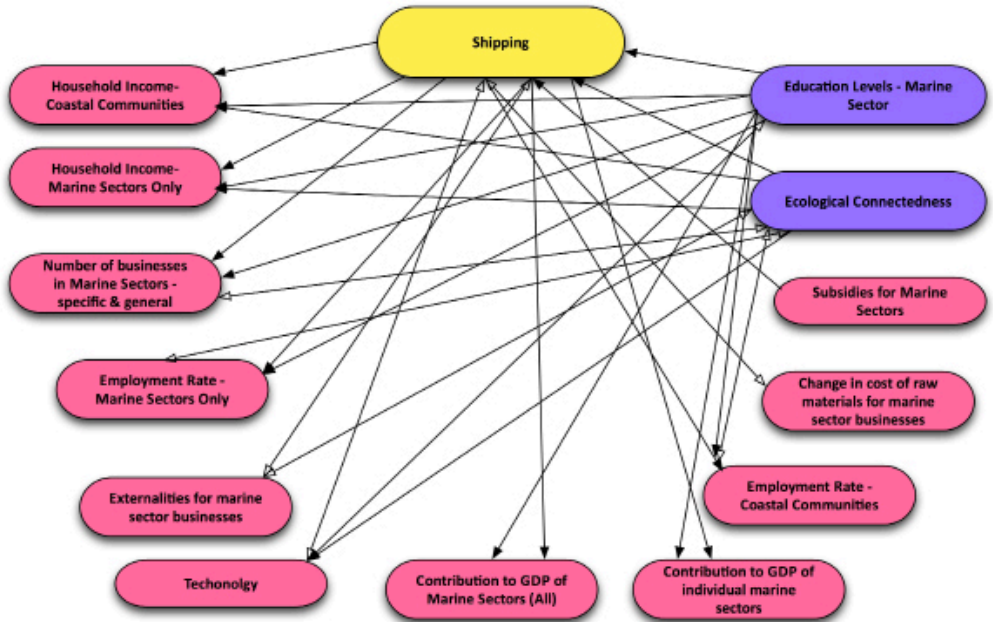

Figure 5.5 The linkages between the Shipping Sector and the economic (pink) and socio-cultural (purple) components. The arrows indicate the direction of the linkage relationship, e.g. Ecological Connectedness (socio-cultural) has a direct relationship to Externalities for Marine Sector Businesses (economic). A line with a double - headed arrow indicates that the linkage relationship is bidirectional, that is, both characteristics influence each other, for example, Education Levels – Marine Sector (socio-cultural) and Technology (economic) influence one another. The linkages between the Sector, Socio-cultural and Economic components are based on the ODEMM linkage framework (Fig 4.1) and illustrate the complex relationships between component characteristics.

[8]Further information describing the linkages between components can be found in the ODEMM Linkage Framework Guidance Document and associated Linkage Tables.

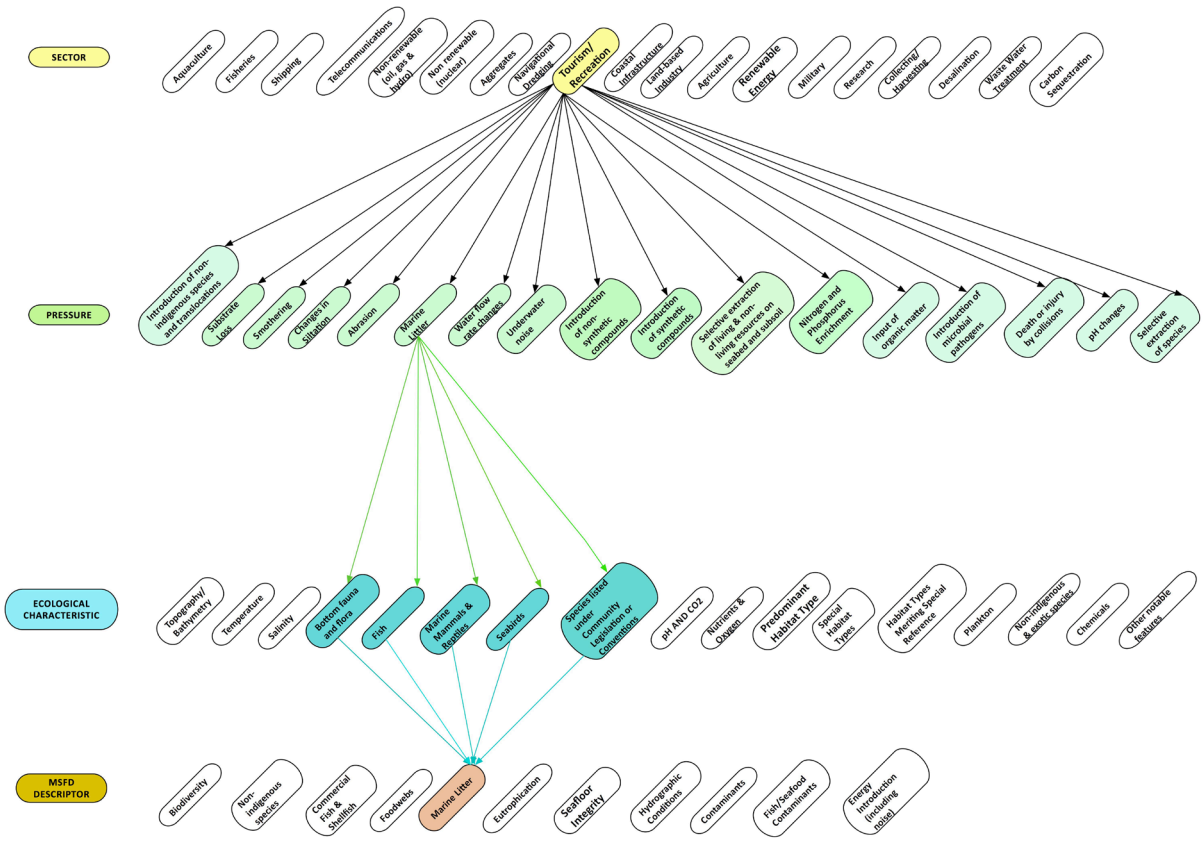

Figure 5.6 This figure illustrates how the Tourism and Recreation (yellow) exerts a number of pressures (green), and specifically to the Ecological Characteristics (blue), Bottom Fauna and Flora, Fish, Marine Mammals and Reptiles, Seabirds, and Species listed under Community Legislation or Conventions. This in turn influences the ability to achieve GES for the MSFD Descriptor Marine Litter (brown). The lines with directional arrows are the linkages between the four components as described in Figure 4.1 of this report[8]

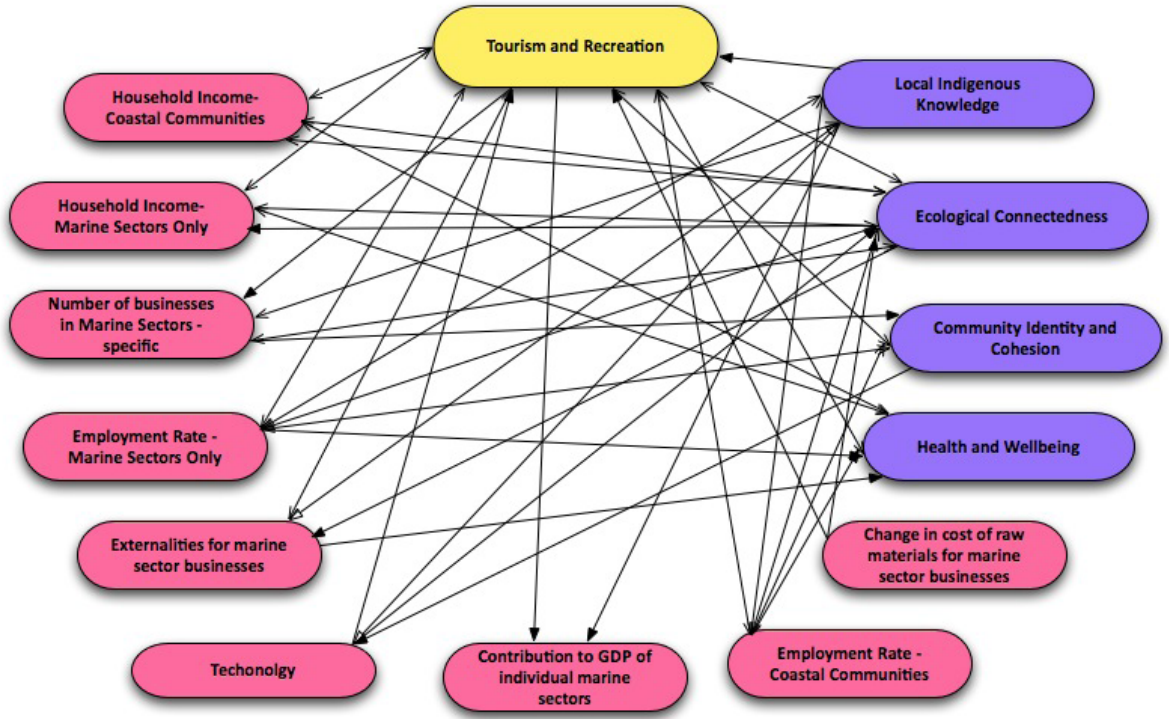

Figure 5.7 The linkages between the Tourism and Recreation Sector and the economic (pink) and socio-cultural (purple) components. The arrows indicate the direction of the linkage relationship, e.g. Local Indigenous knowledge (socio-cultural) has a direct relationship to Employment Rate – Coastal Communities (economic). A line with a double - headed arrow indicates that the linkage relationship is bidirectional, that is, both characteristics influence each other, for example, Community Identity and Cohesion (socio-cultural) and Employment Rate – Marine and Coastal (economic) directly influence each other. The linkages between the Sector, Socio-cultural and Economic components are based on the ODEMM linkage framework (Figure 4.1) and illustrate the complex relationships between these component characteristics.

[8]Further information describing the linkages between components can be found in the ODEMM Linkage Framework Guidance Document and associated tables (www.liv.ac.uk/odemm/outputs/guidancedocuments).

There are numerous sectors through which their activities contribute to marine litter being a pressure in all European regional seas. In this example, the Tourism and Recreation sector will be considered in terms of its contribution to the pressure of Marine Litter through the following activities: angling, boating and yachting, diving, and use of public beaches and tourist resorts.

This sector is interesting in terms of its relationship with Marine Litter because it is both a contributor and also a receiver of the pressure. Not only does the Tourism and Recreation sector create marine litter through various activities, but it can also be affected by the detrimental impact of this pressure, for example, litter created by tourists ending up on public beaches. This is further complicated by the source, pathway and end point of this pressure's distribution varying in ways that are not always predictable. For example, marine litter disposed from angling charters or recreational boating (source), can travel in oceanic currents (pathway) and wash up on shores on popular tourist resorts kilometres away (end point), or be ingested by marine mammals and reptiles, seabirds and fish feeding in other seas (end point) which could themselves be important in attracting tourists in the first place[9]. In addition, Marine Litter created by Tourism and Recreation activities can affect other sectors such as fisheries and aquaculture, either due to reductions in productivity of their activities due to physical disruption from large plastics, or due to the indirect consequences on those sectors from any impacts on ecological characteristics that they depend on. However, it should be noted that the fisheries and aquaculture sectors are also contributors to marine litter (e.g. lost fishing nets, feed bags and plastics).

Tourism and Recreation supports various economic and socio-cultural characteristics (Figure 5.7 and Box 5.5). For populations who live in coastal communities, peak tourist periods create employment opportunities in specific marine businesses which cater for visitors. These businesses can range from diving and angling charters, to hotel and resort services, or street stalls selling tourist curios. Those employed in these businesses form most of their annual income during these peak periods.

It seems logical that the economic benefits to those working in this sector are partly dependent on healthy ecological conditions and the maintenance of pleasing natural aesthetics of popular tourist destinations. The need to protect these healthy and aesthetically pleasing conditions requires both the sector and local coastal communities to take on the role of stewards. Theory suggests that the direct involvement and dependence of some coastal communities in the Tourism and Recreation sector, should give them a sense of identity and cohesion, especially if the majority of the coastal community population are employed in the industry. This can lead to the direct benefit of coastal communities experiencing health and wellbeing associated with controlling their own pressures on their local environment (Box 5.6). This illustrates that a relationship should exist between the safeguarding of household income and employment rates and the requirement to protect local coastal and marine ecosystems. However, there are still very high levels of marine litter recorded in Europe's regional seas, not least in those regions where tourism is of great importance to the local communities. Thus these theories are not well supported in Europe's tourist destinations making it difficult to imagine how the amount of Marine Litter added in these areas and related to this industry could be voluntarily reduced without significant enforcement and regulation incentives.

Tourism and Recreation as a broad sector is clearly an important contributor to national and regional GDP, particularly in southern and eastern Europe with continued growth likely in the future, especially in the Mediterranean and Black Seas (Box 5.5). It is also not the only human activity that adds litter to the marine environment; infact Shipping (as discussed in Example 2) is also noted as a contributor of Marine Litter. It is clear that in order to move towards achievement of GES for this descriptor a concerted effort will be required to identify all major sources of litter to Europe's regional seas before any improvement in status can be achieved.

Where it is identified that Tourism and Recreation activities are a significant source of litter, a new way of thinking may be required to convince politicians and their communities to reduce introductions substantially, if significant enforcement and regulation incentives are to be avoided. Despite theory suggesting that those communities that benefit themselves from this sector would have a vested interest in reducing littering, particularly where it impacts on their coastal resources, Europe's beaches and seas still contain high levels of litter. It is therefore clear that managing this pressure and achieving GES for this descriptor will not be straightforward. In addition achievement of GES for marine litter will be further complicated by the transboundary nature of the pressure in terms of its pathways and the relationship between source and end point. From a governance perspective, this could be a particularly hard GES descriptor to achieve and for example Mediterranean NGOs are already pushing for a new legislative framework going beyond the current directives on packaging and packaging waste and relevant legislation on imports.

[9]Please refer to Annexes I - IV for an example of associated costs due to Marine litter

Box 5.4 The Importance of Tourism and Recreation and the Pressure of Marine Litter in the Black and Mediterranean Seas

Of the four European Regional Seas, the Black and Mediterranean Seas receive the highest numbers of international and domestic tourists on their coastal zones. The sector of Tourism and Recreation are spatially extensive and provide economic security for coastal populations in these two regional seas. Additionally, this sector contributes towards national GDP of EU Member and non-Member States.

Black Sea

Regionally, the economic importance of tourism and recreation is increasing rapidly (BSERP 2007). The growth of this industry is closely tied to the rapid development of coastal infrastructure, which impacts on the coastal and marine ecology of the region. Although there is an underlying tenet of integrated coastal zone management, the institutional structures vary considerably between countries creating a piecemeal approach to environmental protection (BSERP 2007). This will be a future issue of concern with summer populations in coastal resorts projected to be three times greater than winter resident populations (BSERP 2007).

During 2006, a questionnaire to understand public attitude of the Black Sea was conducted in a range of surrounding coastal cities and towns (BSERP 2007). Coastal respondents felt that it was important to protect the Black Sea due to holiday and recreation opportunities, and that most people associated the region with holidays, recreation and fishing (BSERP 2007). Pollution, rubbish and litter were identified as being the main cause of damage to the Black Sea (BSERP 2007). This questionnaire revealed that Black Sea coastal residents identify that tourism and recreation is an important source of regional and personal income, yet marine litter and rubbish are environmental issues of concern to the health of the Black Sea.

Mediterranean Sea

International and regional tourism is an important sector contributing to economic development in the Mediterranean region (UNEP 2011). Due to its currency contribution, the tourism and recreation industry in this region has the ability to provide for sustainable development if the impact on the environment is reduced and the wealth that it brings is distributed evenly (UNEP 2011). However, tourism distribution in the form of international and European domestic visitors is not evenly spread which can cause sustainable development to be implemented in a piecemeal fashion.

At the crossroads of three continents, Mediterranean countries attract 30% of global international tourism arrivals, receiving for example in 2007 around 275 million international tourists (UNEP/MAP-Plan Bleu 2009). During the summer 2010 season, the most popular destinations for non-European tourists were: Spain, Italy and Greece (Dimitrakopoulou 2011). During the same sampling season, Malta and Cyprus experienced more than 80% of nights spent by non-European tourists (Dimitrakopoulou 2011). According to the current European Environment State and Outlook Report (EEA 2010), marine litter is quite prevalent in the Mediterranean region, with plastics representing the common type of litter found on, for example, Greek beaches considered important for the tourism and recreation sector. The increase in tourist numbers in the Mediterranean Sea plays a crucial role in the source and spread of marine litter.

Box 5.5 Health and Wellbeing

A recent report on European environment, health and quality of life (EEA 2010) highlights that the environment plays a crucial role in people's physical, mental and social wellbeing. Environmental degradation, through air pollution, noise, chemicals, poor quality water and loss of natural areas, combined with lifestyle changes, may be contributing to substantial increases in rates of obesity, diabetes, diseases of the cardiovascular and nervous systems and cancer — all of which are major public health problems for Europe's population (EEA 2010). Reproductive and mental health problems, which are also closely linked to environmental health, are also on the rise (EEA 2010). Specifically for children, asthma, allergies, and some types of cancer related to environmental pressures are becoming apparent (EEA 2010).

Understanding the differences in the social distribution of environmental quality can be helpful for policy, since specific population groups, such as those on low incomes, children, and the elderly, may be more vulnerable — mostly due to their health, economic and educational status, access to health care, and lifestyle factors that affect their adaptation and coping capacities (EEA 2010).

People like to live by the sea because of arguably a better quality of life through lifestyle change (EEA 2006). However, current land use and economic practices can expose coastal populations to threats such as coastal flooding and erosion (EEA 2006). These risks can severely compromise human wellbeing associated with coastal and marine ecosystems

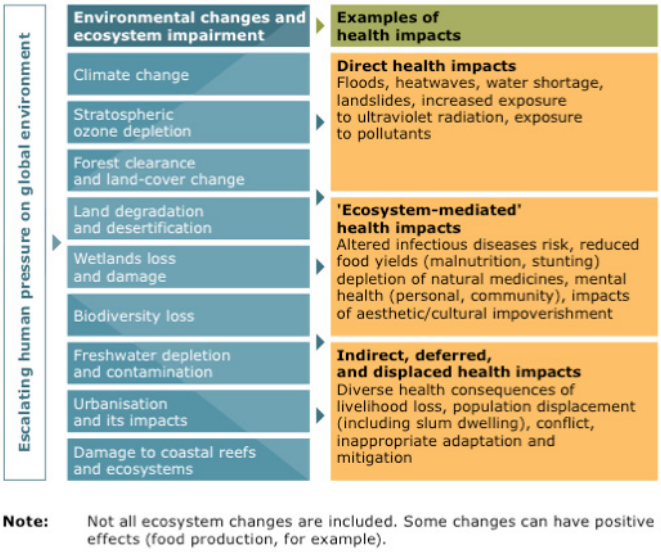

Figure 5.8 Harmful effects of ecosystem change on human health (MEA 2005).

5.4 Indices to explore the potential of MSs to achieve sustainable development

The above three examples highlight the various complexities and considerations that are associated with achieving the high level objectives of the MSFD. For this reason, ODEMM will go on to consider different approaches and information that can be used to assist in implementation of the MSFD including identifying major barriers to success. This includes identifying whether Regional Seas and associated Member States have the capacity to implement marine management strategies that appropriately address sustainable development. One way of exploring this is through the use of indices that describe the capacity of Member States to implement sustainable development, and an approach that has explored including assessments of Europe's regional seas is described below.

The United Nations Environment Program (UNEP 2006) developed the Marine Activity Index (MAI) as a measure of marine activity intensity. It is based on industrial and recreational activities, such as fisheries, aquaculture, tourism, shipping, and non-renewable resources, occurring at the national level of coastal nations and is meant as a tool for setting priorities. It is not a monetary measure, rather a nation's activity level. The data compares activity levels in physical units (quantities, not prices) for each individual marine activity across coastal nations. This comparison is valuable for gauging relative levels of economic activity by marine industrial sectors amongst coastal nations. However, this index cannot be used to compare the combinations of marine activities occurring in each nation and across coastal nations. Further, the index can only provide a very crude understanding of activity levels for regional aggregates of all or portions of nations that are included in LMEs and Regional Seas (UNEP 2006).

The MAI physical value has no dimension and is not measured in specific units of any kind. UNEP (2006) has ranked each marine activity by each nation's activity level relative to all others on a worldwide basis. Decision makers must make assumptions about the weights that each activity is to be accorded when compiling an aggregate MAI from its individual activities (UNEP 2006). Further assumptions must be made to combine each nation's MAI with others' from the relevant region to produce a regional MAI (UNEP 2006). The indices can be combined in a variety of ways into one or more aggregate indices by assigning weights to each individual index and then summing them across weighted index values.

The MAI can be used in conjunction with two other indices: The Human Development Index (HDI) and the Socioeconomic Index (SEI). The HDI for each nation reported in the United Nations Development Program's Human Development Project measures a nation's socioeconomic development (UNEP 2006). It is based on three key indicators:

1. Life expectancy (at birth);
2. Education (adult literacy rate and combined gross enrolment ratio for primary, secondary and tertiary schools); and
3. GDP per capita (purchasing power parity in US dollars).

The SEI can be used as an indicator of the potential for regions to undertake self-financing management. The MAI is compared to the Human Development Index (HDI) (developed by the United Nations Development Program (UNDP) and the comparison between MAI and HDI identifies regions that may be capable of achieving sustainable development of their regional marine environment without financial aid and those that are less likely to do so (UNEP 2006). Together, these indices provide an overview of the socioeconomic dimension of different regional seas (UNEP 2006). Typically, regions with high levels of marine industry activities demand high levels of management attention to address issues related to resource depletion, environmental degradation, and multiple use conflicts (UNEP 2006) (Table 5.6). These indices at the regional sea level must be treated with a level of caution due to the heterogeneity of Member States, based on economic development and marine activity.

Table 5.6 The range of values for the Marine Activity Index (MAI) and the Social Economic Index (SEI) (UNEP 2006).

	High	Medium	Low
MAI	≥ 20	5 ≤ and <20	< 5
SEI	≥ 80	50 ≤ and <80	< 50

Indices are also available for specific marine sectors, including: Fisheries, Aquaculture, Tourism, Shipping, Shipbuilding and Oil Production. These indices are calculated from a range of values (Table 5.7). Some of these indices are dependent on a clean marine environment such as Fisheries, Aquaculture and Tourism, whilst others do not depend on a clean marine environment and could be contributors to environmental degradation (UNEP 2006). The weighting of these indices can be adjusted based on different economic or ecological criteria using the equations suggested by UNEP (2006).

A brief description for each regional sea's ability to be self-financing to implement sustainable strategies is presented below (Table 5.8). The indices provided for each country and regional sea need to be treated with caution, specifically where there is limited information on marine sector activities and economic data from EU member states (further details on the methodlogy of the indices can be found in UNEP 2006).

Baltic Sea

The Baltic Sea indicies reveal low marine industry activity and high socioeconomic development (Table 5.8). These values imply that Member States within the Baltic Sea region have the ability to undergo self-financing to implement sustainable marine strategies to ensure GES.

North East Atlantic

The indices for the NE Atlantic indicate that there is a high level of socioeconomic development, and overall, medium intensity of marine industry activities. These values imply that Member States within the NE Atlantic region have the ability to undergo self-financing to implement sustainable marine strategies to ensure GES.

Mediterranean Sea

Index values of the Mediterranean Sea indicate that there is a high level of socioeconomic development, and overall, medium intensity of marine industry activities. Although the lower SEI figure reflects that Member States in the Mediterranean Regional Sea have the potential to undertake self-financing for implementing sustainable marine management strategies, there will be governance and implementation problems associated with there being high numbers of non-Member States (who are not obliged to implement the MSFD) who also border the Mediterranean.

Black Sea

The Black Sea indices describe high levels of socioeconomic development, and overall, medium intensity of marine industry activities. Although the Black Sea SEI figure is medium, indicating Member States would need to undertake some self-financing for implementing sustainable marine management strategies, the low MAI suggests there could be governance and implementation problems associated with non-Member States who also border the Black Sea.

In considering implementation of the MSFD and in particular, barriers to achieving GES, it will be interesting to examine whether the indices described here reflect the differences in potential to achieve sustainable developemnt amongst EU member states. This is something that will be considered further in ODEMM's future work.

Table 5.7 Marine Industry Indicators and Data Sources for the marine sectors of Fisheries, Aquaculture, Tourism, Shipping, Shipbuilding and Oil Production (non-renewable energy) (UNEP 2006).

Indicator	Unit	Year	Data Source
Human Development Index (HDI)	Dimensionless	2002	Human Development Report 2004 (UNDP 2004)
Fishery landings	Metric Tons	2003	Fisheries Global Information System 2003 (FAO 2005)
Aquaculture production	Metric Tons	2003	Fisheries Global Information System 2003 (FAO 2005)
International tourism number of arrivals	Number of visitors	2004	World development indicators 2004 (World Bank)
Shipbuilding order book*	Gross Tonnage (GT)	2nd quarter 2004	Shipping Statistics Year Book 2004 (ISL 2004)
Shipping cargo traffic**	Metric Tons	2002	Shipping Statistics Yearbook (ISL 2004)
Merchant fleet***	Deadweight Tons (DWT)	Jan 1 2004	Shipping Statistics Yearbook (ISL 2004)
Offshore oil production****	Average barrel/day	2004	Oil and Gas Journal Databook 2004 (OGI 2004) US Department of the Interior (2005)
Offshore rig count	Number	Dec 2003	Oil and Gas Journal Databook 2004 (OGI 2004)

* Ships of 100GT and over.

** Units for a small fraction of ports are in freight tons, revenue tons, or harbor tons (see ISL 2004).

*** By nation of domicile; ships of 1000 GT and over.

**** Data for some countries are partial due to (1) missing data for some offshore fields and (2) lack of separate statistics for offshore (vs. onshore) production.

Table 5.8 The human development (HDI), marine activity (MAI), socio-economic (SEI) and marine industry indices for EU Member States (UNEP 2006). Note that some member states are represented in more than one region. HDI is represented at the national level, whilst all other indicies are representative for each regional sea.

Regional Sea	Country	HDI	MAI	SEI	Fisheries and Aquaculture	Tourism	Shipping and Oil
Baltic Sea	Denmark	0.932					
	Estonia	0.853					
	Finland	0.935					
	Latvia	0.823	3.468	90.324	12.271	12.271	15.642
	Lithuania	0.842					
	Poland	0.850					
	Sweden	0.946					
NE Atlantic	Belgium	0.942					
	France	0.932					
	Germany	0.925					
	Ireland	0.936					
	Netherlands	0.942	12.831	94.021	7.957	12.271	14.642
	Norway	0.956					
	Portugal	0.897					
	Spain	0.922					
	UK	0.963					
Meditteranean Sea	Croatia	0.830					
	Cyprus	0.833					
	Greece	0.902					
	Italy	0.920					
	Malta	0.875					
	Israel	0.908					
	Algeria	0.704	8.413	83.262	1.087	27.192	4.595
	Egypt	0.653					
	Lebanon	0.758					
	Libya	0.794					
	Morocco	0.620					
	Syria	0.710					
	Tunisia	0.745					
Black Sea	Bulgaria	0.796					
	Romania	0.778					
	Turkey	0.751	2.865	77.323	2.859	7.941	1.176
	Ukraine	0.777					
	Georgia	0.739					

5.5 Summary and Complexities to Consider in Future ODEMM Research

There is little of the European marine seascape that has been untouched by humans. Due to this it is important to consider and understand how society through sectoral activities, its economic and cultural characteristics, and its political and legal obligations, interacts, influences and creates complexities in our ability to achieve GES for any one of the MSFD descriptors in all European regional seas. The relationships between all these components will vary for each MSFD descriptor, and must be understood and explored in order to meet the Maritime Policy objective, "*exploiting the full economic potential of Europe's oceans and seas is done in a sustainable manner*".

The exploration of socio-cultural, economic and sector component complexities for MSFD descriptors also addresses the overarching Three Dimension concept of sustainable development, a key requirement in a number of global directives. By building sustainable development principles into ODEMM's operational framework, it will ensure that the approaches developed by the project are addressing the ability of Europe to meet global directives in its regional seas, including: Convention on Biological Diversity (CBD) (UN 1992), Agenda 21 (UN 1993), World Summit on Sustainable Development (UN 2002), Convention on the Law of the Sea (UN 1982), and Jakarta Mandate on the Conservation and Sustainable Use of Marine and Coastal Biodiversity to the CBD (UN 1995).

The numerous relationships and multi-faceted linkages illustrated in this Chapter reveal that there are no straight-forward solutions or methods in achieving GES for any one descriptor. The examples explored highlighted the following issues:

- The duality of some descriptors also being a pressure and that management measures applied to achieve GES for pressure descriptors could therefore result in improvements against other environmental objectives.
- One sector can cause multiple pressures or multiple sectors can cause the same pressure and sectors can themselves be affected by one or more pressures. Individual sectors can also cause external impacts for other sectors on various temporal and spatial scales.
- Status of any one GES Descriptor can potentially influence the status of others. For example, failure to achieve GES for non-indigenous species could also result in failure to achieve GES for Biodiversity or Food webs.
- Conflicts can arise between international conventions, regional and national policies. There is therefore a clear need to include the political and legal context (e.g. other major directives and the management of these under different directorates) in considering barriers to achieving GES. This means ODEMM's linkage framework must be further developed as the project goes forward.
- That sustainable development also requires social and economic growth and that the growth in human use of resources related to this, will conflict with the environmental objectives set by the MSFD in many different ways (e.g. the conflict illustrated in the example on seafloor integrity and the renewable energy sector).
- Some EU member states and non-member states are represented in more than one regional sea (Table 5.9). This can create an overlap in ecological, economic andsocio-cultural information, and creates political and transboundary complexities. Additionally, pressure/s exerted from a Member State may vary between its associated regional seas. For example, a pressure created by a sector in the French NE Atlantic may differ to a pressure created in the French Mediterranean Sea.

Table 5.9 Member and non-member EU states with coastlines represented along more than one European Regional Sea.

Country	Regional Seas	
Germany	NE Atlantic	Baltic Sea
Spain	NE Atlantic	Mediterranean Sea
France	NE Atlantic	Mediterranean Sea
Turkey	Black Sea	Mediterranean Sea
Denmark	NE Atlantic	Baltic Sea

Future ODEMM research, through the use of case studies, will explore these complexities in a bid to understand how the relationships between the different components will influence the attainment of GES for any one descriptor in each European Regional Sea (see WPs 4-8 described at www.liv.ac.uk/odemm).

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Sustainability of Europe's Regional Seas: A Review of MSFD-relevant information

Introduction

The Marine Strategy Framework Directive (Council Directive 2008/56/EC; MSFD herein) and Commission Decision (2010/477/EU) outlined several components of the MSFD including:

- A list of Descriptors that should be described in terms of Good Environmental Status (Annex I, 2008/56/EC);
- The (ecological) characteristics, pressures and impacts that contribute to the assessment of Good Environmental Status (Annex III, 2008/56/EC); and
- The criteria and indicator(s) of ecological characteristic status (Part B, 2010/477/EU).

The combination of these documents and annexes provided guidance of how to evaluate each of the 11 GES descriptors. As part of the Initial Assessment process, (1) the status of those ecological characteristics, and (2) pressures and (3) impacts of human activities relevant to each descriptor should be described by each Member State by 2012. Here, we provide a review of the status and trends information currently available for the four Regional Sea areas under existing legislative frameworks, monitoring or research programmes. Further, the results of a pressure assessment approach identifying the mechanisms through which human activities affect the marine environment are presented for each regional sea.

The information presented has been compiled from an extensive literature review undertaken by a panel of experts from each Regional Sea and includes information from both the primary (peer-reviewed journal articles) and grey (e.g. Regional Advisory Councils (RAC), National Governments) literature. A database of the source information is available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/data). The information has been collated on a Regional Sea basis, with a separate Annex dedicated to each Region. Information has been collated on an individual descriptor basis and descriptions of status and trends of an ecological characteristic and/or pressure assessment outcomes are presented. The information has been specifically tailored for its specific relevance to each descriptor. For example, under the GES Descriptor 1: Biodiversity of Fish (1), information was included describing both commercially-exploited and non-commercial fish species, whereas under the GES Descriptor 3: Commercial Fish and Shellfish, this information was truncated to include only commercial fish species and non-commercial fish species were excluded from the review (see a summary of the relevant information for each Descriptor in Table 1).

Where status and trends information on ecological characteristics does not provide the necessary information to evaluate a GES descriptor (e.g. cases where pressure and impact information is required), a pressure assessment approach was used (Robinson and Knights, 2011). This methodology evaluates the mechanisms through which a human activity (pressure) affects the ecosystem, rather than direct evaluation of the ecological characteristic itself. For example, bottom-trawling fishing results in several pressures, such as physical disturbance through abrasion, species extraction, and loss of substrate. If the generic effects of those pressures are understood coupled with a broad understanding of the distribution of the habitat(s)/species impacted by this activity and the extent and frequency of the activity, the 'severity' of the activity can be described. Pressure severity is a function of the ability of the habitat and its species to recover (resilience), the persistence of the pressure post-activity cessation and the degree of impact of the pressure on the habitat and its species. Pressure is presented as pre-defined combinations of pressure severity, extent and frequency that ODEMM has considered as 'High threat' combinations. The criteria for High threat combinations are shown in the relevant GES descriptor tables and further details of the pressure assessment approach is available from the ODEMM website (www.liv.ac.uk/odemm/outputs/guidance documents).

The pressure assessment approach has been used to provide information for either all or part of the following Descriptors, although may also be used to evaluate Descriptors 8 and 9:

- Descriptor 2: Introduction of Non-indigenous species and translocations
- Descriptor 5: Eutrophication
- Descriptor 6: Seafloor Integrity
- Descriptor 7: Hydrographic conditions
- Descriptor 10: Marine Litter
- Descriptor 11: Introduction of Energy (Underwater noise)

Table 1. Ecological characteristics, criteria and indicators used to evaluate GES for each descriptor.

