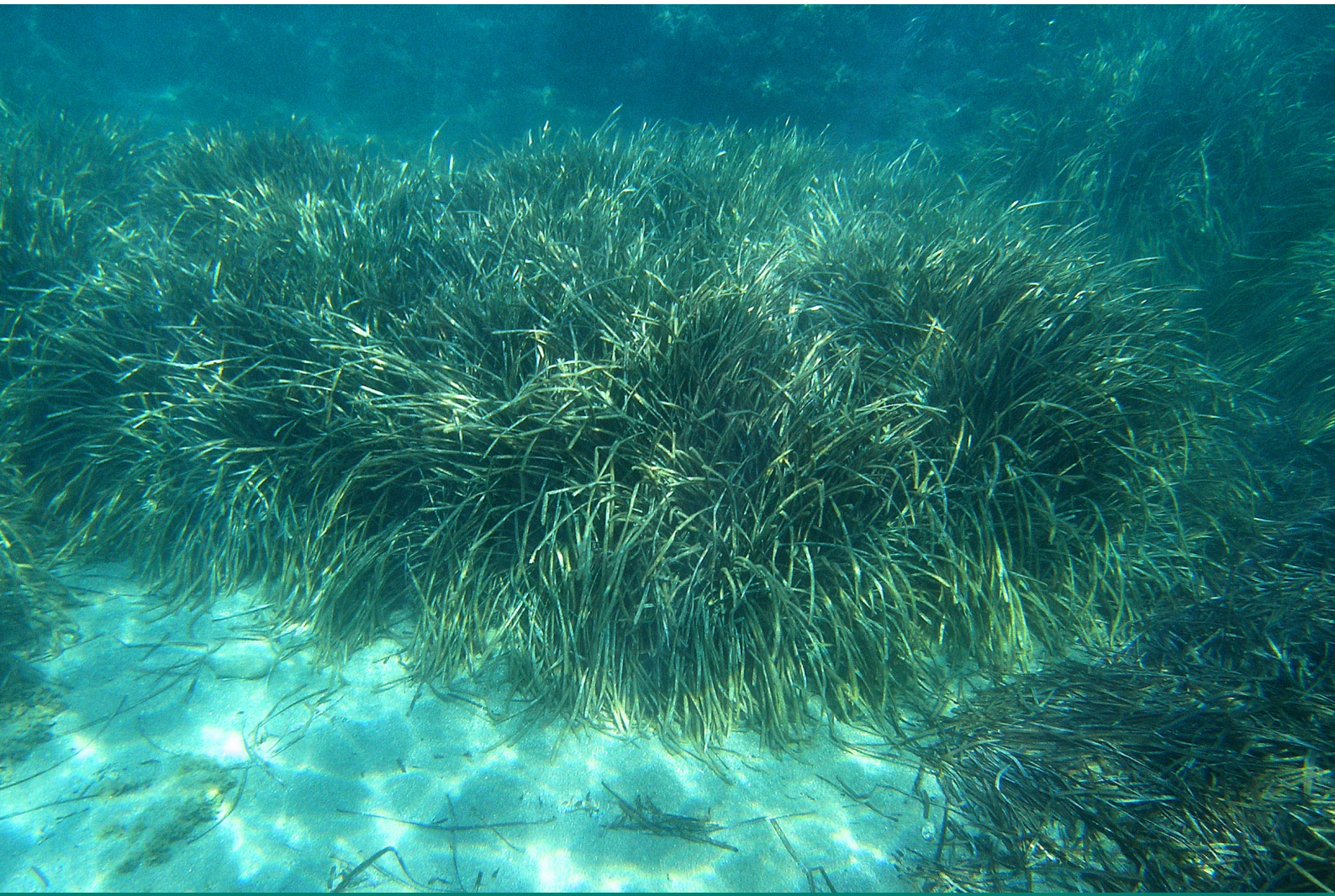
ETC/ICM Technical Report 3/2019

Biodiversity in Europe's seas



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Authors and acknowledgements

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The report is to a large extent based on the long-term work of the European Topic Centre on Inland, Coastal and Marine waters with David Vaughan and Samuli Korpinen as task leads, and Ángel Borja as Science Manager. It is anchored in information reported by the Regional Seas Conventions (RSCs) and some EU Member States as part of reporting under the Marine Strategy Framework Directive (MSFD), the Habitats Directive (HBD), Water Framework Directive (WFD) and as well as other general such as the IUCN Red List of Threatened Species and the IPBES Regional Assessment Report on Biodiversity and Ecosystem Services for Europe and Central Asia as well as a suite of other sources of information, e.g. seabed habitat data from EMODNet.

1 Executive Summary

This report seeks to provide an overall view of the state of biodiversity in order to help answer questions posed by European policy and international obligations on whether the loss of biodiversity has been reduced. It is a thematic assessment of Biodiversity which combines existing assessment results from a range of regional and international sources, alongside with integrating approaches and tools to assess biodiversity trend and status at a European level.

Existing assessments have provided different perspectives of the status of biodiversity in meeting different policy objectives to provide an overall synthesis of outcomes at the European level and to assess whether the overall picture aligns with the EU Biodiversity Strategy to 2020 in its headline target to halt biodiversity loss by 2020 (EC, 2011).

This report does not attempt to utilise results from Member States updates under Art.17 of the Marine Strategy Framework Directive (MSFD) as the results are not complete at time of publication. However, the report does include assessments produced by the Regional Seas Conventions, and other regional or international sources.

The Report is divided into the following sections:

Why evaluate biodiversity in Europe's Seas?
This section covers what drives the need to evaluate marine biodiversity while setting out the complexity of this task due to practical difficulties in gathering data and understanding marine systems.

Safeguarding biodiversity is at the heart of the 'living well within limits' agenda
This covers the policy framework on biodiversity status and trends assessments.

Status & trends in European marine life
This addresses the state of individual components of biodiversity and the species or habitat specific pressures and trends that affect their current state. It also introduces the integrating tools to provide a common assessment approach.

The Ecosystem Approach: Integrated Biodiversity Assessments
Here the aim is to identify the ways in which biodiversity has been assessed following an ecosystem-based approach and to show a way forward to developing more standardised indicators and tool-based metrics for assessing status and trends across all European Seas.

Synthesis & Outlook for Marine Biodiversity
This final chapter brings together the collective outcomes presented in earlier chapters and key messages on overall state and prospects.

i. A high proportion of marine species and habitats continues to be in unfavourable status, so EU Member States need to ensure full implementation of existing political commitments to halt the loss of marine biodiversity by 2030. The underlying drivers of degradation of marine ecosystems are not changing favourably and pressures and effects of climate change are set to continue. Reaching agreed goals for mitigating climate change are essential for preserving the resilience of marine ecosystems.
ii. While there have been very few extinctions of European marine species to date, there are risks that increasing declines in biodiversity will lead to more extinctions in future.
iii. Measurement of progress is also impeded by large number of data gaps both from lack of synoptic monitoring and availability of operational indicators of status for all European Seas. The assessment of outlooks still relies primarily on expert judgment.

iv. Fisheries management show what can be achieved for biodiversity components with a direct economic relation – the challenge now is to present the value of other components through methods and approaches like natural capital accounts.

This publication is number one in a series of European Environment Agency (EEA) marine thematic reports covering a broad range of topics: (1) contaminants, (2) eutrophication, (3) marine biodiversity, (4) potential cumulative effects of multiple human pressures, (5) sustainable use, and (6) marine protected areas (MPAs). The seventh publication will be the second edition of the EEA Marine Messages report. Preparing these thematic assessments provided the marine input to The European environment – State and Outlook 2020 report by the EEA.

2 Why evaluate biodiversity in Europe's seas?

KEY MESSAGES:

- Europe's economic prosperity and well-being is underpinned by its natural capital, which deliver ecosystem services essential for human activity, as promoted in the EU Biodiversity Strategy and the priority objective of the 7th Environment Action Programme.
- Delivering marine ecosystem services depends on biodiversity being in a healthy state and not in decline.
- While there has been considerable effort to evaluate European marine biodiversity both at Member State and Regional level, it is important to synthesise these outcomes to inform policy evaluation and refinement at European level.
- While most keystone marine species are invertebrates, most monitoring of species populations occurs for vertebrates, which could suggest that signals of changes in trends in lower levels of the food web or even systemic change in ecosystem health may be missed.

2.1 Staying within planetary boundaries

The concept of Planetary Boundaries (see Box 2.1 and Figure 2.1) provides a visual way of understanding the state of key global environmental processes and assesses whether they are reaching critical limits (Rockström et al., 2009). Biodiversity is one of the nine boundary zones as it underpins Biosphere integrity, though more recently, this boundary has been divided into Functional diversity and Genetic diversity (Steffen et al., 2015).

Genetic diversity (and hence species diversity) is regarded as being at high risk and this is the driver behind most current biodiversity assessments of species and habitats (Steffen et al., 2015). Functional diversity includes related concepts of recovery and resilience, although here the authors could not quantify the risk. This is important as these are the elements arguably more directly linked to provision of ecosystem services and to the maintenance of natural capital. This implies there are potential but unquantified risks to continued provision of services to society from marine biodiversity.

The measure for the main planetary boundary for biodiversity is the extinction rate of species, as extinctions per million species per year (E/MSY) (Steffen et al., 2015).