GES Descriptor	Ecological Characteristic, Criteria and Indicator Selection
Biodiversity	The ecological characteristics and criteria used to evaluate GES of Biodiversity were described in Annex I and III of Directive 2008/56/EC and further expanded upon in the Commission Decision on the "criteria and methodological standards on good environmental status of marine waters" (2010). Suggested characteristics include: Physical and chemical features (5), habitat types (3), biological features (7) and other features (2) (see Annex III, Table 1 for further details of characteristics). Criteria were described on a Descriptor-by-Descriptor basis e.g. Descriptor 2: Non-indigenous species criteria include: Abundance and state characterisation of non-indigenous species, in particular, invasives (2.1), and Environmental impacts of invasive non-indigenous species (2.2) (See Part B of the Commission Decision (2010/477/EC) for further details on all descriptors).
Non-indigenous species introduced by man	GES for Non-indigenous species (NIS) is a function of their relative abundances and distribution ranges, and environmental impact. Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere and have an adverse effect on environmental quality and are of most concern in terms of posing a risk to GES. NIS species included in the tables are those that are established (defined as reproducing within the assessment area) and grouped by broad type e.g. Pelagic/plankton species, Bottom fauna and flora, invasive fish species. Supporting evidence of clear impacts on native species is also presented.
Commercial fish and shellfish	The ecological characteristics and criteria used to evaluate GES of Commercial fish and shellfish were described in Annex I and III of Directive 2008/56/EC and further expanded upon in the Commission Decision on the "criteria and methodological standards on good environmental status of marine waters" (2010). There are three recommended criteria: Level of pressure of fishing activity (e.g. fishing mortality) (3.1), Reproductive capacity of the stock (e.g. spawning stock biomass) (3.2), and Population age and size distribution (e.g. proportion of large fish) (3.3).
Food webs	Annex I of Directive 2008/56/EC does not describe the ecological characteristics used to evaluate GES of food webs, but further guidance was provided in the Commission Decision (2010). Suggested indicators include: productivity of key species or trophic groups including predators (e.g. mammals, seabirds and fish), abundance of functionally important groups/species such as primary producers (e.g. plankton) and population structure of large fish (i.e. large fish indicator).
Eutrophication	The assessment of eutrophication in marine waters needs to take into account the assessment for coastal and transitional waters under Directive 2000/60/EC (Annex V, 1.2.3 and 1.2.4) and related guidance (European Commission, 2009). The assessment needs to combine information on nutrient levels and on a range of those primary effects and of secondary effects which are ecologically relevant taking into account relevant temporal scales. The Commission Decision guidance (2010) identified nutrient concentrations (ambient and enhanced) and direct and indirect effects (e.g. Chl-*a* or opportunistic algae) as relevant indicators of GES for Eutrophication. Information may be in the form of status and/or trends data, but may also include qualitative evidence of impacts of elevated nutrient levels such as fish kills or dissolved oxygen depletion.
Seafloor Integrity	Seafloor integrity is assessed using EUNIS 2 level predominant habitat types only. The assessment is based on the outcomes of the ODEMM pressure assessment and status/trends information where available. Seafloor integrity is assessed in terms of the extent of damage caused by the various human activities that interact with it. This is done indirectly through a pressure assessment, but information from state indicators on aspects of benthic community condition may also be referred to (e.g. presence of particularly sensitive, tolerant or opportunistic species) (see COM decision paper for a full list).
Hydrographic Conditions	Adverse effects of permanent alterations on hydrographical conditions is assessed for EUNIS 2 predominant habitat types only. The assessment is based on the ODEMM pressure assessment and any other information on status/trends at this habitat level. Risk of failure to achieve GES is assessed based on (i) the extent and distribution of the various human activities with pressures that permanently alter hydrographical conditions in the regional sea area, and (ii) the severity of the effects where alterations occur. This is done indirectly through a pressure assessment, but information from state indicators on aspects of habitat functions may also be referred to. State indicators include status and trend information describing temperature, salinity, pH, pCO_2, nutrients and oxygen.

Contaminants	Assessment of whether concentrations of contaminants are at levels not giving rise to pollution effects are based on monitoring programmes for chemical contaminants, and on biological measurements relating to the effects of pollutants on marine organisms in each of the assessment regions. A number of contaminants in the marine environment give rise to concern, both from an environmental and public health point of view. Regulatory levels have been laid down for lead (Pb), cadmium (Cd), mercury (Hg), polycyclic aromatic hydrocarbons (PAH), dioxins & dioxin-like polychloride-benzene (PCB) and radionuclides. Other substances of concern are arsenic, non-dioxin like PCBs, phthalates, organochlorine pesticides, organotin compounds, brominated flame retardants and polyfluorinated compounds (PFC).
Contaminants in Fish and Shellfish	As per contaminants. Biota used in assessment include mussels, fish and seabirds.
Marine Litter	Several ecological characteristics can be used to evaluate impacts of marine litter within the marine environment. Marine mammals and seabirds are commonly used to evaluate levels of marine litter as measured by the amount and composition of ingested material e.g. microplastics. Marine litter can result in injury or death to several components but the broad-scale impacts of marine litter on marine species is largely unknown. In the absence of empirical data describing marine litter impacts, the ODEMM pressure assessment is used to evaluate the sources of marine litter (i.e. activities) and encounter rate with ecological components. Therein, the impact of marine litter based on extent and frequency of introduction may be inferred.
Introduction of Energy (incl. Underwater Noise)	There is little information describing the impacts of underwater noise on the marine ecosystem, but noise may have deleterious impacts on several ecological characteristics including fish, marine mammals and seabirds. Indicators for environmental status have been developed based on pressures addressing the distribution in time and place of loud, low and mid frequency impulsive sound that is mainly introduced by offshore construction using pile driving (e.g. for offshore wind farms), seismic surveys and shipping.

Table Contents and Layout

The tables provide a review of the easily accessible information available to each Regional Sea or Member State as found, to date, and represent a summary of the current state of knowledge regarding the MSFD descriptors. Care should be taken in interpretation of this information. There are some difficulties in applying existing status assessments to the objectives of the MSFD (see Chapter 2 for further discussion) and the threshold (target levels) used in those assessments should be carefully considered when relating this information to GES under the MSFD.

ODEMM has developed its own approach to interpret this information using a risk assessment approach and the outcome of the risk assessment is presented at the start of the section on each GES descriptor (see details in Chapter 3 and Breen *et al*. In prep). The level of risk was defined using existing status, trend and pressure assessment outcomes measured against pre-defined criteria, which describe each of three risk categories (i.e. High, Medium or Low). A working definition of GES was developed for each descriptor and risk criteria defined based on this definition (see Annex 5). In the regional annexes following, the definition of GES is presented for each descriptor and shown in italics before each summary information table

Information is presented in a standardised way for all Regional Seas. Each Regional Sea Annex includes a description of the Regional Sea in terms of its habitats and broad ecology. This is followed by a short description of information types available for each assessment and a summary breakdown of this information by each GES descriptor. The GES descriptor tables present relevant status, trends or pressure assessment outcomes. Where information on status and trends of ecological characteristics is used, the source of information used to describe each ecological characteristic is shown as well as the criteria used to evaluate each indicator (e.g. population size of seabirds) (see a description of the types of information presented as status and trends in Table 2). Definitions of the assessment criteria used to assign status to an ecological characteristic are presented in the associated Status and Trends database (www.liv.ac.uk/odemm/outputs/data). Pressure assessment outcomes are either described in text following the status/trends information, or presented in a table (e.g. see a description in Table 3). Pressure assessment tables describe the proportion of sector-pressure-ecological characteristic (SPEC) combinations in each category and are presented in relation to the predominant habitat type where the combination is occurring and followed by identification of high threat combinations (the criteria used to define 'high threat' is described in Annex V after Breen et al. in prep). A detailed description of the pressure assessment methodology is available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/guidance documents).

Table 2. Description of the information included where status and trends of ecological characteristics are relevant for a GES Descriptor. The headers used in this table relate to the headers used in the status and trends tables for GES Descriptors.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Ecological characteristics are grouped by broad type e.g. Fish, Marine mammals and reptiles. Additional information includes taxonomic information, and the number of habitats, species or assemblages reported in terms of status or trend, the total number of which is shown in brackets.	Indicates if status assessment information is available. The number of habitats, species or assemblages assessed is shown in brackets.	The status categories used to assess habitats and species are shown. Categories may be specific to a Member State, Regional Advisory Council or Sea and the criteria used to describe status are described in further detail in the ODEMM Status and Trends database (see www.liv.ac.uk/odemm/outputs/data). Status assessment may be undertaken by several reporting bodies and use multiple criteria to evaluate each characteristic and indicator e.g. Marine mammals (striped dolphin) may be assessed in terms of population size and range of habitat. The proportion of assessments in each status category is shown; however, these values do not necessarily correlate to the number of species or habitats falling within that category. Where applicable, notable status assessment outcomes are shown e.g. a species in unfavourable condition under its respective legislation.	Indicates if trends information is available. The number of habitats, species or assemblages assessed is shown in brackets.	The trend categories and proportion of trend assessments within each category are shown. As per the status assessment, multiple criteria per indicator may be described in terms of trend e.g. striped dolphin population size is decreasing, but range is increasing. Notable examples are shown in further detail.	The source(s) used to describe the status and/or trend information is shown. The criteria used to evaluate either the status and/or trend information is shown.

Table 3. Description of the information included in the pressure assessment outcomes table as used to evaluate Descriptor 6: Seafloor integrity. The headers used in this table relate to the headers used in the pressure assessment tables for Descriptor 6. Definitions of pressure assessment categories are presented in Robinson and Knights (2011) (www.liv.ac.uk/odemm/outputs/guidancedocuments).

Pressure Assessment Summary	Extent of Overlap	Frequency of Occurrence	Degree of Impact	Resilience (Recovery Time)	Persistence of Pressure
A description of the potential number of sector-pressure-ecological characteristic (SPEC) combinations and the actual number of combinations where overlap between the pressure and ecological characteristic occurs **e.g. 486 Pressure Combinations (actual) of the 1056 (potential) evaluated** The number of sectors operating in the regional sea and the number of pressures generated by those activities are described (see Koss et al. (2011) for a full list of sectors and pressures; www.liv.ac.uk/odemm/outputs/guidancedocuments) **e.g. Sectors – 18; Pressure Types – 21**	The proportion of each SPEC combination by class in terms of extent of overlap between the pressure and ecological characteristic **e.g.** **Widespread Patchy (34%)** **Locally Even (1%)** **Locally Patchy (34%)** **Site (31%)**	The proportion of each SPEC combination by class in terms of frequency of occurrence of the overlap **e.g.** **Persistent (38%)** **Common (16%)** **Occasional (21%)** **Rare (25%)**	The proportion of each SPEC combination by class in terms of Degree of Impact of the pressure **e.g.** **Acute (26%)** **Chronic (56%)** **Low (18%)**	A summary of the range of resilience categories of the predominant habitat types and specific values for each habitat type **e.g.** **Moderate to High**	The proportion of each SPEC combination in terms of persistence following cessation of the activity causing the pressure. **e.g.** **Continuous (14%)** **High (15%)** **Moderate (23%)** **Low (48%)**

Annex I

The Baltic Sea

Introduction

The status of habitats and species occurring throughout the Baltic Sea is generally well described. As a heavily exploited resource, the Baltic Sea supports 18 of the 20 sectors identified within the ODEMM project, each of which contributes to the current status of its ecological components throughout the region (see Koss et al. (www.liv.ac.uk/odemm/outputs/guidancedocuments) for a description of sectors). Sectors not present on the region are water desalination and carbon sequestration.

The Baltic Sea is a brackish shallow sea of approximately 377,000km^2. Average water depth is 55 m, although in small areas can reach over 450 m. Bounded by the Scandinavian Peninsula, the mainland of Europe and the Danish Islands, the Baltic Sea is connected to the Atlantic Ocean only via the small entrances of the Sound and the Belt Sea (Figure 1). Water exchange is extremely limited and can remain in the Baltic for up to 30 yr prior to exchange resulting in a highly eutrophic marine environment with substantial areas of oxygen depletion throughout.

The Baltic Sea is surrounded by Norway, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland and Germany, of which eight are EU Member States. The Baltic Sea region hosts one-fifth of the EU's population, but has a lower population density than the EU as a whole (EU 2010). The recent Communication Concerning the European Union Strategy for the Baltic Sea Region (EU 2010) highlighted current challenges for the region, two of which are: enabling a sustainable environment, and enhancing the region's prosperity. These two challenges are in juxtapose, as increasing economic gains could come at a cost to the Baltic Sea's marine environment.

It is currently evident in the Baltic Sea region that human activities, associated with economic gains, are causing widespread pressures to marine ecosystems. For example, excess nutrients entering the marine environment, from land based industry and agriculture, is causing eutrophication and algal blooms (EU 2010). Overfishing, land-based pollution, rising sea temperatures, the presence of hazardous compounds and adapting to climate change are causing widespread impacts to leisure activities and small-scale commercial use across the region (EU 2010).

However, the Baltic Sea region has experienced economic prosperity, and the highest GDP growth in the EU, since the late 1990's (EU 2010). It is important to note that there are large disparities within the Baltic Sea Region with a clear east/west divide, with the west being more prosperous than the east (EU 2010). Much of the west Baltic Sea region's prosperity is due to increased labour productivity and innovation. This prosperity was destabilised during the

recent global financial crisis (EU 2010). It is hoped through future economic stabilisation and regional support for development, that the Baltic Sea region will regain high GDP growth (EU 2010).

The Baltic Regional Sea east/west divide poses socio-political and economic issues of which the Strategy for the Baltic Sea Region seeks to address. This strategy is an attempt to bridge the divide by addressing environmental, economic, social and cultural issues and create more effective co-ordination of activities. This strategy proposes that with better intra-regional communication, that other directives and policies, such as the MSFD, will be adequately addressed.

Availability of Information: Regional Summary

The Baltic Sea Member States are well placed to undertake their Initial Assessment obligations (Article 8, Directive 2008/56/EC) in which they must assess the current environmental status of the Baltic Sea waters and the environmental impact of human activities by 2020. The Helsinki Commission (HELCOM) leads a coordinated effort of systematic and standardised collection of environmental data from each Member State and Research Institutes in the Baltic Sea region (www.helsinki.fi). Information is available for all ecological characteristics outlined in the MSFD (Annex III, Table 1, Directive 2008/56/EC) and a summary of this information is presented below (more detailed descriptions of this data are available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/data).

For those descriptors requiring a pressure assessment approach to evaluate GES, additional information is needed that describes the extent and frequency of the pressures from specific sectors and their impacts on ecological characteristic(s) (e.g. Marine Litter and Underwater Noise pressure and impact effects on ecological characteristics). Much of the information required to undertake a pressure assessment is widely available for the Baltic Sea region; for example, detailed maps of the spatial distribution of marine sectors (e.g. aquaculture facilities) can be downloaded from the HELCOM website in a geo-referenced format. The frequency and impact of specific pressures and the resilience of habitats and species characteristic of the region is also well documented in published literature (i.e. journal articles). Where information was unavailable, expert judgement by ODEMM partners in the Regional Sea and wider European partnership was used to evaluate the frequency and impact of pressures and habitat/species resilience and drew on published literature from surrounding regions.

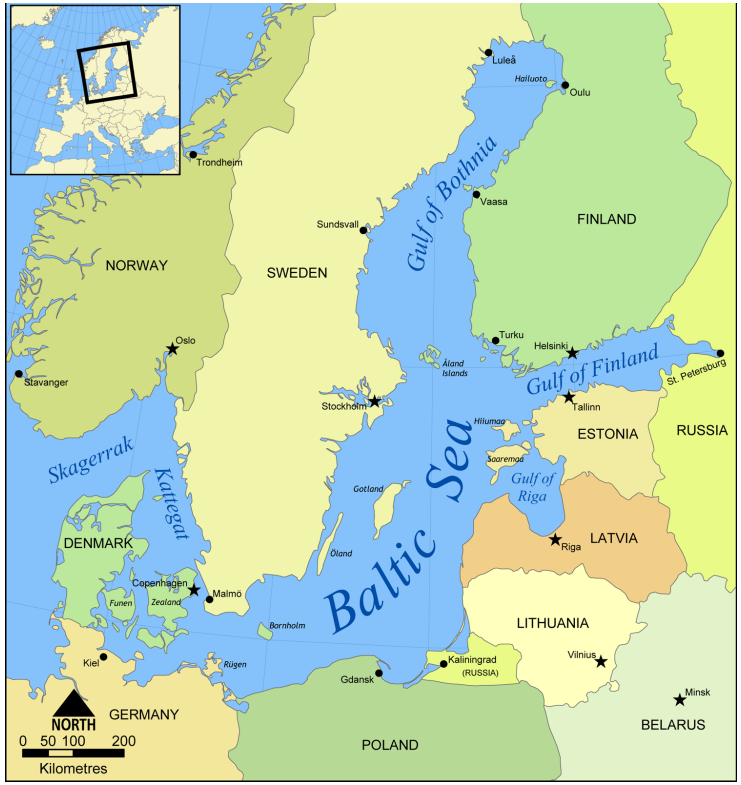


Figure 1. The Baltic Sea and surrounding countries. Shown are EU Member States and non-Member States and sub-regional sea areas. Map (Wikipedia, 2010).

Problem Areas and Likelihood of Failure to Achieve GES

Areas of concern and the likelihood of failure to achieve GES for each descriptor in the Baltic Sea were identified (Table 4). Of the 16 ecological characteristics listed in Annex III of the MSFD as recommended for assessment, 50% of those are currently considered either in poor or threatened status using a combination of assessment criteria under the Habitats Directive (HD), Water Framework Directive (WFD), HELCOM and ICES guidance. Not all species or habitats within each characteristic type are in poor or threatened status, nor do all indicators available for a given species or habitat indicate poor/inadequate status (see more detailed regional descriptions for download from www.liv.ac.uk/odemm/outputs/data). However, problems were identified for all GES Descriptors (Table 4) stemming from the contribution of poor or threatened ecological characteristic(s) to multiple GES descriptors (e.g. marine mammals contribute to the assessment of GES descriptors: Biodiversity, Food webs and Habitat Directive species).

Available status information indicated that several ecological characteristics are currently threatened. These include: nutrients and oxygen content in the near-bottom layers, predominant and listed habitats, fish (listed and commercial species), bottom flora and fauna, plankton, marine mammals and seabirds. Status information was unavailable for temperature, salinity, non-indigenous invasive species, and pH/pCO2 but these could at least be described using trend information where available. Topography/bathymetry is the only component that cannot be described using status and/or trend information.

Where status and trend information was not appropriate to evaluate a GES descriptor, a pressure assessment was used. Following the approach and criteria developed within ODEMM, several threats to the environment arising from human activities were identified. Those sectors which were considered as contributing pressures that could be detrimental to the marine environment (ecological characteristic(s) or achievement of GES) included Agriculture, Coastal Infrastructure, Fishing, Shipping and Waste water treatment. Assessment of the contribution of each sector to current status or the highest threat to the marine environment and its components will be evaluated in later ODEMM work packages.

A large fishing fleet in the Baltic Sea (Photo: Reuters)

Table 4. A Summary of Areas of Concern, Risks to GES, and Confidence in Risk Assessment of GES Descriptors in the Baltic Sea. Each GES Descriptor is described by one or more components: ecological characteristics, pressure and/or impacts information (see Chapter 2). The components used to evaluate each descriptor are shown in more detail in the following summary tables and outline the availability of information and criteria used to assess current status and trends of components in each Regional Sea. * indicates a pressure assessment approach was used, either in part or in its entirety, to evaluate the descriptor. Risk assessment criteria and confidence assessment definitions are described in Chapter 3 and Annex 5 of this report.

GES Descriptor	Problems	Areas of Concern	Risks to GES	Risk Confidence
1a. Plankton	Yes	Increased dinoflagellate and cyanobacteria blooms, increases in Chl-a (a proxy for phytoplankton)	Moderate	Moderate
1b. Fish	Yes	Some commercial species outside safe biological limits (high fishing mortality) with declining commercial catches, but no species is likely to become extinct in the next 10 years. Several Habitats Directive listed species of fish are currently in unfavourable condition.	Moderate	High
1c. Marine Mammals	Yes	The status of marine mammal species is variable within the Baltic Sea region; in some sub-regional areas species are at or below the Limit Reference Level (LRL) or Safe Biological Limit. For example, the Harbour porpoise is listed as critically endangered by the IUCN and facing a high risk of extinction in some areas and of least concern in other areas.	Moderate	High
1d. Seabirds	Yes	Stellar's Eider is a vulnerable species (IUCN Redlist) and several other species are in decline in terms of population (breeding) size	Moderate	High
1e. Predominant Habitats	Yes	The highly eutrophic conditions commonly occurring threaten many of the predominant habitats to the extent that dominance of habitat types has shifted or specific habitats are at risk of being lost in the next 10 years	High	High
2. Non-indigenous species (NIS)*	Yes	There are several invasive species in the Baltic Sea that are increasing in abundance and rapidly expanding their range.	High	High
3. Commercial fish and shellfish	Yes	Several species are currently in poor condition and outside safe biological limits (e.g. cod and salmon)	High	Moderate-High
4. Food webs	Yes	Alterations in the dominance of plankton species and declines in the distribution and population size of several top predators	High	High
5. Eutrophication*	Yes	Widespread eutrophication throughout the region resulting in high-biomass algal blooms, oxygen deficits and mortality events	High	High
6. Seafloor Integrity*	Yes	Human activities such as agriculture, fishing, coastal infrastructure, shipping and waste water treatment contribute widespread and persistent pressures that have detrimental effects on several aspects of the Baltic Sea ecosystem	High	Moderate
7. Hydrographic conditions*	Yes	Widespread increases in Sea surface/bottom temperatures (SST/SBT) coupled with increasing acidification (pH) and oxygen deficiencies	Not assessed	Not assessed
8. Contaminants	Yes	The concentration of some metals (e.g. Mercury and Cadmium) has increased but are restricted to localised areas	Moderate-High	High
9. Fish and Shellfish Contamination	Yes	The concentration of metals in bivalve mollusc, fish and seabird species has increased, but vary among sub-regions	Moderate	Moderate-High
10. Marine Litter*	Yes	The concentration of microplastic has increased throughout the region. In some regions, over 12,000kg/yr/500m of beach has been removed	High	Moderate
11. Energy (Underwater noise)*	Yes	Trends indicate an increase in shipping and renewable energy activities leading to increased underwater noise throughout the region	Moderate-High	Moderate
12a. Habitats Directive Habitats	Yes	81% of the habitats listed are currently in unfavourable condition for at least one criterion	High	High
12b. Habitats Directive Species	Yes	50% of the species listed are currently in unfavourable condition for at least one criterion	High	High

GES Descriptor 1: Biodiversity

Risk Assessment Outcome: Moderate to High

GES Definition: Good status is achieved when biodiversity is maintained in the regional sea such that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Loss of biodiversity can be described as occurring where there is a reduction in genetic, species, habitat or ecosystem diversity within the regional sea over this time scale. More specifically loss of particular meta-populations, species, habitat types or ecosystem properties within the region (e.g. extirpations) would certainly count as a loss of biodiversity, but so could a noticeable change in diversity based on changes in evenness (e.g. shifts in dominance). GES under Biodiversity should be assessed individually for each of the major ecosystem characteristics listed in Annex III of the MSFD as recommended in the COM decision.

Table 5. Status and trend information of ecological characteristics used to evaluate GES: Biodiversity. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Predominant Habitat	See Descriptor 6: Seafloor Integrity for a pressure assessment evaluation of each predominant habitat type.				

Listed Habitat (15)
 	
• 15 habitat are listed in the Article 17 report
• Habitat codes are: 1110, 1130, 1140, 1150, 1160, 1170, 1180, 1230, 1310, 1330, 1610, 1620, 1630, 1640, and 1650.
	Yes (15)	• Favourable (46%);
		• Unfavourable – inadequate (33%);
		• Unfavourable – bad (14%);
		• Unknown (8%)
		
		• Based on one-out, all-out of Habitats Directive, 81% of listed habitats in unfavourable condition
		
		• Favourable habitats are:
		  • Vegetated sea cliffs (1230)
		  • Boreal Baltic inlets and small islands (1620)
			Yes (11)	• Decrease (18%);
				• Stable (73%);
				• Increase (9%)
					Reports
					• Article 17 Reports (2007)
					
					Criteria
					• Area
					• Future prospects
					• Range
					• Structure and Function
					• Overall Assessment

Plankton (6) • Phytoplankton (dinoflagellate, diatom, Chl-*a*, cyanobacteria) • Zooplankton (*Pseudocalanus* and *Temora* abundance and biomass)	Yes (1)	• Poor (100%)	Yes (6)	• Increase (67%); • Decrease (33%)	**Reports** • HELCOM (2009) BSEP 115B • HELCOM (2010) BSEP 122 • ICES WGRED (2007) • Published literature **Criteria** • Spring bloom intensity • Concentration • Summer bloom frequency and intensity • Abundance • Biomass

Bottom fauna and flora (10) • 9 spp. and zoobenthos assemblage information • Species include *Mytilus* spp., *Fucus* spp., *Zostera* spp., *Chara* spp. and *Lamprothamnium* sp.	Yes (9)	• Moderate (22%); • Threatened/Declining (67%); • Poor/Bad (11%). • The benthic invertebrate community of the entire Baltic Proper was in a severely disturbed state between 2003-2007 • Status was good in the Bothnian Sea and Bothnian Bay during the same period (HELCOM 2010)	Yes (10)	• Fluctuating (9%); • Decrease (91%).	**Reports** • HELCOM (2007b) BSEP 113 • HELCOM (2009) BSEP 115B, 116B • HELCOM (2010) BSEP 125 **Criteria** • Distribution • Species richness • Diversity • Depth distribution
Fish (13) • 13 species reported using multiple assessment criteria and incl. commercial species.	Yes (12)	• Good (6%); • Poor (6%); • Stock exploited at MSY (6%); • Stock outside safe biological limits (19%); • Uncertain (6%); • Unknown (50%); • Unlikely (6%)*	Yes (7)	• Increase (27%); • Stable (18%); • Fluctuating (9%); • Decrease (45%).	**Reports** • ICES (2010) **Criteria** • Fishing Mortality (F) • CPUE • Catch • Smolt production capacity
Marine mammals (4) 4 species reported and evaluated by both population size and species distribution • Baltic harbour seal; • Harbour porpoise; • Baltic ringed seal; • Grey seal.	Yes (4)	<u>HELCOM Seal 4 and BSEP 113</u> • Critically Endangered (10%); • Least Concern (40%); • Near threatened (10%) • Above the LRL (10%) • At or slightly above the LRL (20%); • Below the LRL (10%). • The Harbour porpoise is critically endangered and the Baltic Ringed seal below the Limit Reference Level (LRL)[&].	Yes (4)	• Increase (10%); • Stable (50%); • Stable/Decrease (10%); • Fluctuating (10%); • Unknown (20%).	**Reports** • HELCOM (2007b) BSEP 113 • ICES Advice (2005) • HELCOM Seal 4 (2010) **Criteria** • Species distribution • Population size
Seabirds (9) 9 species are reported with all evaluated by population (breeding) size.	Yes (1)	• Vulnerable (100%) • Stellar's eider *Polysticta stelleri* is the only species assessed for status.	Yes (9)	• Increase (40%); • Stable (20%); • Decrease (40%).	**Reports** • HELCOM (2007b) BSEP 113 • HELCOM (2009) BSEP 116B **Criteria** • Population size • Breeding population size
Listed species (19) • 19 species listed in the Article 17 report and assessed using 5 criteria	Yes (19)	• Favourable (54%); • Unfavourable – inadequate (21%); • Unfavourable – bad (24%); • Unknown (1%) • 7 of the 19 species is in favourable conservation status (based on the one-out all-out approach)	Yes (11)	• Decrease (29%); • Increase (29%); • Stable (29%); • Fluctuating (5%); • Unknown (8%)	**Reports** • Article 17 Reporting (2007) **Criteria** • Abundance • Population size • Habitat • Range • Overall Assessment

*Unlikely status assessment refers to the likelihood of salmon reaching 75% PSPC in a given river. There are 4 Status categories: Very likely, Likely, Uncertain, and Unlikely where stock status is determined by the probability of it reaching 75% PSPC. Stocks are considered **very likely** to reach this objective when the probability is more than 90%; **likely** when the probability is between 70 and 90%; and **unlikely** when the probability is less than 30%. When the probability of reaching the objective is between 30 and 70%, it is considered **uncertain** if they will reach the objective in 2010.

[&]The Limit Reference Level (LRL) The Limit Reference Level (LRL) is the population size when the long-term persistence of the population is ensured, which also has been termed as "Safe Biological Level".

GES Descriptor 2: Non-indigenous species introduced by man

Risk Assessment Outcome: High

GES Definition: GES for Non-indigenous species (NIS) is a function of their relative abundances and distribution ranges, and environmental impact. Good status will be maintained when significant adverse effects on environmental quality from NIS are avoided, including no elimination or extinction of sensitive and/or rare populations, alteration of native communities, seasonal dominance of algal blooms, or alteration of water chemistry (oxygen, nutrient content, pH and transparency). Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere and have an adverse effect on environmental quality. Therefore, invasive NIS are of most concern in terms of posing a risk to GES.

This table lists the NIS species and its characteristic group as an adult. For example, the ctenophore *Mnemiopsis leidyi* (comb jelly) would be recorded as a *pelagic (incl. plankton)* characteristic, and the barnacle *Balanus* spp. recorded within the *bottom fauna and flora* category due to it spending its adult life as a sessile benthic species despite a planktonic developmental/juvenile life stage. Available Information on NIS is in the form of abundance or distribution data for each species.

Pressure Assessment: Major Pathways of Introduction

Three sectors were identified as vectors for the introduction of non-indigenous species in the Baltic Sea. These sectors and the mechanisms introducing such species include:

- Aquaculture - importation of culture species, secondary spread;
- Military - fouling and ballast water exchange;
- Shipping - fouling and ballast water exchange.

The most important and widespread impacts are habitat modification and competition for food and space with indigenous organisms. Widespread impacts were attributed to shipping and local impacts from Aquaculture and Military sectors. All predominant habitats within the Baltic Sea with the exception of the deep sea (representing a relatively small area in the Baltic Sea) are impacted by non-indigenous species. Notable examples of NIS introductions in the Baltic Sea include the comb jelly *Mnemiopsis leidyi* and polychaete *Marenzellaria* spp. These species can compete with and prey on native species, resulting in significant habitat modification and change benthic nutrient dynamics (Tsagarakis et al. 2010; Hietanen et al. 2007).

Table 6. Trend information of ecological characteristics used to evaluate GES: Non-indigenous species. The number of Non-indigenous species in each ecological characteristic type is shown in brackets.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Pelagic (incl. plankton) (3) • Arctic comb jelly *Mertensia ovum*; • American comb jelly *Mnemiopsis leidyi*; • Fishhook water flea *Cercopagis pengoi*	No	N/A	No formal trend assessment due to the recent occurrence of these NIS species within the Baltic Sea.	• Rapid expansion within the Baltic Sea (100%) in terms of distribution	**Report** • HELCOM (2007b) BSEP 113 **Criteria** • Distribution
Bottom fauna and flora (3) • Worm *Marenzellaria* spp.*;* • Barnacle *Balanus* spp.; • Bivalve *Dreissena polymorpha*.	No	N/A	No formal trend assessment due to the recent occurrence of these NIS species within the Baltic Sea.	• Rapid expansion within the Baltic Sea (100%) in both abundance and distribution	**Report** • HELCOM (2007b) BSEP 113 **Criteria** • Distribution • Abundance
Fish (1) • Round goby *Neogobius melanostomus.*	No	N/A	Yes (1)	• Increase (100%) in frequency of occurrence	**Report** • HELCOM (2007b) BSEP 113 **Criteria** • Frequency of occurrence in dredge hauls (%)
Marine mammals and reptiles	There are no established NIS marine mammals and reptiles reported in the Baltic Sea				
Seabirds	There are no established NIS seabird species, or associated impacts of NIS introduction(s) on seabird species				

GES Descriptor 3: Commercial fish and shellfish

Risk Assessment Outcome: High

GES Definition: GES for commercially exploited fish and shellfish will be achieved when stocks are sustainably exploited consistently with high long-term yields and have full reproductive capacity. To achieve GES it will also be necessary, in addition to sustainably exploited stocks at full reproductive capacity, for the age and size distribution of fish and shellfish populations to be representative of a healthy stock, assessed by reference to the proportion of older and larger fish in the population. GES is achieved for a particular stock only if criteria for all attributes are fulfilled (i.e. one-out, all-out).

Table 7. Status and trend information of ecological characteristics used to evaluate GES: Commercial fish and shellfish. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Commercial shellfish (0) • No commercial shellfish were reported • Commercial cultivation and harvesting of blue mussels, *Mytilus edulis* occurs in Denmark	Not reported	Not reported	Not reported	Not reported	Not reported
Commercial Fish (10) • 10 commercial species reported using multiple assessment criteria and incl. commercial species.	Yes (10)	• Good (6%); • Poor (6%); • Stock exploited at MSY (6%); • Stock outside safe biological limits (SBL) (19%); • Uncertain (6%); • Unknown (50%); • Unlikely (6%)* • Some cod and salmon stocks are either in poor condition or outside SBL	Yes (4)	• Increase (16.3%); • Stable (16.3%); • Fluctuating (16.3%); • Decrease (50%). • Decreasing species include sprat and salmon. The reduction in sprat numbers is a return toward former fish assemblage structure.	**Reports** • ICES (2010) **Criteria** • Fishing Mortality (F) • Potential Smolt Production Capacity (PSPC)

*Unlikely status assessment refers to the likelihood of salmon reaching 75% PSPC in a given river. There are 4 Status categories: Very likely, Likely, Uncertain, and Unlikely where stock status is determined by the probability of it reaching 75% PSPC. Stocks are considered **very likely** to reach this objective when the probability is more than 90%; **likely** when the probability is between 70 and 90%; and **unlikely** when the probability is less than 30%. When the probability of reaching the objective is between 30 and 70%, it is considered **uncertain** if they will reach the objective in 2010.

GES Descriptor 4: Food webs

Risk Assessment Outcome: High

GES Definition: The interactions between species in a food web are complex and constantly changing, making it difficult to identify one condition that represents 'good' status. However, some changes in species' relative abundance in an ecosystem can have significant adverse effects on food web status. Good Environmental Status of food webs will be achieved when energy flows through the food web, and the size, abundance and distribution of key trophic groups/species, are all within acceptable ranges that will secure the long-term viability of all food web components in line with prevailing natural conditions.

Table 8. Status and trend information of ecological characteristics used to evaluate GES: Food webs. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Plankton (6) • Phytoplankton (dinoflagellate, diatom, Chl-*a*, cyanobacteria) • Zooplankton (*Pseudocalanus* and *Temora* abundance and biomass)	Yes (1)	• Poor (100%)	Yes (6)	• Increase (67%); • Decrease (33%).	**Reports** • HELCOM (2009) BSEP 115B • HELCOM (2010) BSEP 122 • Published literature **Criteria** • Spring bloom intensity • Concentration • Summer bloom frequency and intensity • Abundance • Biomass
Fish (9) • 9 commercial species were identified as top predators or important components in the foodweb. Species include: cod, herring, plaice, salmon, sea trout, sprat, perch, roach and zander.	Yes (6) Spatial variation in status in two species. Cod are in Good and Poor status depending on sub-region (ICES SD22-24 and SD25-32). Herring are over-exploited in some regions (ICES SD22-29, and 32) and not others (ICES SD30)	• Good (9%)*; • Poor (9%)*; • Stock exploited at MSY (9%)[&]; • Stock outside safe biological limits (27%)[&]; • Uncertain (9%)[&]; • Unknown (36%)*.	Yes (7)	• Increase (27%)*; • Stable (18%)*; • Fluctuating (9%)*; • Decrease (45%)*.	**Reports** • ICES (2010)[&] • HELCOM (2007) BSEP 109* and 113* **Criteria** • Fishing Mortality (F) • CPUE • Catch • Smolt production capacity

Marine mammals (4) 4 species reported and evaluated by both population size and species distribution • Baltic harbour seal; • Harbour porpoise; • Baltic ringed seal; • Grey seal.	Yes (4)	• Critically Endangered (11%); • Least Concern (44%); • Above the LRL (11%) • At or slightly above the LRL (22%); • Below the LRL (11%). • The Harbour porpoise is critically endangered and the Baltic Ringed seal below the Limit Reference Level (LRL)[&].	Yes (4)	• Increase (10%); • Stable (50%); • Stable/Decrease (10%); • Fluctuating (10%); • Unknown (20%).	**Reports** • IUCN Redlist • HELCOM Seal 4 (2010) **Criteria** • Species distribution • Population size
Seabirds (6) • Includes planktivorous feeding species e.g. cormorant, tern, and razorbill.	Yes (1)	• Stellar's Eider are vulnerable and face a high risk of extinction in the wild	Yes (6)	• Increase (33%); • Stable (17%); • Decrease (50%). • Decreasing species include Dunlin and Eider spp. • Increasing or stable species include cormorant and razorbill	**Reports** • IUCN Redlist (Status assessment) • HELCOM (2007b) BSEP 113 • HELCOM (2009) BSEP 116B **Criteria** • Population size • Breeding population size
Listed species (7) • 7 species listed in the Article 17 report were identified as top predators in the food chain and include fish and marine mammals	Yes (7)	• Favourable (13%); • Unfavourable – inadequate (29%); • Unfavourable – bad (55%); • Unknown (3%). • All top predator species do not achieve FCS for at least one assessment criterion	Yes (5)	• Increase (40%); • Decrease (20%); • Locally variable between increase and decrease (40%)	**Reports** • Article 17 Reporting (2007) **Criteria** • Abundance • Population size • Habitat • Range • Overall Assessment

*Unlikely status assessment refers to the likelihood of salmon reaching 75% PSPC in a given river. There are 4 Status categories: Very likely, Likely, Uncertain, and Unlikely where stock status is determined by the probability of it reaching 75% PSPC. Stocks are considered **very likely** to reach this objective when the probability is more than 90%; **likely** when the probability is between 70 and 90%; and **unlikely** when the probability is less than 30%. When the probability of reaching the objective is between 30 and 70%, it is considered **uncertain** if they will reach the objective in 2010.

[&]The Limit Reference Level (LRL) The Limit Reference Level (LRL) is the population size when the long-term persistence of the population is ensured, which also has been termed as "Safe Biological Level".

GES Descriptor 5: Eutrophication

*Risk Assessment Outcome: **High***

GES Definition: GES with regard to eutrophication has been achieved when the biological community remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive harmful algal blooms, low dissolved oxygen, declines in sea grass, kills of benthic organisms and/or fish) and/or where there are no nutrient-related impacts on sustainable use of ecosystem goods and services.

The assessment of eutrophication in marine waters needs to take into account the assessment for coastal and transitional waters under Directive 2000/60/EC (Annex V, 1.2.3 and 1.2.4) and related guidance (European Commission, 2009). The assessment needs to combine information on nutrient levels and on a range of those primary effects and of secondary effects which are ecologically relevant taking into account relevant temporal scales. The Commission Decision guidance (2010) identified nutrient concentrations (ambient and enhanced) and direct and indirect effects (e.g. Chl-*a* or opportunistic algae) as relevant indicators of GES for Eutrophication. Information may be in the form of status and/or trends data, but may also include qualitative evidence of impacts of elevated nutrient levels such as fish kills or dissolved oxygen depletion.

Eutrophication in the Baltic Sea is currently addressed by one of the four thematic segments of the HELCOM Baltic Sea Action Plan, the goal of which is a "Baltic Sea unaffected by eutrophication." Eutrophication status of the Baltic Sea is evaluated using the HELCOM eutrophication assessment tool (HEAT) and HELCOM Core Set Indicators for eutrophication. The methodology is described in the *Integrated thematic assessment of the effects of nutrient enrichment in the Baltic Sea* (HELCOM, 2009). There are five HELCOM eutrophication objectives: (1) Concentrations of nutrients close to natural levels, (2) clear water, (3) natural level of algal blooms, (4) natural distribution and occurrence of plants and animals, and (5) natural oxygen levels. These indicators are weighted depending on their ecological significance for the site being assessed and combined under the quality elements *physico-chemical features, plankton* and *benthic invertebrate fauna*. The overall integration of the eutrophication status is derived from the results of each of the quality assessments using the HEAT tool.

Pressure Assessment Outcomes

A pressure assessment can be used to assess the human activity sources of nutrient enrichment in the marine environment. Nitrogen and phosphorus introductions in to the Baltic Sea are shown to originate from five sectors (Table 9), with predominant introduction via riverine input. Widespread and persistent introductions were identified as originating from diffuse sources discharges, such as land run-off and leaching from agricultural activities.

Summer phyto-plankton bloom in the Baltic Sea (Photo: Earthlabs)

Localised and persistent point source introductions arise from aquaculture, land-based industry, and tourism and recreation. The amounts of nutrients released from land-based sources vary according to land use and population density e.g. point source in urban areas and diffuse source in agricultural areas (Krause-Jensen et al. 2005). The rate of turnover of nutrients in soils and sediments in the Baltic Sea can result in nutrient releases for decades after cessation of the source. Thus, even small-scale (both in terms of extent and frequency) introductions may lead to undesirable impacts and as such, efforts to limit nutrient input has been of high priority in the Baltic Sea (see Baltic Sea Action Plan; HELCOM 2010).

Table 9. Major widespread and localised sources of nutrients (nitrogen, phosphorus and organic matter) into the marine environment.

Sector	Extent	Frequency	Source
Agriculture	Widespread	Persistent	Fertilizers, animal feed, biofuels
Aquaculture	Locally patchy	Persistent	Fish food
Land-based industry	Widespread	Persistent	Fertilizer industry, biofuels
Waste water treatment	Widespread	Persistent	Organic material

Table 10. Status, trend and impact information of ecological characteristics used to evaluate GES: Eutrophication. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Nutrients and Oxygen (4) • DIN/TN • DIP/TP • Dissolved Oxygen (near-bottom layer)	Yes (4)	• Poor (50%); • Poor/Bad (50%) • Phosphorus and Dissolved Oxygen concentrations are Poor/Bad • High levels of DIP remain in the surface waters in several sub-regions and target levels not met • Good/High status reported in Kattegat and Bothnian Sea sub-regions. • DIN levels in 2003-2007 below 1993-2002 average although HELCOM target level not met in some sub-regions (e.g. northern Baltic Proper, Gulf of Finland, Gulf of Riga and Bothnian Sea).	Yes (4)	• Stable (25%); • Fluctuating (25%)*; • Decrease (50%). • Oxygen concentrations fluctuate on an inter-annual basis	**Reports** • HELCOM (2009) BSEP 115B • BALANCE Interim Report 17 • HELCOM (2008) Indicator factsheet **Criteria** • Concentration
Bottom fauna and flora • Acute and chronic effects of eutrophication • High-biomass algal blooms, oxygen deficits and mortality events • HEAT integrated classification derived using benthic invertebrate community status	Yes	• Estimates of nutrient concentrations are reported (e.g. Pastuszak et al. 2006) • The whole Baltic except the open Bothnian Bay and certain coastal areas in the Gulf of Bothnia affected by eutrophication during 2003-2007 (HELCOM 2010) • Values range from HIGH (best) to BAD (worst) (www.helcom.fi/BSAP_ assessment/eutro/HEAT)	No	N/A	**Reports** • HELCOM (2007b) BSEP 113 • HELCOM (2009) BSEP 115B, 116B • HELCOM (2010) BSEP 125 • HELCOM EUTRO project (2005) **Criteria** • Distribution • Species richness • Diversity • Depth distribution • HEAT integrated classification
Plankton (6) • Phytoplankton (dinoflagellate, diatom, Chl-*a*, cyanobacteria)_ • Zooplankton (*Pseudocalanus* and *Temora* abundance and biomass)	Yes (1)	• Chl-*a* water bottle data indicated poor or bad status in the north eastern sub-areas where Chl-*a* are high • Moderate status in the south western sub-areas where [Chl-*a*] are slightly elevated	Yes (6)	• Increase (67%); • Decrease (33%). • Reductions in phytoplankton in the water has decreased over the last decade in the Gulf of Riga, the Western Gotland Basin, the Arkona Sea and the Kattegat	**Reports** • HELCOM BSEP 115B and 122 • ICES WGRED (2007) • Published literature **Criteria** • Spring bloom intensity • Concentration of Chl-*a* • Summer bloom frequency and intensity • Abundance • Biomass

* A fluctuating trend indicates no trend i.e. no clear relationship. Refer to the status and trends excel spreadsheet for details of the reference points and descriptions of relationship.

GES Descriptor 6: Seafloor Integrity

Risk Assessment Outcome: High

GES Definition: GES is achieved where seafloor integrity is at a level that ensures that the structures and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. "Sea Floor" includes both the physical structure and biotic composition of the benthic community. "Integrity" includes the characteristic functioning of natural ecosystem processes and spatial connectedness. "Not adversely affected" is interpreted as meaning that impacts may be occurring, but all impacts are sustainable such that natural levels of diversity, productivity, and ecosystem processes are not degraded.

Table 11. Pressure assessment of overlap between human activities and pressures with predominant habitat types in the Baltic Sea. Shown are the total number of sector-pressure-ecological characteristic combinations evaluated and a summary of overlap, frequency of occurrence, degree of impact, habitat resilience and pressure persistence in the marine ecosystem (top) and predominant habitat types (bottom). Specific sectors and pressures constituting a *high threat* to GES are shown for each habitat (*high threat* is defined in the risk assessment criteria in Annex V after Breen et al. (in prep)). Proportional values exclude all No Overlap (NO) combinations and the pelagic water column predominant habitat is not assessed. Category definitions are described in full in the pressure assessment guidance document (www.liv.ac.uk/odemm/outputs/guidancedocuments).

Pressure Assessment Summary	**Extent of Overlap**	**Frequency of Occurrence**	**Degree of Impact**	**Resilience (Recovery Time)**	**Persistence of Pressure**
486 Pressure Combinations of the 1056 evaluated Sectors – 18 Pressure Types – 21	Widespread Patchy (34%) Locally Even (1%) Locally Patchy (34%) Site (31%)	Persistent (38%) Common (16%) Occasional (21%) Rare (25%)	Acute (26%) Chronic (56%) Low (18%)	Moderate to High	Continuous (6%) High (15%) Moderate (17%) Low (48%) High/Continuous (8%)* Low/Continuous (6%)*

*Persistence can vary between sectors depending on likelihood of their being management options that would actually remove the pressure

Pressure Assessment by Habitat					
Littoral Rock 76 pressure combinations 15 Sectors operate in this habitat	Widespread Patchy (41%) Locally Even (1%) Locally Patchy (34%) Site (24%)	Persistent (43%) Common (16%) Occasional (20%) Rare (21%)	Acute (20%) Chronic (55%) Low (25%)	High	Continuous (7%) High (12%) Moderate (16%) Low (53%) High/Continuous (5%)* Low/Continuous (8%)*
26 High Threat Combinations	**Sectors** • Agriculture • Coastal Infrastructure • Fishing • Shipping • Waste water treatment	**Pressures** • Abrasion • Change in wave exposure • Emergence regime change • Input of organic matter • Introduction of NIS • Introduction of non-synthetic compounds • Introduction of synthetic compounds		• Marine litter • Nitrogen and Phosphorus enrichment • Selective extraction of species • Smothering • Substrate loss • Water flow rate changes	

Littoral Sediment 95 pressure combinations 17 sectors that have activities with pressures on this habitat	Widespread Patchy (32%) Locally Even (1%) Locally Patchy (38%) Site (29%)	Persistent (43%) Common (13%) Occasional (25%) Rare (19%)	Acute (24%) Chronic (45%) Low (31%)	High	Continuous (6%) High (11%) Moderate (28%) Low (42%) High/Continuous (6%)* Low/Continuous (6%)*
24 High Threat Combinations	**Sectors** • Agriculture • Coastal Infrastructure • Fishing • Shipping • Waste water treatment	**Pressures** • Abrasion • Change in wave exposure • Emergence regime change • Input of organic matter • Introduction of NIS • Introduction of non-synthetic compounds • Introduction of synthetic compounds		• Marine litter • Nitrogen and Phosphorus enrichment • Selective extraction of species • Smothering • Substrate loss • Water flow rate changes	
Infralittoral Rock 96 pressure combinations 16 sectors that have activities with pressures on this habitat	Widespread Patchy (32%) Locally Even (1%) Locally Patchy (28%) Site (39%)	Persistent (43%) Common (14%) Occasional (17%) Rare (27%)	Acute (24%) Chronic (73%) Low (3%)	High	Continuous (8%) High (9%) Moderate (14%) Low (52%) High/Continuous (8%)* Low/Continuous (8%)*
32 High Threat Combinations	**Sectors** • Agriculture • Coastal Infrastructure • Fishing • Shipping • Waste water treatment	**Pressures** • Abrasion • Change in wave exposure • Change in siltation • Emergence regime change • Input of organic matter • Introduction of microbial pathogens • Introduction of NIS • Introduction of non-synthetic compounds		• Introduction of synthetic compounds • Marine litter • Nitrogen and Phosphorus enrichment • pH changes • Salinity regime changes • Selective extraction of species • Smothering • Substrate loss • Water flow rate changes	

Pressure Assessment Summary	Extent of Overlap	Frequency of Occurrence	Degree of Impact	Resilience (Recovery Time)	Persistence of Pressure
Circalittoral Rock 87 pressure combinations 15 sectors that have activities with pressures on this habitat	Widespread Patchy (36%) Locally Even (1%) Locally Patchy (31%) Site (32%)	Persistent (36%) Common (17%) Occasional (18%) Rare (29%)	Acute (30%) Chronic (62%) Low (8%)	High	Continuous (5%) High (11%) Moderate (14%) Low (54%) High/Continuous (10%)* Low/Continuous (7%)*
29 High Threat Combinations	**Sectors** • Agriculture • Coastal Infrastructure • Fishing • Shipping • Waste water treatment	**Pressures** • Abrasion • Change in wave exposure • Change in siltation • Emergence regime change • Input of organic matter • Introduction of microbial pathogens • Introduction of NIS • Introduction of non-synthetic compounds		• Introduction of synthetic compounds • Marine litter • Nitrogen and Phosphorus enrichment • Selective extraction of species • Smothering • Substrate loss • Water flow rate changes	
Sublittoral Sediment 106 pressure combinations 17 sectors that have activities with pressures on this habitat	Widespread Patchy (29%) Locally Even (1%) Locally Patchy (36%) Site (34%)	Persistent (33%) Common (17%) Occasional (23%) Rare (27%)	Acute (30%) Chronic (44%) Low (25%)	Moderate	Continuous (5%) High (23%) Moderate (11%) Low (48%) High/Continuous (8%)* Low/Continuous (5%)*
27 High Threat Combinations	**Sectors** • Agriculture • Coastal Infrastructure • Fishing • Shipping • Waste water treatment	**Pressures** • Abrasion • Change in siltation • Input of organic matter • Introduction of microbial pathogens • Introduction of NIS • Introduction of non-synthetic compounds		• Introduction of synthetic compounds • Marine litter • Nitrogen and Phosphorus enrichment • Selective extraction of species • Smothering • Substrate loss • Water flow rate changes	
Deep Sea 26 pressure combinations 8 sectors that have activities with pressures on this habitat	Widespread Patchy (46%) Locally Even (4%) Locally Patchy (27%) Site (23%)	Persistent (19%) Common (31%) Occasional (27%) Rare (23%)	Acute (27%) Chronic (65%) Low (8%)	Moderate	Continuous (0%) High (46%) Moderate (25%) Low (21%) High/Continuous (8%)* Low/Continuous (0%)
13 High Threat Combinations	**Sectors** • Agriculture • Fishing • Shipping	**Pressures** • Changes in siltation • Input of organic matter • Introduction of microbial pathogens • Introduction of non-synthetic compounds		• Introduction of synthetic compounds • Marine litter • Nitrogen and Phosphorus enrichment • Selective extraction of species	

Table 12. High threat to GES Sector-Pressure combinations in all predominant habitats types in the Baltic Sea. Risk assessment criteria are those described in Annex V after Breen et al. (in prep).

High Threat Pressure Combinations following the Risk Assessment Criteria					
Criteria	**Extent**	**Frequency**	**Degree of Impact***	**Resilience**	**Persistence**
	1. Widespread 2. Widespread 3. Widespread	1. N/A 2.Persistent/Common/Occasional 3. Persistent/Common	1. Acute/Chronic 2. Acute 3. Chronic	N/A	1. Continuous/High 2. N/A 3. N/A
Summary of High Threat Sectors: ▪ Agriculture ▪ Coastal Infrastructure ▪ Fishing ▪ Shipping ▪ Waste water treatment	Sector-Pressure Ecological Characteristic Combinations with the categories defined above and taken from the Risk Assessment framework document. Combination 1: Sectors include Agriculture, Coastal Infrastructure, Fishing, Shipping and Waste water treatment Pressures: Changes in wave exposure; emergence regime change; introduction of non-indigenous species; introduction of synthetic compounds; Nitrogen and Phosphorus enrichment, marine litter, salinity regime changes, substrate loss and water flow rate changes Combination 2: Sectors include Coastal Infrastructure and Shipping. Pressures: Abrasion and smothering Combination 3: Sectors include Agriculture, Coastal Infrastructure, Fishing, Shipping and Waste water treatment Pressures: Changes in siltation; changes in wave exposure; emergence regime change; input of organic matter; introduction of microbial pathogens; introduction of non-synthetic and synthetic compounds; Nitrogen and Phosphorus enrichment; pH changes; salinity regime changes; water flow rate changes.				

* An acute or chronic degree of impact is defined as having a detrimental effect on the habitat or its characteristic species i.e. loss, removal or mortality.

GES Descriptor 7: Hydrographic Conditions

GES Definition: Permanent alterations of hydrographical conditions by human activities may consist, for instance, of changes in the tidal regime, sediment and freshwater transport, current or wave action, leading to modifications of the physical and chemical characteristics set out in Table 1 of Annex III to Directive 2008/56/EC. Good status is achieved when the various permanent alterations within a regional sea do not lead to adverse effects on marine ecosystems to the extent that the characteristic structures and features of those ecosystems are altered. In particular, the hydrographical conditions of habitats (water column or seafloor) should not be affected to the extent that their key functions (e.g. provision of spawning, breeding and feeding areas, or migration routes) are degraded.

Sea defences affecting the tidal regime, sediment transport, current and wave action of the coastal margin (Photos: A. Delaney)

Identification of Sector-Pressures affecting hydrographic conditions

The pressure assessment was used to identify sectors that contribute pressures (Table 13), which can affect the ecological characteristics used to describe hydrographic conditions (Table 14).

Table 13. Pressure assessment identification of widespread common or persistent pressures affecting hydrographic characteristics.

Pressure	Sector
Change in wave exposure	• Coastal infrastructure
Emergence regime change	• Coastal infrastructure
Input of Organic matter	• Agriculture • Waste water treatment
Introduction of non-synthetic compounds	• Agriculture • Fishing • Land-based industry • Shipping • Waste water treatment
Introduction of synthetic compounds	• Agriculture • Coastal infrastructure • Fishing • Land-based industry • Shipping • Waste water treatment
Nitrogen and Phosphorus enrichment	• Agriculture • Land-based industry
pH changes	• Land-based industry • Waste water treatment
Water flow rate changes	• Coastal infrastructure • Waste water treatment

Table 14. Status and trend information of ecological characteristics describing hydrographic (chemical) conditions of the Baltic Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Temperature (2) • Bottom temperature • Sea surface temperature	No	N/A	Yes (2)	• Increase (100%)	**Reports** • Assessment of Climate Change for the Baltic Sea Basin (BACC) • Published literature **Criteria** • SST • SBT
Salinity (1)	No	N/A	Yes (1)	• Decrease (100%)	**Reports** • ICES (2010)
pH, pCO_2 (2) • pH • Carbonate alkalinity	No	N/A	Yes (2)	• Increase (50%); • Decrease (50%). • pH is declining, pCO_2 is increasing	**Reports** • Omstedt et al. (2010)
Nutrients and Oxygen (3) • DIN/TN • DIP/TP • Dissolved Oxygen (near-bottom layer)	Yes (3)	• Poor (50%); • Poor/Bad (50%) • Phosphorus and Dissolved Oxygen concentrations are Poor/Bad • High levels of DIP remain in the surface waters in several sub-regions and target levels not met • Good/High status reported in Kattegat and Bothnian Sea sub-regions. • DIN levels in 2003-2007 below 1993-2002 average although HELCOM target level not met in some sub-regions (e.g. northern Baltic Proper, Gulf of Finland, Gulf of Riga and Bothnian Sea).	Yes (3)	• Stable (25%); • Fluctuating (25%)*; • Decrease (50%). • Oxygen concentrations fluctuate on an inter-annual basis	**Reports** • HELCOM (2009) BSEP 115B • BALANCE (2008) Interim Report 17 • HELCOM (2008) Indicator Factsheet **Criteria** • Concentration

[§] Sea surface temperature (SST) has been increasing in the NW Shelf.

GES Descriptor 8: Contaminants

Risk Assessment Outcome: Moderate-High

GES Definition: GES will be achieved when concentrations of contaminants in water, sediment and biota are below assessment thresholds identified on the basis of toxicological data; pollution levels are below assessment thresholds representing harm at organism, population, community and ecosystem levels; and trends in concentrations of contaminants in water, sediment and biota, and the occurrence and severity of pollution effects, are within acceptable limits and declining.

Table 15. Status and trend of contaminant concentrations in the Baltic Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals • PAHs • Dioxins • PCBs • Heavy metals • TBT • Insectices, pesticides • Radioactive substances	Yes	• Regional variation in status ranging from **High** to **Bad** in sub-regions. • See HELCOM integrated chemical status assessment	Yes	• Increases in some metals e.g. Mercury and Cadmium • Decreases in TBT, Lindane and Heavy metal • Variable trends depending on sub-region	**Reports** • HELCOM (2010b) BSEP 120B • Published literature **Criteria** • Integrated Chemical Status • Concentrations in sediments, tissues and water column

GES Descriptor 9: Fish and Seafood Contaminants

Risk Assessment Outcome: Moderate

GES Definition: GES would be achieved if all contaminants are at levels below the levels established for human consumption or showing a downward trend (for the substances for which monitoring is on-going but for which levels have not yet been set).

Table 16. Status and trend of contaminant concentrations in the Baltic Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals in tissues • Bivalves (*Mytilus* spp., *Macoma balthica*) • Fish (perch, herring, cod, eelpout and plaice) • Seabirds (TCDD concentration in Guillemot eggs)	Yes	• Regional variation in status ranging from **High** to **Bad** in sub-regions. • Integrated and individual species assessments • Concentration of PCBs in mussels above maximum limit concentrations for human consumption in some areas	Yes	• Increases in some metals e.g. Mercury and Cadmium • Decreases in TBT, Lindane and Heavy metal • Variable trends depending on sub-region	**Reports** • HELCOM (2010b) BSEP 120B • Published literature **Criteria** • Concentration in tissues

GES Descriptor 10: Marine Litter

*Risk Assessment Outcome: **High***

GES Definition: GES occurs when the properties and quantities of marine litter do not cause harm to the coastal and marine environment. This can be achieved through a measurable and significant decrease in comparison with the baseline (i.e. the situation up until 2012) in the total amount of marine litter by 2020 using as attributes the characteristics of litter in the marine and coastal environment and the impacts of litter on marine life.

Table 16. Status, trend and background information on marine litter in the Baltic Sea. Some supporting evidence indicates the generic interaction between an ecological characteristics and marine litter and undertaken outside of the Baltic Sea region

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Bottom flora and fauna	The impact of marine litter on bottom fauna is largely unknown, but may affect the ingestion rates of deposit- and filter-feeding species e.g. *Arenicola marina* and *Mytilus edulis*[1,2].				
Fish	Impacts of ghost fishing described by the FAO (1995) as "one of the most serious negative impacts from the capture fishing industry" but little scientific evidence to support claim. See Matsuoka et al (2005) for review[3].				
Marine mammals and reptiles	The primary impact of marine litter on marine mammals and reptiles is entanglement, yet little is known of the extent to which this impacts species within this group. 43% of all marine mammal species are affected worldwide[4,5].				
Seabirds ▪ Fulmar ingestion of plastics	Yes	▪ Poor ▪ Measured against an EcoQO of 10% of stomach contents	No		**Reports** ▪ OSPAR (2009)
Litter in water column and subtidal habitats	The amount of litter in the water column and subtidal habitats is unknown.				**Reports**
Litter in intertidal habitats	N/A	2-12,000kg / 500 m of beach	Yes (1)	▪ Increase in microplastic concentration (m^{-3})	**Reports** ▪ HELCOM (2007a) ▪ OSPAR (2009) ▪ Published literature

[1]Browne, M.A. *et al.* (2008) Environmental Science and Technology 42(13): 5026-5021.

[2]Moore, C.J. (2008) Environmental Research 108(2): 131-139.

[3]Matsuoka, T. *et al*. (2005) Fisheries Science 71: 691-702.

[4]Laist, D.W. (1997) In: Coe, J.M., Rogers, D.B. (Eds.), Marine Debris – Sources, Impacts and Solutions. Springer- Verlag, New York, pp. 99–139.

[5]Derraik, J.G.B. (2002) Marine Pollution Bulletin 44: 842-852.

Pressure Assessment Outcomes

Eight sectors were identified as contributing to the widespread or localised distribution of marine litter in the Baltic Sea (Table 17). In the OSPAR Maritime Area, the overall amount of marine litter is consistently high and has not reduced despite recent efforts (OSPAR, 2009). No consistent approach to monitoring marine litter has been undertaken in the Baltic Sea, with the majority of information collected by NGOs (e.g. WWF, Ocean Conservancy). Large differences in the amount of litter on beaches observed between Baltic Sea countries, varying between 2 and 12,000 kg / 500 m of beach (HELCOM 2007a).

Five countries reported tourism and recreation to be the most common source of marine litter in the Baltic Sea, including plastic and glass bottles, plastic bags and other packaging materials (HELCOM 2007). The environmental impact of marine litter on the marine ecosystem and its characteristic species is variable and uncertain. Lost fishing gears can result in the mortality of some species (i.e. ghost fishing) however the extent to which such mortality could affect the persistence of affected species is unknown and likely to occur in localised areas. Other types of litter, such as microplastics, are increasing in concentration (particles m^{-3}). Evaluation of the amount of microplastic in the stomach of Fulmars indicates >50% of birds exceed the recommended EcoQO target of 10% of the total stomach contents but a detrimental impact cannot be evaluated as only deceased birds are monitored and the variability in amount of plastic in the stomach of living Fulmars is unknown (OSPAR, 2009).

Washed-up debris on the Swedish coastline (Photo: Smith)

Table 17. Major widespread and localised sources of marine litter in the Baltic Sea marine environment.

Sector	Extent	Frequency	Source
Aquaculture	Locally patchy or site	Occasional	Nets, plastics
Coastal Infrastructure	Widespread	Common	General litters (cans, plastics)
Fishing	Widespread	Common	Lost gear/nets, general litter (cans, plastics)
Land-based industry	Locally patchy	Persistent	Fertilizer industry, General litter (cans, plastics, containers)
Military	Locally patchy	Common	Munitions
Non-renewable energy (oil and gas)	Site	Occasional	Decommissioned rigs, General litter (cans, plastics)
Shipping	Widespread	Common	General litter (cans, plastics)
Tourism and Recreation	Locally patchy or site	Occasional or Rare	General litter (cans, plastics)

GES Descriptor 11: Energy Introduction (incl. noise)

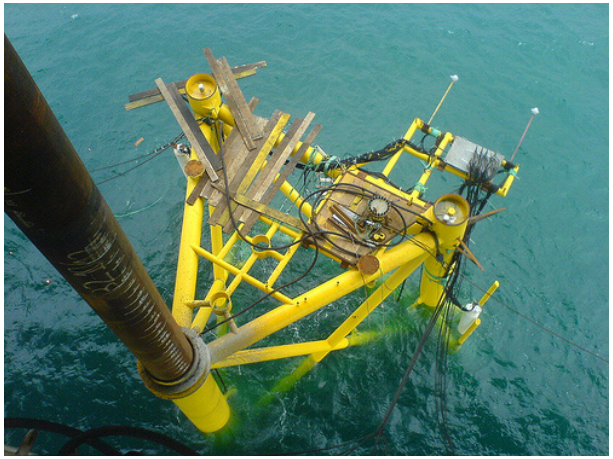
Risk Assessment Outcome: Moderate-High

There is little information describing the impacts of underwater noise on the marine ecosystem, but noise may have deleterious impacts on several ecological characteristics including fish, marine mammals and seabirds. In a recent Task Group report to the Commission (Tasker et al. 2010), three possible indicators of underwater noise were developed. However, in no case was the Task Group able to define when GES occurs on the axes of the indicators. This was in part to do with insufficient evidence, but also due to no clear definition of when underwater noise effects are detrimental (Tasker et al. 2010).

In the absence of existing monitoring programmes for indicators of underwater noise, a pressure assessment approach has been used to estimate the distribution of the 3 indicators recommended in the Task Group report, namely: (1) low and mid-frequency impulsive sound, (2) high frequency impulsive sound, and (3) low frequency continuous sound. Principle sectors contributing these types of underwater noise are shipping, military (sonar) and offshore construction and the extent and frequency of those sectors as used to inform the risk assessment (see Annex V for criteria) is shown (Table 18). The extent and frequency of those sound types in the Baltic Sea are well described with good information available on the location of contributing sectors. Note that the extent of the sector may not directly reflect the extent of the pressure and changes in the resonance of the sound as it travels through the water column is not considered here.

Table 18. Extent and frequency of sectors contributing underwater noise pressures in the Baltic Sea.

Sector	Extent	Frequency
Shipping	Widespread patchy	Occasional to Persisten
Military (sonar)	Locally patchy	Rare to Common
Offshore contruction (including non-renewable and renewable energy sectors)	Locally patchy or site	Rare to Persistent



Pile-driving is a common technique used in offshore construction (Photos: OSPAR; L. Barlow)

Habitats Directive: Listed Species

Risk Assessment Outcome: High

FCS Definition: The habitats directive species will be assessed as being at favourable conservation status when the population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, when the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future and when there is and will probably continue to be a sufficiently large habitats to maintain its populations on a long-term basis. Most assessments also considered an overall score for the species which combines these criteria. A one-out all-out approach has been adopted by the EEA (2009) as best practice for evaluation of multiple criteria per species, in which case, if one criteria falls below favourable conservation status, then the overall assessment for that species is reported as unfavourable.

Table 19. Status and trend information of Listed species under the Habitats Directive (Council Directive 92/43/EC) in the Baltic Sea. Status category criteria are defined in the Article 17 supporting documentation available from the European Environment Agency website (www.eea.eionet.europa.eu). The number of species evaluated is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species assessed. Overall Favourable Conservation Status is based on the one-out all-out approach, i.e. the worst case of any of the five criteria is the status applied to the species.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria

Listed species (19)
 	
• 19 species listed in the Article 17 report and assessed using 5 criteria
	Yes (19)	• Favourable (54%);
		• Unfavourable – inadequate (21%);
		• Unfavourable – bad (24%);
		• Unknown (1%).
		
		• 7 of the 19 species are in favourable conservation status (based on the one-out all-out approach)
		• Species include:
		  • *Cottus gobio*
		  • *Coregonus albula*
		  • *Astacus astacus*
		  • *Coregonus lavaretus*
		  • *Pelecus cultratus*
		  • *Sabanejewia aurata*
		  • *Cobitus taenia*
			Yes (11)	• Decrease (29%);
				• Increase (29%);
				• Stable (29%);
				• Fluctuating (5%);
				• Unknown (8%).
					Reports
					• Article 17 Reports (2007)
					
					Criteria
					• Abundance
					• Population size
					• Habitat
					• Range
					• Overall Assessment

Habitats Directive: Habitats

*Risk Assessment Outcome: **High***

FCS Definition: The habitats directive habitats will be assessed as being at favourable conservation status when the habitats natural range and area it covers within that range are stable or increasing, 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 and the conservation stats of its typical species is favourable as defined for the habitats directive listed species. A one-out all-out approach has been adopted by the EEA (2009) as best practice for evaluation of multiple criteria per habitat, in which case, if one criteria falls below favourable conservation status, then the overall assessment for that species is reported as unfavourable.

Table 20. Status and trend information of Listed habitats under the Habitats Directive (Council Directive 92/43/EC) in the Baltic Sea. Status category criteria are defined in the Article 17 supporting documentation available from the European Environment Agency website (www.eea.eionet.europa.eu). The number of habitats evaluated is shown in brackets and may be evaluated using multiple criteria (see criteria in table) and therefore, status/trend category proportions shown may not match the number of habitats assessed. Overall Favourable Conservation Status is based on the one-out all-out approach, i.e. the worst case of any of the five criteria is the status applied to the habitat.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria

Listed Habitat (16)
 	
• 16 habitat are listed in the Article 17 report
• Habitat codes are: 1110, 1130, 1140, 1150, 1160, 1170, 1180, 1230, 1240, 1310, 1330, 1610, 1620, 1630, 1640, and 1650.
	Yes (16)	• Favourable (46%);
		• Unfavourable – inadequate (33%);
		• Unfavourable – bad (14%);
		• Unknown (8%)
		
		• Based on one-out, all-out of Habitats Directive, 81% of listed habitats in unfavourable condition
		
		• Favourable habitats are:
		  • Vegetated sea cliffs (1230)
		  • Sea cliffs with endemic *Limonium* spp. (1240)
		  • Boreal Baltic inlets and small islands (1620)
			Yes (11)	• Decrease (18%);
				• Stable (73%);
				• Increase (9%).
					Reports
					• Article 17 Reports (2007)
					
					Criteria
					• Area
					• Future prospects
					• Range
					• Structure and Function
					• Overall Assessment

Annex II

The North East Atlantic

Introduction

The North Sea is a relatively shallow marginal sea (average depth 95m) and located between the UK, mainland Europe and Scandinavia, the North Sea supports all 20 sectors identified by the ODEMM project (see the linkage guidance document available for download from www.liv.ac.uk/odemm/outputs/guidancedocuments for further details). Approximately 750,000 km2 in area, the North Sea presents a diverse ecosystem comprising deep fjords, sandy beaches and wide mudflats. Dense populations of surrounding countries have led to heavy industrialisation and utilisation of the North Sea's marine resources. Over 230 species of fish are supported including cod, haddock, mackerel, plaice and sole, as well as large populations of plankton, migratory and resident birds, marine mammals and plants (OSPAR 2010).

The Celtic Sea, lying off the south coast of Ireland, and west of the southern UK and northern France is bounded by the continental shelf and the Atlantic Ocean. Like the North Sea, the Celtic Sea is relatively shallow, on average between 90 – 100 m to the northeast (St. George's Channel) and reaching depths of up to ~150 m to the southwest where sand ridges, similar in depth to the northeast region, are interspersed with deep toughs (Hardisty, 1990). The Celtic Sea supports many of the sectors found within the North Sea.

The Irish Sea separates the island of Ireland and Great Britain. Connected to the Atlantic Ocean via the St. George's Channel to the south and the North Channel to the north, the Irish Sea is of important economic significant supporting shipping, transport, fisheries and power generation.

The NE Atlantic is a heavily exploited regional sea. All 20 of the sectors identified in ODEMM as those contributing to the current status of its ecological components are active within the region. However, any assessment of status and/or trend using indicators, such as range and distribution, should be treated cautiously as other factors (e.g. environmental conditions; climate change) may greatly influence any observed pattern(s). This is further complicated by the wide variety of overlap among Descriptors, attributes and indicators.