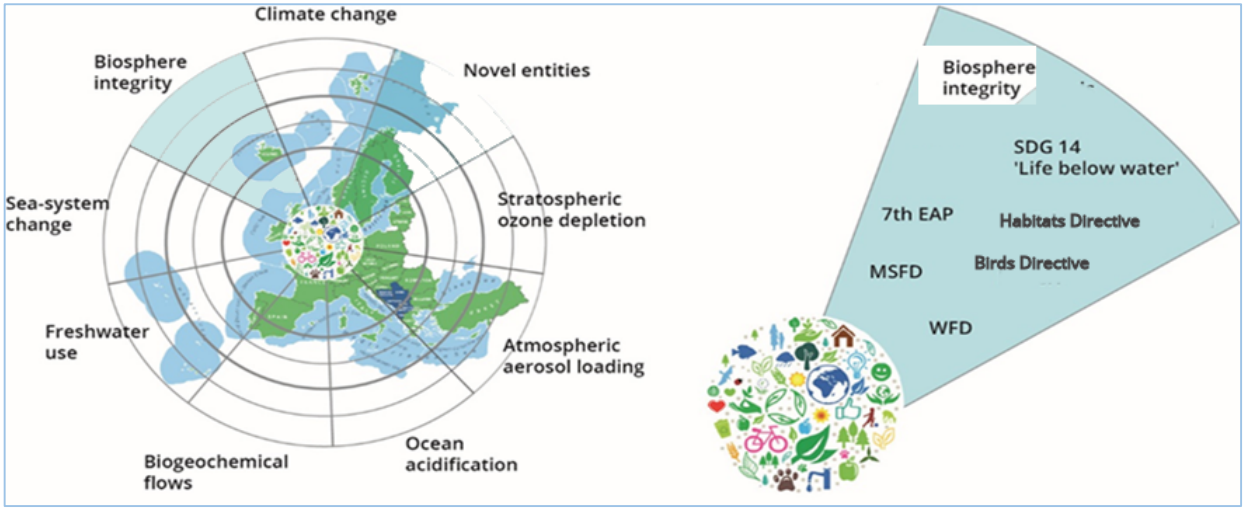
Box 2.1 The planetary boundary framework

The planetary boundaries framework set out to define a safe operating space for human societies to develop and thrive. It builds upon our growing understanding of the functioning of the Earth system. It has defined nine evolving planetary boundaries.

This report focuses on 'biodiversity'.

Source: Steffen et al., 2015

Figure 2.1: Biodiversity Loss & Planetary Boundaries



Source: Steffen et al. (2015), modified after Rockström et al. (2009)

It is striking that to date the number of known extinctions in European marine fauna is very low (see on European Red List) (IUCN, 2019). However, this is due in part to the lack of knowledge of abundance of marine fauna, especially invertebrates, and the wider ranges of many of the vertebrate species than is the case in freshwaters or on land. This is not a cause for less evaluation – understanding the changes in status and trends of a wide range of species means we are better able to identify more widespread risks of extinctions whether locally across Europe (extirpation) or globally.

2.2 The biodiversity of European seas

Europe's seas cover more than 11 million km^2, and range from shallow, semi-enclosed seas to vast expanses of the deep ocean. They host a wide, highly diverse range of coastal and marine ecosystems with a large variation of habitats and species. For example, the Mediterranean Sea is one of the world's hot spots for biodiversity. Its highly diverse ecosystems host around up to 18 % of the world's macroscopic marine biodiversity (Bianchi and Morri, 2000) with potentially at least 7,000 species (Coll et al., 2010). In comparison, the Bothnian Bay in the Baltic Sea holds only approximately 300 species (HELCOM, 2018b).

Biodiversity as a term covers the diversity of life in our seas, from individual species (and their genetic diversity) to whole ecosystems (see Box 2.2) which follows the definition under the Convention on Biological Diversity. The species interact and depend on each other through food web dynamics, competition for space or through mutual synergies by providing shelter or foraging areas. They are connected through an intricate dynamic 'web of life' – a web which is the foundation for the capacity of the marine ecosystem to provide ecosystem services and benefits for humanity. These connections are at the core of Ecosystem Based Management (EEA, 2015c). The disturbance of the individual strings of the web through interaction with human activities may cause undesirable changes. The ability to absorb disturbance with such changes is 'ecosystem resilience'.

The challenge is to maintain ecosystem resilience within the boundaries under which humanity has evolved and thrived. From Figure 2.1, this implies that ecosystem resilience must be kept within a range that can help support the halt of biodiversity loss. For this reason and given the complexity of interactions between the individual components, both the individual pieces and overall complexity of ecosystem resilience need to be addressed (albeit in a simplified manner). This report seeks to evaluate the essence of ecosystem resilience i.e. the status of species and habitats along with the overall condition of marine ecosystems.

So, why should marine biodiversity be considered at a European scale? European policies require a continent-wide perspective. There are common impacts and pressures across all seas and consistency in methods and approach help to identify the state of globally important trends such as the direction of change of the Biosphere planetary boundaries in Section 2.1 to underpin efforts to mitigate potential impacts of these events.

Box 2.2 Biodiversity (or biological diversity) is...

> "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".
>
> (United Nations Environment Programme, 1992)

Habitat diversity in European seas

Figure 2.2 shows the four main European Seas which are formed from coherent biogeographical characteristics. It may appear that there is limited biological connectivity between them, but this is not always the case. Some species are migratory or range widely (e.g. cetaceans, or non-breeding waders), or where parts of their life histories are dependent on planktonic stages moving between different habitats. For example, loggerhead turtle population trends in the Mediterranean are largely based on the status of breeding populations in the Mediterranean although turtles of Atlantic origin also enter the Mediterranean Sea and utilise specific foraging grounds. Many species and habitats occur across regional seas, albeit with different sub-populations, which means that an overall assessment of biodiversity at European scale is desirable, given the benefits from comparing successes in monitoring and management.

Figure 2.2: Europe's regional seas

Source: EEA, 2019c

European seas and their associated marine and coastal ecosystems encompass shallow semi-enclosed seas to the deep ocean, from cold Arctic waters to warmer sub-tropical seas. The diverse coastal zones host prolific intertidal areas, lagoons and ancient seagrass beds (EEA, 2015d). Half of Europe's seas are hidden in a permanent darkness below 2,000 m – a place where little is known about the biodiversity and even less so of the impacts caused by human activities. Deep habitats can be very close to the coast (as in the Mediterranean or Iberian Coast) but, due to technical problems (partially solved in recent years), they are still understudied and monitored.

This variation in depth influences other physical factors such as light penetration, which enables plants to grow, and patterns of current circulation. Along with different gradients of principal abiotic variables such as reduced salinity in areas with high freshwater inundation or energy and light exposure, these macro-physical factors set the scenario for the development of a huge diversity in marine habitats and ecological niches across the constituent European seas.

Species diversity

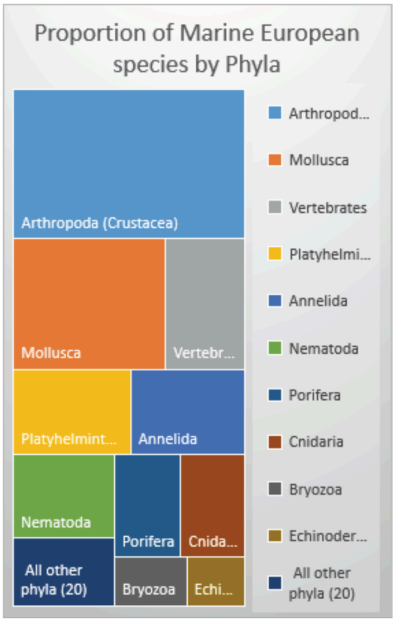
The definition in Box 2.1 shows the complexity of trying to assess biodiversity consistently across all its components. Worldwide, there are estimated to be around 200,000 known species of marine animals, 7,600 plants and at least 21 000 other phyla (Appeltans et al., 2012) with 27,000 found in European waters (Costello et al., 2007). This is considerably lower than the number of terrestrial species. This has significance when issues such as rarity and endemism are considered (see below).

Figure 2.3 shows biodiversity by the number of species where molluscs (shellfish) and arthropods (crustacea) account for 40 % of the total.

The understanding of species diversity is complicated by the availability of data and by the types of monitoring being undertaken, which tend to focus on specific taxa or habitat types. Most species assessments focus on vertebrates (with a few exceptions such as specific invertebrate or seagrasses).

Taxonomic diversity – counting the number of species – is essentially a measure of overall genetic diversity and hence evolutionary resilience. This is the main reason why exceeding the planetary boundary in Figure 2.1 is such a high risk and particularly in the medium term.