Sector activities in the North East Atlantic maritime areas contribute 1.8% to the regional Gross Domestic Product, in addition to contributing a 2.1% employment rate (OSPAR 2010). The fishing and tourism industries are the largest employers followed by shipping (OSPAR 2010). Coastal tourism is important for France, Spain and Portugal. Non-renewable and renewable energy production in the NE Atlantic represents some of the largest of these sector activities globally. Particularly, the renewable energy sector is seeing fast growth due to increasing energy demands by growing populations in the region. This growth meets the objectives of EU renewable energy directives (EC 2009), for sustainable energy production. Denmark, Netherlands, and Norway host some of the main European seaports, and are world leaders in the aggregate and navigational dredging sectors (EC 2006; OSPAR 2010). All these sector activities promote regional economic development and growth, yet to the detriment of North East Atlantic marine ecosystems.

Coastal areas in the North-East Atlantic are densely populated, more so than inland areas, and are either highly industrialised or used intensively for agriculture (OSPAR 2010). Most populations in some areas of Northern Europe are concentrated in coastal settlements (OSPAR 2010). The highest coastal populations are on the Iberian and North Sea coasts (with over 500 inhabitants per km^2) and lowest in both the Artic Waters (with fewer than 10 inhabitants per km^2 in some remote areas) and the wider Atlantic, which is dominated by High Seas (OSPAR 2010). Coastal areas with low and high population densities can exert pressures on the sea. One of the major challenges facing the North East Atlantic region will be the demand for marine ecosystem services and resources by the region's increasing population. This will require innovative strategies and co-operation between countries to meet sustainable growth and development, without compromising the ability to achieve GES for MSFD descriptors.

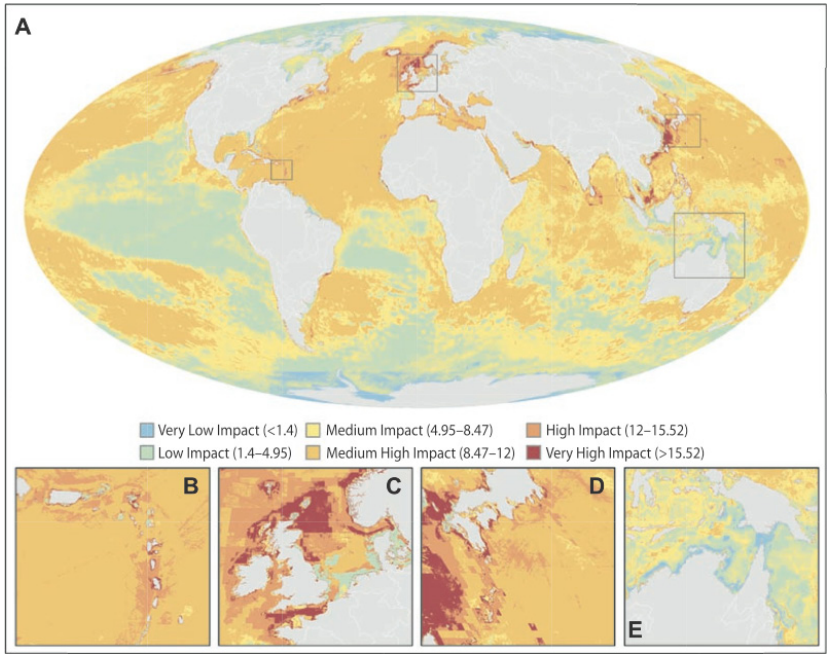


Figure 2. Global map of cumulative impacts showing highly impacted regions of the Eastern Caribbean (B), North-east Atlantic/North Sea (C), Sea of Japan (D), and one of the least impacted regions off northern Australia (E). Redrawn with permission (Halpern et al. 2008, Science Publishing).

Availability of Information: Regional Summary

The NE Atlantic Member States are well placed to undertake their Initial Assessment obligations (Article 8, Directive 2008/56/EC) in which they must assess the current environmental status of the NE Atlantic region and the impact of human activities by 2020. OSPAR, a Regional Advisory Council for the NE Atlantic has led a coordinated effort of systematic and standardised collection of environmental data in the region. This has led to the availability of a broad assessment of the region (e.g. Quality Status Reports), which provides a good basis for the initial assessment of the NE Atlantic region (see OSPAR 2010 for the most recent report). The structure of QSR, however, does not fit the Marine strategy framework, in that the compilation of ecological characteristics, pressures and impacts is by use of the environment (e.g. human impacts) rather than by ecological characteristics as per the MSFD.

Information relevant to the assessment of some GES descriptors is not also presented in QSR. For example, the status of predominant habitats in UK territorial waters has been evaluated by the UK government (DEFRA, 2010) and does not extend beyond that area. As such, the current status of the NE Atlantic described herein is described using a combination of the information described with QSR 2010, but supplemented by Member State specific information, such as that compiled within the UK's status assessment: Charting Progress 2 (DEFRA, 2010), or by ICES (e.g. Fish IBTS stock summary information, www.ices.dk).

Information was available for all ecological characteristics outlined in the MSFD (Annex III, Table 1, Directive 2008/56/EC) and a summary of this information is presented below (more detailed descriptions of this data are available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/data). Further information to undertake the regional pressure assessment (for GES Descriptors 2, 5, 6, 7, 10 and 11) was compiled using a combination of published literature and expert judgement by ODEMM partners from the Regional Sea.

Problem Areas and Likelihood of Failure to Achieve GES

The primary areas of concern and likelihood of failure to achieve GES for each descriptor in the NE Atlantic were identified (Table 21). Of the 16 components listed in Annex III of the MSFD as recommended for assessment, representatives of 50% (8) of these components are currently considered to either be in poor or threatened status as assessed under the Habitats Directive (HD) or Water Framework Directive (WFD) criteria. Not all species or habitats within each ecological characteristic type are in poor or threatened status. For example, several marine mammals such as bottlenose dolphin, common dolphin and harbour porpoise are considered to be in favourable conservation status, as indicated by the four of their five attributes, namely: abundance, range, habitat and future prospects (Article 17, Council Directive 92/43/EEC).

Status assessments indicate currently threatened ecological characteristics to include commercial and listed fish species, predominant and listed habitats, marine mammals and reptiles, seabirds, plankton, and bottom flora and fauna. Status information was unavailable for: Topography, temperature, salinity, pH/pCO2, nutrients and oxygen, and contaminants, however, trend information was available for all with the exception of topography/bathymetry where no information was available.

Where status and trend information was not appropriate for evaluation of a GES descriptor, a pressure assessment was used. Following the approach and criteria developed within ODEMM, several threats to the marine environment arising from human activities were identified. Those sectors that contribute potentially detrimental pressures affecting an ecological characteristic (or achievement of GES for pressure-impact descriptors e.g. Marine litter) include Agriculture, Aquaculture, Coastal Infrastructure, Fishing, Military, Non-renewable Energy (Oil & Gas), Research, Shipping and Telecommunications. Assessment of the contribution of each sector to current status or the highest threat to the marine environment and its components will be evaluated in later ODEMM work packages.

A local catch and large container ship (Photos: L. Paltriguera; J v Leeuwen)

Table 21. A Summary of Areas of Concern, Risks to GES, and Confidence in Risk Assessment of GES Descriptors in the NE Atlantic. Each GES Descriptor is described by one or more components: ecological characteristics, pressure and/or impacts information (see Chapter 2). The components used to evaluate each descriptor are shown in more detail in the following summary tables and outline the availability of information and criteria used to assess current status and trends of components in each Regional Sea. * indicates a pressure assessment approach was used, either in part or in its entirety, to evaluate the descriptor. Risk assessment criteria and confidence assessment definitions are described in Chapter 3 and Annex 5 of this report.

GES Descriptor	Problems	Areas of Concern	Risks to GES	Risk Confidence
1a. Plankton	Yes	Plankton assemblages in the North Sea are currently stable, but a decline in coldwater zooplankton species (i.e. *Calanus finmarchicus*) since the 1960s indicates a change in dominance	Low-moderate	Low-moderate
1b. Fish	Yes	Several species of fish are at risk or in poor status due to reduced spawning stock biomass (SSB). Some regional variation in the reproductive capacity of those stocks. Two species (cod and hake) are at increased risk from over-fishing. Several Habitats Directive listed species are currently in unfavourable (inadequate) condition, but none are expected to go extinct in the next 10 years	Moderate	Moderate-high
1c. Marine Mammals	Yes	27% of listed marine mammals are currently in unfavourable status (Habitats Directive), but many species are stable or increasing in one or more assessment criteria	Low-moderate	Low
1d. Seabirds	Yes	Several seabird species are in unfavourable status under the Birds Directive and decreasing breeding population sizes have been reported throughout the region	Moderate	Moderate
1e. Predominant Habitats	Yes	Several predominant habitat types are in moderate or poor status, however, the assessment has only been undertaken in the UK territorial waters. Status assessment was undertaken using a pressure assessment after Robinson et al. (in prep) and a moderate/poor status indicates a decline in the area of the habitat, but habitats are not expected to disappear	Moderate	Low
2. Non-indigenous species (NIS)*	Yes	Species of non-indigenous have increased in abundance and extended their range throughout the NE Atlantic region	High	Moderate-high
3. Commercial fish and shellfish	Yes	Several species of fish are at risk or in poor status due to reduced spawning stock biomass (SSB). Some regional variation in the reproductive capacity of those stocks. Two species (cod and hake) are at increased risk from over-fishing and there has been a decline in catch size of many species indicating long-term degradation of stocks	High	High
4. Food webs	Yes	A reduction in primary producers (zooplankton) has been observed in North Sea regions, as well as a decrease in the number of top predators including fish and seabirds affecting the balance of the food web	High	Moderate
5. Eutrophication*	Yes	Nutrient concentrations continue to decline throughout the region in response to various EU Directives, although in some sub-regions concentrations can deviate from normal levels	Moderate	High
6. Seafloor Integrity*	Yes	Human activities such as agriculture, aquaculture, coastal infrastructure, fishing, non-renewable energy (oil and gas), military and research activities and shipping contribute widespread and persistent pressures that have detrimental effects on several aspects of the NE Atlantic ecosystem	High	Moderate
7. Hydrographic conditions*	Yes	Widespread increases in Sea surface temperature (SST), ocean acidification and reductions in dissolved oxygen. Coastal infrastructure and non-renewable energy (oil & gas) introduce changes in wave exposure, emergence regime, water flow rate changes in addition to widespread introduction of synthetic and non-synthetic compounds into the water column.	Not assessed	Not assessed
8. Contaminants	Yes	Contaminants in sediment and biota are stable or reducing in concentration following the introduction of several EU legislative tools, but some localised areas of high concentrations remain	Moderate	High
9. Fish and Shellfish Contamination	Yes	Contaminants in biota are stable or reducing in concentration following the introduction of several EU legislative tools, but some localised areas of high concentrations remain	Low-moderate	Low-moderate
10. Marine Litter*	Yes	Large quantities of litter are removed from beaches and the water column each year and quantities are not reducing	High	Low-moderate
11. Energy (Underwater noise)*	Yes	Trends indicate an increase in shipping and a marked increase in renewable energy activities leading to greater levels of underwater noise throughout the region	High	High
12a. Habitats Directive Habitats	Yes	Based on a one-out, all-out approach as per the Habitats Directive (Article 17) guidance, 90% of listed habitats are in unfavourable condition.	High	Moderate
12b. Habitats Directive Species	Yes	The dolphin, *Lagenorhynchus albirostris* is the only species of 27 reported that is in favourable condition based on the one-out, all-out approach of the Habitats Directive with 57% of criteria unfavourable.	High	Moderate

GES Descriptor 1: Biodiversity

Risk Assessment Outcome: Low to Moderate

GES Definition: GES is achieved when biodiversity is maintained in the regional sea such that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Loss of biodiversity can be described as occurring where there is a reduction in genetic, species, habitat or ecosystem diversity within the regional sea over this time scale. More specifically loss of particular meta-populations, species, habitat types or ecosystem properties within the region (e.g. extirpations) would certainly count as a loss of biodiversity, but so could a noticeable change in diversity based on changes in evenness (e.g. shifts in dominance). GES under Biodiversity should be assessed individually for each of the major ecosystem characteristics listed in Annex III of the MSFD as recommended in the COM decision.

Table 22. Status and trend information of ecological characteristics used to evaluate GES: Biodiversity. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Predominant Habitat (7) Predominant habitats in the UK were evaluated using a pressure assessment approach and assessed the extent of each predominant habitat type.	Yes (7)	• Good (42%); • Moderate (29%); • Bad (29%).	Yes (7)	• Stable (57%); • Decrease (43%).	**Reports** • DEFRA 2010[§] ([§] indicates sub-regional assessment only) **Criteria** • Robinson et al. 2008 (Pressure assessment approach)
Listed Habitat (10 habitat types; 5 criteria per habitat)	Yes (10)	• Favourable (30%); • Unfavourable – inadequate (12%); • Unfavourable – bad (30%); • Unknown (28%) • Based on one-out, all-out of Habitats Directive, 80% of listed habitats in unfavourable condition	No	N/A	**Reports** • Article 17 Reporting (2007) **Criteria** • Area • Future prospects • Range • Structure and Function • Overall Assessment
Plankton (assemblage)	Yes (assemblage)	• Moderate (100%)	Yes (assemblage)	• Stable (100%).	**Reports** • DEFRA 2010[§] **Criteria** • Phytoplankton colour index (PCI)
Bottom fauna and flora	Where assessed, bottom fauna and flora were assessed as components of Predominant habitats in the NE Atlantic. Further information is available on request.				

Fish (33) 33 species reported using multiple assessment criteria and incl. commercial species.	Yes (24)	<u>Charting Progress 2 Assessment</u> • Good (11%); • Moderate (8%); • Bad (9%) <u>ICES IBTS Assessment</u> • Improving (5%); • Deteriorating (2%); • Full reproductive capacity (22%); • Harvested sustainably (17%); • Increased Risk (8%); • Reduced reproductive capacity (12%); • No change (5%); • Unknown (3%)	Yes (28)	<u>ICES IBTS Assessment</u> • Increase (39%); • Stable (19%); • Decrease (42%).	**Reports** • ICES IBTS and Stock Summary Data (2009); • FAO Statistics (2009) • DEFRA(2010)[§] **Criteria** • Landings • Large Fish Indicator (LFI) • Spawning Stock Biomass (SSB) • Fishing Mortality (F) • Abundance, Biomass and Productivity • Size composition • Species Evenness & richness • Diversity • Life-history trait composition • State change*
Marine mammals and reptiles 23 species reported using multiple assessment criteria	Yes (23)	• Favourable (45%); • Unfavourable – inadequate (10%); • Unfavourable – bad (10%); • Unknown (36%). • Based on one-out, all-out of Habitats Directive, 27% of listed marine mammal and reptiles species are in unfavourable condition	Yes (4)	• Stable or increasing (77%); • Fluctuating (9%); • Unknown (14%).	**Reports** • Article 17 Reporting (2007) **Criteria** • Abundance • Population size • Habitat • Range • Overall Assessment
Seabirds[$] 8 spp, 3 genus (diver, tern and gull) and assemblage information	Yes (12)	• Favourable (33%); • Unfavourable (67%).	Yes (4)	• Stable (50%); • Decrease (50%).	**Reports** • Birdlife International (2010). **Criteria** • Breeding population size.
Listed species 27 species reported using multiple assessment criteria	Yes (26)	• Favourable (19%); • Unfavourable – inadequate (31%); • Unfavourable – bad (26%); • Unknown (24%) • Of the 26 species, only 1 species (*Lagenorhynchus albirostris*) is in overall favourable conservation status[&]	Yes (11)	• Decrease (29%); • Increase (29%); • Stable (29%); • Fluctuating (5%); • Unknown (8%)	**Reports** • Article 17 Reporting (2007) **Criteria** • Abundance • Population size • Habitat • Range • Overall Assessment

[$] 8 spp. and 3 genus (diver, tern and gull) are listed in addition to an overall assessment of the seabird assemblage. The list is not exhaustive and focuses on the primary species found in the NE Atlantic. Further information can be found in Birdlife International (2004) Birds in the EU: A status assessment pp. 59.

[&] Habitats Directive Article 17 Overall Assessment is determined using a one-out all-out approach i.e., if one criteria does not meet the FCS criteria, the species as a whole does not meet FCS even if all other criteria meet the FCS requirements.

GES Descriptor 2: Non-indigenous species introduced by man

*Risk Assessment Outcome: **High***

GES Definition: GES for Non-indigenous species (NIS) is a function of their relative abundances and distribution ranges, and environmental impact. Good status will be maintained when significant adverse effects on environmental quality from NIS are avoided, including no elimination or extinction of sensitive and/or rare populations, alteration of native communities, seasonal dominance of algal blooms, or alteration of water chemistry (oxygen, nutrient content, pH and transparency). Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere and have an adverse effect on environmental quality. Therefore, invasive NIS are of most concern in terms of posing a risk to GES.

This table lists the NIS species and its characteristic group as an adult. For example, the ctenophore *Mnemiopsis leidyi* (comb jelly) would be recorded as a *pelagic (incl. plankton)* characteristic, and the slipper limpet *Crepidula fornicata* recorded within the *bottom fauna and flora* category due to it spending its adult life as a sessile benthic species despite a planktonic developmental/juvenile life stage. Available Information on NIS is in the form of abundance or distribution data for each species.

Pressure Assessment: Major Pathways of Introduction

Four sectors were identified as major vectors introducing non-indigenous species into the NE Atlantic. These sectors and the mechanisms introducing NIS species include:

- Aquaculture - importation of culture species, secondary spread;
- Military - hull fouling and ballast water exchange;
- Research - hull fouling, and ballast water exchange;
- Shipping - hull fouling and ballast water exchange.

The pressure assessment identified widespread impacts and persistent introductions from Shipping and Aquaculture sources. In all other cases, introductions are considered to have local impacts. Habitats affected include sublittoral sediments, circalittoral, infralittoral and littoral rock and littoral sediment habitats. Many invasive species have been recorded in the NE Atlantic (e.g. DAISIE). For example, the Chinese mitten crab *Eriocheir sinensis,* introduced in ballast water, has spread throughout the NE Atlantic region causing widespread modification of habitat and loss of native species (Dittel and Epifanio 2009). The slipper limpet *Crepidula fornicata*, originally introduced for aquaculture has also greatly modified habitat structure and function by out-competing native species resulting in the loss of native species of fauna and flora from intertidal shores (Thieltges, 2005; Thieltges et al. 2006).

The invasive jellyfish, *Mnemiopsis leidyi* is found throughout the eastern North Sea

The slipper limpet, *Crepidula fornicata* has invaded the large areas of the NE Atlantic (Photo: MARLIN)

Table 23. Trend information of ecological characteristics used to evaluate GES: Non-indigenous species. The number of Non-indigenous species in each ecological characteristic type is shown in brackets. This table lists the NIS species and its characteristic group as an adult. Species are listed in the ODEMM Status and trends database available online (www.liv.ac.uk/odemm/outputs/data)

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Pelagic (incl. plankton) (2)	Yes (2)	• Alien/Established* (100%)	No	N/A	**Report** • OSPAR 2010; • Olenin et al (2010) • DAISIE **Criteria** • Reproductive output
Bottom fauna and flora (27)	Yes (24)	• Alien/Established* (100%)	Yes (14)	• Increase (86%) • Stable (14%)	**Report** • OSPAR 2010; • Olenin et al (2010) • DAISIE **Criteria** • Reproductive output
Fish and Crustacea (2)	Yes	Alien/Established* (50%)	No	N/A	**Report** • Marine Climate Change Impacts Partnership (2010)
Marine mammals and reptiles	There are no established NIS marine mammals and reptiles reported in the NE Atlantic				
Seabirds	There are no established NIS seabird species, or associated impacts of NIS introduction(s) on seabird species				

*An assessment outcome of 'Established' indicates that the species is reproducing within the assessment area.

§ Indicates the assessment is undertaken at the sub-regional level only e.g. in the NE Atlantic region, assessment occurred only in the North Sea.

GES Descriptor 3: Commercial fish and shellfish

Risk Assessment Outcome: High

GES Definition: GES for commercially exploited fish and shellfish will be achieved when stocks are sustainably exploited consistently with high long-term yields and have full reproductive capacity. To achieve GES it will also be necessary, in addition to sustainably exploited stocks at full reproductive capacity, for the age and size distribution of fish and shellfish populations to be representative of a healthy stock, assessed by reference to the proportion of older and larger fish in the population. GES is achieved for a particular stock only if criteria for all attributes are fulfilled (i.e. one-out, all-out).

Table 24. Status and trend information of ecological characteristics used to evaluate GES: Commercial fish and shellfish. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Commercial shellfish (0) • No commercial shellfish are reported	No	N/A	No	N/A	N/A
Commercial fish (23) 23 species reported using multiple assessment criteria and incl. commercial species.	Yes (14)	<u>Charting Progress 2 assessment</u> • Good (6%); • Moderate (8%); • Poor (10%) <u>ICES Stock Summary Data</u> • Full reproductive capacity (27%); • Harvested sustainably (21%); • Increased Risk (10%); • Reduced reproductive capacity (15%); • Unknown (4%).	Yes (22)	<u>ICES Stock Summary Data</u> • Increase (21%) • Stable (26%) • Decrease (53%)	**Reports** • ICES Stock Summary Data (2007, 2010); • DEFRA 2010[§] **Criteria** • Spawning Stock Biomass (SSB) • Fishing Mortality (F) • Landings (trend) • Abundance (trend) • State change*

Local fishermen and their boats fishing for lobster off the north-east coast of England. Photo (H.J. Bloomfield)

GES Descriptor 4: Food webs

*Risk Assessment Outcome: **High***

GES Definition: The interactions between species in a food web are complex and constantly changing, making it difficult to identify one condition that represents 'good' status. However, some changes in species' relative abundance in an ecosystem can have significant adverse effects on food web status. Good Environmental Status of food webs will be achieved when energy flows through the food web, and the size, abundance and distribution of key trophic groups/species, are all within acceptable ranges that will secure the long-term viability of all food web components in line with prevailing natural conditions.

Table 25. Status and trend information of ecological characteristics used to evaluate GES: Food webs. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Plankton (assemblage) • Assessment of changes in plankton community composition	Yes (assemblage)	Moderate (100%)	Yes (assemblage)	• Stable (100%). • In the North Sea, the population of previously dominant and important cold-water zooplankton spp. have declined in biomass by 70% since the 1960s, although recent abundance is stable (FRS, 2010)	**Reports (§sub-regional for UK territorial waters only)** • DEFRA (2010)§ • Fisheries Research Service (2010) **Criteria** • Phytoplankton colour index (PCI)
Fish (6) The fish species selected are important top predators and include demersal piscivores (haddock, cod, saithe and whiting) and pelagic piscivores (horse mackerel and Atlantic mackerel) after Heath 2005*. Planktivorous fish that are also important components (sand eel and sprat) are also included.	Yes (5)	Charting Progress 2 • Good (6%); • Moderate (6%); • Bad (18%) ICES Stock Summary • Full reproductive capacity (24%); • Harvested sustainably (24%); • Increased Risk (6%); • Reduced reproductive capacity (18%).	Yes (6)	ICES Stock Summary Data • Stable (73%); • Decrease (27%)	**Reports** • ICES Stock Summary Data (2007, 2010); • Charting Progress 2§ (2010) **Criteria** • Spawning Stock Biomass (SSB) • Fishing Mortality (F) • State change*

Marine mammals and reptiles 23 species reported using multiple assessment criteria. Marine mammals are planktivorous feeders and top predators in the food chain. Species include striped dolphin *Stenella coeruleoalba,* common dolphin, *Delphinus delphis*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, harbour porpoise *Phocoena phocoena*, white beaked-dolphin *Lagenorhynchus albirostris and* grey seal *Halichoerus grypus*.	Yes (23)	• Favourable (45%); • Unfavourable – inadequate (10%); • Unfavourable – bad (10%); • Unknown (36%) • Based on one-out, all-out of Habitats Directive, 27% of listed marine mammal and reptiles species are in unfavourable condition	Yes (4)	• Stable or increasing (77%); • Fluctuating (9%); • Unknown (14%).	**Reports** • Article 17 Reporting (2007) **Criteria** • Abundance • Population size • Habitat • Range • Overall Assessment
Seabirds (7) • 6 species of seabird and assemblage information • All 6 species are important diver/planktivorous feeding species	Yes (7)	• Favourable (20%); • Unfavourable (40%) • Only the oyster catcher is in favourable conservation status	Yes (7)	• Stable (60%) • Decrease (40%)	**Reports** • Birdlife International (2004) **Criteria** • Population size
Listed species (9)	Yes (9)	• Favourable (60%); • Unfavourable – inadequate (9%); • Unfavourable – bad (11%); • Unknown (20%)	Yes (3)	• Increasing (45%); • Stable (9%); • Decrease (45%).	**Reports** • Article 17 Reporting (2007) **Criteria** • Abundance • Population size • Habitat • Range • Overall Assessment

*Heath, M. R. (2004). ICES Journal of Marine Science, 62: 847-868.

GES Descriptor 5: Eutrophication

Risk Assessment Outcome: Moderate

GES Definition: GES with regard to eutrophication has been achieved when the biological community remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive harmful algal blooms, low dissolved oxygen, declines in sea grass, kills of benthic organisms and/or fish) and/or where there are no nutrient-related impacts on sustainable use of ecosystem goods and services.

Table 27. Status, trend and impact information of ecological characteristics used to evaluate GES: Eutrophication. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Nutrients and Oxygen (3) • DIN/TN • DIP/TP • Dissolved Oxygen	No	N/A	Yes (3)	• Stable/Decrease (33%); • Decrease (66%).	**Reports** • OSPAR (2010) • ICES/MUDAB/UBA Digital North Sea Atlas • Published literature **Criteria** • Concentration
Plankton (assemblage)	Yes (assemblage)	Moderate (100%)*	Yes (assemblage)	Stable (100%)[&] ▪ In the North Sea, the population of previously dominant and important cold-water zooplankton spp. have declined in biomass by 70% since the 1960s, although recent abundance is stable (FRS, 2010)	**Reports** • DEFRA (2010) [§*] • Fisheries Research Service (2010)[&] • Published literature **Criteria** • Phytoplankton colour index (PCI)
Bottom fauna and flora	No information on status or trends is available, however, anecdotal evidence suggests that nutrient enrichment decay by algal blooms may lead to oxygen deficiencies leading to kills of benthic invertebrates in the region (OSPAR 2010).				
Fish	No information on status or trends is available, however, anecdotal evidence suggests that nutrient enrichment decay by algal blooms may lead to oxygen deficiencies leading to kills of fish in the region (OSPAR 2010).				

Pressure Assessment Outcomes

Introduction of nitrogen and phosphorus into the marine environment can originate from several human activities. Nutrients are predominantly introduced in the marine environment from rivers and sources can be diffuse, such as land run-off and leaching from agriculture, or point source introductions from activities such as aquaculture, land-based industry, and tourism and recreation. The amounts of nutrients released from land-based sources vary according to land use and population density e.g. point source in urban areas nd diffuse source in agricultural areas (OSPAR 2010). Farmland accounts for up to 70% of the coastal margin in some sub-regions of the NE Atlantic (e.g. North Sea and Irish Sea) and introduces the majority of nutrients into the marine environment in those areas (OSPAR 2010). However, the extent and frequency of introduction does not necessarily infer an undesirable impact (here, defined as resulting in harmful algal blooms, oxygen deficiency, decline in flora and fauna or kills of benthos and fish). For example, widespread and frequent introductions from tourism and recreation sources may not affect the biological communities and its functions, whereas site and occasional introductions from aquaculture into sheltered sea lochs can lead to mass mortality of fish as a result of algal blooms and oxygen deficiency (OSPAR 2010).

In the NE Atlantic, several sectors were identified by the pressure assessment as introducing Nitrogen and Phosphorus into the marine environment. These include: Agriculture, Aquaculture, Fishing, Land-based industry, Tourism and recreation and waste water treatment.

Table 27. Major widespread and localised sources of nutrients in the marine environment in the NE Atlantic.

Sector	Extent	Frequency	Source
Agriculture	Widespread	Persistent	Fertilizers, animal feed, biofuels
Aquaculture	Site	Persistent	Fish food
Fishing	Locally patchy	Persistent	Discards
Land-based industry	Locally patchy or site	Persistent	Fertilizer industry
Tourism and Recreation	Site	Persistent	Fertilizers
Waste water treatment	Locally patchy	Persistent	Organic material

Agricultural run-off into a large river (Photo: WRI)

GES Descriptor 6: Seafloor Integrity

Risk Assessment Outcome: High

GES Definition: GES is achieved where seafloor integrity is at a level that ensures that the structures and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. "Sea Floor" includes both the physical structure and biotic composition of the benthic community. "Integrity" includes the characteristic functioning of natural ecosystem processes and spatial connectedness. "Not adversely affected" is interpreted as meaning that impacts may be occurring, but all impacts are sustainable such that natural levels of diversity, productivity, and ecosystem processes are not degraded.

Table 28. Pressure assessment of overlap between human activities and pressures with predominant habitat types in the NE Atlantic. Shown are the total number of sector-pressure-ecological characteristic combinations evaluated and a summary of overlap, frequency of occurrence, degree of impact, habitat resilience and pressure persistence in the marine ecosystem (top) and predominant habitat types (bottom). Specific sectors and pressures constituting a *high threat* to GES (*high threat* is defined in the risk assessment criteria in Annex V after Breen et al. (in prep)) are shown for each habitat. Proportional values exclude all No Overlap (NO) combinations and the pelagic water column predominant habitat is not assessed. Category definitions are described in full in the pressure assessment guidance document (www.liv.ac.uk/odemm/outputs/guidancedocuments).

Pressure Assessment Summary	**Pressure Extent**	**Frequency of Occurrence**	**Degree of Impact**	**Resilience (Recovery Time)**	**Persistence of Pressure**
408 Pressure Combinations of the 1170 evaluated Sectors – 18 Pressure Types – 21	Widespread Patchy (12%) Locally Even (4%) Locally Patchy (46%) Site (38%)	Persistent (40%) Common (9%) Occasional (17%) Rare (34%)	Acute (36%) Chronic (43%) Low (21%)	Low to High	Continuous (7%) High (12%) Moderate (11%) Low (55%) High/Continuous* (9%) Low/Continuous* (6%)
Persistence can vary between sectors depending on likelihood of their being management options that would actually remove the pressure					
Littoral Rock 86 pressure combinations 17 sectors that have activities with pressures on this habitat	Widespread Patchy (8%) Locally Even (5%) Locally Patchy (41%) Site (47%)	Persistent (36%) Common (13%) Occasional (20%) Rare (31%)	Acute (33%) Chronic (44%) Low (23%)	High	Continuous (8%) High (7%) Moderate (12%) Low (60%) High/Continuous* (9%) Low/Continuous* (3%)
9 High Threat Combinations	**Sectors** • Agriculture • Aquaculture • Fishing • Military • Research • Shipping	**Pressures** • Introduction of NIS • Marine Litter • Nitrogen and Phosphorus enrichment			

Littoral Sediment 105 pressure combinations 17 sectors that have activities with pressures on this habitat	Widespread Patchy (12%) Locally Even (2%) Locally Patchy (36%) Site (50%)	Persistent (42%) Common (13%) Occasional (18%) Rare (27%)	Acute (34%) Chronic (38%) Low (28%)	High	Continuous (6%) High (7%) Moderate (18%) Low (55%) High/Continuous* (9%) Low/Continuous* (6%)
13 High Threat Combinations	**Sectors** • Agriculture • Coastal Infrastructure • Fishing • Military • Shipping	**Pressures** • Change in wave exposure • Emergence regime change • Introduction of NIS • Marine litter • Nitrogen and Phosphorus enrichment • Substrate loss • Water flow rate changes			
Infralittoral Rock 45 pressure combinations 15 sectors that have activities with pressures on this habitat	Widespread Patchy (11%) Locally Even (0%) Locally Patchy (42%) Site (47%)	Persistent (20%) Common (2%) Occasional (11%) Rare (67%)	Acute (49%) Chronic (42%) Low (9%)	Moderate	Continuous (16%) High (11%) Moderate (2%) Low (56%) High/Continuous* (11%) Low/Continuous* (4%)
4 High Threat Combinations	**Sectors** • Fishing • Military • Research • Shipping	**Pressures** • Introduction of NIS • Marine litter			
Circalittoral Rock 36 pressure combinations 16 sectors that have activities with pressures on this habitat	Widespread Patchy (11%) Locally Even (0%) Locally Patchy (31%) Site (58%)	Persistent (28%) Common (3%) Occasional (11%) Rare (58%)	Acute (44%) Chronic (47%) Low (8%)	Moderate	Continuous (14%) High (14%) Moderate (3%) Low (53%) High/Continuous* (11%) Low/Continuous* (6%)
5 High Threat Combinations	**Sectors** • Fishing • Military • Research • Shipping	**Pressures** • Introduction of NIS • Marine litter			

Pressure Assessment Summary	Pressure Extent	Frequency of Occurrence	Degree of Impact	Resilience (Recovery Time)	Persistence of Pressure
Sublittoral Sediment 112 pressure combinations 16 sectors that have activities with pressures on this habitat	Widespread Patchy (17%) Locally Even (4%) Locally Patchy (65%) Site (14%)	Persistent (51%) Common (6%) Occasional (20%) Rare (23%)	Acute (29%) Chronic (44%) Low (27%)	Moderate	Continuous (4%) High (17%) Moderate (11%) Low (52%) High/Continuous* (7%) Low/Continuous* (10%)
18 High Threat Combinations	**Sectors** • Agriculture • Fishing • Non-renewable Energy (oil and gas) • Shipping • Telecom	**Pressures** • Abrasion • Changes in siltation • Introduction of NIS • Introduction of non-synthetic compounds • Introduction of synthetic compounds		• Marine litter • Nitrogen and Phosphorus enrichment • Selective extraction of species • Substrate loss • Water flow rate changes	
Deep Sea 24 pressure combinations 6 sectors that have activities with pressures on this habitat	Widespread Patchy (4%) Locally Even (25%) Locally Patchy (54%) Site (17%)	Persistent (46%) Common (4%) Occasional (17%) Rare (33%)	Acute (46%) Chronic (46%) Low (8%)	Low	Continuous (0%) High (29%) Moderate (13%) Low (46%) High/Continuous* (13%) Low/Continuous* (0%)
2 High Threat Combinations	**Sectors** • Fishing	**Pressures** • Marine litter		*Remarks: Abrasion and substrate loss listed as LP rather than WP.*	

Table 29. High threat to GES Sector-Pressure combinations in all predominant habitats types in the NE Atlantic. Risk assessment criteria are those described in Annex V after Breen et al. (in prep).

High Threat Pressure Combinations following the Risk Assessment Criteria					
Criteria	**Extent**	**Frequency**	**Degree of Impact**	**Resilience**	**Persistence**
408 Pressure Combinations of the 1170	1. Widespread 2. Widespread 3. Widespread	1. N/A 2.Persistent/Common/Occasional 3. Persistent/Common	1. Acute/Chronic 2. Acute 3. Chronic	N/A	1. Continuous/High 2. N/A 3. N/A
Summary of High Threat Sectors: ▪ Agriculture ▪ Aquaculture ▪ Coastal Infrastructure ▪ Fishing ▪ Military ▪ Non-renewable energy (oil and gas) ▪ Research ▪ Shipping ▪ Telecom	Sector-Pressure Ecological Characteristic Combinations with the categories defined above and taken from the Risk Assessment framework document. Combination 1: Sectors include Aquaculture, Coastal Infrastructure, Fishing, Military, Non-renewable Energy (Oil & Gas), Research, Shipping, Telecom Pressures: Change in wave exposure; emergence regime change; introduction of non-indigenous species; introduction of synthetic compounds; marine litter; selective extraction of spp.; substrate loss; and water flow rate changes Combination 2: Sectors - Fishing Pressures: Abrasion; marine litter; selective extraction of spp.; and substrate loss. Combination 3: Sectors include Agriculture; Aquaculture; Coastal Infrastructure; Fishing; Non-renewable energy (oil & gas) and Shipping Pressures: Changes in siltation; emergence regime change; Nitrogen and Phosphorus enrichments; introduction of non-synthetic and synthetic compounds; introduction of non-indigenous species; change in wave exposure and water flow rate changes.				

* Acute and chronic degree of impact is defined as having a detrimental effect on the habitat or its characteristic species i.e. loss, removal or mortality.

GES Descriptor 7: Hydrographic Conditions

GES Definition: Permanent alterations of hydrographical conditions by human activities may consist, for instance, of changes in the tidal regime, sediment and freshwater transport, current or wave action, leading to modifications of the physical and chemical characteristics set out in Table 1 of Annex III to Directive 2008/56/EC. Good status is achieved when the various permanent alterations within a regional sea do not lead to adverse effects on marine ecosystems to the extent that the characteristic structures and features of those ecosystems are altered. In particular, the hydrographical conditions of habitats (water column or seafloor) should not be affected to the extent that their key functions (e.g. provision of spawning, breeding and feeding areas, or migration routes) are degraded.

Identification of Sector-Pressures affecting hydrographic conditions

The pressure assessment was used to identify sectors that contribute pressures (Table 31), which can affect the ecological characteristics used to describe hydrographic conditions (Table 30).

Table 31. Pressure assessment identification of widespread common or persistent pressures affecting hydrographic characteristics.

Pressure	Sector
Change in wave exposure	• Coastal infrastructure
Emergence regime change	• Coastal infrastructure
Introduction of non-synthetic compounds	• Non-renewable energy (oil & gas)
Introduction of synthetic compounds	• Non-renewable energy (oil & gas)
Nitrogen and Phosphorus enrichment	• Agriculture
Water flow rate changes	• Coastal infrastructure • Non-renewable energy (oil & gas)

Table 30. Status and trend information of ecological characteristics describing hydrographic (chemical) conditions of the NE Atlantic.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria §Indicates UK territorial waters only

Temperature (2)
• Sea surface temperature
• Bottom temperature
	No	N/A	Yes (2)	• *Increase (50%)*
				  • Sea surface temperature
				• *Decrease* (50%)
				  • Bottom temperature
					Reports
					• DEFRA 2010§
					• Published literature

Salinity (1)	No	N/A	Yes (1)	• Increase (100%)	**Reports** • DEFRA 2010§
pH, pCO_2 (2)	No	N/A	Yes (2)	• Decrease (100%)	**Reports** • DEFRA 2010 § • IPCC • Published literature
Nutrients and Oxygen (3) • DIN/TN • DIP/TP • Dissolved Oxygen	No	N/A	Yes (3)	• Stable/Decrease (33%); • Decrease (66%).	**Reports** • OSPAR 2010 • ICES/MUDAB/UBA Digital North Sea Atlas • Published literature **Criteria** • Concentration

GES Descriptor 8: Contaminants

Risk Assessment Outcome: Moderate

GES Definition: GES will be achieved when concentrations of contaminants in water, sediment and biota are below assessment thresholds identified on the basis of toxicological data; pollution levels are below assessment thresholds representing harm at organism, population, community and ecosystem levels; and trends in concentrations of contaminants in water, sediment and biota, and the occurrence and severity of pollution effects, are within acceptable limits and declining.

State and trends of the concentration of selected contaminants in sediment and biota are widely available for the NE Atlantic region, largely due to the monitoring requirements under existing EU directives such as the Nitrates Directive (91/676/EEC), Integrated Pollution Prevention and Control (IPCC) Directive (2008/1/EC), EU National Emissions Ceiling Directive (2001/81/EC), MARPOL Annex VI and UNECE Convention on Long-range Transboundary Air Pollution (Gothenburg Protocol).

Table 32. Status and trend of contaminant concentrations in the NE Atlantic.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals • PAHs • PCBs • Mercury • Lead • Cadmium	Yes (10)	• Status range from Acceptable to Unacceptable • Concentrations of chemicals in biota are highly variable within sub-regions with great uncertainty in status assessment in many cases	Yes (10)	• Stable (80%) • Stable or decreasing (20%)* • Stable or declining trends recorded in PAH and PCB concentrations in biota.	**Reports** • OSPAR(2010) **Criteria** • Concentration in sediment • Concentration in biota

GES Descriptor 9: Fish and Seafood Contaminants

Risk Assessment Outcome: Low to Moderate

GES Definition: GES would be achieved if all contaminants are at levels below the levels established for human consumption or showing a downward trend (for the substances for which monitoring is on-going but for which levels have not yet been set).

Table 33. Concentration of contaminants in fish and seafood in the NE Atlantic.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals in tissues • PAHs • PCBs • Mercury • Lead • Cadmium	Yes (5)	• Status ranges from Acceptable to Unacceptable • Concentrations of chemicals in biota are highly variable within sub-regions with great uncertainty in status assessment in many cases • Unacceptable status indicates contaminant levels exceed EcoQO levels and an unacceptable risk of chronic effects on marine species	Yes (5)	• Stable (60%) • Stable or decreasing (40%)	**Reports** • OSPAR Coordinated Environmental Monitoring Programme (CEMP) • OSPAR (2010) **Criteria** • Concentration in biota

GES Descriptor 10: Marine Litter

*Risk Assessment Outcome: **High***

GES Definition: GES occurs when the properties and quantities of marine litter do not cause harm to the coastal and marine environment. This can be achieved through a measurable and significant decrease in comparison with the baseline (i.e. the situation up until 2012) in the total amount of marine litter by 2020 using as attributes the characteristics of litter in the marine and coastal environment and the impacts of litter on marine life.

Table 34. Status, trend and background information on marine litter in the NE Atlantic.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Bottom flora and fauna	The impact of marine litter on bottom fauna is largely unknown, but may affect the ingestion rates of deposit- and filter-feeding species e.g. *Arenicola marina* and *Mytilus edulis*[1,2].				
Fish	Impacts of ghost fishing described by the FAO (1995) as "one of the most serious negative impacts from the capture fishing industry" but little scientific evidence to support statement. See Matsuoka et al (2005) for review[3].				
Marine mammals and reptiles	The primary impact of marine litter on marine mammals and reptiles is entanglement, yet little is known of the extent to which this impacts species within this group. 43% of all marine mammal species are affected worldwide[4,5].				
Seabirds Ingestion rate by northern fulmar	Yes (1)	• Poor (100%)	Yes (1)	• Decrease (100%)	**Reports** • OSPAR 2010
Listed species	See above for impacts on characteristic species.				
Litter in water column and subtidal habitats	The amount of litter in the water column and subtidal habitats is unknown. Fishing for Litter (FFL) initiative has removed 240 tonnes yr^{-1} in OSPAR Regions II (North Sea) and III (Celtic Sea).				**Reports** • OSPAR 2010
Litter in intertidal habitats Amount of litter on beaches in the NE Atlantic region	No	N/A	Yes (1)	• Stable (100%)	**Reports** • OSPAR 2010

[1]Browne, M.A. *et al.* (2008) Environmental Science and Technology 42(13): 5021-5026.
[2]Moore, C.J. (2008) Environmental Research 108(2): 131-139.
[3]Matsuoka, T. *et al*. (2005) Fisheries Science 71: 691-702.
[4]Laist, D.W. (1997) In: Coe, J.M., Rogers, D.B. (Eds.), Marine Debris – Sources, Impacts and Solutions. Springer- Verlag, New York, pp. 99–139.
[5]Derraik, J.G.B. (2002) Marine Pollution Bulletin 44: 842-852.

Pressure Assessment Outcomes

Seven sectors were identified as contributing to the widespread or localised distribution of marine litter in the NE Atlantic (Table 35). Within the NE Atlantic and wider OSPAR Maritime Area, the overall amount of marine litter is consistently high and is not reducing despite recent efforts (OSPAR, 2009). An assessment of amounts of beach litter indicated that the greatest amounts of marine litter in the NE Atlantic region are found in the Greater North Sea, Southern North Sea and Celtic Sea and English Channel. The Bay of Biscay and Iberian coastlines have considerably less litter on their beaches (OSPAR, 2009).

The environmental impact of marine litter on the marine ecosystem and its characteristic species is variable and uncertain. Lost fishing gears can result in the mortality of some species (i.e. ghost fishing) however the extent to which such mortality could affect the persistence of affected species is unknown and likely to occur in localised areas. Other types of litter, such as microplastics, are increasing in concentration (particles m^{-3}). Evaluation of the amount of microplastic in the stomach of Fulmars indicates >50% of birds exceed the recommended EcoQO target of 10% of the total stomach contents but a detrimental impact cannot be evaluated as only deceased birds are monitored and the variability in amount of plastic in the stomach of living Fulmars is unknown (OSPAR, 2009).

Table 35. Major widespread and localised sources of marine litter in the NE Atlantic.

Sector	Extent	Frequency	Source
Aquaculture	Locally patchy	Rare to Persistent	Nets, plastics
Coastal Infrastructure	Widespread to locally patchy	Persistent	Construction materials
Fishing	Widespread	Rare to Persistent	Lost gear/nets, general litter (cans, plastics)
Land-based industry	Widespread to locally patchy	Occasional to Persistent	Fertilizer industry, General litter (cans, plastics, containers)
Non-renewable energy (oil and gas)	Site	Occasional	Decommissioned rigs, General litter (cans, plastics)
Shipping	Widespread to locally patchy	Rare to Common	General litter (cans, plastics)
Tourism and Recreation	Locally patchy	Occasional to Common	General litter (cans, plastics)

Litter on a beach in the UK (Photos: The Guardian; J v Leeuwen)

GES Descriptor 11: Energy Introduction (incl. noise)

*Risk Assessment Outcome: **High***

There is little information describing the impacts of underwater noise on the marine ecosystem, but noise may have deleterious impacts on several ecological characteristics including fish, marine mammals and seabirds. In a recent Task Group report to the Commission (Tasker et al. 2010), three possible indicators of underwater noise were developed. However, in no case was the Task Group able to define when GES occurs on the axes of the indicators. This was in part to do with insufficient evidence, but also due to no clear definition of when underwater noise effects are detrimental (Tasker et al. 2010).

In the absence of existing monitoring programmes for indicators of underwater noise, a pressure assessment approach has been used to estimate the distribution of the 3 indicators recommended in the Task Group report, namely: (1) low and mid-frequency impulsive sound, (2) high frequency impulsive sound, and (3) low frequency continuous sound. Principle sectors contributing these types of underwater noise are shipping, military (sonar) and offshore construction and the extent and frequency of those sectors as used to inform the risk assessment (see Annex V for criteria) is shown (Table 37). The extent and frequency of those sound types in the NE Atlantic are well described with good information (e.g. VMS for shipping) available on the location of contributing sectors. Note that the extent of the sector may not directly reflect the extent of the pressure and changes in the resonance of the sound as it travels through the water column is not considered here.

Table 36. Extent and frequency of sectors contributing underwater noise pressures in the NE Atlantic.

Sector	Extent	Frequency
Shipping	Widespread patchy to site	Rare to Persistent
Military (sonar)	Widespread patchy to site	Rare to Persistent
Offshore construction (including non-renewable and renewable energy sectors)	Widespread patchy to site	Rare to Persistent

The offshore renewable and non-renewable energy sector can introduce underwater noise into the marine environment (Photos: CUYC; The Guardian)

Habitats Directive: Listed Species

*Risk Assessment Outcome: **High***

FCS Definition: The habitats directive species will be assessed as being at favourable conservation status when the population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, when the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future and when there is and will probably continue to be a sufficiently large habitats to maintain its populations on a long-term basis. Most assessments also considered an overall score for the species which combines these criteria. A one-out all-out approach has been adopted by the EEA (2009) as best practice for evaluation of multiple criteria per species, in which case, if one criteria falls below favourable conservation status, then the overall assessment for that species is reported as unfavourable.

Table 37. Status and trend information of Listed species under the Habitats Directive (Council Directive 92/43/EC) in the NE Atlantic. Status category criteria are defined in the Article 17 supporting documentation available from the European Environment Agency website (www.eea.eionet.europa.eu). The number of species evaluated is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species assessed. Overall Favourable Conservation Status is based on the one-out all-out approach, i.e. the worst case of any of the five criteria is the status applied to the species.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Listed species 27 species reported using multiple assessment criteria	Yes (26)	• Favourable (19%); • Unfavourable – inadequate (31%); • Unfavourable – bad (26%); • Unknown (24%) • Of the 26 species, only 1 species (*Lagenorhynchus albirostris*) is in overall favourable conservation status[&]	Yes (11)	• Decrease (29%); • Increase (29%); • Stable (29%); • Fluctuating (5%); • Unknown (8%)	**Reports** • Article 17 Reporting (2007) **Criteria** • Abundance • Population size • Habitat • Range • Overall Assessment

Habitats Directive: Habitats

*Risk Assessment Outcome: **High***

FCS Definition: The habitats directive habitats will be assessed as being at favourable conservation status when the habitats natural range and area it covers within that range are stable or increasing, 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 and the conservation stats of its typical species is favourable as defined for the habitats directive listed species. A one-out all-out approach has been adopted by the EEA (2009) as best practice for evaluation of multiple criteria per species, in which case, if one criteria falls below favourable conservation status, then the overall assessment for that species is reported as unfavourable.

Table 38. Status and trend information of Listed habitats under the Habitats Directive (Council Directive 92/43/EC) in the NE Atlantic. Status category criteria are defined in the Article 17 supporting documentation available from the European Environment Agency website (www.eea.eionet.europa.eu). The number of habitats evaluated is shown in brackets and may be evaluated using multiple criteria (see criteria in table) and therefore, status/trend category proportions shown may not match the number of habitats assessed. Overall Favourable Conservation Status is based on the one-out all-out approach, i.e. the worst case of any of the five criteria is the status applied to the habitat.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Listed Habitat (11) • 11 habitats are listed in the Article 17 report • Habitat codes are: 1110, 1130, 1140, 1150, 1160, 1170, 1180, 1230, 1310, 1330, and 1410.	Yes (11)	• Favourable (30%); • Unfavourable – inadequate (12%); • Unfavourable – bad (30%); • Unknown (28%) • Based on one-out, all-out of Habitats Directive, 90% of listed habitats in unfavourable condition • Vegetated sea cliffs of the Atlantic and Baltic coasts (1230) is the only habitat in Favourable Conservation Status	No	N/A	**Reports** • Article 17 Reports (2007) **Criteria** • Area • Future prospects • Range • Structure and Function • Overall Assessment

Annex III
The Black Sea

Introduction

The Black Sea is an almost enclosed basin with large river runoff and bounded exchange with the Mediterranean Sea through the Bosphorus Strait. Covering an area of 436,000 km^2 it presents a large variety of topography with a central flat abyssal plain (maximum depth 2,200 m) and ~200 km wide shelf in the north-west (depth <100 m, constituting 25% of the total area).

The drainage basin is five times larger than the sea area (Ludwig et al., 2009) and operates as a virtually isolated ecosystem, being particularly sensitive to distant anthropogenic activities (Stenseth et al. 2011). The drainage basin delivers industrial, domestic, and agricultural runoff of a population of more than 162 million people, primarily via three major rivers in the northwestern sector (Mee, 1992; Revenga et al., 1998). The riverine inflow is a key driver of ecosystem processes on the shelf, while the deep central sea is mostly isolated from the riverine influence.

The hydrographic regime is characterized by low salinity surface waters of river origin overlying high-salinity deep waters of Mediterranean origin, with a sharp and permanent pycnocline found between. The pynocline restricts the penetration of vertical mixing depth to 100–150 m. As a result a two-layered chemical structure of water is formed with oxygen only in the upper 150-200 m depth (13% of the sea volume) and anoxic conditions in the deep waters. There are sulfate reducing bacteria in the deep sea that lead to the accumulation of hydrogen sulfide and some other sulfur compounds (BSC, 2008).

The flora and fauna of the world's largest meromictic basin, which was formed under the conditions of relatively low salinity and the existence of an anoxic zone beneath the upper oxygen-containing layer, is distinguished by low species diversity within the present taxa. However, high productivity in near-shore regions results in high abundances of key commercial species and rich fish resources. Low species diversity combined with high habitat diversity in the Black Sea provides favourable conditions for the introduction of alien species (Shiganova et al., 2009; BSC 2010).

The Black Sea is bounded by Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine and supports many of the sectors identified by the ODEMM partnership as those exploiting its marine resources. Of the 20 sectors identified in ODEMM as those contributing to the current status of its ecological components, 18 sectors (except desalination operations and carbon sequestration) are operational within the region. Shipping, fishing, tourism, land based industry and infrastructure could be identified as the most important for economic development of all countries surrounding the Black Sea. But several sectors are largely country specific in terms of extent. More than 70 % of the total fisheries landings in the Black Sea belongs to the Turkish fishing fleet (www.seaaroundus.org, 2005). Aquaculture sector is developing in all Black sea countries, but it has grown rapidly into an important activity in Turkey and Bulgaria (BSC, 2007, Deniz, 2001). Oil and natural gas still supply main part of countries energy needs. The significant increase in upstream oil production created a midstream challenge of providing proper transportation of oil from the Caspian region to

western markets. This required construction of new oil pipelines as well as expanding existing ones (Oral, 2006). Nuclear power plays a significant role in the energy supply of Russia and Ukraine but nuclear stations are located far from coast. Wind farms as a renewable energy sector have been recently developed on the Bulgarian shore.

The Black Sea Region has undergone major socio-economic changes over the past 20 years. The regional economic collapse at the end of the 1980s, and the resultant break-up of the Soviet Union and birth of the CIS2 countries, together with a much less dramatic but still influential economic slow-down in 1997-98 have had major social and environmental implications. Since 2000, personal wealth has increased, but not as rapidly as inflation. Furthermore, this increase in wealth has been concentrated in the hands of a small number of very rich individuals. The size of the middle class remains small (BSC, 2007).

EBM of the Black Sea and in particular, implementation of the MSFD legislation is expected to be complex. Several countries including Russia, Georgia, Turkey and Ukraine are not Member States of the EU, and therefore are under no obligation under EU legislation (e.g., MSFD, HD). As such, effective EBM may not be possible unless non-Member States agree to support the objectives outlined in the EU legislation. If non-Member States choose not to play an active role in this process, transboundary effects are likely to greatly affect the success of marine ecosystem management in the Black Sea (BSC, 2007).

Availability of Information: Regional Summary

The Black Sea Member States are well placed to undertake their Initial Assessment obligations (Article 8, Directive 2008/56/EC) in which they must assess the current environmental status of the Baltic Sea waters and the environmental impact of human activities by 2020. The Commission on the Protection of the Black Sea Against Pollution (Black Sea Commission/BSC) via its permanent secretariat is an intergovernmental body that coordinates implementation of the Bucharest Convention, its protocols and development of the strategic action plan for the environmental protection and rehabilitation of the Black Sea. Research by scientific institutes, universities, governmental bodies and joint international programmes provide descriptions for all ecological characteristics outlined in the MSFD (Annex III, Table 1, Directive 2008/56/ECC) and a summary of this information is presented below (more detailed descriptions of this data are available for download from the ODEMM website (www.liv.ac.uk/odemm/outputs/data).

For those descriptors requiring a pressure assessment approach to evaluate GES, additional information is needed that describes the extent and frequency of the pressure and its impact on ecological characteristic(s) (e.g. Marine Litter and Underwater Noise pressure and impact effects on ecological characteristics). Geographic information was largely unavailable, thus assessment of pressure footprint (extent) and frequency was undertaken by a group of regional experts.

The resilience of habitats and species to a pressure(s) was derived from published literature (i.e. journal articles). When data were unavailable, expert judgement by ODEMM partners in the Regional Sea and wider European partnership was undertaken.

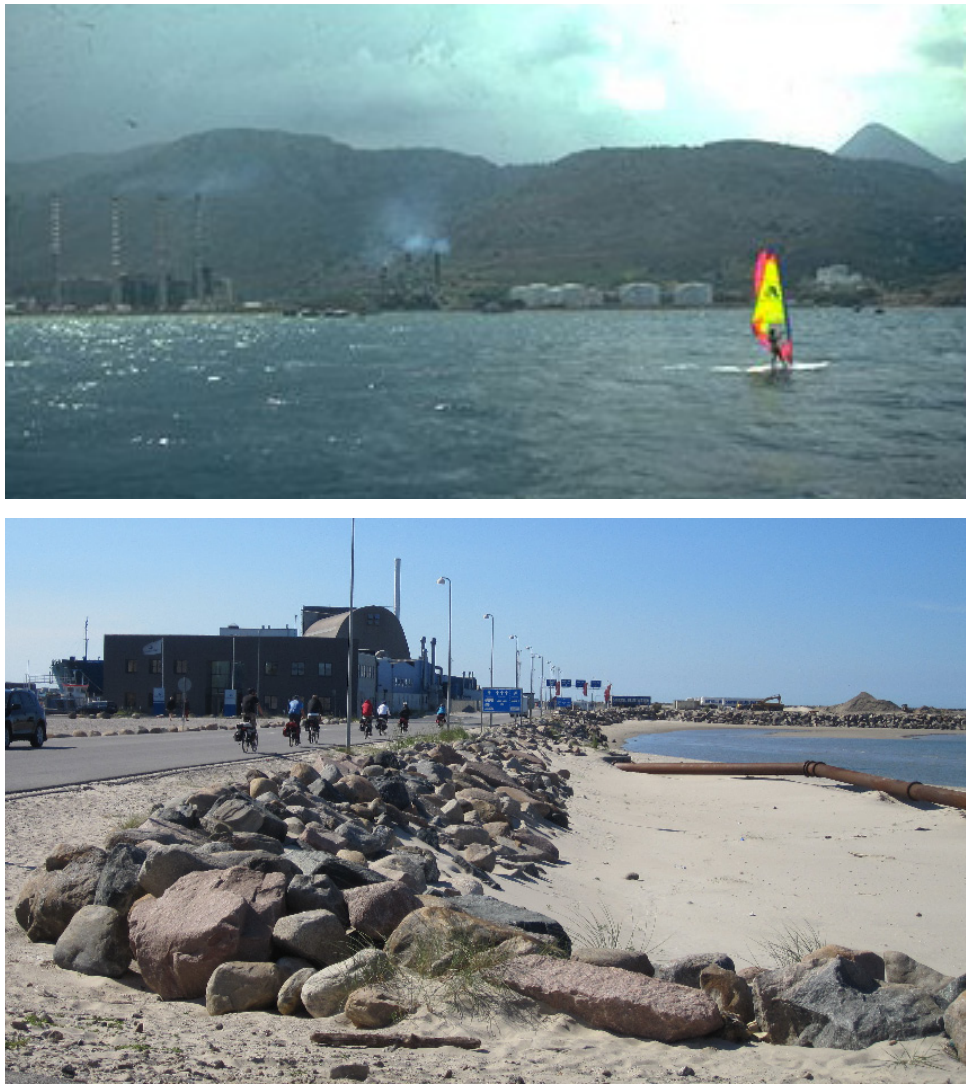
Figure 3. The Black Sea extent and bounding countries.

Problem Areas and Likelihood of Failure to Achieve GES

The primary areas of concern and likelihood of failure to achieve GES for each descriptor in the Black Sea were identified (Table 39). Of the 14 ecological characteristics listed in Annex III of the MSFD as recommended for assessment, 57% of those are currently considered either in poor or threatened status. Not all species or habitats within each characteristic type are in poor or threatened status nor do all indicators available for a given species or habitat indicate poor/ inadequate status. However, problems were identified for all GES Descriptors (Table 39) due to the contribution of poor or threatened ecological characteristic(s) to multiple GES descriptors (e.g. marine mammals contribute to the assessment of GES descriptors: Biodiversity, Foodwebs and Habitat Directive species).

Available status information indicated that several ecological characteristics are currently threatened. These include: nutrients and oxygen concentrations, predominant and habitats meriting special reference, fish (listed, commercial and non-commercial species), bottom flora and fauna, pH/pCO2, marine mammals/reptiles and seabirds. Status information was unavailable for temperature, salinity, plankton, and non-indigenous invasive species but could be described using trend information was available. Topography/bathymetry is the only component that cannot be described using status and/or trend information.

Where status and trend information was not appropriate to evaluate a GES descriptor, a pressure assessment was used. Following the approach and criteria developed within ODEMM, several threats to the environment arising from human activities were identified. Those sectors which were considered as contributing pressures that could be detrimental to the marine environment (ecological characteristic(s) or achievement of GES) included agriculture, coastal infrastructure, fishing, shipping, tourism and recreation, and waste water treatment. Assessment of the contribution of each sector to current status or the highest threat to the marine environment and its components will be evaluated in later ODEMM work packages.



Multiple uses of the coastal margin from industry to tourism and recreation (Photo: N. Papadopoulou; A. Delaney)

Table 39. A Summary of Areas of Concern, Risks to GES, and Confidence in Risk Assessment of GES Descriptors in the Black Sea. Each GES Descriptor is described by one or more components: ecological characteristics, pressure and/or impacts information (see Chapter 2). The components used to evaluate each descriptor are shown in more detail in the following summary tables and outline the availability of information and criteria used to assess current status and trends of components in each Regional Sea. * indicates a pressure assessment approach was used, either in part or in its entirety, to evaluate the descriptor. Risk assessment criteria and confidence assessment definitions are described in Chapter 3 and Annex V of this report.

GES Descriptor	Problems	Areas of Concern	Risks to GES	Risk Confidence
1a. Plankton	No	Plankton communities are broadly stable throughout the region, but alterations in dissolved nutrient ratios have led to a change in phytoplankton dominant groups	Moderate	Moderate
1b. Fish	Yes	Intense and unregulated fishing has led to over-exploitation of major fish stocks with several commercial and non-commercial species in unfavourable status and/or declining in abundance. Some recovery of populations has been seen since the mid-1990s.	Moderate	Moderate
1c. Marine Mammals	Yes	Several marine mammal species in the Black Sea are endangered in terms of population size and distribution and have the potential to become extinct within the next 10 - 20 yr	Moderate-high	High
1d. Seabirds	Yes	Several seabird species are currently under threat in terms of distribution and population size, several of which are threatened, vulnerable or at endangered status and likely to become extinct in the next 10 yr	High	High
1e. Predominant Habitats	Yes	Much of the coastline has been subject to anthropogenic pressures resulting in a decline in diversity and reduction in status, despite extensive protection of habitats and management plans.	Moderate-high	Moderate
2. Non-indigenous species (NIS)*	Yes	Two NIS species, *Rapana venosa* and *Mnemiopsis leidyi* have historically caused widespread problems in the region. Despite a reduction in *Mnemiopsis leidyi* abundance, the density and distribution of the species continue to cause impacts in the region	High	High
3. Commercial fish and shellfish	Yes	Destructive fishing practices and over-exploitation has led to the decline of many benthic and pelagic fish species with stocks collapsing in the 1980s. Stocks have been slow to recovery with several species under threat	High	Moderate
4. Food webs	Yes	Commercial fishing led to mass destabilisation of the marine food web with removal of important top predator fish species. This was a factor in the rapid expansion of the invasive ctenophore, *Mnemiopsis leidyi* and reductions in native plankton species	High	Moderate
5. Eutrophication*	Yes	Oxygen deficiency frequent and widespread throughout the north-west shelf and summer-autumn hypoxia is an annual phenomena associated with active eutrophication. Historic nutrient discharges from agriculture and industrial sources led to heavy enrichment and widespread eutrophication but discharge control has led to reductions in nutrient concentrations in recent years.	Moderate	High
6. Seafloor Integrity*	Yes	Human activities such as agriculture, coastal infrastructure, fishing, shipping, tourism and recreation, and waste water treatment contribute widespread and persistent pressures that have detrimental effects on several aspects of the Black Sea ecosystem	High	Moderate
7. Hydrographic conditions*	No	Sea surface temperatures are variable and temperature and thickness of cold-intermediate layer (CIL) waters vary with cyclic dynamics (current trends indicate an increase in temperature and decrease in thickness).	Not assessed	Not assessed
8. Contaminants	Yes	Petroleum hydrocarbons and pesticides in sediments are in elevated concentrations and exceed threshold levels in localised areas	Moderate-high	High
9. Fish and Shellfish Contamination	Yes	Chemical concentrations in biota are highly variable and may exceed threshold concentrations, however, there is a great deal of uncertainty in estimates	Moderate	Low-moderate
10. Marine Litter*	Unknown	The amount of litter in the region is not known, however, it is a 'visible' problem along the Black Sea coastline. Several human activities including coastal infrastructure, fishing, land-based industry and shipping introduce commonly introduce litter throughout the region	High	Moderate
11. Energy (Underwater noise)*	Yes	Shipping is widespread and continues to increase throughout the region introducing low-frequency sound throughout the region	High	Moderate
12a. Habitats Directive Habitats	Unknown	The Habitats Directive was adopted by the Black Sea Member States in 2007 and status is yet to be reported under Article 17.	N/A	N/A
12b. Habitats Directive Species	Unknown	The Habitats Directive was adopted by the Black Sea Member States in 2007 and status is yet to be reported under Article 17.	N/A	N/A

GES Descriptor 1: Biodiversity

Risk Assessment Outcome: Moderate to Moderate-High

GES Definition: GES is achieved when biodiversity is maintained in the regional sea such that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Loss of biodiversity can be described as occurring where there is a reduction in genetic, species, habitat or ecosystem diversity within the regional sea over this time scale. More specifically loss of particular meta-populations, species, habitat types or ecosystem properties within the region (e.g. extirpations) would certainly count as a loss of biodiversity, but so could a noticeable change in diversity based on changes in evenness (e.g. shifts in dominance). GES under Biodiversity should be assessed individually for each of the major ecosystem characteristics listed in Annex III of the MSFD as recommended in the COM decision.

Table 40. Status and trend information of ecological characteristics used to evaluate GES: Biodiversity. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. For more details, see in text (Chapter 2).

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Predominant Habitat (5) • Littoral rock and other hard substrate • Littoral sediment • Infralittoral rock and other hard substrata • Sublittoral sediment • Pelagic water column	Yes (4)	• Good (20%); • Moderate (60%); • Bad (20%).	Yes (5) Each habitat was evaluated using multiple criteria (a total of 19 combinations).	• Increase (37%); • Stable (10%); • Fluctuating (6%); • Decrease (47%).	**Reports** • BSC (2007) • NAFA (2007) • ICES WGIAB (2010) • BSC SoEBS Report (2008) **Criteria** • Habitat condition • Area • Distribution • Condition (physical, chemical) • Species diversity
Listed Habitat 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.					
Seabirds (14) • 14 spp. of seabird are reported including gull, duck, pelican, shearwater and shag (see Status and Trends database for a complete list)	Yes (14)	• Critically Endangered (8%); • Endangered (14%); • Vulnerable (14%); • Near threatened (14%); • Least Concern (50%).	Yes (14)	• Increase (29%); • Stable (21%); • Decrease (50%).	**Reports** • IUCN Redlist • Birdlife International (2004) **Criteria** • Species distribution • Population size

Plankton (6) • Bacterioplankton • Zooplankton (fodder) • Mezozooplankton (fodder) • Mezozooplankton (non-fodder) • Gelatinous (e.g. *M. leidyi*) • Phytoplankton	No	N/A	Yes (6)	• Increase (22%); • Stable (72%); • Decrease (6%)	**Reports** • BSC SoEBS Report (2008) • Published Literature **Criteria** • Abundance • Biomass • Chl-*a* • Species richness • Primary production
Bottom fauna and flora (17) • Macrozoobenthos • *Mytilus galloprovincialis* • *Chamelea gallina* • *Modiolula phaseolina* • *Phyllophora nervosa* • *Cystoseira* spp. • *Zostera* sp.	Yes (8)	• Good-Moderate (12%); • Moderate (37%); • Unfavourable (12%); • Bad (12%)	Yes (17)	• Increase (30%); • Stable (30%) • Decrease (40%)	**Reports** • BSC SoEBS Report (2008) **Criteria** • Abundance • Biomass • Species diversity and structure • Diversity index • Area extent
Fish (12) • 12 species reported using multiple assessment criteria and incl. commercial species based on catch data. • Assemblage information on demersal, pelagic, and anadromous species.	Yes (2) • Pontic shad, Horse mackerel, turbot, anadromous and demersal fish assemblage	• Unfavourable (60%); • Poor (40%).	Yes (9)	• Increase (28.5%); • Stable (43%); • Decrease (28.5%).	**Reports** • BSC SoEBS Report (2008) • JRC STECF Review (2009) **Criteria** • Age • Average length & weight • Biomass • Catch • CPUE • Landings • Recruitment • Stock size • Spawning Stock Biomass (SSB) • Fishing Mortality (F)
Marine mammals (4) 4 species reported and evaluated by both population size and species distribution • Common bottlenose dolphin; • Harbour porpoise; • Mediterranean monk seal; • Short-beaked common dolphin.	Yes (4)	• Critically Endangered (19%); • Endangered (27%); • Vulnerable (27%); • Data deficient (27%). • Only the Mediterranean monk seal is critically endangered (both criteria), and all other species are endangered in terms of population size and vulnerable in terms of distribution.	Yes (4)	• Increase (44%); • Decrease (44%); • Unknown (12%).	**Reports** • IUCN Redlist **Criteria** • Species distribution • Population size
Listed Species 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.					

GES Descriptor 2: Non-indigenous species introduced by man

Risk Assessment Outcome: ***High***

GES Definition: GES for Non-indigenous species (NIS) is a function of their relative abundances and distribution ranges, and environmental impact. Good status will be maintained when significant adverse effects on environmental quality from NIS are avoided, including no elimination or extinction of sensitive and/or rare populations, alteration of native communities, seasonal dominance of algal blooms, or alteration of water chemistry (oxygen, nutrient content, pH and transparency). Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere and have an adverse effect on environmental quality. Therefore, invasive NIS are of most concern in terms of posing a risk to GES.

This table lists the NIS species and it characteristic group as an adult. For example, the ctenophore *Mnemiopsis leidyi* (comb jelly) would be recorded as a *pelagic (incl. plankton)* characteristic. Available Information on NIS is in the form of abundance or distribution data for each species.

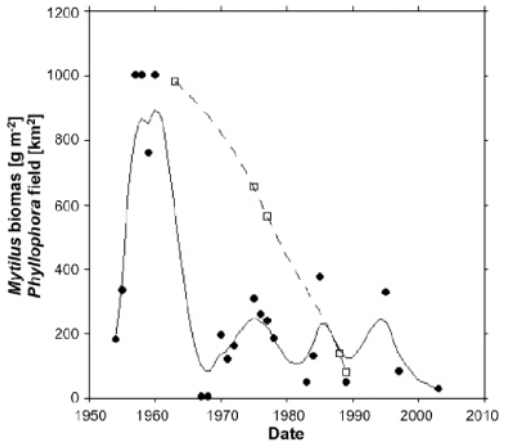
Pressure Assessment: Major Pathways of Introduction

Five sectors were identified as major pathways introducing non-indigenous species into the Black Sea. The sectors and the mechanisms include:

- Aquaculture - importation of culture species, secondary spread;
- Fishing - hull fouling, fouling (nets)
- Military - hull fouling and ballast water exchange;
- Research - hull fouling, and ballast water exchange;
- Shipping - hull fouling and ballast water exchange.