Figure 2.3: Proportion of species in European seas by phyla



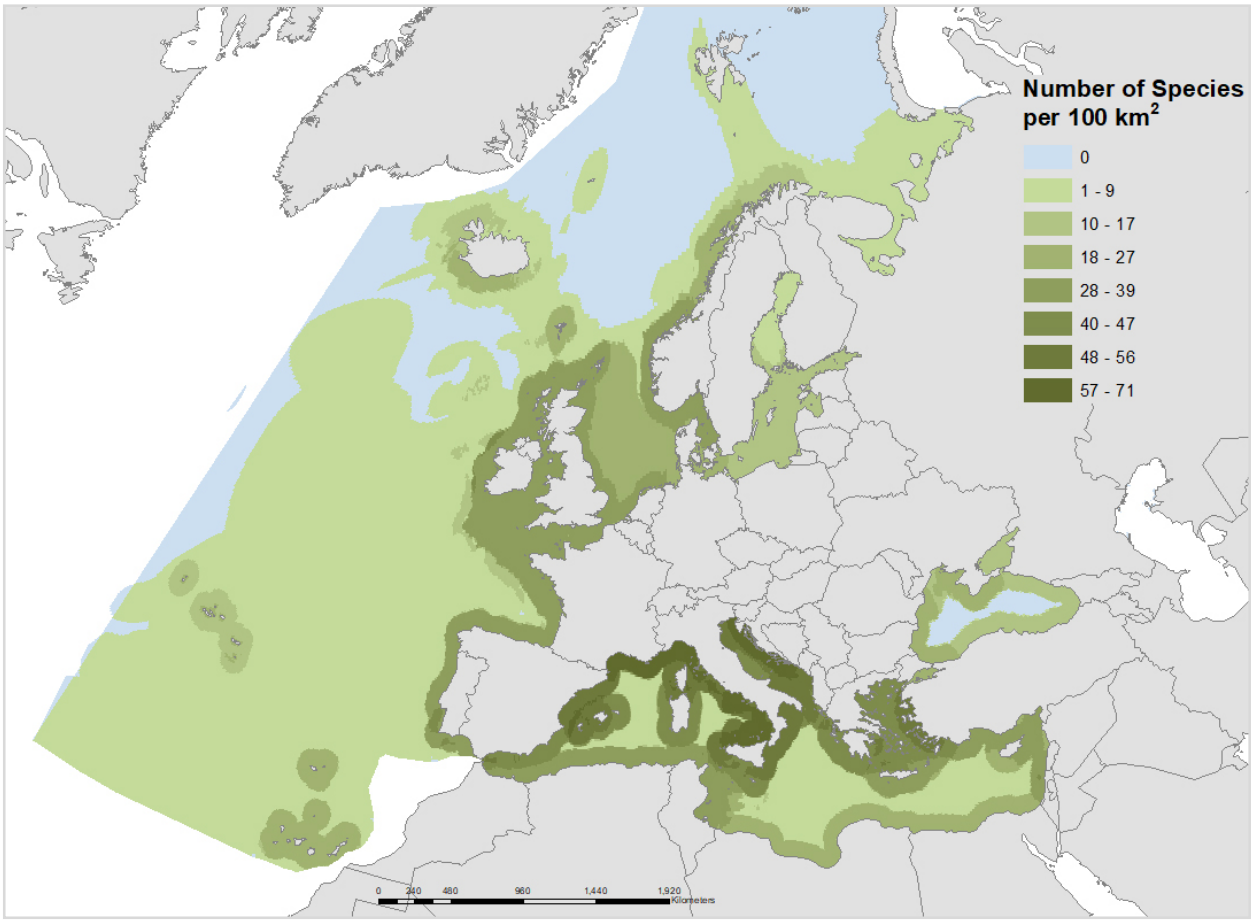
Source: Data from MarBEF, 2009

Species diversity and endemism

Not all species are wide-ranging, and this report also pays attention to those species which either have small or fragmented population or limited ranges. These include rare and threatened species listed in the various European Red Lists (Gubbay et al., 2016; Nieto et al., 2015; Temple and Terry, 2007a; IUCN, 2019), but also endemic species restricted to European waters (Figure 2.4).

These species tend to inhabit more restricted habitats, so population declines are especially damaging in wider conservation terms. The Mediterranean Sea is one of the world's 25 hot spots for biodiversity, hosting around 4 to 18 % of the world's marine biodiversity (Coll et al., 2010; Gabrié et al., 2012). This shows that European marine biodiversity is of significant global as well as continental interest.

Figure 2.4: Distribution of endemic fish species in Europe



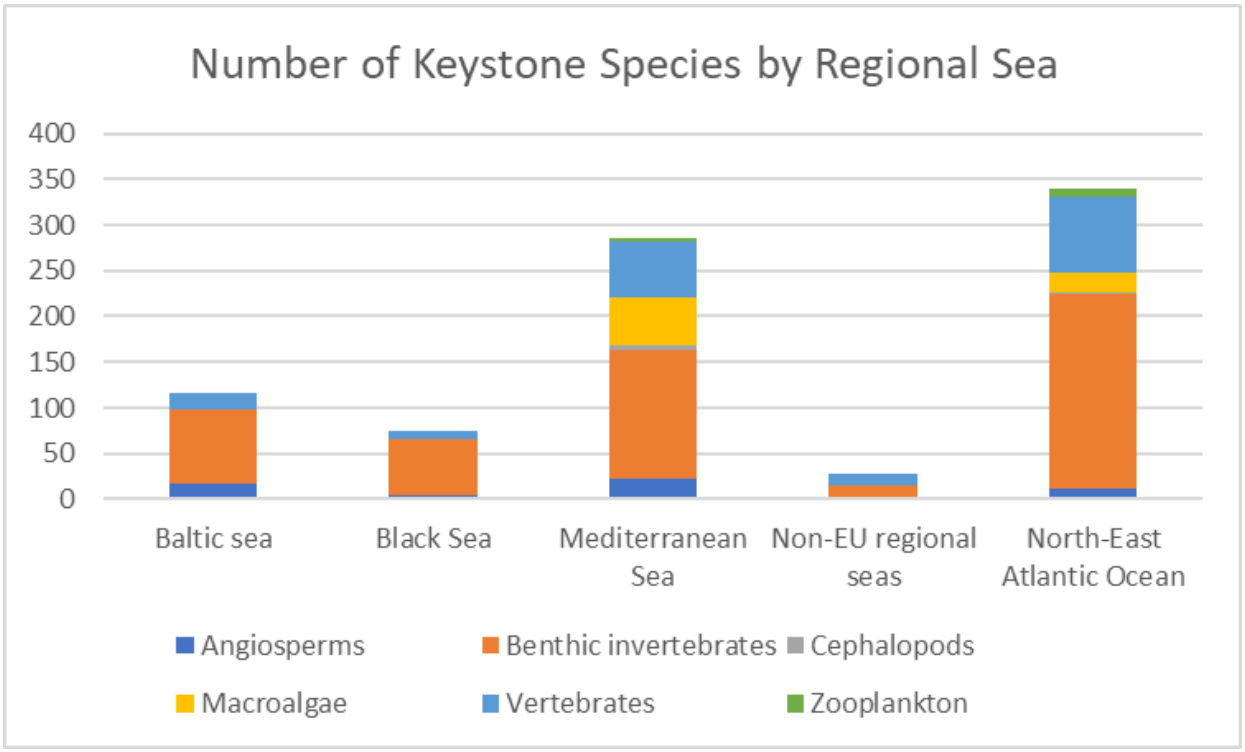
Source: Nieto et al., 2015

Keystone species

Keystone species are defined by their role rather than their taxonomic relationships – they have a disproportionate level of influence on their environment relative to their abundance (MarBEF, 2009). A review in the EU DEVOTES project (Smith et al., 2014) listed experimental studies where loss of a keystone species in some circumstances could mean a regime shift in the ecosystem, meaning that their conservation priority should be high (Figure 2.5). The review also identified three key groups of European marine keystone species – keystone predators (e.g. fish-eating mammals, habitat forming species (e.g. seagrass) and bioengineering species such as bioturbators). Overall the review identified 210 keystone species, approximately divided equally into the three groups.

One of the key findings of the review was that most keystone species in EU waters were invertebrates, while in non-EU (Norwegian Sea) waters the few keystone species tended to be predatory fish (Figure 2.5).

Figure 2.5: Keystone species by regional sea



Source: Data from Smith et al., 2014

The implication of this finding is that while most systematic species monitoring will include vertebrate keystone species, there are a large number of invertebrate species that are not monitored nor assessed.

Ecosystem diversity and the Ecosystem approach

The third class of biological diversity is at the ecosystem level and this is considered to be the level for developing integrated management strategies to for conservation and sustainable use (Secretariat of the Convention on Biological Diversity, 2004). Understanding the state of ecosystem diversity and related functions is the essential building block for the development of Ecosystem Based Management, as described in the EEA's State of Europe's Seas report (EEA, 2015d).

Figure 2.6, taken from that report, shows how these different biological components relate to each other and also how they are combined to support the ecosystem approach (EEA, 2015d). This thematic assessment aims to synthesise outcomes from a range of sources to address as many of these components as possible.

In the figure, the additional elements for an ecosystem approach are to understand the marine socio-economic status and the associated drivers of change which can impact on biodiversity. This is brought together in the DPSIR (Drivers-Pressures-State-Impact-Responses) model (EEA, 2015d)

Figure 2.6: Biodiversity as the state element in the DPSIR model

Source: State of Europe's Seas (EEA, 2015d)

2.3 Threats to marine biodiversity

Threats to biodiversity come directly or indirectly from human activities. Long-term effects of climate change, ocean acidification and litter are difficult to assess, especially over short time frames, but their impacts are likely to be significant over time if they maintain their current trajectories (Korpinen et al., 2019).

Other threats come from pressures linked to human activities. However, the level of impact of different pressures varies according to where they are delivered and on the receptor components of biodiversity. For example, the most significant threat for fish is from fishing activity (Nieto et al., 2015), followed by pollution from contaminants and eutrophication. Impacts on biodiversity may have uneven effects for different features – fishing has the most significant effect on threatened fish species, but this is then followed by coastal development and energy production (IPBES, 2018b).

2.4 The value of healthy seas

Europe's seas are relatively well-monitored and managed compared to other parts of the world which enables a better understanding of how human pressures are affecting the state of biodiversity. Despite this there are many gaps or missing time series and while there are fewer marine species than terrestrial in Europe, this underlines the significance of declines in species diversity or abundances.

To understand these impacts more thoroughly, the ideal outcome would be to understand how changes in biodiversity affect the natural capital necessary for human society (EEA, 2015d), which is the essence of the Ecosystem-based approach.

This links the health of biodiversity inextricably to the overall health of human society through provisioning, cultural, regulation and maintenance ecosystem services, which, in turn, depend on the status of ecosystem assets. It supports different management objectives and allows systematic treatment of trade-offs between ecological, sociological and economic factors.

However, using these links in practice in any predictive way is a huge undertaking with marine systems. To ensure that health is maintained – or that we reach Good Environmental Status using the MSFD definition – we need to understand both the state of ecosystems and which pressures affect which components to lead to an integrated assessment

Scale and scope of this report

This report is a thematic assessment of the state of biodiversity, which draws on a range of existing work from published marine assessments to country reporting and research outputs. There has been a significant amount of work conducted under existing EU legislation across Europe, notably the MSFD (see Chapter 3) so this report seeks to build on these resources but also place them in a wider context of European seas beyond those covered by MSFD.

The key consideration then is to link biodiversity status (see Chapter 3) as natural capital to ecosystem state or health in order to understand how changes may impact on the provision of ecosystem services (Maes et al., 2016) (see Chapter 6). While the focus of this Thematic report is on the state of marine biodiversity, the role of the drivers of change in impacting biodiversity components will need to be acknowledged. These are covered in parallel reports from the EEA and the European Topic Centre (ICM) on pressures (Korpinen et al., 2019), contaminants (EEA, 2018a), eutrophication (EEA, 2019b), and the link between seabed damage and ecosystem services (Piet and Royo-Gelabert, 2019).