Widespread impacts from shipping were identified and local impacts from all other sectors. Affected habitats include sublittoral and littoral rock and sediment, and pelagic water column habitats. Notable examples in the Black Sea include the *Rapana venosa* (Rapa/veined whelk), which was introduced for aquaculture and outcompetes native species (Giberto et al. 2006) and the comb jelly *Mnemiopsis leidyi*, introduced by ballast water and results in competition with native species and cascading trophic effects on the food web (e.g. Tsagarakis et al. 2010).

The invasive jellyfish, *Mnemiopsis leidyi* caused widespread fish kills throughout the Black Sea during the 1990s (Photo: Independent)



Reductions in native mussel biomass in association with the invasion of a red algae (Steckbauer et al. Environ. Res. Lett 6, 2011)

Table 41. Trend information of ecological characteristics used to evaluate GES: Non-indigenous species in the Black Sea. The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets. This table lists the NIS species and its characteristic group as an adult.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Pelagic (incl. plankton) (3) • *Beroe ovata*; • *Mnemiopsis leidyi*; • NIS assemblage including plankton spp.	No	N/A	Yes (4)	• Increase (29%); • Stable (57%); • Decrease (14%). • A decrease in the abundance of *M. leidyi* has been recorded but numbers are still high	**Report** • BSC SoEBS Report (2008); • JRC STECF Review (2009); • BSC (2008) **Criteria** • Abundance • Species richness • Biomass
Bottom fauna and flora (2) • *Rapana venosa;* • NIS assemblage including macroalgae and zoobenthos.	No	N/A	Yes (2)	• Increase (67%); • Decrease (33%). • A decrease in the biomass of *Rapana venosa* has been recorded but numbers are still high	**Report** • BSC SoEBS Report (2008); • JRC STECF Review (2009); • BSC (2008) **Criteria** • Species richness • Biomass
NIS assemblage: Abundance of marine NIS spp (2)	No	N/A	Yes (2)	• Increase (100%)	**Report** • JRC STECF Review (2009); • BSC (2008)
Marine mammals and reptiles	There are no established NIS marine mammals and reptiles reported in the Black Sea				
Seabirds	There are no established NIS seabird species, or associated impacts of NIS introduction(s) on seabird species				

*An assessment outcome of 'Established' indicates that the species is reproducing within the assessment area.

GES Descriptor 3: Commercial fish and shellfish

*Risk Assessment Outcome: **High***

GES Definition: GES for commercially exploited fish and shellfish will be achieved when stocks are sustainably exploited consistently with high long-term yields and have full reproductive capacity. To achieve GES it will also be necessary, in addition to sustainably exploited stocks at full reproductive capacity, for the age and size distribution of fish and shellfish populations to be representative of a healthy stock, assessed by reference to the proportion of older and larger fish in the population. GES is achieved for a particular stock only if criteria for all attributes are fulfilled (i.e. one-out, all-out).

Table 42. Status and trend information of ecological characteristics used to evaluate GES: Commercial fish and shellfish. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. For more details, see the full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Commercial bottom fauna and flora (3) • *Chamelea gallina;* • *Mytilus galloprovincialis*; • *Rapana* spp.	Yes (1)	• Unfavourable (100%)	Yes (3)	• Increase (66%); • Decrease (33%)	**Reports** • BSC SoEBS Report (2008) **Criteria** • Capacity • Landings • Stock size
Commercial Fish (9) • 9 species reported using multiple assessment criteria and incl. commercial species based on catch data • Assemblage information on demersal, pelagic, and anadromous species.	Yes (3) Pontic shad, Horse mackerel and turbot	• Unfavourable (34%)*; • Poor (66%)*.	Yes (9) • Anchovy – stable • Sprat - stable • Horse mackerel- decrease • Pontic shad – stable • Whiting – decrease • Picked dogfish –decrease • Turbot – stable • Striped mullets – decrease • Golden mullet -increase	• Increase (12%); • Stable (44%); • Decrease (44%).	**Reports** • BSC SoEBS Report (2008)*; • JRC STECF Review (2009). **Criteria** • Age • Average length & weight • Biomass • Catch • CPUE • Landings • Recruitment • Stock size • Spawning Stock Biomass (SSB) • Fishing Mortality (F)

A mixed-catch from a trawler (Photo: N.P. Papadopoulou)

A busy harbour with boats of various size (Photo: A. Delaney)

GES Descriptor 4: Food webs

*Risk Assessment Outcome: **High***

GES Definition: The interactions between species in a food web are complex and constantly changing, making it difficult to identify one condition that represents 'good' status. However, some changes in species' relative abundance in an ecosystem can have significant adverse effects on food web status. Good Environmental Status of food webs will be achieved when energy flows through the food web, and the size, abundance and distribution of key trophic groups/species, are all within acceptable ranges that will secure the long-term viability of all food web components in line with prevailing natural conditions.

Table 43. Status and trend information of ecological characteristics used to evaluate GES: Food webs. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. For more details, see in text (Chapter 2).

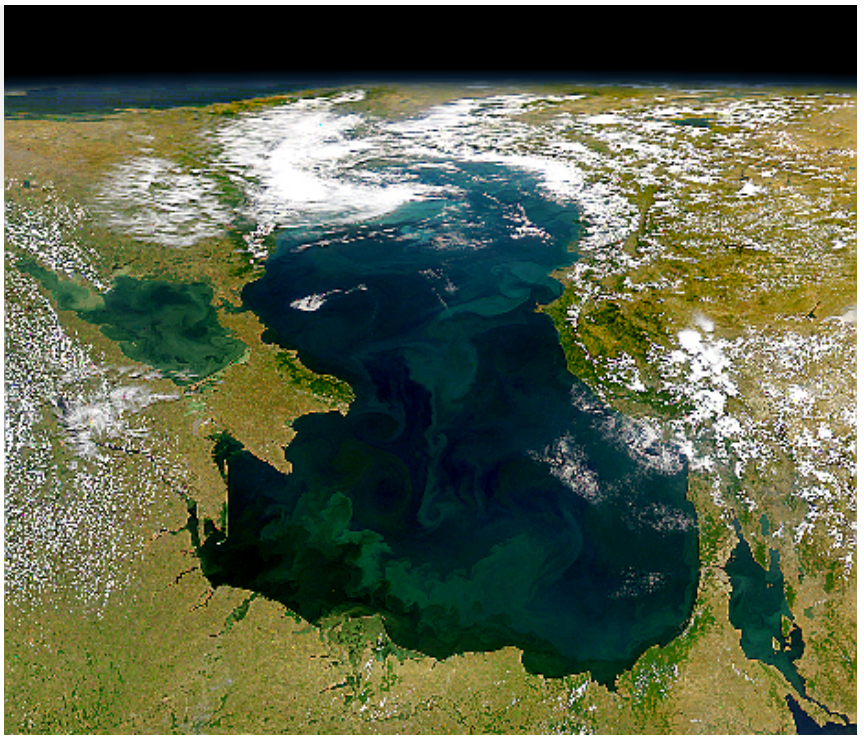
Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Plankton (6) • Bacterioplankton • Zooplankton (fodder) • Mezozooplankton (fodder) • Mezozooplankton (non-fodder) • Gelatinous (e.g. *M. leidyi*) • Phytoplankton	No	N/A	Yes (6)	• Increase (22%); • Stable (72%); • Decrease (6%)	**Reports** • BSC SoEBS Report (2008) • BSC (2008) • Published Literature **Criteria** • Abundance • Biomass • Chl-*a* • Species richness • Primary production
Fish (4) • Pelagic species • Anadromous species • Species in these groups are top predators and planktivorous feeders	Yes (2)	• Partial recovery (33%); • Unfavourable (66%).	Yes (4)	• Increase (50%); • Stable (20%); • Decrease (20%).	**Reports** • BSC SoEBS Report (2008) **Criteria used:** • Catch

Marine mammals (4) 4 species reported and evaluated by both population size and species distribution. All are top predators in the food chain. • Common bottlenose dolphin; • Harbour porpoise; • Mediterranean monk seal; • Short-beaked common dolphin.	Yes (4)	• Critically Endangered (19%); • Endangered (27%); • Vulnerable (27%); • Data deficient (27%). • Only the Mediterranean monk seal is critically endangered (both criteria), and all other species are endangered in terms of population size and vulnerable in terms of distribution.	Yes (4)	• Increase (44%); • Decrease (44%); • Unknown (12%).	**Reports** • IUCN Redlist **Criteria** • Species distribution • Population size
Seabirds (14) • 14 spp. of seabird are reported including gull, duck, pelican, shearwater and shag (see Status and Trends database for a complete list). All species are active predators of marine species of fish.	Yes (14)	• Critically Endangered (8%); • Endangered (14%); • Vulnerable (14%); • Near threatened (14%); • Least Concern (50%).	Yes (14)	• Increase (29%); • Stable (21%); • Decrease (50%).	**Reports** • IUCN Redlist • Birdlife International (2004) **Criteria** • Species distribution • Population size
Listed Species 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.					

GES Descriptor 5: Eutrophication

Risk Assessment Outcome: Moderate

GES Definition: GES with regard to eutrophication has been achieved when the biological community remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive harmful algal blooms, low dissolved oxygen, declines in sea grass, kills of benthic organisms and/or fish) and/or where there are no nutrient-related impacts on sustainable use of ecosystem goods and services.



Eutrophication in the Black Sea possible associated with agricultural run-off from the River Danube (NASA, 1999)

Pressure Assessment Outcomes

Nitrogen and phosphorus introductions into the Black Sea originate from six sectors (Table 44). Nutrients are predominantly introduced in the marine environment from rivers. Widespread and persistent introductions originate from diffuse sources discharges, such as land run-off and leaching from agricultural (BSC SoEBS Report, 2008; Borysova et al. 2005). Localised and persistent point source introductions arise from aquaculture, land-based industry, and tourism and recreation (Borysova et al. 2005). The amounts of nutrients released from land-based sources vary according to land use and population density e.g. point source in urban areas and diffuse source in agricultural areas (BSC SoEBS Report, 2008; BSC, 2007), however, the extent and frequency of introduction does not necessarily infer a detrimental effect on the ecosystem and the physical characteristics (e.g. currents and residence time) of the region should be carefully considered when evaluating the impact(s) of nitrogen and phosphorus enrichment and its role in eutrophication.

Nutrient loadings in the northwestern part of the Black Sea, the Azov Sea and the lower parts of the Danube, Dnipro and Don Rivers are close to maximal levels, but implementation of the EU Directives (e.g. Nitrates Directive (91/676/EEC) and Integrated Pollution Prevention and Control (IPCC) Directive (2008/1/EC)) for control of the discharge of Nitrogen and Phosphorus are expected to lead to reductions over time.

Table 44. Major widespread and localised sources of nutrients in the marine environment.

Sector	Extent	Frequency	Source
Agriculture	Widespread	Common	Fertilizers, animal feed, biofuels
Aquaculture	Locally patchy or site	Persistent	Fish food
Fishing	Site	Rare	Discards
Land-based industry	Locally patchy or site	Common	Fertilizer industry
Tourism and Recreation	Locally patchy or site	Common	Fertilizers
Waste water treatment	Locally patchy	Persistent	Organic material

Table 45. Status, trend and impact information of ecological characteristics used to evaluate GES: Eutrophication. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. For more details, see the full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Nutrients and Oxygen (3) • DIN/DON • DIP • Dissolved Oxygen (near-bottom layer)	Yes (3)	• Moderate (80%); • Bad (20%).	Yes (3)	• Increase (18%); • Stable (18%); • Fluctuating (47%)*; • Decrease (18%).	**Reports** • Zaytcev et al. (2006) • BSC SoEBS Report (2008) • Published literature **Criteria** • Concentration
Fish kills	There is no data describing fish kills in the Black Sea.				
Bottom fauna and flora (5) Benthos kills of: • *Mytilus galloprovincialis* • Macrophytes	No	N/A	Yes	• Fluctuation in abundance due to hypoxia events (for *M. galloprovincialis*), • Part recovery after decrease in 70-80s	**Reports** • BSC SoEBS Report (2008) **Criteria** • Biomass • Area extent
Plankton (2) • Harmful blooms (e.g. *M. leidyi*) • Phytoplankton density	No	N/A	Yes (2)	• Stable (100%)	**Reports** • BSC (2008) **Criteria** • Biomass • Primary production

* A fluctuating trend refers to a quadratic trend. Refer to the status and trends excel spreadsheet for details of the reference points and descriptions of relationship.

GES Descriptor 6: Seafloor Integrity

Risk Assessment Outcome: High

GES Definition: GES is achieved where seafloor integrity is at a level that ensures that the structures and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. "Sea Floor" includes both the physical structure and biotic composition of the benthic community. "Integrity" includes the characteristic functioning of natural ecosystem processes and spatial connectedness. "Not adversely affected" is interpreted as meaning that impacts may be occurring, but all impacts are sustainable such that natural levels of diversity, productivity, and ecosystem processes are not degraded.

Table 46. Pressure assessment of overlap between human activities and pressures with predominant habitat types in the Black Sea. Shown are the total number of sector-pressure-ecological characteristic combinations evaluated and a summary of overlap, frequency of occurrence, degree of impact, habitat resilience and pressure persistence in the marine ecosystem (top) and predominant habitat types (bottom). Specific sectors and pressures constituting a high threat to GES (high threat is defined in the risk assessment criteria in Annex V) are shown for each habitat. Proportional values exclude all No Overlap (NO) combinations and the pelagic water column predominant habitat is not assessed. Category definitions are described in full in the pressure assessment guidance document (www.liv.ac.uk/odemm/outputs/guidancedocuments).

Pressure Assessment Summary	**Pressure Extent**	**Frequency of Occurrence**	**Degree of Impact**	**Resilience (Recovery Time)**	**Persistence of Pressure**
385 Pressure Combinations of the 880 evaluated Sectors – 15 Pressure Types – 19	Widespread Patchy (22%) Locally Even (0%) Locally Patchy (44%) Site (34%)	Persistent (30%) Common (14%) Occasional (32%) Rare (24%)	Acute (27%) Chronic (50%) Low (23%)	Moderate to High	Continuous (4%) High (20%) Moderate (8%) Low (54%) High/Continuous* (6%) Low/Continuous* (9%)
*Persistence can vary between sectors depending on likelihood of there being management options that would actually remove the pressure					
Littoral rock 87 pressure combinations 15 sectors that have activities with pressures on this habitat	Widespread Patchy (23%) Locally Even (0%) Locally Patchy (36%) Site (41%)	Persistent (32%) Common (13%) Occasional (28%) Rare (28%)	Acute (25%) Chronic (47%) Low (28%)	High	Continuous (3%) High (23%) Moderate (0%) Low (61%) High/Continuous* (3%) Low/Continuous* (9%)
19 High Threat Combinations	**Sectors** • Agriculture • Coastal infrastructure • Fishing • Shipping • Tourism and Recreation • Waste water treatment	**Pressures** • Change in wave exposure • Introduction of NIS • Introduction of synthetic compounds • Marine litter • Nitrogen and Phosphorus enrichment • Smothering • Substrate loss • Water flow rate			

Littoral sediment 99 pressure combinations 15 sectors that have activities with pressures on this habitat	Widespread Patchy (20%) Locally Even (0%) Locally Patchy (43%) Site (36%)	Persistent (30%) Common (17%) Occasional (28%) Rare (24%)	Acute (23%) Chronic (43%) Low (33%)	High	Continuous (3%) High (18%) Moderate (11%) Low (54%) High/Continuous* (5%) Low/Continuous* (9%)
13 High Threat Combinations	**Sectors** • Agriculture • Coastal infrastructure • Fishing • Shipping • Tourism and Recreation	**Pressures** • Change in wave exposure • Introduction of NIS • Introduction of synthetic compounds • Marine litter • Nitrogen and Phosphorus enrichment • Smothering • Substrate loss • Water flow rate			
Infralittoral rock 90 pressure combinations 15 sectors that have activities with pressures on this habitat	Widespread Patchy (21%) Locally Even (0%) Locally Patchy (48%) Site (31%)	Persistent (32%) Common (9%) Occasional (36%) Rare (23%)	Acute (28%) Chronic (68%) Low (4%)	Moderate	Continuous (7%) High (19%) Moderate (0%) Low (60%) High/Continuous* (7%) Low/Continuous* (8%)
16 High Threat Combinations	**Sectors** • Coastal infrastructure • Fishing • Shipping	**Pressures** • Change in wave exposure • Introduction of NIS • Marine litter • Selective extraction of species • Water flow rate changes			
Sublittoral sediment 109 pressure combinations 15 sectors that have activities with pressures on this habitat	Widespread Patchy (24%) Locally Even (0%) Locally Patchy (49%) Site (28%)	Persistent (28%) Common (15%) Occasional (38%) Rare (20%)	Acute (31%) Chronic (43%) Low (26%)	Moderate	Continuous (4%) High (19%) Moderate (19%) Low (42%) High/Continuous* (7%) Low/Continuous* (8%)
20 High Threat Combinations	**Sectors** • Agriculture • Coastal infrastructure • Fishing • Shipping • Waste water treatment	**Pressures** • Abrasion • Change in wave exposure • Changes in siltation • Introduction of NIS • Introduction of synthetic compounds • Marine litter • Nitrogen and Phosphorus enrichment • Selective extraction of species • Substrate loss • Water flow rate changes			
Deep Sea	No activities			High	

Table 47. High threat to GES Sector-Pressure combinations in all predominant habitats types in the Black Sea. Risk assessment criteria are those described in Annex V after Breen et al. (in prep).

High Threat Pressure Combinations following the Risk Assessment Criteria					
Criteria	**Extent**	**Frequency**	**Degree of Impact**	**Resilience**	**Persistence**
385 Pressure Combinations of the 880 evaluated	1. Widespread 2. Widespread 3. Widespread	1. N/A 2.Persistent/Common/Occasional 3. Persistent/Common	1. Acute/Chronic 2. Acute 3. Chronic	N/A	1. Continuous/High 2. N/A 3. N/A
Summary of High Threat Sectors: • Agriculture • Coastal Infrastructure • Fishing • Shipping • Tourism and Recreation • Waste Water Treatment	Sector-Pressure Ecological Characteristic Combinations with the categories defined above and taken from the Risk Assessment framework document. Combination 1: Sectors include Agriculture, Coastal Infrastructure, Fishing, Shipping, Tourism and Recreation and Waste water treatment. Pressures: Change in wave exposure; introduction of non-indigenous species; introduction of synthetic compounds; marine litter; selective extraction of spp., substrate loss; and water flow rate changes Combination 2: Sectors include Coastal infrastructure, and Fishing. Pressures: Abrasion; marine litter; selective extraction of spp.; smothering; and substrate loss. Combination 3: Sectors include Agriculture, Coastal Infrastructure, Fishing, Shipping and Waste water treatment Pressures: Changes in siltation; change in wave exposure; introduction of synthetic compounds; Nitrogen and Phosphorus enrichment; and water flow rate changes.				

* Acute and chronic degree of impact is defined as having a detrimental effect on the habitat or its characteristic species i.e. loss, removal or mortality.

GES Descriptor 7: Hydrographic Conditions

GES Definition: Permanent alterations of hydrographical conditions by human activities may consist, for instance, of changes in the sediment and freshwater transport, current or wave action, leading to modifications of the physical and chemical characteristics set out in Table 1 of Annex III to Directive 2008/56/EC. Good status is achieved when the various permanent alterations within a regional sea do not lead to adverse effects on marine ecosystems to the extent that the characteristic structures and features of those ecosystems are altered. In particular, the hydrographical conditions of habitats (water column or seafloor) should not be affected to the extent that their key functions (e.g. provision of spawning, breeding and feeding areas, or migration routes) are degraded.

Table 48. Status and trend information of ecological characteristics describing hydrographic (chemical) conditions of the Black Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Temperature (3) • Sea surface temperature (seasonal average) • CIL thickness; • CIL temperature	No	N/A	Yes (3)	• Fluctuating (100%) • Cyclic dynamics (at present: decrease of CIL thickness and increase of CIL temperature[§]	**Reports** • Zaytcev et al. (2006) • BSC SoEBS Report (2008) • Published literature
Salinity (4) • Near-bottom salinity • Sea surface salinity	No	N/A	Yes (4)	• Fluctuating (100%)[§]	**Reports** • Zaytcev et al. (2006) • BSC SoEBS Report (2008) • Published literature **Criteria** • Climatological average • Seasonal average
pH, pCO_2 (2) • pH • Carbonate alkalinity	Yes (2)	• Good (50%) • Unknown	No	N/A	**Reports** • Hdb Env Chem Vol 5, Part Q (2008).
Plankton	No	N/A	Yes	• Cyclic dynamics (correlated with climate indexes – atmosphere index ATI and physical climate index – PCI)	**Reports** • BSC SoEBS Report (2008) • Published literature **Criteria** • Ecological index (ECOI= The composite Black Sea ecological index (ECOI) • Constructed using standardised time series data: phytoplankton and mesozooplankton biomass within the euphotic zone, Secchi depth, summer surface Chl-a concentration, H2S at16.4 kg/m^3.

[§] Sea surface temperature (SST) has been increasing in the NW Shelf.

Identification of Sector-Pressures affecting hydrographic conditions

The pressure assessment was used to identify sectors that contribute pressures (Table 49), which can affect the ecological characteristics used to describe hydrographic conditions (Table 48).

Table 49. Widespread common or persistent pressures affecting hydrographic characteristics of the environment.

Pressure	Sector
Change in wave exposure	• Coastal infrastructure
Introduction of synthetic compounds	• Agriculture • Coastal infrastructure • Fishing • Land-based industry • Shipping
Nitrogen and Phosphorus enrichment	• Agriculture
Water flow rate changes	• Coastal infrastructure • Land-based industry • Waste water treatment

A large sea wall/breakwater protecting a harbour (Photo: A. Delaney)

GES Descriptor 8: Contaminants

Risk Assessment Outcome: Moderate-High

GES Definition: GES will be achieved when concentrations of contaminants in water, sediment and biota are below assessment thresholds identified on the basis of toxicological data; pollution levels are below assessment thresholds representing harm at organism, population, community and ecosystem levels; and trends in concentrations of contaminants in water, sediment and biota, and the occurrence and severity of pollution effects, are within acceptable limits and declining

Table 50. Status and trend of contaminant concentrations in the Black Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals • Pesticides • Heavy metals • Total petroleum hydrocarbons • Radionuclides (concentration in sediment and water)	Yes (4)	• Acceptable - Below threshold (50%: pesticides in water (but with local hot spots) and radionuclides in water/sediment) • Unacceptable - Higher threshold (50%: Petroleum hydrocarbons; pesticides in sediment)	N/A	N/A	**Reports** • Polikarpov & Egorov (2009) • BSC (2007) • BSC SoEBS Report (2008) • Published literature **Criteria** • Concentration in sediment • Concentration in water

GES Descriptor 9: Fish and Seafood Contaminants

Risk Assessment Outcome: Moderate

GES Definition: GES would be achieved if all contaminants are at levels below the levels established for human consumption or showing a downward trend (for the substances for which monitoring is on-going but for which levels have not yet been set).

Table 51. Status and trend of contaminant concentrations in the Black Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals • Radionuclides (Cs_{137} and Sr_{90}) • Heavy metals • Oil pollution	Yes (3)	• Acceptable - unknown • Unacceptable - unknown • Local areas/points assessed e.g. Turkish coast and Romanian coastal waters near the Danube delta, but concentrations of chemicals in biota are highly variable and the uncertainty in the assessment is great.	N/A	N/A	**Reports** • BSC (2007) • BSC SoEBS Report (2008) • Published literature **Criteria** • Concentration in biota • MAC (Max. acceptable concentration)

GES Descriptor 10: Marine Litter

Risk Assessment Outcome: High

GES Definition: GES occurs when the properties and quantities of marine litter do not cause harm to the coastal and marine environment. This can be achieved through a measurable and significant decrease in comparison with the baseline (i.e. the situation up until 2012) in the total amount of marine litter by 2020 using as attributes the characteristics of litter in the marine and coastal environment and the impacts of litter on marine life.

Pressure Assessment Outcomes

Seven sectors were identified as contributing to the widespread or localised distribution of marine litter in the Baltic Sea (Table 53). Marine litter, either originating from the vessels or from the shores or rivers, is a "visible" pollution problem along the coasts of the Black Sea, in the sea itself and on the bottom of the sea (Black Sea Commission, 2009 "Marine Litter in the Black Sea").

Table 52. Status, trend and background information on marine litter in the Black Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Bottom flora and fauna	The impact of marine litter on bottom fauna is largely unknown, but may affect the ingestion rates of deposit- and filter-feeding species e.g. *Mytilus galloprovincialis*[1,2].				
Fish	Impacts of ghost fishing described by the FAO (1995) as "one of the most serious negative impacts from the capture fishing industry". Estimates of impact are discussed for the NW Shelf (BSC SoEBS Report 2008).				
Marine mammals and reptiles	No quantitative information available, but the impact of lost gears on dolphins is described in the BSR Marine litter report (2009).				
Seabirds	N/A	N/A	N/A	N/A	N/A
Listed species	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.				
Litter in water column and subtidal habitats	There is some information about litter in surface waters (Ukrainian coastal)				**Reports** • The Black Sea Report on Marine litter (2009)

[1]Browne, M.A. *et al.* (2008) Environmental Science and Technology 42(13): 5026-5021.

[2]Moore, C.J. (2008) Environmental Research 108(2):131-139.

Table 53. Major widespread and localised sources of marine litter in the marine environment.

Sector	Extent	Frequency	Source
Aquaculture	Locally patchy or site	Occasional	Nets, plastics
Coastal Infrastructure	Widespread to locally patchy	Persistent	General litter (cans, plastics)
Fishing	Widespread	Rare to Persistent	Lost gear/nets, general litter (cans, plastics)
Land-based industry	Widespread to locally patchy	Occasional to Persistent	Fertilizer industry, General litter (cans, plastics, containers)
Non-renewable energy (oil and gas)	Site	Occasional	Decommissioned rigs, General litter (cans, plastics)
Shipping	Widespread to locally patchy	Common or rare	General litter (cans, plastics)
Tourism and Recreation	Locally patchy	Occasional or Common	General litter (cans, plastics)

GES Descriptor 11: Energy Introduction (incl. noise)

*Risk Assessment Outcome: **High***

There is little information describing the impacts of underwater noise on the marine ecosystem, but noise may have deleterious impacts on several ecological characteristics including fish, marine mammals and seabirds. In a recent Task Group report to the Commission (Tasker et al. 2010), three possible indicators of underwater noise were developed. However, in no case was the Task Group able to define when GES occurs on the axes of the indicators. This was in part to do with insufficient evidence, but also due to no clear definition of when underwater noise effects are detrimental (Tasker et al. 2010).

In the absence of existing monitoring programmes for indicators of underwater noise, a pressure assessment approach has been used to estimate the distribution of the 3 indicators recommended in the Task Group report, namely: (1) low and mid-frequency impulsive sound, (2) high frequency impulsive sound, and (3) low frequency continuous sound. Principle sectors contributing these types of underwater noise are shipping, military (sonar) and offshore construction and the extent and frequency of those sectors as used to inform the risk assessment (see Annex V for criteria) is shown (Table 54). Information describing the extent and frequency of those sound types in the Black Sea were evaluated using expert judgment in the absence of information describing the extent of marine activities introducing underwater noise of the type described above. Note that the extent of the sector may not directly reflect the extent of the pressure and changes in the resonance of the sound as it travels through the water column are not considered here.

A beached cargo ship in the Black Sea (Photo: Allianz)

Table 54. Extent and frequency of sectors contributing underwater noise pressures in the Black Sea

Sector	Extent	Frequency
Shipping	Widespread to site	Rare to Common
Military (sonar)	Locally patchy to site	Rare to Common
Offshore construction (including non-renewable and renewable energy sectors)	Locally patchy to site	Rare to Persistent

Annex IV

The Mediterranean Sea

Introduction

The Mediterranean, historically at the crossroads of people, biota and maritime routes, a recognised global biodiversity hotspot, a world tourist destination and key shipping highway, remains both a coveted asset and a heterogeneous mosaic of pressures. Though much of the basin is unmanaged and open to threats, it is still a mystery in terms of knowledge about ecological processes, species distribution, the condition of its ecosystems and the drivers for biodiversity loss (Notarbartolo di Sciara & Agardy 2009). Recent reviews of the Mediterranean Biodiversity Knowledge reported on some of the known drivers of biodiversity loss as well as highlighting areas where our understanding is limited and the significant regional differences in data coverage that occur in the region (Coll et al 2010, Danovaro et al 2010, UNEP/MAP-Plan Blue 2009, UNEP/MAP-RAC/SPA 2010).

The Mediterranean is the largest (296,900 km^2) and deepest (average depth 1,460 m, deepest 5,267 m) enclosed sea on Earth, connecting to the Atlantic Ocean through the Strait of Gibraltar in the west and through the Dardanelles to the Sea of Marmara and the Black Sea in the northeast. In the southeast, the man-made Suez Canal links the Mediterranean to the Red Sea and the Indian Ocean. A shallow ridge (at 400 m depth) in the Strait of Sicily divides the sea into its western and eastern sub-regions, which show marked differences following various gradients (Coll et al 2010). High temperatures, high homothermy from 300–500 m to the bottom (12.8–15.5°C), high salinity (37.5–39.5‰), a negative hydrological balance with evaporation exceeding precipitation and river runoff, a microtidal regime, high oxygen concentrations, oligotrophic conditions (increasing along both the west-east and north-south axes), and low nutrient availability especially for phosphorus (that may be buffered by inputs from highly populated coasts and riverine and atmospheric inputs) characterize the Mediterranean (EEA 2006, Coll et al 2010, Danovaro et al 2010, Siokou-Frangou et al 2010).

The Mediterranean Sea includes 7% of the world's marine species (approx 17,000 marine species) for an area that represents less than 1% the world's ocean surface (UNEP/MAP-Plan Bleu, 2009). Many of the ecological characteristics in the Mediterranean Sea are under threat (see summary information for GES Descriptors above), with over 20% of the known species under threat, and will likely increase given that currently undescribed species will be added in the future and a large proportion of species are either not assessed or assessed as Data Deficient (an issue in itself). This includes emblematic species of conservation concern, such as, the world's most endangered pinniped, the critically endangered Mediterranean monk seal, sea turtles, several whales, dolphins, sharks, skates and rays at risk of extinction or threatened, and the overexploited bluefin tuna (Cuttelod et al 2008, UNEP/MAP-Plan Bleu, 2009).

There are several unique habitats at various levels of risk, including the seagrass meadows of the endemic *Posidonia oceanica* (an important indicator of human impacts and a host of crucial ecosystem services), vermetid reefs, coralligenic concretions, maerl beds, seamounts and deep sea coral reefs. As a tool to protect its marine environment and biota, 800 marine and coastal protected areas have been established in the Mediterranean so far. The current network is however not representative and excluding the Pelagos Sanctuary (87,000 km2 the only high-sea MPA) coastal MPAs cover only 0.4% of the Mediterranean Sea (Abdulla et al 2009).

Past and recent human activities and economic development in the Mediterranean impact the environment, particularly coastal ecosystems. Apart from carbon sequestration and renewable energy, 18 of the 20 sectors identified in ODEMM are present in the region. Main and emergent threats include loss and habitat degradation (through urbanization, industrialization, coastal infrastructure, shipping and tourism), pollution (including litter), harmful algal blooms, 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). Significant increases in pressures are expected through further increases in coastal population and tourism, coastal power plants, desalination plants and industrial complexes as well as significant additional increases in maritime traffic (contributing to alien species introductions and noise, POP and oil pollution), aquaculture and renewable energy.

Of particular economic, social and political interest and importance within the Mediterranean region, is the sector of Shipping. Maritime traffic in the Mediterranean Sea accounts for 15% of global shipping activity (REMPEC 2008). This is because the Mediterranean is considered a major transit route between non-Mediterranean ports. The increase in seaborne shipping activities is reflected by the growth in cargo volume and ship sizes (REMPEC 2008). The introduction of the Motorways of the Sea model by the European Council (EC 2004) will support future growth within this sector, through new specific businesses, such as shipbuilding, cargo transport and logistics The new model is to increase the European maritime logistic chain in an attempt to reduce road traffic and congestion due to increasing use of heavy good vehicles (EC 2004). Although the introduction of this model will support economic and social development of the Mediterranean Sea region, it will come at a cost to the marine environment.

A Mediterranean Sea Sustainable Development progress report revealed that Member and non-Member States are not considered to be within an acceptable index range to support sustainable development (UNEP 2011). Of all countries surrounding the Mediterranean Sea, only four states (EU non-Member states) have ecological footprints deemed to be adequate by UNEP Ecological Footprint Index (UNEP 2011). These high ecological footprints are closely coupled with economic activities. Based on the World Bank economic classifications, countries within the Mediterranean Sea region belong to one of two economic groupings. The first group consists of middle-income countries, with low Human Development Index (HDI) and ecological footprints, and includes: southern and eastern Mediterranean states, and Balkan countries (UNEP 2011). The second group comprises high income countries with high HDI and ecological footprints, and is represented by EU Mediterranean states and Israel (UNEP 2011).

The socio-economic division between these two groups will create political issues in implementing a regional approach to achieving GES for the MSFD Descriptors. Some Mediterranean Sea states will not have the financial and institutional capacity to implement strategies to meet the objectives of the MSFD. This challenge is coupled with the promotion of economic and social reforms to increase development in a sustainable manner. Presently, the environmental capacity in the Mediterranean Sea region is consumed faster than it is renewed (UNEP 2011), indicating marine ecosystems are at threat. These issues will pose difficulties for the Mediterranean region to meet its own sustainable development and environmental strategies.

Availability of Information: Regional Summary

A large body of work describing the marine ecosystem and its ecological characteristics of the Mediterranean Sea is available. 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. Twenty-one states have a coastline on the Mediterranean Sea, but only seven are Member States of the EU (Spain, France, Italy, Greece, Cyprus, Slovenia and Malta). Non-member states have no obligation to maintain the environment in a manner described in several EU directives (e.g. Habitats Directive, WFD or MSFD) and thus, the absence of a coordinated effort toward the objectives of those directives may lead to difficulties in the achievement of those goals. However, since 1975, The United Nations Environment Programme (UNEP) has played a key role in coordinating a Mediterranean-wide regional sea programme. The Mediterranean Action Plan (MAP) was the first ever plan adopted as a Regional Seas Programme under UNEP's umbrella and was initially adopted by 16 Mediterranean countries and the European Community. Today, this has been extended to involve all 21 countries that border the Mediterranean Sea. There are five objectives of the MAP: (1) to assess and control marine pollution, (2) to assist in the formulation of national environmental policies, (3) to improve the ability of governments to identify better options for alternative patterns of development, (4) to optimise the choices for allocation of resources, and (5) to incorporate integrated coastal zone planning and management as a tool to support the environmental, social and economic objectives of the programme.

The roadmap to the application of the Ecosystem Approach (and the wider implementation of MSFD) includes seven steps. Step 3 is on-going and its aims include the "identification of important ecosystem properties and assessment of ecological status and pressures. Step 4 aims at the "development of a set of ecological objectives corresponding to the Vision and Strategic goals". Currently UNEP MAP is finalizing the assessment report that covers pollution and biodiversity, physicochemical and oceanographic parameters. 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) in 2003. Chapter 1 of SAPBIO 2003 was the "I. MEDITERRANEAN MARINE AND COASTAL BIODIVERSITY: Status, Threats and Trends" i.e. the region's assessment at national and regional level. SAPBIO is currently under review with new targets and objectives are expected in 2011.

Problem Areas and Likelihood of Failure to Achieve GES

In addition to UNEP, there are several bodies actively working toward environmental conservation objectives in the Mediterranean Sea region. For example, the International Union for Conservation of Nature (IUCN), Mediterranean Science Commission (CIESM), International Commission for the Conservation of Atlantic Tunas (ICCAT), and the General Fisheries Commission for the Mediterranean (GFCM) all contribute to a network of scientists to support a better understanding of the fast-changing Mediterranean Sea environment.

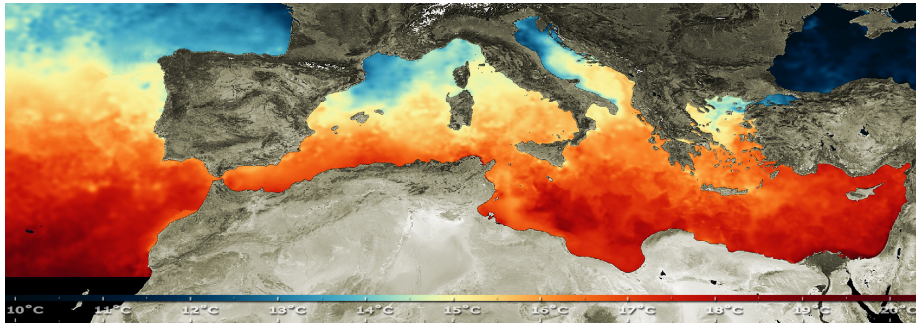
Information describing the status and trends of ecological characteristics, and pressure and impact information has been collated for the Mediterranean Sea based on extensive literature review including regional reviews, EU data sources and Mediterranean research (including supportive information from non-member states e.g. Israel). State or status information is reported for 8 ecological characteristics and includes: bottom fauna and flora, fish and shellfish (commercial and non-commercial), marine mammals and reptiles, non-indigenous species, pH/pCO_2, predominant habitats, seabirds and Habitats Directive listed habitats and species. Trend (temporal and spatial) information was reported for a further 4 characteristics: nutrients and oxygen, plankton, salinity and temperature. Descriptions of topography and bathymetry characteristics are not described in the tables as status and trend information is not an appropriate metric for these ecological characteristics, despite information being available that describes them.

The use of status and trends is not appropriate for the evaluation of some GES descriptors (see discussion in Chapter 2). Instead, an assessment of pressure and impact is required (e.g. Descriptor 6: Seafloor integrity). A pressure assessment evaluates the mechanisms through which human activities have an effect on the marine ecosystem. In cases such as Descriptor 6 where there are few maps describing the distribution of habitats or species, this expert judgement approach can link the pressures and impacts of human activities to predict the likely condition of the habitat based on the extent, frequency, severity (a function of degree of impact and habitat resilience) and persistence of the pressure and its overlap with an ecological characteristic (see ODEMM pressure assessment guidance document for further details). This approach was used, either in conjunction with status and trends information or solely to evaluate several GES descriptors, namely Descriptors 2, 5, 6, 7, 10 and 11.

A summary of the areas of concern (Table 55 below) for the region and the likelihood of failure to achieve GES following a risk assessment (see Chapter 3 and Breen et al. in prep) for each descriptor were identified. Of the 14 ecological characteristics listed in Annex III of the MSFD as recommended for assessment, 57% of those are currently considered either in poor or threatened status. Not all species or habitats within each characteristic type are in poor or threatened status nor do all indicators available for a given species or habitat indicate poor/inadequate status. However, problems were identified for all GES Descriptors (Table 55) stemming from the contribution of threatened ecological characteristic(s) to multiple GES descriptors (e.g. marine mammals contribute to the assessment of GES descriptors: Biodiversity, Food webs and Habitat Directive species).

Available status information indicated that several ecological characteristics are currently threatened or in poor state. These include: nutrients and oxygen, predominant habitats, fish (listed, commercial and non-commercial species), bottom flora and fauna, pH/pCO_2, marine mammals/reptiles and seabirds. In addition, trend assessments of those ecological characteristics indicated a decline in the assessment criteria of many indicators (e.g. population size), suggesting that those indicators are under threat.

Following the pressure assessment approach, several threats to the environment arising from human activities were identified. Those sectors which were considered as contributing pressures (e.g. the introduction of non-indigenous species) that could be detrimental to the marine environment (ecological characteristic(s) or achievement of GES) included aggregates, agriculture, aquaculture, coastal infrastructure, fishing, shipping, non-renewable energy (oil & gas), navigational dredging and tourism and recreation. Assessment of the contribution of each sector to current status or the highest threat to the marine environment and its components will be evaluated in later ODEMM work packages.



Sea temperatures of the Mediterranean Sea and Iberian coast. Changes in average water temperature range from cool (dark blue; 10°C) to hot (dark red; 20°C) (Photo: ESA).

Table 55. A Summary of Areas of Concern, Risks to GES, and Confidence in Risk Assessment of GES Descriptors in the Mediterranean Sea. Each GES Descriptor is described by one or more components: ecological characteristics, pressure and/or impacts information (see Chapter 2). The components used to evaluate each descriptor are shown in more detail in the following summary tables and outline the availability of information and criteria used to assess current status and trends of components in each Regional Sea. * indicates a pressure assessment approach was used, either in part or in its entirety, to evaluate the descriptor. Risk assessment criteria and confidence assessment definitions are described in Chapter 3 and Annex V of this report.

GES Descriptor	Problems	Areas of Concern	Risks to GES	Risk Confidence
1a. Plankton	Yes	Alterations in the dominance of plankton species are on-going, but no notable or maintained changes are occurring.	Moderate	Moderate
1b. Fish	Yes	30 species of cartilaginous fish in the Mediterranean Sea are current threatened with as many as 73% of bony fish outside safe biological limits. Trends indicate a decline in the abundance of many species	Moderate	Moderate
1c. Marine Mammals & reptiles	Yes	Several species of marine mammal and reptiles are currently threatened (IUCN criteria) with rates of decline in abundance and distributional range suggesting those species may be lost within the next 10 years	High	High
1d. Seabirds	Yes	60% of Annex II SPA-BD species (Barcelona Convention) are listed as threatened or endangered shown by reducing population (breeding) sizes, however, these species are not currently expected to be lost	Moderate	Moderate
1e. Predominant Habitats	Yes	Nearly all predominant habitat types in the Mediterranean are declining or exhibiting some degree of degradation with many in poor, endangered or unfavourable status	Moderate	Moderate
2. Non-indigenous species (NIS)*	Yes	There are a considerable number of invasive species in the Mediterranean that have resulted in widespread negative impacts on native species. Introductions continue to occur as a result of shipping, mariculture and entry via the Suez canal	High	High
3. Commercial fish and shellfish	Yes	More than 25% are exploited beyond sustainable levels, with most key pelagic and demersal species over-exploited and at high risk of stock collapse. Contributing factors include unregulated fishing practices, lack of enforcement, illegal gears and fishing and absence of management or protection measures	High	Moderate
4. Food webs	Yes	The prevalence of invasive jellyfish species and structure of top predators suggests that the Mediterranean food web is in an advanced state of degradation	High	Moderate
5. Eutrophication*	Yes	Algal blooms, hypoxia, eutrophication hot spots coupled with local oxygen deficiencies are of some concern, but due to low nutrient inputs and given the large area of the basin, eutrophication is a problem limited to sheltered marine waters such as harbours or bays and not expected to be of concern in the next two decades	Moderate	High
6. Seafloor Integrity*	Yes	Human activities such as agriculture, coastal infrastructure, fishing, navigational dredging, non-renewable energy (oil & gas), shipping, and tourism and recreation contribute widespread and persistent pressures that have detrimental effects on several aspects of the Mediterranean Sea ecosystem	High	Moderate
7. Hydrographic conditions*	Yes	Increases in sea surface and bottom temperatures indicate warming sea in conjunction with continued ocean acidification and increases in pCO_2	Not assessed	Not assessed
8. Contaminants	Yes	Heavy concentrations of some heavy metals are present in the region and concentrations continue to rise from transport introductions, however, other contaminants are declining e.g. Pb and PAHs.	Moderate	High
9. Fish and Shellfish Contamination	Yes	Concentrations of Mercury currently exceed benchmark dose limits (BMDL) and some heavy metals are high in concentration, but they occur from natural sources	Low	Moderate
10. Marine Litter*	Yes	More than 111 species of seabird and several species of marine mammals and reptiles have been reported to ingest marine debris. Although the amount of litter (number of items and mass) has reduced, shoreline and recreational activities continue to discard large volumes of litter in to the marine environment	High	High
11. Energy (Underwater noise)*	Yes	Trends indicate an increase in shipping activity leading to an increase in underwater noise throughout the region	High	Moderate
12. Habitats Directive Habitats	Yes	35% of habitats are in unfavourable status under at least one assessment criterion and over 40% declining in some aspect (e.g. range, area, structure and function, or future prospects). There is considerable uncertainty of the status of many habitats.	High	High
12. Habitats Directive Species	Yes	>50% of species are in unfavourable condition, with many species exhibiting declines across all assessment criteria (range, population size, habitat, and future prospects).	High	High

GES Descriptor 1: Biodiversity

Risk Assessment Outcome: Moderate to High

GES Definition: GES is achieved when biodiversity is maintained in the regional sea such that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Loss of biodiversity can be described as occurring where there is a reduction in genetic, species, habitat or ecosystem diversity within the regional sea over this time scale. More specifically loss of particular meta-populations, species, habitat types or ecosystem properties within the region (e.g. extirpations) would certainly count as a loss of biodiversity, but so could a noticeable change in diversity based on changes in evenness (e.g. shifts in dominance). GES under Biodiversity should be assessed individually for each of the major ecosystem characteristics listed in Annex III of the MSFD as recommended in the COM decision.

Table 56. Status and trend information of ecological characteristics used to evaluate GES: Biodiversity. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Predominant Habitat (5) • Littoral rock (A1) • Littoral sediment (A2) • Sublittoral rock (A4) • Sublittoral sediment (A5) • Deep sea (A6)	Yes (39) • Multiple community and species status assessments e.g. coralligenous communities, gorgonian gardens.	• Endangered (36%); • Threatened (36%); • Poor (24%); • Unfavourable - inadequate (4%)	Yes (10)	Decrease (100%) • Declining trend in all habitats except Deep Sea (A6) where no trend is reported.	**Reports** • OCEANA (2006) • ELME (2007) • SOED (2009) • EEA (2006) • Published literature **Criteria** • Extent • Condition
Listed Habitat • 11 habitats are listed in the Article 17 reports • Habitat Reference Codes are: 1110, 1120, 1130, 1140, 1150, 1160, 1170, 1180, 1240, 1310 and 1410	Yes (15)	• Favourable (5%); • Unfavourable-inadequate (15%); • Unfavourable-bad (13%); • Unknown (58%); • Variable - Favourable to Bad* (9%) • *Spatial variation in assessment for Mediterranean salt meadows (*Juncetalia maritimi*)	Yes (5)	• Decrease (40%); • Stable (20%); • Increase (20%); • Variable (no clear trend) (20%) • Decreasing trends reported for Sea cliffs with endemic *Limonium* spp. (1240)	**Reports** • Article 17 Reporting (2007) **Criteria** • Range (distribution) • Area • Structure and Function • Future prospects • Overall
Plankton (3) • Algal blooms • Harmful Algal Blooms (HABs)	No	N/A	Yes (3)	• Increase (100%)	**Reports** • EEA Priority Issues in the Mediterranean (2006) • Published literature **Criteria** • HABs • Hotspots

Bottom fauna and flora (20) • Alveolata (2) • Annelids (2) • Ascidia (2) • Chlorophytes (3) • Cnidaria (4) • Crustacea (4) • Mollusc (3)	Yes (20)	• Established invasive (65%) • Poor state (35%) • Many species in the Mediterranean are invasive and status is reported as 'established'.	Yes (11)	• Increase (100%)	**Report** • Published literature **Criteria** • IUCN/GISP • SEBI 2010 WG5 • Documented or potential negative impacts on biodiversity and/or socio-economy • Reports • Population spread • Reproduction
Fish and shellfish (99) • 78 cartilaginous species reported • 6 commercial fish species • 3 commercial shellfish species • Assemblage data	Yes (99)	<u>IUCN (2007)</u> • Critically Endangered (17%); • Endangered (11%); • Vulnerable (12%); • Near Threatened (20%); • Least Concern (12%); • Not evaluated (16%); • Data deficient (1%) <u>ICES/FAO Statistics</u> • Over-exploited (4%); • >MSY (3%); • <MSY (1%); • Outside safe biological limits (1%); • Sustainable (1%); • Unknown (1%).	Yes (30)	• Decrease (100%) • All species assessed in terms of trend information are decreasing in terms of population size and distribution	**Reports** • IUCN (2007) • ICCAT (2009) • ICES (2010) • FAO (2005) • EEA (2009) • Published literature **Criteria** • Population size • Distribution • Fishing Mortality (F) • Spawning stock biomass (SSB)
Marine mammals, sea turtles & reptiles (18) • 15 species reported and evaluated in terms of population size, distribution in addition to assessment • Overall marine mammal and reptile assemblage (3)	Yes (16)	• Critically Endangered (12%); • Endangered (35%); • Vulnerable (12%); • Threatened (6%); • Unknown/Data Deficient (36%) • All of the 15 species listed under the SPA/BD protocol as Endangered/Threatened • The monk seal is critically endangered species and is considered the world's most threatened pinniped	Yes (17)	• Decrease (53%); • Unknown/Data Deficient (47%).	**Reports** • IUCN Redlist • Barcelona Convention SPA/BD Protocol **Criteria** • Species distribution • Population size

GES Descriptor 1: Biodiversity (continued)

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Seabirds (12) • 11 species are reported and all evaluated by population size • Seabird assemblage assessment	Yes (11)	• Critically Endangered (4%); • Endangered (50%); • Near Threatened (8%); • Least Concern (8%); • Favourable (17%); • Unfavourable (13%). • The Balearic shearwater *Puffinus mauretanicus* is the only critically endangered species	Yes (9)	• Increase (30%); • Stable (20%); • Decrease (50%).	**Reports** • IUCN (2009) • Birds Directive • Birdlife International (2004) • Barcelona Convention SPA/BD Protocol **Criteria** • Population size • Breeding population size
Listed Species (35) • 35 species are listed in the Article 17 reports • Species include: fish, marine mammals and reptiles, crustacean and molluscs	Yes (35)	• Favourable (7%); • Unfavourable-inadequate (30%); • Unfavourable-bad (26%); • Unknown (37%). • Only 1 of 35 species, Canestrini's goby (*Pomatoschistus canestrini*) is currently in Favourable Conservation Status	Yes (14)	• Decrease (61%); • Stable (8%); • Increase (15%); • Stable/Decrease (8%). • 8 of 14 species show decrease in all criteria • Mediterranean monk seal, humpback whale an Canestrini's goby all stable • Increases reported for SW European nase and Valencia toothcarp.	**Reports** • Article 17 Reports (2007) **Criteria** • Range (distribution) • Population size • Habitat • Future prospects • Overall

GES Descriptor 2: Non-indigenous species introduced by man

*Risk Assessment Outcome: **High***

GES Definition: GES for Non-indigenous species (NIS) is a function of their relative abundances and distribution ranges, and environmental impact. Good status will be maintained when significant adverse effects on environmental quality from NIS are avoided, including no elimination or extinction of sensitive and/or rare populations, alteration of native communities, seasonal dominance of algal blooms, or alteration of water chemistry (oxygen, nutrient content, pH and transparency). Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere and have an adverse effect on environmental quality. Therefore, invasive NIS are of most concern in terms of posing a risk to GES.

This table lists the NIS species and it characteristic group as an adult. For example, the ctenophore *Mnemiopsis leidyi* (comb jelly) would be recorded as a *pelagic (incl. plankton)* characteristic, and the nimble spray crab, *Percnon gibbesi* recorded within the *bottom fauna and flora* category due to it spending its adult life as a sessile benthic species despite a planktonic developmental/juvenile life stage. Available Information on NIS is in the form of abundance or distribution data for each species.

Pressure Assessment: Major Pathways of Introduction

Five sectors were identified as major pathways of introduction for non-indigenous species into the Mediterranean Sea. The sectors and the mechanisms include:

- Aquaculture - importation of culture species, secondary spread;
- Fishing - fouling (nets) and secondary spread;
- Military - hull fouling and ballast water exchange;
- Shipping - hull fouling and ballast water exchange; and
- Tourism and Recreation - hull fouling.

The pressure assessment identified impacts from all sectors with persistent introductions from Shipping primarily from ballast water exchange. Predominant habitats affected include sublittoral rock and sediments, littoral rock sediment and the pelagic water column. Species of particular concern have been the seagrass *Caulerpa taxifolia* and the dinoflagellate *Alexandrinum* (Heil et al. 2005). Impacts include competition among invading and native species resulting in high invader abundances, habitat modification and loss of native biodiversity. These effects also cascade to other trophic levels including fish and benthic invertebrate flora (Schaffelke et al. 2007).

On IUCN's list of 100 'World's Worst; invaders, the spread of *Mnemiopsis leidyi* to the Mediterranean is of major concern (Photo: L. Hansson)

Table 57. Status and trend information of ecological characteristics used to evaluate GES: Non-indigenous species. The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets. This table lists the NIS species and its characteristic group as an adult.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Pelagic (incl. plankton) (4) • Jellyfish (2) • Diatoms (2)	Yes (4) • *Rhopilema nomadica* • *Mnemiopsis leidyi* • *Alexandrinum* spp.	• Established Invasive (100%)*	Yes (8)	• Increase (100%)	**Report** • Published literature **Criteria** • IUCN/GISP • SEBI 2010 WG5 • Documented or potential negative impacts on biodiversity and/or socio-economy • Olenin et al. 2010 • Records (spatial and temporal distribution) • Population spread • Reproduction
Bottom fauna and flora (13) • Algae (3) • Molluscs (3) • Crustacea (4) • Annelids (2)	Yes (13)	• Established invasive (100%)	Yes (13)	• Increase (100%)	**Report** • Published literature **Criteria** • IUCN/GISP • SEBI 2010 WG5 • Documented or potential negative impacts on biodiversity and/or socio-economy • Olenin et al. 2010 • Population spread • Reproduction
Fish (7) • 7 non-indigenous spp. of fish are reported	Yes (7)	• Established invasive (100%)	Yes (7)	• Increase (100%)	**Report** • Published literature **Criteria** • IUCN/GISP • SEBI 2010 WG5 • Documented or potential negative impacts on biodiversity and/or socio-economy • Olenin et al. 2010 • Population spread • Reproduction
Marine mammals and reptiles	There are no known impacts of NIS on marine mammals and reptiles				
Seabirds	Associated impacts of NIS introduction(s) are from terrestrial NIS species only				

*An assessment outcome of 'Established invasive' indicates that the species is reproducing within the assessment area and is self-maintaining.

GES Descriptor 3: Commercial fish and shellfish

Risk Assessment Outcome: High

GES Definition: GES for commercially exploited fish and shellfish will be achieved when stocks are sustainably exploited consistently with high long-term yields and have full reproductive capacity. To achieve GES it will also be necessary, in addition to sustainably exploited stocks at full reproductive capacity, for the age and size distribution of fish and shellfish populations to be representative of a healthy stock, assessed by reference to the proportion of older and larger fish in the population. GES is achieved for a particular stock only if criteria for all attributes are fulfilled (i.e. one-out, all-out).

Table 58. Status and trend information of ecological characteristics used to evaluate GES: Commercial fish and shellfish. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Commercial shellfish (3) 3 species reported: • *Aristeus antennatus* • *Nephrops norvegicus* • *Parapenaeus longlirostris*	Yes (3)	• Fully exploited (67%); • Over-exploited (33%).	No	N/A	**Reports** • ICES • FAO • GFCM • EEA (2009) • SOED (2009) • Published literature **Criteria** • MSY
Commercial Fish (12) • 6 commercial species reported using multiple assessment criteria • Fish assemblage assessments	Yes (10)	• Over-exploited (38%); • >MSY (23%); • <MSY (23%); • Outside safe biological limits (8%); • Sustainable or fully exploited (23%).	No	N/A	**Reports** • ICCAT (2009) • ICES • FAO • GFCM • EEA (2009) • Published literature **Criteria** • Fishing Mortality (F); • Spawning stock biomass (SSB); • Landings; • MSY*; • Species diversity; • Safe biological limits (SBL) • Stock size; • Proportion of stocks over-fished

*MSY, Maximum Sustainable Yield, is the long-term yield of fish to a fishery that can be sustained indefinitely.

GES Descriptor 4: Food webs

Risk Assessment Outcome: High

GES Definition: The interactions between species in a food web are complex and constantly changing, making it difficult to identify one condition that represents 'good' status. However, some changes in species' relative abundance in an ecosystem can have significant adverse effects on food web status. Good Environmental Status of food webs will be achieved when energy flows through the food web, and the size, abundance and distribution of key trophic groups/species, are all within acceptable ranges that will secure the long-term viability of all food web components in line with prevailing natural conditions.

Table 59. Status and trend information of ecological characteristics used to evaluate GES: Food webs. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Plankton (3) • Algal blooms • Harmful Algal Blooms (HABs) • Alien HABs	No	N/A	Yes (2)	• Increase (100%)	**Reports** • EEA Priority Issues in the Mediterranean (2006) • Published literature **Criteria** • Hotspots • HABs
Fish and shellfish (99) • 78 cartilaginous species reported • 6 commercial fish species • 3 commercial shellfish species • Assemblage data • All species reported are top predator species and play an important role in the food chain	Yes (99)	• Critically Endangered (17%); • Endangered (11%); • Vulnerable (12%); • Near Threatened (20%); • Least Concern (12%); • Not evaluated (16%). • Over-exploited (4%); • Data deficient (1%) • >MSY (3%); • <MSY (1%); • Outside safe biological limits (1%); • Sustainable (1%); • Unknown (1%).	Yes (30)	• Decrease (100%)	**Reports** • IUCN • ICCAT (2009) • ICES • FAO • GFCM • EEA (2009) • Published literature **Criteria** • Population size • Distribution • Fishing Mortality (F) • Spawning stock biomass (SSB)

Marine mammals (5) • 5 species reported and evaluated in terms of population size, distribution in addition to assessment • Marine mammals are top predators and play an important role in the food chain. Described are status and trends of dolphin (4) and seal (1) species	Yes (16)	• Critically Endangered (11%); • Endangered (22%); • Vulnerable (22%); • Unknown/Data Deficient (44%) • All species are listed under the SPA/BD protocol as Endangered/Threatened	Yes (17)	• Decrease (50%); • Unknown/Data Deficient (50%).	**Reports** • IUCN 2006, 2009, 2010 • Barcelona Convention SPA/BD Protocol • Published literature **Criteria** • Species distribution • Population size
Seabirds (11) • All 11 seabird species reported are active fish predators in the Mediterranean Sea	Yes (11)	• Critically Endangered (5%); • Endangered (43%); • Near Threatened (10%); • Least Concern (10%); • Unfavourable (14%); • Favourable (19%)	Yes (11)	• Increase (30%); • Stable (20%); • Decrease (50%)	**Reports** • Birdlife International (2009) • Barcelona Convention SPA/BD Protocol • Published literature **Criteria** • Population size • Breeding population size
Listed Species (19) • 19 listed species were identified as top predator species in the Mediterranean Sea • Species include fish and marine mammals	Yes (19)	• Favourable (1%); • Unfavourable-inadequate (32%); • Unfavourable-bad (29%); • Unknown (38%). • All top predators are classified as in unfavourable conservation status for at least one criterion	Yes (9)	• Decrease (68%); • Stable (16%); • Increase (3%); • Stable/Decrease (14%). • Decreased in 5 spp (Iberian nase, SW European nase, Italian barbel, Atlantic sturgeon, SE toothcarp) • Mediterranean monk seal, humpback whale stable • Increase reported for Valencia toothcarp	**Reports** • Article 17 Reports (2007) **Criteria** • Range (distribution) • Population size • Habitat • Future prospects • Overall

GES Descriptor 5: Eutrophication

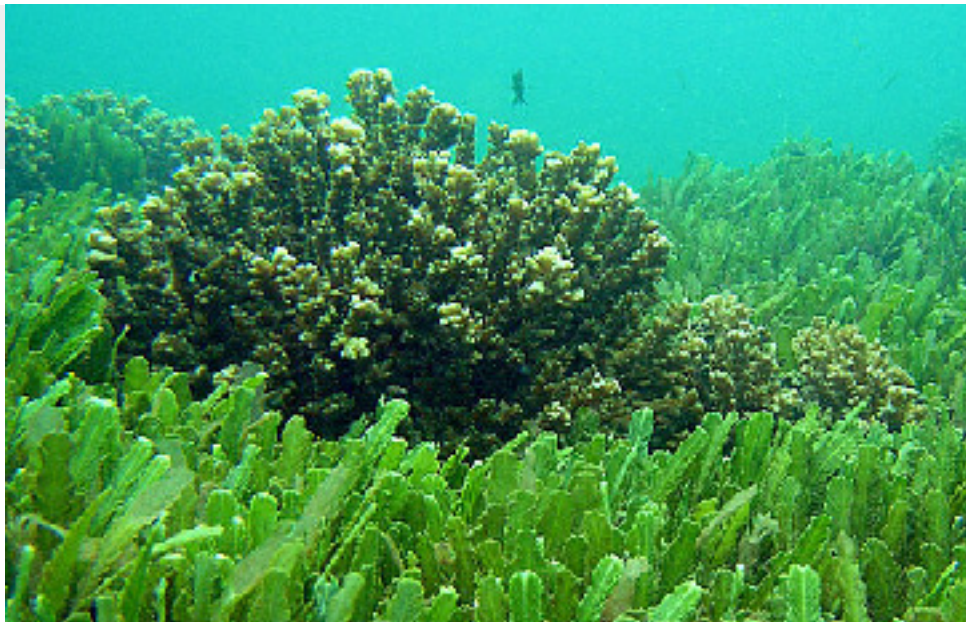
Risk Assessment Outcome: Moderate

GES Definition: GES with regard to eutrophication has been achieved when the biological community remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive harmful algal blooms, low dissolved oxygen, declines in sea grass, kills of benthic organisms and/or fish) and/or where there are no nutrient-related impacts on sustainable use of ecosystem goods and services.

Pressure Assessment Outcomes

The EEA (2006) stated that eutrophication is a very common problem in the sheltered marine water bodies such as harbours and semi-enclosed bays mainly in the vicinity of coastal towns of the Mediterranean, and eutrophication is reported as worsening (UNEP 2010; Langmead et al. 2007). Due to low nutrient inputs and the large area of the basin, it is not expected that the basin will be seriously threatened by eutrophic pressures over the next 2 decades (Karydis & Chatzichristofas, 2003), and the UNEP 2010 Outlook for the Mediterranean Sea is recorded as Moderate.

Nitrogen and phosphorus introductions into the Mediterranean Sea were identified through the ODEMM pressure assessment as originating from six sectors (Table 60). Areas where eutrophication is particularly prevalent include the Adriatic, Gulf of Lion and northern Aegean Sea (EEA, 2001) where agricultural and aquaculture sources persistently discharge in to the marine environment leading to widespread impacts in sublittoral and littoral rock and sediment habitats.



Elevated algal growth as a result of the introduction of nutrients from the agriculture industry (Photo: Reuters)

Table 60. Major widespread and localised sources of nutrients in the marine environment.

Sector	Extent of introduction	Frequency	Source
Agriculture	Widespread and local	Persistent	Fertilizers, animal feed, biofuels
Aquaculture	Widespread, local and site	Persistent	Fish food
Desalination	Site	Persistent	Backwash from process
Fishing	Widespread and local	Persistent	Discards
Land-based industry	Widespread and local	Occasional	Fertilizer industry
Tourism and Recreation	Widespread, local and site	Persistent	Fertilizers

Table 61. Status, trend and impact information of ecological characteristics used to evaluate GES: Eutrophication. Status category criteria are defined in the Status and trends supporting documentation (www.liv.ac.uk/odemm/outputs/data). The number of species/stocks/assemblages of each ecological characteristic type is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species/stocks/assemblages. Nb - a negative or positive trend does not necessarily indicate a 'Good' or 'Bad' outcome. See a full discussion in Chapter 2.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Nutrients and Oxygen (6) • DIN • N/P Ratio • DIP • Dissolved Oxygen • Oxygen depletion risk (OXYRISK)	No	• N/A	Yes (4)	• Stable (Surface DO, N and P) • Decrease (Near-bottom DO)	**Reports** • EEA (2009)
Plankton (3) • Algal blooms • Harmful Algal Blooms (HABs) • Alien HABs	No	N/A	Yes (3)	• Increase (100%)	**Reports** • EEA Priority Issues in the Mediterranean (2006) • Published literature **Criteria** • Hotspots • HABs

GES Descriptor 6: Seafloor Integrity

Risk Assessment Outcome: High

GES Definition: GES is achieved where seafloor integrity is at a level that ensures that the structures and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. "Sea Floor" includes both the physical structure and biotic composition of the benthic community. "Integrity" includes the characteristic functioning of natural ecosystem processes and spatial connectedness. "Not adversely affected" is interpreted as meaning that impacts may be occurring, but all impacts are sustainable such that natural levels of diversity, productivity, and ecosystem processes are not degraded.

Table 62. Pressure assessment of overlap between human activities and pressures with predominant habitat types in the Mediterranean Sea. Shown are the total number of sector-pressure-ecological characteristic combinations evaluated and a summary of overlap, frequency of occurrence, degree of impact, habitat resilience and pressure persistence in the marine ecosystem (top) and predominant habitat types (bottom). Specific sectors and pressures constituting a *high threat* to GES (*high threat* is defined in the risk assessment criteria in Annex V after Breen et al. in prep) are shown for each habitat. Proportional values exclude all No Overlap (NO) combinations and the pelagic water column predominant habitat is not assessed. Category definitions are described in full in the pressure assessment guidance document (www.liv.ac.uk/odemm/outputs/guidancedocuments).

Pressure Assessment Summary	**Pressure Extent**	**Frequency of Occurrence**	**Degree of Impact**	**Resilience (Recovery Time)**	**Persistence of Pressure**
276 Pressure Combinations of the 816 evaluated Sectors – 17 Pressure Types – 18	Widespread Patchy (44%) Locally Even (0%) Locally Patchy (32%) Site (24%)	Persistent (43%) Common (15%) Occasional (26%) Rare (16%)	Acute (31%) Chronic (50%) Low (18%)	Low to High	Continuous (7%) High (14%) Moderate (14%) Low (56%) High/Continuous* (5%) Low/Continuous* (5%)
* Persistence can vary between sectors depending on likelihood of there being management options that would actually remove the pressure					
Littoral rock 68 pressure combinations 17 sectors that have activities with pressures on this habitat	Widespread Patchy (49%) Locally Even (0%) Locally Patchy (20%) Site (31%)	Persistent (46%) Common (15%) Occasional (26%) Rare (16%)	Acute (27%) Chronic (59%) Low (14%)	Moderate	Continuous (9%) High (9%) Moderate (16%) Low (56%) High/Continuous* (4%) Low/Continuous* (7%)
29 High Threat Combinations	**Sectors** • Agriculture • Coastal infrastructure • Fishing • Non-renewable energy (oil & gas) • Shipping • Tourism and recreation	**Pressures** • Abrasion • Changes in wave exposure • Input of organic matter • Introduction of NIS • Introduction of synthetic compounds • Marine litter • Nitrogen and phosphorus enrichment		• Smothering • Substrate loss • Thermal regime change • Water flow rate changes	

Littoral sediment 71 pressure combinations 17 sectors that have activities with pressures on this habitat	Widespread Patchy (51%) Locally Even (0%) Locally Patchy (24%) Site (25%)	Persistent (47%) Common (14%) Occasional (26%) Rare (14%)	Acute (26%) Chronic (49%) Low (25%)	High	Continuous (7%) High (7%) Moderate (19%) Low (56%) High/Continuous* (4%) Low/Continuous* (7%)
28 High Threat Combinations	**Sectors** • Agriculture • Coastal infrastructure • Fishing • Navigational dredging • Non-renewable energy (oil & gas) • Shipping • Tourism and recreation	**Pressures** • Abrasion • Changes in wave exposure • Input of organic matter • Introduction of NIS • Introduction of synthetic compounds • Marine litter • Nitrogen and phosphorus enrichment • Smothering • Substrate loss • Thermal regime change			
Sublittoral sediment 63 pressure combinations 14 sectors that have activities with pressures on this habitat	Widespread Patchy (51%) Locally Even (0%) Locally Patchy (41%) Site (8%)	Persistent (40%) Common (14%) Occasional (29%) Rare (17%)	Acute (37%) Chronic (48%) Low (15%)	Moderate	Continuous (6%) High (25%) Moderate (5%) Low (57%) High/Continuous* (5%) Low/Continuous* (3%)
34 High Threat Combinations	**Sectors** • Aggregates • Aquaculture • Coastal infrastructure • Fishing • Navigational dredging • Shipping • Tourism/Recreation	**Pressures** • Abrasion • Changes in siltation • Input of organic matter • Introduction of NIS • Introduction of synthetic compounds • Marine litter • Nitrogen and phosphorus enrichment • Selective extraction of non-living resources • Selective extraction of species • Smothering • Substrate loss			
Sublittoral rock 50 pressure combinations 13 sectors that have activities with pressures on this habitat	Widespread Patchy (26%) Locally Even (0%) Locally Patchy (44%) Site (30%)	Persistent (43%) Common (22%) Occasional (22%) Rare (14%)	Acute (31%) Chronic (49%) Low (20%)	Moderate	Continuous (8%) High (14%) Moderate (16%) Low (53%) High/Continuous* (6%) Low/Continuous* (4%)
15 High Threat Combinations	**Sectors** • Aquaculture • Coastal infrastructure • Fishing • Shipping • Tourism/Recreation	**Pressures** • Changes in siltation • Introduction of NIS • Introduction of synthetic compounds • Marine litter • Selective extraction of species • Smothering • Substrate loss			

Pressure Assessment Summary	Pressure Extent	Frequency of Occurrence	Degree of Impact	Resilience (Recovery Time)	Persistence of Pressure
Deep Sea 13 pressure combinations 4 sectors operate in this habitat	Widespread Patchy (8%) Locally Even (0%) Locally Patchy (46%) Site (46%)	Persistent (15%) Common (15%) Occasional (38%) Rare (31%)	Acute (54%) Chronic (31%) Low (15%)	Low	Continuous (0%) High (31%) Moderate (8%) Low (54%) High/Continuous* (8%) Low/Continuous* (0%)
No High Threat Combinations	**Sectors** • None	**Pressures** • None			

Table 63. High threat to GES Sector-Pressure combinations in all predominant habitats types in the Mediterranean Sea. Risk assessment criteria are those described in Annex V after Breen et al. (in prep).