3 Safeguarding biodiversity is at the heart of the 'living well within limits' agenda

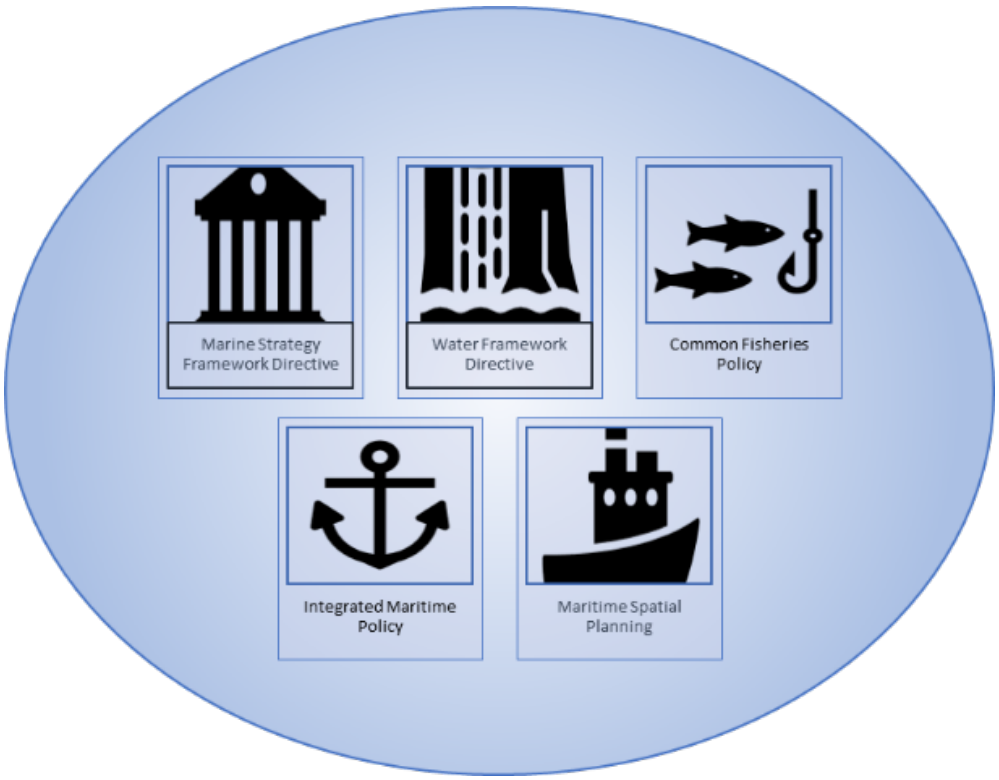
KEY MESSAGES:

- Knowledge of biodiversity status is required to support implementation of a wide range of maritime policies, which have a sustainable development focus.
- Loss of biodiversity implies loss of species (or populations), but it is important also to assess changes in populations and extents in order to put in place remedial measures before extinctions occur.
- Assessment of biodiversity include analysing trends and status where condition is assessed against a target

3.1 Supporting European and international policy

Across Europe, there is a range of policies which aim to improve the status of marine biodiversity or which imply that maintaining the status of biodiversity is a key requirement to reach sustainability goals. Figure 3.1 shows the close link between the state of marine biodiversity in Europe's seas and the delivery of sectoral marine policies that reach beyond the environmental arena.

Figure 3.1: Marine biodiversity status underpins a range of policies



The primary legislative drivers which focus on marine biodiversity are listed in Table 3.1 below. These cover both European legislation directed at maintenance of biodiversity in European territory and regional action where European interests are considered as underpinning global concerns that go beyond the regional scope. The European Directives (except for the Birds Directive) have a requirement to assess biodiversity components to identify specific status levels. These assessments, or the background preparation for these assessments, are drawn on as primary data sources for this report.

Regional European conventions

While the reporting of the legislation listed in Table 3.1 is at a European level (from Member States contributions), a considerable amount of work is also undertaken at the regional level under the auspices of the four Regional Seas Conventions (RSCs) that operate in European seas. Each of the Conventions has produced an Intermediate Assessment (or similar) which includes reporting on indicators of biodiversity status. Collectively, this work brings together several years work by national experts, across EU member states and beyond. This identifies needs for, and improvements to, operational indicators and also to ensure the definition and the implementation of monitoring programmes that can inform those indicators.

The indicators that have been developed so far through the different RSCs provide a solid base from which to assess biodiversity more broadly at the ecosystem level. The general references of the assessments for each of the RSCs is outlined in Table 3.2.

Table 3.1 European and international legislative requirements

EU Biodiversity Strategy (EUBS)	• Halting the loss of biodiversity and ecosystem services **in the EU and help stop global biodiversity loss by 2020.**
Marine Strategy Framework Directive (MSFD)	• Achieving Good Environmental Status (GES) in marine waters by 2020
Habitats Directive (HD)	• Maintaining or restoring natural habitats and species of Community interest to Favourable Conservation Status (FCS).
Birds Directive (HD)	• Conserving all species of naturally occurring birds in the wild state, including establishing special protection areas (SPAs)
Water Framework Directive (WFD)	• Aiming to achieve good status of the waters by 2021 (including Good Ecological Status)
Maritime Spatial Planning Directive (MSP)	• Through a framework for maritime spatial planning, aiming to promote the sustainable growth of maritime economies and use of marine resources
Convention on Biological Diversity (CBD)	• Conserving biological diversity, ensure sustainable use of its components – includes meeting Aichi Targets
Convention on Migratory Species (CMS)	• Conserving migratory species, especially those endangered or at unfavourable conservation status.
UN Convention on the Law of the Sea (UNCLOS)	• Protecting and preserving the marine environment and exploit resources in accordance with this. Prevent, reduce and control marine pollution.
The 2030 Agenda: UN Sustainable Development Goals (SDGs)	• Goal 14 is to "Conserve and sustainably use the oceans, seas and marine resources"

Table 3.2 Regional intermediate assessments

Regional Sea Convention	Scope and period of assessment	Regional Sea Convention	Scope and period of assessment
OSPAR	OSPAR Intermediate Assessment 2017 20 indicators for birds, mammals, fish, pelagic & benthic habitats (OSPAR Commission, 2017d)	**Barcelona Convention**	UNEP-MAP 2017 Mediterranean Quality Status Report (UNEP-MAP, 2017b) – 10 indicators under Ecological Objective EO1 (Biodiversity)
HELCOM	HOLASII State of the Baltic Sea 2018 (HELCOM, 2018e), 12 indicators	**Bucharest Convention**	Black Sea State of Environment Report 2009–2014/5 (BSC, 2019)

Marine species

The marine species groups identified by the MSFD and species listed in Annexes of the Habitats Directives are primarily vertebrate groups which include most of the species at the apex of food webs.

Away from coasts, there is a smaller proportion of marine invertebrate species being monitored than vertebrates, except for selected Mediterranean endemic species such as the ribbed limpet and the noble pen shell, those with commercial aspects such as *Nephrops*, or mobile species such as cephalopods. Knowledge of the status of invertebrate tends to be through monitoring the habitats that they inhabit (e.g. cold-water corals, coralligenous assemblages, etc.). Many species-specific assessments for invertebrates and plant are undertaken in support of the Water Framework Directive (WFD) (EEA, 2018c) though the marine content is restricted to coastal and transitional waters.

To date, most assessments have focused on individual components of the marine ecosystems as precursors to a more ecosystem-based assessment. This is reflected by the way the Habitats Directive and MSFD reporting requirements are structured, with the focus on monitoring and assessing individual species or species groups and marine habitats.

Marine habitats

In the MSFD, habitats are divided into broad seabed (benthic) habitats and pelagic habitats. The benthic broad habitats are characterised by the substrate (whether rock, coarse or mixed sediments, or sand or mud) and the depth which ranges from shoreline littoral habitats to deep abyssal forms (EC, 2017). The pelagic broad habitats primarily consist of planktonic forms in different physical environments (coastal, shelf and oceanic, plus variable salinity environments). Other, nektonic forms are generally covered as individual species).

There are nine marine habitats listed in Annex I of the Habitats Directive which vary from specific biotopes such as *Posidonia* beds, to substrate types such as reefs and also more complex physiographic habitats such as estuaries which are aggregations of other habitats. For example, reefs cover both those where communities of animals develop over hard substrate such as kelp beds (Teagle et al., 2017) and also biogenic reefs formed by invertebrates or calcareous algae capable of forming solid concretions (e.g. mussels such as *Mytilus* and *Modiolus* in the North-East Atlantic, or coralligenous in the Mediterranean).

3.2 Combining data from different assessments

Different regulatory responses may also require different data collection processes, although there are strong moves towards harmonisation of reporting at the EU level. For example, biological quality elements data for the WFD is only collected for coastal and transitional waters in the marine realm, which extend to 1 nm from shore whereas chemical status data is up to 12 km from shore (the precise distance varies with Member State).

A complication in biodiversity assessment is that data sources are often drawn from monitoring set up to meet specific questions or regulations. This implies that only parts of the ecosystem may be monitored at any one time. Because of the nature of some of the European Directives much of the monitoring is coastal or near-coast because it focuses on the marine elements defined by policies such as the WFD and the HD. However, the offshore waters, representing approximately 95 % of European seas, are generally not as comprehensively monitored (EEA, 2015; Liquete, 2011). Over 50 % of European waters lie at depths greater than 2,000 m. Despite the difficulties in monitoring or even performing baseline surveys in deeper waters, much progress has been made to provide a more synoptic view of the state of marine biodiversity, especially through the last round of the MSFD.

While recognising that there are a considerable number of challenges with biodiversity data, synthesis and their interpretation, this report seeks to pull together a common assessment view across a full range of previous reports and start to use new methods and tools to integrate assessments of trends and status.

3.3 Measuring state, status and trends

The aim of a biodiversity assessment is usually to identify how 'well' biodiversity is performing (i.e. equivalent to understanding the ecosystem health). The terms **state** and **status** have been used in different circumstances and reports to describe the health preferably in a quantifiable way. While the terms are equivalent in other respects, in this report they are distinguished as follows:

When reported for example for European Directives, Ecosystem **state,** as defined by, is the "physical, chemical and biological condition of an ecosystem at a particular point in time" (Rendon et al., 2019 from Maes et al., 2016). State is therefore equivalent to condition and to its quality and therefore the system's ability to deliver its functions.