High Threat Pressure Combinations following the Risk Assessment Criteria					
Criteria	**Extent**	**Frequency**	**Degree of Impact**	**Resilience**	**Persistence**
106 High Threat Pressure Combinations identified	1. Widespread 2. Widespread 3. Widespread	1. N/A 2.Persistent/Common/Occasional 3. Persistent/Common	1. Acute/Chronic 2. Acute 3. Chronic	N/A	1. Continuous/High 2. N/A 3. N/A
Summary of High Threat Sectors: • Aggregates • Agriculture • Aquaculture • Coastal Infrastructure • Fishing • Navigational dredging • Non-renewable energy (oil & gas) • Shipping • Tourism and Recreation	Sector-Pressure Ecological Characteristic Combinations with the categories defined above and taken from the Risk Assessment framework document. Combination 1: Sectors include Aquaculture, Coastal infrastructure; Fishing; Shipping; Non-renewable energy (oil & gas); and Tourism/Recreation. Pressures: Changes in wave exposure; Introduction of NIS; Introduction of synthetic compounds; Marine litter; Substrate loss; and Water flow rate changes. Combination 2: Sectors include Agriculture; Aquaculture, Coastal Infrastructure; Fishing, Navigational dredging; Non-renewable energy (oil & gas), and tourism/recreation. Pressures: Abrasion; Introduction of synthetic compounds; Marine litter; Selective extraction of non-living resources; Selective extraction of species; Smothering; and Substrate loss. Combination 3: Sectors include Aggregates; Agriculture; Aquaculture; Coastal infrastructure; Fishing; Non-renewable energy (oil & gas); Shipping; and Tourism/Recreation Pressures: Abrasion; Changes in wave exposure; Changes in siltation; Input of organic matter; Introduction of NIS; Introduction of synthetic compounds; Marine litter; Nitrogen & Phosphorus enrichment; Smothering; Thermal regime changes; and Water flow rate changes.				

* Acute and chronic degree of impact is defined as having a detrimental effect on the habitat or its characteristic species i.e. loss, removal or mortality.

GES Descriptor 7: Hydrographic Conditions

GES Definition: GES is achieved when the various permanent alterations within a regional sea do not lead to adverse effects on marine ecosystems to the extent that the characteristic structures and features of those ecosystems are altered. In particular, the hydrographical conditions of habitats (water column or seafloor) should not be affected to the extent that their key functions (e.g. provision of spawning, breeding and feeding areas, or migration routes) are degraded.

Identification of Sector-Pressures affecting hydrographic conditions

The pressure assessment was used to identify sectors that contribute pressures (Table 64), which can affect the ecological characteristics used to describe hydrographic conditions (Table 65).

Table 64. Widespread common or persistent pressures affecting hydrographic characteristics of the environment.

Pressure	Sector
Change in wave exposure	• Coastal infrastructure
Input of organic matter	• Agriculture • Aquaculture • Fishing • Tourism/Recreation
Introduction of Synthetic compounds	• Agriculture • Aquaculture • Fishing • Non-renewable energy (oil & gas) • Shipping
Nitrogen & Phosphorus enrichment	• Agriculture • Aquaculture • Tourism/Recreation
Water flow rate changes	• Coastal infrastructure

Table 65. Status and trend information of ecological characteristics describing hydrographic (chemical) conditions of the Mediterranean Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Temperature (2) • Bottom temperature (Mean SST change) • Sea surface temperature (Mean SST change, Total SST change)	No	N/A	Yes (2)	• Increase (67%); • Stable (33%). • Spatial gradients in temperature observed with warmer waters in the eastern basin than the western basin	**Reports** • CIESM (2008) • UNEP LME Report (2009) • Published literature
Salinity (1)	No	N/A	Yes (1)	• Increase (100%) • Spatial gradients in salinity observed with higher salinity waters in the eastern basin than the western basin	**Reports** • Published literature **Criteria** • ppt
pH, pCO_2 (2) • pH • Carbonate alkalinity	No	N/A	Yes (2)	• Increase (50%); • Decrease (50%). • pH is decreasing, pCO_2 is increasing	**Reports** • Report 206 • Published literature

GES Descriptor 8: Contaminants

Risk Assessment Outcome: Moderate

GES Definition: GES will be achieved when concentrations of contaminants in water, sediment and biota are below assessment thresholds identified on the basis of toxicological data; pollution levels are below assessment thresholds representing harm at organism, population, community and ecosystem levels; and trends in concentrations of contaminants in water, sediment and biota, and the occurrence and severity of pollution effects, are within acceptable limits and declining.

Table 66. Status and trend of contaminant concentrations in the Mediterranean Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals • Heavy metals • Hydrocarbons (PAH) • Dioxins	No	High concentrations of some heavy metals e.g. Cd Pb, Zn and Cu	Yes	• Increase (Mercury, PAH [transport introductions]) • Stable (Cd, Zn, Cu, Fe, Mn, Cr, Dioxins) • Decrease (Pb, PAH [biota], PCB)	**Reports** • EEA 1999 • EEA 2006 • EEA 2010 • Eurostat 2011

Pollution of marine and coastal areas is a recurrently cited problem threatening biodiversity. The TDA MED and SAP MED identified 103 hot spots and 51 sensitive areas of regional importance in the Mediterranean basin (UNEP, 2003).

Types of pollution can be categorized as (1) organic, (2) microbiological, (3) chemical, and (4) radioactive (including thermal effluents). The causes of pollution can be identified as:

- Urban pollution: untreated sewage discharge (via rivers or outfalls), solid waste disposal (dumping)
- Industrial effluent: persistent organic pollutants, heavy metals, organometallic compounds, organohalogen compounds, radioactive substances, nutrients, and hazardous waste (such as lubricating oil or obsolete batteries)
- Agriculture: run-off of pesticides, fertilizers, metals, pathogens, salts, trace elements, etc.
- Aquaculture: pharmaceuticals, anti-bacterials
- Navigation and sea traffic (including the effects of ballast waters, cleaning tanks, and oil spills due to accidents).

Pollution of the coastal zone and its wetlands by solid and liquid domestic and industrial by-products is reported as a major problem by many Mediterranean countries, as the lack of appropriate treatment facilities is very common. In particular, chemical and petrochemical industries concentrated around major coastal cities are a major source of pollution. Runoff from agricultural sources can introduce high concentrations of fertilisers, pesticides and other agrochemicals. Their combined impact on the health of habitats and on particular species is often quite high. However, this is not an irreversible effect as removal of the sources of pollution can lead to biodiversity restoration (UNEP, 2003 MAP-RAC/SPA).

GES Descriptor 9: Fish and Seafood Contaminants
Risk Assessment Outcome: Low

GES Definition: GES would be achieved if all contaminants are at levels below the levels established for human consumption or showing a downward trend (for the substances for which monitoring is on-going but for which levels have not yet been set).

Fish species can be affected by man-made chemicals in the marine environment (Photo: Reuters)

Table 67. Status and trend of contaminant concentrations in the Mediterranean Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Chemicals in biological tissues • Heavy metals • Hydrocarbons (PAH) • Trace elements	Yes (1)	• Hg concentration above US Benchmark Dose Limit (BMDL) • High concentrations of some heavy metals e.g. Cd Pb, Zn and Cu but from natural sources (see MEDPOL)	Yes (3) • Concentration of Hg and Pb in mussels • POP concentration in seabirds, mammals and fish shown but not long-term trends (Fossi et al. 2002).	• Stable (Hg) • Decrease (Pb, POPs e.g. PCBs, DDT)	**Reports** • UNEP 2003 • EEA 2006 • Published literature **Criteria** • Concentration in tissues

GES Descriptor 10: Marine Litter

Risk Assessment Outcome: High

GES Definition: GES occurs when the properties and quantities of marine litter do not cause harm to the coastal and marine environment. This can be achieved through a measurable and significant decrease in comparison with the baseline (i.e. the situation up until 2012) in the total amount of marine litter by 2020 using as attributes the characteristics of litter in the marine and coastal environment and the impacts of litter on marine life.

Table 68. Status, trend and background information on marine litter in the Mediterranean Sea.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Bottom flora and fauna	The impact of marine litter on bottom fauna is largely unknown, but may affect the ingestion rates of deposit- and filter-feeding species e.g. *Arenicola marina* and *Mytilus edulis*[1,2].				
Fish	Impacts of ghost fishing described by the FAO (1995) as "one of the most serious negative impacts from the capture fishing industry" but little scientific evidence to support claim. See Matsuoka et al (2005) for review[3].				
Marine mammals and reptiles	The primary impact of marine litter on marine mammals and reptiles is entanglement, yet little is known of the extent to which this impacts species within this group. 43% of all marine mammal species are affected worldwide[4,5]. A high frequency of occurrence of debris has been reported in the stomachs of some species e.g. *Caretta caretta*[6]				
Seabirds	More than 111 species of seabirds (~36%) have been reported to ingest marine debris[7] although the impact of ingestion is unknown.				
Listed species	See above for impacts on characteristic species.				
Litter in water column and benthic habitats	52% of the marine litter in the Mediterranean originates from shoreline and recreational activities and only 5% originates from sea and waterway activities[8].		Yes (1)	• A recent poliferation of lighter items and a prevalence of plastics/microplastics has been observed	**Reports** • UNEP (2009)

[1]Browne, M.A. *et al.* (2008) Environmental Science and Technology 42(13): 5026-5021.
[2]Moore, C.J. (2008) Environmental Research 108(2): 131-139.
[3]Matsuoka, T. *et al*. (2005) Fisheries Science 71: 691-702.
[4]Laist, D.W. (1997) In: Coe, J.M., Rogers, D.B. (Eds.), Marine Debris – Sources, Impacts and Solutions. Springer- Verlag, New York, pp. 99–139.
[5]Derraik, J.G.B. (2002) Marine Pollution Bulletin 44: 842-852.
[6]Tomás, J et al. (2002) Marine Pollution Bulletin 42 (8): 677-688.
[7]Katsanevakis, (2008) In: Hofer TN (ed) Marine Pollution: New Research. Nova Science Publishers, New York. pp. 53–100.
[8]UNEP (2009). Marine litter: A global challenge. UNEP pp. 232.

Pressure Assessment Outcomes

Seven sectors were identified as contributing to the widespread or localised distribution of marine litter in the Mediterranean Sea (Table 69).

Table 69. Major widespread and localised sources of marine litter in the marine environment.

Sector	Extent	Frequency	Source
Aquaculture	Widespread patchy to Site	Persistent	Nets, plastics
Coastal Infrastructure	Widespread or Site	Common or Occasional	Construction materials, general litter
Fishing	Widespread and Locally patchy	Common	Lost gear/nets, general litter (cans, plastics)
Military	Widespread to Site	Rare	Munitions, general litter
Non-renewable energy (oil and gas)	Locally patchy or Site	Occasional	Decommissioned rigs, General litter (cans, plastics)
Shipping	Widespread or Locally patchy	Common	General litter (cans, plastics)
Tourism and Recreation	Widespread or Locally patchy	Common	General litter (cans, plastics)

Litter in the Mediterranean Sea
(Photo: C.J. Smith)

GES Descriptor 11: Energy Introduction (incl. noise)

*Risk Assessment Outcome: **High***

There is little information describing the impacts of underwater noise on the marine ecosystem, but noise may have deleterious impacts on several ecological characteristics including fish, marine mammals and seabirds. In a recent Task Group report to the Commission (Tasker et al. 2010), three possible indicators of underwater noise were developed. However, in no case was the Task Group able to define when GES occurs on the axes of the indicators. This was in part to do with insufficient evidence, but also due to no clear definition of when underwater noise effects are detrimental (Tasker et al. 2010).

In the absence of existing monitoring programmes for indicators of underwater noise, a pressure assessment approach has been used to estimate the distribution of the 3 indicators recommended in the Task Group report, namely: (1) low and mid-frequency impulsive sound, (2) high frequency impulsive sound, and (3) low frequency continuous sound. Principle sectors contributing these types of underwater noise are shipping, military (sonar) and offshore construction and the extent and frequency of those sectors as used to inform the risk assessment (see Annex V for criteria) is shown (Table 69). Note that the extent of the sector may not directly reflect the extent of the pressure and changes in the resonance of the sound as it travels through the water column are not considered here.

Table 70. Extent and frequency of sectors contributing underwater noise pressures in the Mediterranean Sea.

Sector	Extent	Frequency
Shipping	Locally patchy	Rare to Persistent
Military (sonar)	Site	Rare to Persistent
Offshore construction (including non-renewable and renewable energy sectors)	Site	Rare to Persistent

An oil rig in the Mediterranean Sea (Photo: GMC Ltd)

Habitats Directive: Species

*Risk Assessment Outcome: **High***

FCS Definition: The habitats directive species will be assessed as being at favourable conservation status when the population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, when the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future and when there is and will probably continue to be a sufficiently large habitats to maintain its populations on a long-term basis. Most assessments also considered an overall score for the species which combines these criteria. A one-out all-out approach has been adopted by the EEA (2009) as best practice for evaluation of multiple criteria per species, in which case, if one criteria falls below favourable conservation status, then the overall assessment for that species is reported as unfavourable.

Table 71. Status and trend information of Listed species under the Habitats Directive (Council Directive 92/43/EC) in the Mediterranean Sea. Status category criteria are defined in the Article 17 supporting documentation available from the European Environment Agency website (www.eea.eionet.europa.eu). The number of species evaluated is shown in brackets and may be evaluated using multiple criteria and therefore, status/trend category proportions shown may not match the number of species assessed. Overall Favourable Conservation Status is based on the one-out all-out approach, i.e. the worst case of any of the five criteria is the status applied to the species.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Listed Species (35) • 35 species are listed in the Article 17 reports • Species include: fish, marine mammals and reptiles, crustacean and molluscs	Yes (35)	• Favourable (7%); • Unfavourable-inadequate (30%); • Unfavourable-bad (26%); • Unknown (37%) • Only 1 of 35 species, Canestrini's goby (*Pomatoschistus canestrini*) is currently in Favourable Conservation Status.	Yes (14)	• Decrease (61%); • Stable (8%); • Increase (15%); • Stable/Decrease (8%) • 8 of 14 species show decrease in all criteria • Mediterranean monk seal, humpback whale and Canestrini's goby all stable. • Increases reported for SW European nase and Valencia toothcarp.	**Reports** • Article 17 Reporting (2007) **Criteria** • Range (distribution) • Population size • Habitat • Future prospects • Overall

Habitats Directive: Habitats

Risk Assessment Outcome: High

FCS Definition: The habitats directive habitats will be assessed as being at favourable conservation status when the habitats natural range and area it covers within that range are stable or increasing, 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 and the conservation stats of its typical species is favourable as defined for the habitats directive listed species. A one-out all-out approach has been adopted by the EEA (2009) as best practice for evaluation of multiple criteria per habitat, in which case, if one criteria falls below favourable conservation status, then the overall assessment for that species is reported as unfavourable.

Table 72. Status and trend information of Listed habitats under the Habitats Directive (Council Directive 92/43/EC) in the Mediterranean Sea. Status category criteria are defined in the Article 17 supporting documentation available from the European Environment Agency website (www.eea.eionet.europa.eu). The number of habitats evaluated is shown in brackets and may be evaluated using multiple criteria (see criteria in table) and therefore, status/trend category proportions shown may not match the number of habitats assessed. Overall Favourable Conservation Status is based on the one-out all-out approach, i.e. the worst case of any of the five criteria is the status applied to the habitat.

Ecological Characteristic	Existing Status Assessments	Status Assessment Outcomes	Existing Trend	Trend Outcome	Source and Criteria
Listed Habitat • 11 habitats are listed in the Article 17 reports • Habitat Reference Codes are: 1110, 1120, 1130, 1140, 1150, 1160, 1170, 1180, 1240, 1310 and 1410	Yes (15)	• Favourable (5%); • Unfavourable-inadequate (15%); • Unfavourable-bad (13%); • Unknown (58%); • Variable - Favourable to Bad* (9%) • *Spatial variation in assessment for Mediterranean salt meadows (*Juncetalia maritimi*)	Yes (5)	• Decrease (40%); • Stable (20%); • Increase (20%); • Variable (no clear trend) (20%) • Decreasing trends reported for Sea cliffs with endemic *Limonium* spp. (1240)	**Reports** • Article 17 Reporting (2007) **Criteria** • Range (distribution) • Area • Structure and Function • Future prospects • Overall

(Footnotes)

[1] Further information describing each ecological characteristic may be available that is not presented in these tables (e.g. fish assemblages of the NE Atlantic). ODEMM recommends that all end-users should undertake an additional literature review to ensure that any specific objectives are met.

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Annex V
Risk Assessment

Annex V

ODEMM Risk Assessment – HLO descriptions and risk criteria

This Annex includes the description of conditions associated with achievement of GES (or FCS) for each high level objective (HLO), followed by the criteria used for the assessment of risk of failure (low, medium or high) as used for the ODEMM risk assessment described in Chapter 3. The criteria used to assess confidence in the ODEMM risk assessment are also included at the end.

Descriptor 1: Biodiversity

GES is achieved when biodiversity is maintained in the regional sea such that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

Failure of GES is defined to occur where there is loss of biodiversity beyond that expected under prevailing conditions before 2020. Loss of biodiversity can be described as occurring where there is a reduction in genetic, species, habitat or ecosystem diversity within the regional sea over this time scale. More specifically loss of particular meta-populations, species, habitat types or ecosystem properties within the region (e.g. extirpations) would certainly count as a loss of biodiversity, but so could a noticeable change in diversity based on changes in evenness (e.g. shifts in dominance). However, both of these cases would need to be a loss/change beyond that expected under prevailing conditions.

GES under Biodiversity should be assessed individually for each of the major ecosystem characteristics listed in Annex III of the MSFD (EC 2008) as recommended in the COM decision (2010/447/EU, EC 2010). Consideration should be given separately to listed species and habitats under the Habitats Directive. Consistency should be checked against the level of risk identified for other relevant Descriptors (e.g. seafloor integrity for the aspects of habitats-ecosystem level diversity).

Risk categories for Biodiversity

High	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 **and/or** Maintained change in the dominance of genotypes, species, habitat types or ecosystem types (change in evenness) where this change is likely to last for at least the next 10 years
Moderate	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 **and/or** Alterations in the dominance of genotypes, species, habitat types or ecosystem types (change in evenness) within the next 10 years, not necessarily having led to a maintained change
Low	No notable changes in extent and condition of genotypes, species, habitat types or ecosystems at the scale of the region beyond that expected given prevailing conditions within the next 10 years **and** No clear change in dominance of genotypes, species, habitat types or ecosystem types (change in evenness) given prevailing conditions within the next 10 years

Descriptor 2: Non-indigenous species introduced by man

GES for Non-indigenous species (NIS) is a function of their relative abundances and distribution ranges, and environmental impact. These may vary from low abundances in one locality with no measurable adverse effects, up to occurrence in high numbers in many localities resulting in significant impacts. GES will be maintained when significant adverse effects on environmental quality from NIS are avoided, including no elimination or extinction of sensitive and/or rare populations, alteration of native communities, seasonal dominance of algal blooms, alteration of water chemistry (oxygen, nutrient content, pH and transparency) or accumulation of synthetic pollutants.

Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere and have an adverse effect on environmental quality. Therefore it is invasive NIS that are of most concern in terms of posing a risk to GES.

Risk categories for NIS

High	High abundance and increasing trends in abundance of established invasive non-indigenous species in many sub-regions **And/or** High numbers of invasive non-indigenous species in many sub-regions. **And** Clear evidence of significant adverse effects on environmental quality In those sub-regions
Moderate	High abundance of some established invasive non-indigenous species in some sub-regions or generally increasing trends in abundance in some areas. **And/or** High numbers of invasive non-indigenous species in some sub-regions **And** Evidence of adverse effects at species, habitat or ecosystem level but only in some sub regions
Low	Low abundance of established invasive non-indigenous species in the region with no apparent increasing trends. **And/or** Low numbers of invasive non-indigenous species **And** No evidence of adverse effects at species, habitat or ecosystem level

Descriptor 3: Commercial Fish and shellfish

GES for commercially exploited fish and shellfish will be achieved when stocks are sustainably exploited consistently with high long-term yields and have full reproductive capacity. To achieve GES it will also be necessary, in addition to sustainably exploited stocks at full reproductive capacity, for the age and size distribution of fish and shellfish populations to be representative of a healthy stock, assessed by reference to the proportion of older and larger fish in the population. As stated in the Commission Decision paper (2010/447/EU, (EC 2010)) GES is achieved for a particular stock only if criteria for all attributes are fulfilled (one-out all-out approach).

Terms used in the risk criteria include: Spawning stock biomass (SSB); Precautionary SSB (SSBpa); Fishing mortality (F); F at Maximum sustainable yield (FMSY).

Risk categories for commercially exploited fish and shellfish

High	SSB < SSBpa for some stocks **and/or** exploitation rate F exceeds precautionary levels for some stocks (>25%) **and/or** the age and size distribution of fish and shellfish stocks shows consistent long-term degradation. i.e. smaller, younger fish.
Moderate	25% stocks are exploited sustainably (F<FMSY) **and/or** all stocks SSB > SSBpa
Low	All stocks are exploited sustainably (F<FMSY) **and/or** SSB > SSBMSY for >50% of stocks **and/or** all stocks SSB > SSBpa **and/or** the age and size distribution of fish and shellfish stocks show no degradation. i.e. smaller, younger fish.

Descriptor 4: Food webs

The interactions between species in a food web are complex and constantly changing, making it difficult to identify one condition that represents 'good' status. However, some changes in species' relative abundance in an ecosystem can have significant adverse effects on food web status. GES of Food Webs will be achieved when energy flows through the food web, and the size, abundance and distribution of key trophic groups/species, are all within acceptable ranges that will secure the long-term viability of all food web components in line with prevailing natural conditions.

Risk categories for food webs

High	Spatially extensive and long-term changes have occurred in energy flows through the food web, as recorded by changes in the productivity (production per unit biomass) of several key species or trophic groups, which have both direct and indirect effects on different trophic levels. **and/or** Trends in the abundance and distribution of carefully selected indicator populations, and in the proportion of species at the top of food webs, show continuous decline across the Region and provide evidence of adverse impacts on food web integrity.
Moderate	Recent changes in the productivity (production per unit biomass) of some key species or trophic groups suggest that direct and indirect effects have occurred on different trophic levels. **and/or** Trends in the abundance and distribution of local indicator populations, and in the proportion of species at the top of food webs, suggest that adverse impacts to food web structure have occurred in some sub-regions.
Low	Recorded changes in energy flows through the food web, as recorded by changes in the productivity (production per unit biomass) of key species or trophic groups, have no significant direct and indirect effects on different trophic levels. **and/or** Trends in the abundance and distribution of carefully selected indicator populations, and in the proportion of species at the top of food webs, vary in accordance with natural cycles and show no cause for concern in relation to food web structure.

Descriptor 5: Eutrophication

GES with regard to eutrophication has been achieved when the biological community remains well-balanced and retains all necessary functions in the absence of undesirable disturbance associated with eutrophication (e.g. excessive harmful algal blooms, low dissolved oxygen, declines in seagrasses, kills of benthic organisms and/or fish) and/or where there are no nutrient-related impacts on sustainable use of ecosystem goods and services.

The terminology used to describe the extent and frequency of undesirable disturbance associated with Eutrophication shown below, are used in the ODEMM pressure assessment (PA) approach to categorise pressures on the ecosystem (see guidance on ODEMM pressure assessment at www.liv.ac.uk/odemm/outputs/guidancedocuments). As such it is possible to use information on the extent and frequency of the pressure 'nitrogen and phosphorus enrichment' from the PA to inform the risk assessment on Eutrophication where relevant.

Risk categories for Eutrophication

High (3)	Undesirable disturbance* caused by eutrophication is widespread (even or patchy) and frequent in the region (> once a year)
Moderate (2)	Undesirable disturbance* caused by eutrophication is widespread but rare in the region (< once a year) **and/or** Undesirable disturbance* caused by eutrophication only occurs at a site or local scale in the region, but it occurs at least once a year
Low (1)	Undesirable disturbance* caused by eutrophication does not occur in the region, or where it does occur it only occurs rarely (<once a year) and on a very local scale (site or local patchy)

*Undesirable disturbance includes one or more of the following: harmful algal blooms, low dissolved oxygen, associated declines in perennial seaweeds or seagrasses, kills of benthos and fish, dominance by opportunistic macroalgae

Descriptor 6: Seafloor integrity

GES is achieved where sea-floor integrity is at a level that ensures that the structures and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. “Seafloor” includes both the physical structure and biotic composition of the benthic community. “Integrity” includes the characteristic functioning of natural ecosystem processes and spatial connectedness. “Not adversely affected” is interpreted as meaning that impacts may be occurring, but are insufficient to degrade natural levels of diversity, productivity, and dynamic ecosystem processes.

Seafloor integrity will be assessed here for the broad predominant habitat types only where the assessment will be based on the outcomes of the pressure assessment (PA) undertaken in ODEMM (for detailed explanations of the terminology used in the PA and thus in the risk criteria below, see the ODEMM pressure assessment guidance document at www.liv.ac.uk/odemm/outputs/guidancedocuments). Thus the integrity of the seafloor is assessed in terms of the extent of damage caused by the various human activities that interact with it.

The habitats listed under the Habitats Directive will be assessed against the FCS criteria of the Habitats Directive (listed after the MSFD descriptors). If they are achieving FCS they will also be meeting the criteria for GES for seafloor integrity.

Risk categories for Sea-floor integrity

High	Where the pressures and habitats overlap: 1. Extent is widespread (even or patchy), severity is acute or chronic and the persistence of the pressure is high or continuous, irrespective of frequency of occurrence **and/or** 2. Extent is widespread (even or patchy), severity is acute and the frequency of occurrence is occasional or higher, irrespective of Persistence category **and/or** 3. Extent is widespread (even or patchy), severity is chronic and the frequency is persistent or common, irrespective of Persistence category **and/or** 4. A combination of multiple local pressures which result in a widespread extent with a severity, frequency and persistence combination equivalent to one of the above **and/or** 5. The overlap of multiple low severity pressures which combine to form a severe (acute or chronic) impact combination equivalent to one of the above
Moderate	Any combination other than high or low
Low	Where severity is classified as ‘low’ for all interactions with pressures in the region even when they are combined **Or** Where any severe effects (chronic or acute) occur and frequency of occurrence is rare, persistence of the pressure is low, and resilience of the habitat is high

Descriptor 8: Contaminants in the environment

Assessment of whether concentrations of contaminants are at levels not giving rise to pollution effects should be based on monitoring programmes for chemical contaminants, and on biological measurements relating to the effects of pollutants on marine organisms in each of the assessment regions.

GES will therefore be achieved when concentrations of contaminants in water, sediment and biota are below assessment thresholds identified on the basis of toxicological data; pollution levels are below assessment thresholds representing harm at organism, population, community and ecosystem levels; and trends in concentrations of contaminants in water, sediment and biota, and the occurrence and severity of pollution effects, are within acceptable limits and declining.

Risk categories for contaminants in the environment

High	Concentrations of all contaminants in biota, sediments and water exceed the relevant Environmental Quality Standards over extensive areas of the Region. **and/or** Significant impacts on and risk to the marine environment have recently been shown by the occurrence and extent of pollution effects throughout the Region.
Moderate	Concentrations of some contaminants in biota, sediments and water exceed the relevant Environmental Quality Standards in some sub-regions of the Region. **and/or** Impacts on and risk to the marine environment have recently been shown by the occurrence and extent of pollution effects in sub-regions.
Low	Concentrations of contaminants in biota, sediments and water do not exceed the relevant Environmental Quality Standards established for the Region. **and/or** The occurrence and extent of pollution effects throughout the Region indicate no significant impacts on or risk to the marine environment

Descriptor 9: Contaminants in fish and shellfish

Contaminants in the marine environment that are of concern, both from an environmental and public health point of view, have been selected. Regulatory levels exist in Europe for lead, cadmium, mercury, polycyclic aromatic hydrocarbons, dioxins & dioxin-like PCBs and radionuclides (Directive 76/464/EEC). Other substances of concern are arsenic, non-dioxin like PCBs, phthalates, organochlorine pesticides, organotin compounds, brominated flame retardants and polyfluorinated compounds.

GES would be achieved if all contaminants are at levels below the levels established for human consumption or showing a downward trend (for the substances for which monitoring is ongoing but for which levels have not yet been set). However, it is generally felt that GES for Descriptor 9 must be judged in view of the monitoring of Descriptor 8, also dealing with contaminants in the marine environment.

Risk categories for contaminants in fish and shellfish

High	Many contaminants in edible tissues are currently exceeding regulatory limits in some areas of the Region **and/or** Regulatory levels of one or more contaminants in edible tissues are being exceeded on a regular basis in large areas of the Region.
Moderate	Some contaminants in edible tissues are currently exceeding regulatory limits in some areas of the Region. **and/or** Regulatory levels of one or more contaminants in edible tissues are being exceeded occasionally in large areas of the Region.
Low	Levels of contaminants in edible tissues do not currently exceed regulatory limits anywhere in the Region. **or** Regulatory levels are rarely exceeded in large areas of the Region.

Descriptor 10: Marine litter

GES occurs when the properties and quantities of marine litter do not cause harm to the coastal and marine environment. This can be achieved through a measurable and significant decrease in comparison with the baseline (i.e. the situation up until 2012) in the total amount of marine litter by 2020 using as attributes the characteristics of litter in the marine and coastal environment and the impacts of litter on marine life.

In addition, it is possible to use information from the ODEMM pressure assessments on the intertidal habitats for the first criterion given in each risk scenario and the pelagic water column habitat for the second criterion. The information in the pressure assessment can be used to summarise the spatial extent and frequency of any activities adding marine litter to the environment, since marine litter is one of the pressure categories used. Any additional information on the future trends in activity for the major sectors contributing litter can also be used to ascertain whether the extent of marine litter currently recorded in the pressure assessment is likely to change in the future.

Risk categories for Marine Litter

High	Unchanged or increasing trend in the amount of litter washed ashore and / or deposited on coastlines over widespread areas (patchy distribution within this fine) of the region **and/or** Unchanged or increasing trend in the amount of litter in the water column over widespread areas of the region **and/or** Unchanged or increasing trend of micro particles over widespread areas of the region **and/or** Unchanged or increasing trend in litter ingested by large numbers of marine animals in the region
Moderate	Unchanged or increasing trend in the amount of litter washed ashore and / or deposited at coastlines in some sub-regions **and/or** Unchanged or increasing trend in the amount of litter in the water column in some sub regions **and/or** Unchanged or increasing trend of micro particles in some sub regions **and/or** Unchanged or increasing trend in litter ingested by marine animals in some sub regions
Low	Decreasing trend in the amount of litter washed ashore and / or deposited at coastlines over extensive areas of the region **and/or** Decreasing trend in the amount of litter in the water column over extensive areas of the region **and/or** Decreasing trend of micro particles over extensive area of the region. **and/or** Decreasing trend in litter ingested by marine animals over extensive areas of the region.

Descriptor 11: Underwater noise

In relation to underwater noise, GES would occur when there is no adverse effect of underwater noise inputs on any component of the environment. However such an objective is probably not achievable or measurable. Therefore indicators for environmental status have been developed (2010/447/EU, (EC 2010)) that are based on pressures addressing two main issues with regards to underwater noise. One is the distribution in time and place of loud, low and mid frequency impulsive sound that is mainly introduced by offshore construction using pile driving (e.g. for offshore wind farms) and seismic surveys. The other is the trend of continuous low frequency sound indicated mainly by shipping activity.

The offshore sectors that use pile driving in the construction phase (e.g. non-renewable and renewable energy sectors) and shipping are included in the ODEMM pressure assessment (PA). It is thus possible to extract information on the extent of activities related to these sectors from the outputs of the PA.

Risk categories for Underwater noise

High	High activity and increasing trend of offshore construction using pile driving (e.g. oil and gas platforms, offshore wind farms), seismic surveys and sonar systems, which is widespread in the region **and/or** High activity and increasing trend of shipping (commercial and recreational) indicated by the number of tourist vessels and commercial shipping activity (number and intensity of shipping lanes) over widespread areas of the region
Moderate	High activity of offshore construction using pile driving (e.g. oil and gas platforms, offshore wind farms), seismic surveys and sonar systems in some sub regions, or an increasing trend in some areas. **and/or** High activity of shipping (commercial and recreational) indicated by the number of tourist vessels and commercial shipping activity (number and intensity of shipping lanes) in some sub regions or an increasing trend in some areas
Low (1)	Little offshore construction works using pile driving throughout or moderate activity only in a few places (local or site under the pressure assessment) in the region **and** Little shipping activity throughout or moderate activity only in a few places in the region (local or site)

Habitats Directive species

The habitats directive (HD) species are assessed as being at favourable conservation status (FCS) when the population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, when the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future and when there is and will probably continue to be a sufficiently large habitats to maintain its populations on a long-term basis (JNCC, 2007). Most assessments on the HD species also include an overall score for the species which combines these criteria. A one-out all-out approach was used; therefore, if one of these criteria was considered as unfavourable then the overall assessment for that species is considered as unfavourable. The percentage of species used acts only as a basis to separate the risk scenarios and this is not scientifically derived.

Risk categories for Habitats Directive species

High	Greater than 50% of listed marine species relevant to the region, and 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. **and/or** >25% of all species listed in the region have an assessment recorded as unknown
Moderate	Less than 50%, but greater than 10% of listed marine species relevant to the region and that have assessment information available, are shown to be unfavourable for at least one of the criteria used to assess them i.e. population, range and habitat. **and/or** >10% but <25% of all species listed in the region have an assessment recorded as unknown
Low	Greater than 90% of marine species for the region that have assessment information available are at favourable conservation status for all criteria used to assess them i.e. population, range and habitat. **and** There are few species (<10% of all species listed in the region) where the assessment is recorded as unknown

Habitats directive habitats

The habitats directive (HD) habitats are assessed as being at favourable conservation status (FCS) when the habitat's natural range and the area it covers within that range are stable or increasing, 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 and the conservation status of its typical species is favourable as defined for the HD listed species (JNCC, 2007). For most habitats an overall assessment combines these criteria under a one-out all-out approach; therefore when one criterion is found to be unfavourable then the overall assessment is unfavourable for that habitat. The percentage of habitats used acts only as a basis to separate the risk scenarios and this is not scientifically derived.

Risk categories for Habitats Directive habitats

High	Greater than 50% of listed marine habitats relevant to the region, with assessment information available, are shown to be at unfavourable conservation status for at least one of the criteria used to assess them i.e. range, area, structure and function. **and/or** >25% of all habitats listed in the region have an assessment recorded as unknown
Moderate	Less than 50% but greater than 10% of listed marine habitats relevant to the region, with assessment information available, are shown to be unfavourable for at least one of the criteria used to assess them i.e. range, area, structure and function. **and/or** >10% but <25% of all habitats listed in the region have an assessment recorded as unknown
Low	Greater than 90% of marine habitats relevant to the region, with assessment information available, are at favourable conservation status for all criteria used to assess them i.e. range, area, structure and function. **and** There are few habitats (<10% of all habitats listed in the region) where the assessment is recorded as unknown

Criteria for confidence assessment

Confidence should be assessed after every judgement that is made using the criteria below. Some further commentary on confidence and how the decision was made should be written in the relevant section of the assessment commentary document.

Confidence should be assessed based only on the criteria that are listed to be used for the assessment. Any further source of ambiguity with regards the risk score for that descriptor should be listed in the commentary sheet under the question about confidence e.g. impacts of noise on the marine environment.

High	Good quality information is available for the majority of the criteria used for the assessment **and** Information available for that descriptor is easy to interpret in terms of the criteria **and** There is complete agreement amongst experts in the group
Moderate	Good quality information is available for some criteria used for the assessment **and/or** There is some information available for all criteria **and/or** Information that is available for that descriptor can be interpreted in terms of the criteria with expert judgement **and** There is majority agreement amongst experts within the group
Low	Information is available for few criteria used in the assessment **and/or** There were difficulties with interpretation of available information in terms of the criteria used for the assessment **and/or** The group could not reach a common agreement about the risk score

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