This differs to ecosystem **status**, which is defined as "a measure of state over time and compared to an agreed target as in relevant EU environmental directives (e.g. HD, WFD, MSFD)]" (Rendon et al., 2019). Some status definitions (e.g. in the Habitats Directive) also include the concept of **trend**, ("future prospects") to put the measure of state into a temporal direction, and also distributional parameters such as range or extent (EEA, 2013a).

This thematic assessment is primarily focused on bringing together measures of biodiversity status against targets but also includes additional evidence of the state or trends in biodiversity even where a policy or scientific target are not yet defined.

What to measure

The metrics used in biodiversity indicators are very varied and an indicative list of those used for the spatial and trend assessments in this report are shown in Table 3.3.

A key challenge therefore is to find ways of bringing these differing kinds of metrics into a common assessment framework. This will be described later in Section 4.1.

3.4 Assessing integrated ecosystem status and trends

The heart of ecosystem assessments is the understanding of changes between habitats and species as well as between human activities and the biodiversity components. To understand change, we also need to understand the variability of change across space and time due to natural fluctuations as opposed to that driven by external pressures, to integrate this knowledge into an overall statement of the state of biodiversity.

Table 3.3 Indicator types used in assessment

Indicator Code	Number of Indicators
% Good Environmental Status	2
% threatened (Red List Index)	2
Abundance	70
Benthic Index	48
Biomass	3
Pelagic Index	1
Depth distribution	13
Spatial Distribution	0
Ecological Quality Ratio	13
Fishing Index	100
Population data	3
Nutritional status	2
Physico-chemical status	6
Population health	9
% Species	1
Other	239

Sources: EEA, 2019a; DEVOTES, 2016

Using the indicators developed by the RSCs and elsewhere, we have the basis for bringing these assessments into a more general framework covering the European Seas. The primary aim of an integrated assessment at a European scale is to provide a consistent and repeatable way of informing future developments of the legislative drivers listed in Table 3.1 and not primarily to understand effectiveness of national or even regional management responses. Nevertheless, the ecosystem approach needs to be consistent with assessments which are based on component indicators or pressure-based proxies. This will be an ongoing challenge into the future.

This assessment starts the process of delivering integrated assessments by using two modelling approaches, one to understand general **trends** of species and habitats, and the other to provide an overall view of a general **status** of biodiversity by aggregating indicator performance against targets.

4 Status and trends in European marine life

KEY MESSAGES:

Which biological components are most at risk across Europe's seas?

- Seabed habitats are under significant pressures across European seas from the cumulative impacts of demersal fishing, coastal developments and other activities.
- Over 65 % of protected seabed habitats reported by Member States were in unfavourable condition, while more recent regional assessments suggest most seafloor habitats were physically disturbed in the Greater North Sea, Celtic Seas and Baltic Sea. As yet, there has been no similar large-scale assessment of offshore habitats in the Mediterranean and Black Seas.
- Trends for more widespread or common species are mixed. Fish populations subject to commercial fishing are showing improvements in the North-East Atlantic Ocean and Baltic Sea but overfishing remains a challenge in the Mediterranean Sea. Where long-term trends on species abundance exist, birds and mammal trends are, on average, either stable or slightly declining.
- However, within these general trends, 33 % of seabird and 40 % of shark and ray species in Europe had declining populations. Killer whales, a top marine predator, are heavily impacted by long-term contaminants and their longer-term viability is threatened. Over 20 % in seabird populations have declined in the last 25 years for more than a quarter of the species assessed in the North-east Atlantic. In the Baltic Sea, 31 % of breeding water bird populations have declined.

Are the declining trends in biodiversity being reversed?

- European countries have through joint efforts over the last couple of decades managed to reduce selected pressures in the regional seas, such as reducing contaminants and improving water quality with positive effects starting to become visible for species such as Grey seals, White-tailed Eagles in Baltic Sea, Dalmatian Pelicans in the Black Sea and the Mediterranean Bluefin tuna.
- Nevertheless, considering the regional to planet-scale changes e.g. ocean acidification, observed across our oceans and seas as well as the expectations for the blue economy to double by 2030 as the ambitions for sustainable blue growth, not all pressures are addressed adequately nor fast enough to say that the trends for marine biodiversity has been reversed.

4.1 Approach to this assessment

This section provides thematic assessments of marine biodiversity built up from understanding of the status of each of the main biological components (Figure 4.1) identified in the core legislative drivers identified in Section 3. Whole ecosystems, and food webs in particular are covered in Section 4.

The sources for the assessments are drawn from a range of initiatives to provide as wide a consensus view of biodiversity status as possible. The list of primary sources, showing the focus on assessments and tools covering as wide a range of European Seas as possible, is shown in
Figure 4.2.

Figure 4.1: Components covered in this assessment

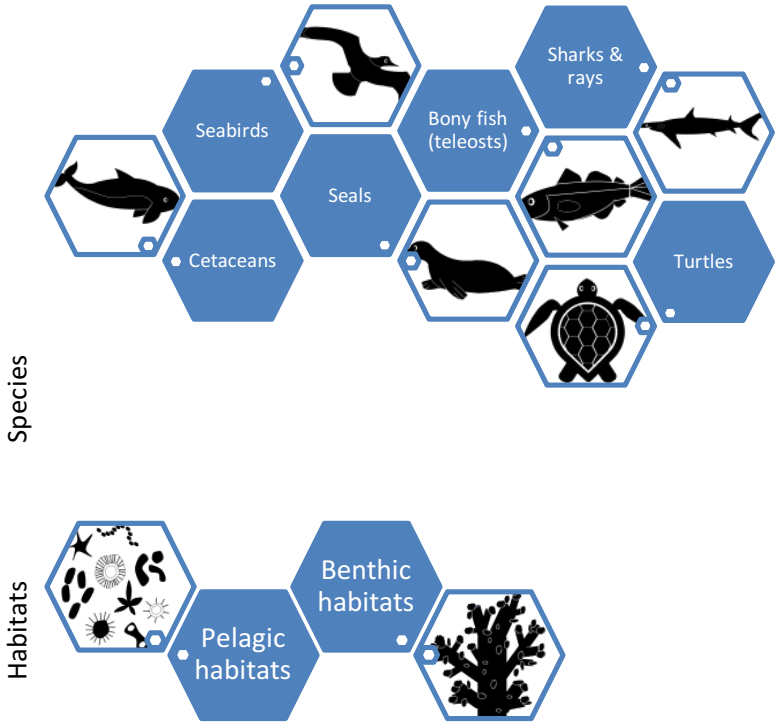


Figure 4.2: Sources of assessments for this report – what they each provide to the overall picture

Source	Assessment contribution	Caveats	1. European scale?	2. All biodiversity?	3. All habitats & species?	4. Has threatened?	5. Status Coverage?	6. Shows trends?
Regional Seas Assessments								
Intermediate assessments for OSPAR, HELCOM and UNEP-MAP from 2017	Ecosystem-level assessments still in development	Indicators not always comparable across regions						
IUCN Red List Assessments								
Overall assessment of rare and endangered species & habitats	Assessments carried out at regular intervals primarily for species (habitats in 2016)	Assessments usually aggregated for whole region scale						
EU Directive Reporting								
Reporting from Member States	Largely based on Habitats Directive 2013; some transitional / coastal data from WFD	Current Art 17 reporting and MSFD Art 8 reporting not available						
IPBES Regional Assessment Europe								
IPBES Regional Assessment Report on Biodiversity and Ecosystem Services for Europe & Central Asia	Covers marine assessments of European Seas, using published data and statutory assessments, similar to those used here	Usually pilot studies not regional scale						
EU Assessment Research Projects								
Integrated assessment data derived from pan-European projects	e.g. EcApRHA (North-East Atlantic), Baltic BOOST in Baltic, MEDCIS (Mediterranean), DEVOTES pan-Europe	Usually pilot studies not regional scale						
Assessment data portals								
Fisheries assessment data from ICES DATRAS database and GFCM data in Mediterranean	Detailed assessments of commercial fish stocks, based on best scientific evidence	Also have research data for non-commercial fish but only trends, not status						
Living Planet Index								
Aggregated index of trends used for Convention on Biological Diversity	Shows average trends of species populations or biomass over time; in use in international assessments	In common with other averaging methods, obscures rare species. Doesn't indicate data gaps						
BEAT+ Integrated Assessment Tool								
Novel tool for integrating indicators (from HOLAS assessments in Baltic)	Provides common approach for integrated assessments across all regional seas	Dependent on reliable targets and baselines for quantitative indicators						

Key: European scale = how much does it cover all European Seas? **All Biodiversity** = how many biodiversity components; **Shows trends** = does it provide quantitative trend data? **Assessment status** = Does it provide an overall status of biodiversity against targets? **All habitats & Species** = does it cover wider habitats & species? **Has Threatened** = does it cover rare or threatened species? **Main Sources:** (OSPAR Commission, 2017d; HELCOM, 2018e; UNEP-MAP, 2017a; IUCN, 2019; ETC/BD, 2012; Uusitalo et al., 2016; ICES, 2019; Nygård et al., 2018; Collen et al., 2009)

Level of European Coverage (0 = sub-regional only, otherwise counts of regional seas)					Level of biodiversity component coverage					Trend assessments		
0	1	2	3	4	1	2	3	4	5	No	Few	Yes

Regional Seas Conventions Assessments

From the assessments undertaken by three of the four RSC's, Table 4.1 provides a brief overview of the main messages for the primary assessment groups. The messages are taken from the overall assessments, based on sets of indicators for each of the main biodiversity components.

Table 4.1 Summary of key messages on biodiversity status & trends from Regional Seas Conventions Assessments 2017–2018

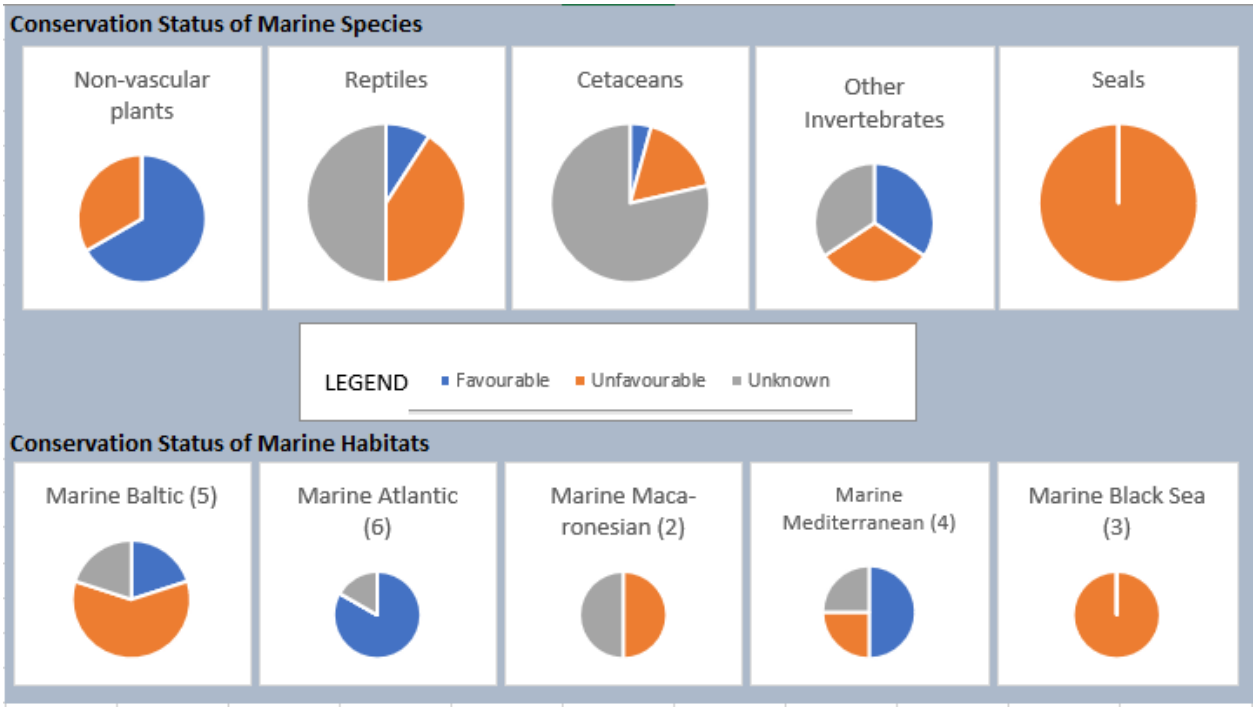
Regional Sea	Benthic Habitats	Pelagic Habitats	Birds	Fish	Mammals	Reptiles
Baltic Sea	Indication of good status in 46 % of areas	Good status only in Kattegat. Coastal pelagic habitats good in < 25 % of area	Waterbirds in good status but open water species declining	Good status in 50 % of coastal areas, none in open water. 30 % of stocks in good status. No clear overall trends across region but evidence of population structure changes	Grey and harbour seals increasing Ringed seal in critical state. Lack of robust assessments of cetaceans	Not applicable
Black Sea	Under threat but status of invertebrate communities not assessed (Turkey). Macrophytes restoring as water quality improves	Increased algal species richness 2008-14 though trends in abundance declining. Water quality for coast & shelf generally good.	Poorly studied to date. 35 species, of which 4 are listed as Vulnerable by Red List	Data summarised from EU fisheries data. Focus on selected stocks generally showing declines in landings, both pelagic (sprat, anchovy) and demersal (turbot, whiting, dogfish)	Not covered	Not applicable
Mediter-ranean Sea	Large proportion threatened Severe lack of data	Further research needed	Limited data – evidence of decline in endemic species. Data issues confounding trends	Fisheries assessments available through the General Fisheries Commission for the Mediterranean (GFCM)	Mammals under threat especially monk seal, fin & sperm whales, common dolphins & orcas	Abundance data patchy for nest sites
NE Atlantic & North Sea	86 % of habitats highly disturbed in North Sea, less in Celtic Sea. No trends reported	Significant community and abundance changes between 2004 & 2014. Phytoplankton species dominance highly variable	Drop of 20 % in abundance in 3 sub-regions compared from 25 years ago. Not healthy – breeding failures occurring but there is regional variability	Fisheries management having positive impact on fish communities at regional scale. High temporal variability in pressure	Bottle-nosed dolphins, grey & harbour seals stable or increasing. Porpoises at risk from by-catch. Species-specific & regional differences in trends	No assessments (infrequent)

Source: OSPAR Commission, 2017d; HELCOM, 2018e; UNEP-MAP, 2017b; GFCM (FAO), 2019; JRC, 2019

Outcomes of EU Directives

A related source of information on protected species and habitats comes from 2012 Article 17 reporting round of the Habitats Directive (ETC/BD, 2012). The next reporting round has completed in 2019 but the results at EU Biogeographical scale were not available when this current report was compiled. Nonetheless, this gives insights into the current situation albeit as a baseline. Figure 4.3 shows the summary for Annex II species and Annex I habitats for marine regions. In general ranges and trends where known are relatively stable except for invertebrates though the marine mammal trend is listed as decrease for 8 % of the species. The key finding here is the very high level of unknown statuses, ranging from 60 % to 100 % of the totals. As also shown in the IPBES assessment (IPBES, 2018b), the 2012 Habitats Directive assessment showed only 7 % of marine species and 9 % of marine habitat show a "favourable conservation status". Moreover 27 % of species and 66 % of assessments of habitat types show an "unfavourable conservation status" and the remainder are uncategorized.

Figure 4.3: Summary of marine species conservation status in Habitats Directive Art.17 reporting 2013



Source: ETC/BD, 2012

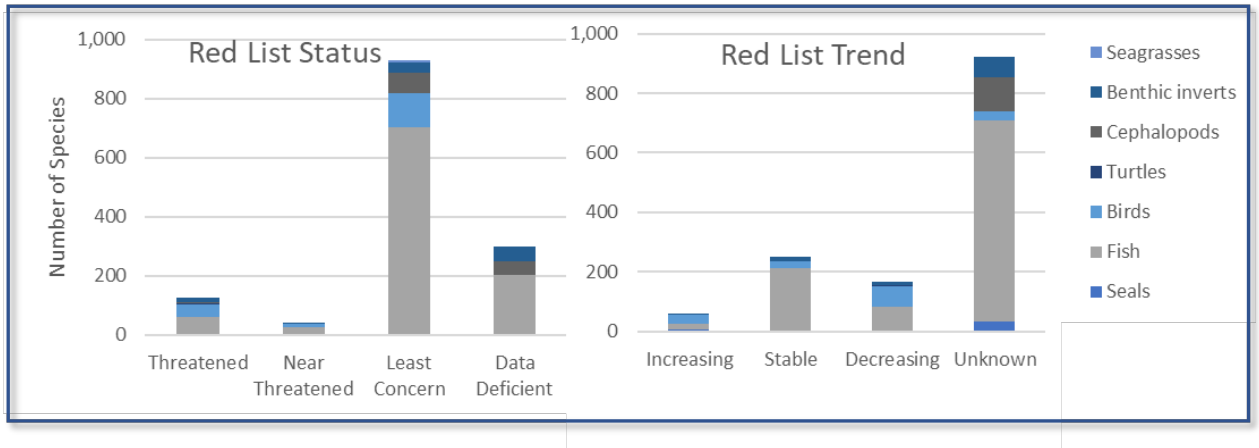
IUCN Red List assessments

Loss of biodiversity in many of the RSC assessments focuses on reduction in populations (either numbers or viability) or in extents (habitats or ranges). A more extreme loss occurs when whole species become extinct, whether extirpated (local extinction) or across Europe as a whole. If the species are endemic, then that represents a global loss. An ICES working group has produced advice on this for incorporation into future rounds of the MSFD (ICES, 2018b).

The IUCN Red List assessments provide a synoptic view of conservation status for species including ones potentially threatened by extinction. The assessments are generally qualitative but provide both a full coverage of species, including individual populations, as well as highlighting those species at particular risk (Nieto et al., 2015; IUCN and BirdLife International, 2014; IUCN, 2019; Bo et al., 2017; Temple and Terry, 2007a).

Figure 4.4 shows the summary of species identified in several European Red List reports (see sources to Figure). While there are significant numbers of species where status and especially trends are unknown, the figures indicate that the majority of species are not yet at extinction threat though very few species are increasing their population sizes.

Figure 4.4: Red list status & trends of European marine species



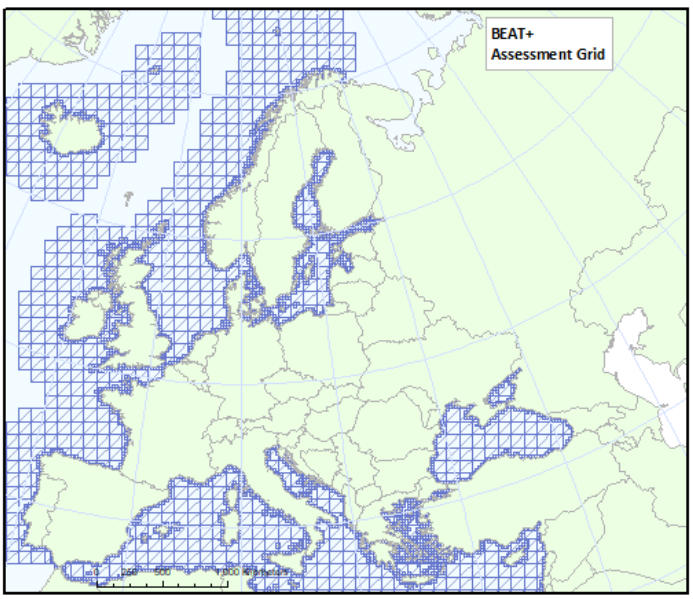
Sources: Nieto et al., 2015; IUCN and BirdLife International, 2014; Temple and Terry, 2007a; IUCN, 2019; Bo et al., 2017

The BEAT+ integrated assessment tool

Based on the BEAT tool used for the HELCOM integrated biodiversity assessment in HOLAS (HELCOM, 2018e), the BEAT+ tool is being used here for the first time to bring together indicator outputs from the RSCs and other sources such as EU Research Programmes to provide a holistic assessment across a wide range of indicators (Nygård et al., 2018).

The BEAT+ tool integrates data from normalised indicators to identify worst case status measures for different biodiversity components. The results are then linked to a standard gridE based Spatial Assessment Unit (SAU) (Fig. 4.5) which is used both for biodiversity and for pressures assessments (Andersen et al., 2014).

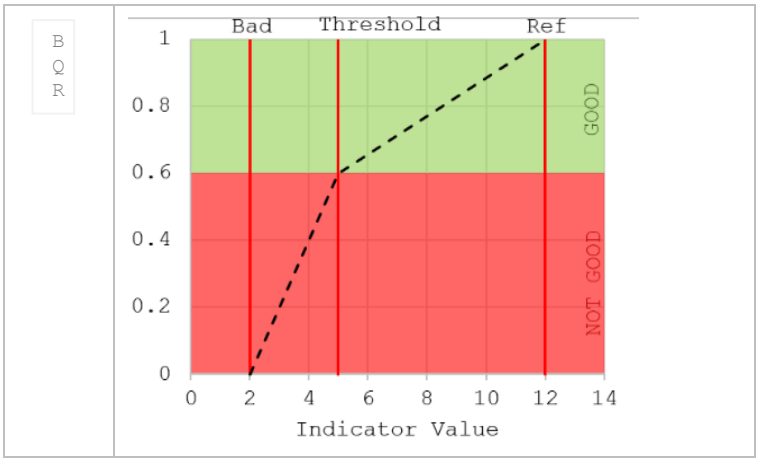
Figure 4.5: BEAT assessment grid



These grid-based SAUs not only allow alignment of indicators for biodiversity and for pressures but provide a means for combining large assessment areas (e.g. for wide-ranging species) with point data collected from biological surveys e.g. WFD monitoring.

BEAT+ aggregates indicator values once the indicators are normalised to a scale from 0 to 1 to provide a **Biological Quality Ratio (BQR)**. Indicator values are tested against a threshold value, set for each indicator as shown in Figure 4.6.

Figure 4.6: Variation of Biological Quality Ratio (BQR) value with indicator value



Note that indicators can show either a positive or a negative response. Figure 4.6 shows a positive one.

The way the indicator value is then transformed into a class value, which is used on the maps, is described in Box 4.1.

Box 4.1: Description of BEAT+ classifications

BEAT+ tool works by calculating a Biological Quality Ratio (BQR) which is an aggregated score of indicator outcomes within a grid square. To allow objective comparison, the indicator outcomes are normalised to a scale of 0 to 1, with five status classes at equal intervals on that scale (from Bad starting at 0, Poor at 0.2, Medium at 0.4, Good at 0.6 and High at 0.8). By this means, indicators based on different biological criteria can be aggregated in a consistent way.

The analyses in this report show BQR values both as averages per SAU and as worst-case values per SAU and biological group, as well as percentage of BQR values reaching a 'Good' threshold for a biological group. Considering all three combinations together gives a good picture of both the overall outcome from all indicators as well as identifying where the worst outcomes occur.

Table 4.2 shows how many indicators have been used in the BEAT+ analyses. The majority of indicators and the thresholds used have come from the following sources:

- Regional Indicators from RSC Assessments (OSPAR Commission, 2017d; HELCOM, 2018e; UNEP-MAP, 2017a)
- ICES Fisheries measures (ICES, 2019)
- Fisheries data for Mediterranean and Black Sea (GFCM (FAO), 2019)
- Published WFD data on BQR values (Riemann et al., 2016)
- Black Sea Basin Directorate Varna (BSBD, 2019)
- DEVOTES Case studies (Uusitalo et al., 2016).

Table 4.2 Number and type of indicators used for BEAT+

Indicator Group	Indicator Metric	Total	Benthic Habitats	Birds	Fish	Mammals	Pelagic Habitats
Count & Weight	Abundance	55		34	5	12	4
	Biomass	42	2		37		3
	Concentration	8					8
	Species Abundance	89	89				
	Species Trend	1		1			
	Trend	3		3			
Geographic	Distribution	17	4			13	
Impacts	Bycatch	1				1	
Index	Index	77	60	2	5	3	7
	Ratio %	10		2	4	4	
Population Status	Breeding Success	27		27			
	Mean Size	2			1		1
	Mortality Index	53	7		46		
	Nutritional status	12			10	2	
	Reproductive status	3			2	1	
Unclassified	Other	4	3				1

The Living Planet Index (LPI*)*

The LPI is a generalised additive model which aggregates trends in a consistent way to find the average trend underlying population changes (Loh et al., 2005; McRae et al., 2008) (see Box 4.2). The LPI has been used for several international and national assessments but has been applied here across species groups and some habitat types to provide a common means of assessing trends between regional seas and ecosystems.

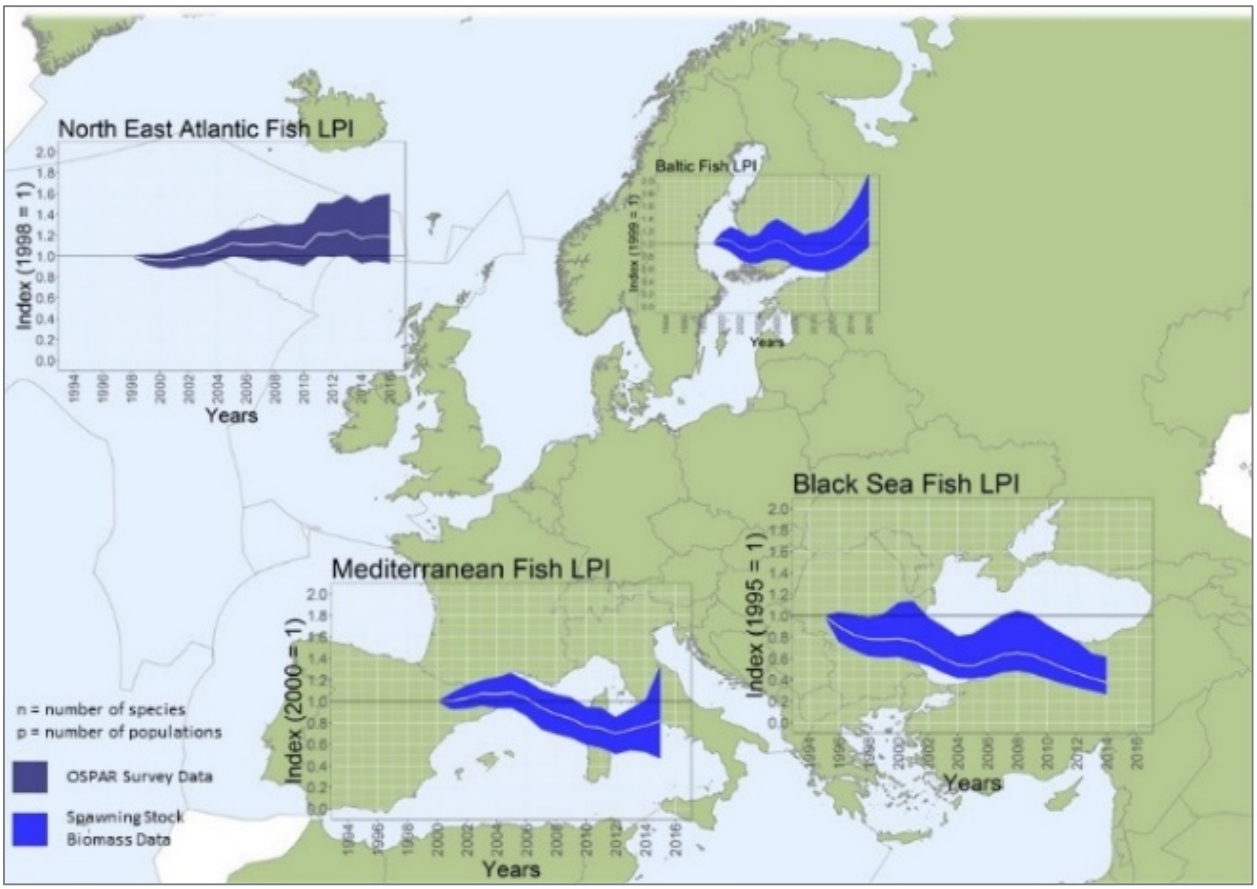
Box 4.2: Description of LPI

The trends are based on a baseline year – 1998 in Figure 4.7. The average trend is shown as the central white line in each of the four graphs. The blue area around the line represents the variation around the estimate. The Index is then shown on a scale of 0 to 2. If the trend is stable, the index line stays close to 1. While these graphs show an upper limit of 2, the actual upper limit can be higher.

The LPI is an established technique for deriving the average of a series of trends within species groups. It is one of a suite of global indicators used to monitor progress towards the Aichi biodiversity targets agreed by the Convention on Biological Diversity's (CBD) in 2010 (WWF, 2015).

It is important to establish guidelines for inclusion of trend data. The primary focus is on abundance changes, but other trends can be used e.g. loss of habitat extent or calculated indices such as AMBI (AZTI's Marine Biotic Index). The rules established by ICES for OSPAR indicators were adopted to ensure consistency in data, namely that they should be based on time series covering at least the last ten years, with a minimum of four counts during that period (ICES, 2018a). Figure 4.7 shows examples of the change in the index over time for fish populations in the four European marine regions.

Figure 4.7: Living Planet Index (LPI) example – European fish trends

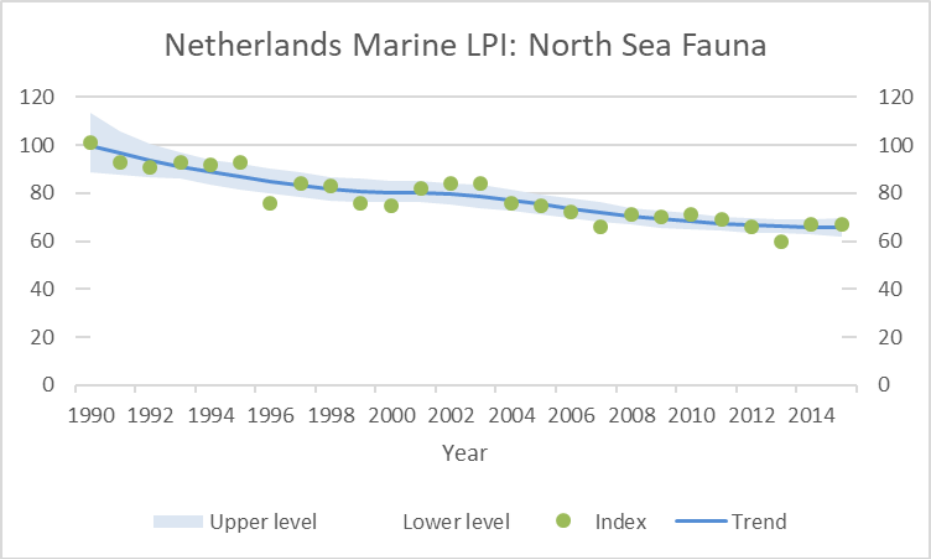


The LPI represents the average trend, not the average abundance, so can incorporate time-series of either population size, density (population size per unit area), abundance (number of individuals per sample) or a proxy of abundance (McRae et al., 2008). It acts in the same way as a socio-economic index (e.g. stock market indices) formed of a basket of indicators.

For this thematic assessment, the data scope of the LPI is extended beyond vertebrates to also include macrophytes and benthic fauna, following examples elsewhere. For example, the Netherlands Government has produced a composite LPI based on trends in seabirds, fish and benthic fauna for the Netherlands North Sea area (see Figure 4.8).

Here the LPI is applied slightly differently with the index being compared to 100 and the confidence limits are calculated in a different way. However, the overall trend line is clearly showing a negative trend from the initial year of 1990.

Figure 4.8: Living Planet Index of Netherlands North Sea fauna



Source: Data from CBS, 2018

Data compiled for LPI analysis

The primary sources of trend data for the LPI analysis have been compiled from those shown in Table 4.3. This shows the distribution of populations (or equivalent) used for each trend (note that the number of species will be less, as trend data is usually presented for populations within a species, not aggregated for a whole species.

Table 4.3 List of primary data sources for Living Planet Index analyses

Source	Reference	Birds	Fish	Mammals	Reptiles
ICES DATRAS	(ICES, 2019)		481		
Cefas Trawls	(Cefas, 2019)		890		
GFCM Fish data	(GFCM (FAO), 2019)		22		
HOLAS II Assessment	(HELCOM, 2018e)	22			
Living Planet Index Database	(WWF and ZSL, 2019)	32	123	228	8
OSPAR Intermediate Assessment	(OSPAR Commission, 2017d)	374			
Integrated Management of the Marine Environment of the Norwegian Sea	(Norwegian Ministry of the Environment, 2009)				2
IUCN Red List	(IUCN, 2019)				
Netherlands Living Planet Index	(CBS, 2019)	41	31		3
Arctic Council – Arctic Species Trend Index	(CAFFS, 2019)	24	24		2
Other Research publications	See supplementary information	13			

4.2 Marine mammals

Summary of regional & European assessments

Seals	**IUCN**	Table 4.4 shows the reported Red List assessments of status and trends in European seal populations, where most species are of Least Concern, except for the Mediterranean monk seal (Temple and Terry, 2007a; IUCN, 2019).
	HD Art.17 2007-12	Only the monk seal populations in the marine Mediterranean and Macaronesia were reported in the 2013 Article 17 Habitats Directive report where 4 member states reported unfavourable status, and 1 reported the status as unknown (EEA, 2013a).
	OSPAR	In the non-Arctic OSPAR Regions grey seal populations are generally stable or increasing in most assessed areas although some harbour seal populations are declining (OSPAR Commission, 2017g).
	HELCOM	In the Baltic Sea, grey seal populations are increasing but their nutritional and reproductive states are not good. Harbour seals are only in a good state in one sub-region and the state of the ringed seal population is critical with less than 100 animals (HELCOM, 2018e).
	UNEP-MAP	The distribution of monk seal in the Mediterranean remains stable or expanding though it is still Endangered and systematic monitoring is needed to assess overall status (United Nations Environment Programme, 2018).
	Cetaceans	
Cetaceans	**IUCN**	Of the 20 cetacean species present in European waters (excluding those with marginal occurrences), 60 % were assessed as data deficient. 3 species were regarded as threatened (Atlantic right whale, Sei whale and Blue whale) while 2 species, harbour porpoises and sperm whales, were regarded as Near Threatened (Temple and Terry, 2007a).
	HD Art.17 2007-12	In the 2013 reporting round of the Habitats Directive for cetaceans in Annexes I, III and IV, the status was generally reported as 'unknown' (84 out of 129 species in five marine biogeographic regions) with 34 being 'unfavourable' and 11 'favourable' in the Marine Atlantic, Baltic and Marine Macaronesian regions). These proportions differed in the Black Sea (2 out of 3 species were 'unfavourable') and the Baltic Sea (4 out of 5 'unfavourable').
	OSPAR	In the OSPAR region, there is no evidence of changes in abundance for white-beaked dolphin, minke whale and harbour porpoise (OSPAR Commission, 2017g) since 1994. There is insufficient evidence for other species except for some coastal bottlenose dolphin populations which have remained low but stable. An assessment of killer whales, a top predator, was undertaken as a pilot due to lack of data although it noted a potential reduction in numbers due to reproductive failure (OSPAR Commission, 2017h).
	HELCOM	A particular concern is the Baltic Proper population of harbour porpoise, with a population size recently estimated at around 500 animals (HELCOM, 2018e).
	UNEP-MAP	In the Mediterranean Sea, there is some evidence of declining numbers of fin whales and common dolphins (United Nations Environment Programme, 2018). Fin whale abundance in the Western Mediterranean was estimated as 3,500 in the mid-1990s, but more recent estimates in 2017 suggested 460 individuals.

KEY: Bad | Poor | Moderate / Mixed | Good | High | Insufficient data

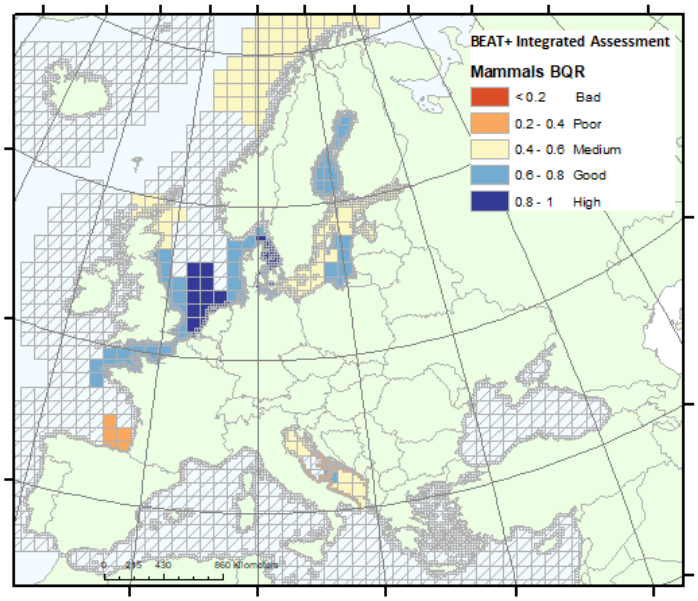
Spatial status of marine mammals

European marine mammals include carnivores such as seals and walruses (in the Arctic) as well as cetaceans (whales and dolphins). Overall there are 33 species of cetaceans in European waters and 7 species of seals, with the highest species richness being in the NE Atlantic region (Temple and Terry, 2007a). Seal populations tend to be measured at terrestrial haul out sites where they moult and breed whereas cetaceans are necessarily monitored through surveys at sea.

Figure 4.9 shows the outcomes of the BEAT+ assessments for all marine mammals combined and shows the average and worst-case values for each sub-region. The indicators are mainly focused on coastal and relatively stable inshore populations of seals, dolphins and porpoises. Some research indicators were developed for cetaceans using sightings data in the Barents Sea and the Central Adriatic in the DEVOTES project (Uusitalo et al., 2016) but these have not been replicated in other regions.

As a result, the BEAT+ analysis focuses mainly on coastal populations with the exception of cetacean indicators developed for Norwegian Sea. (Uusitalo et al., 2016)

Figure 4.9: BEAT+ analysis of marine mammal indicators



The mammal BEAT+ assessment includes both cetaceans and seals together, as there are indicators developed in some areas (e.g. Dutch North Sea) as a mammal diversity index (which in this case gives a high rating). Data for the Baltic Sea is primarily based on seal indicators, as are the other data in the North Sea and Celtic Seas. The data for Norwegian Sea and Bay of Biscay are from the DEVOTES project (see Uusitalo et al., 2016)

Results from BEAT+ Assessment of Mammals

Regional Sea	Average BQR		Worst BQR	
North-East Atlantic Ocean				
Barents Sea	0.45	Medium	0.45	Medium
Norwegian Sea	0.45	Medium	0.45	Medium
Greater North Sea	0.68	Good	0.55	Medium
Celtic Seas	0.61	Good	0.55	Medium
Bay of Biscay and the Iberian	0.46	Medium	0.19	Bad
Baltic Sea				
Baltic Sea	0.59	Medium	0.50	Medium
Mediterranean Sea				
Ionian Sea and the Central	0.62	Good	0.62	Good
Adriatic Sea	0.43	Medium	0.30	Poor

[BQR (Biological Quality Ratio) is the normalised value of an indicator compared to a standard threshold on a scale of 0 to 1 between the 'worst' case and reference values for that indicator]

Detailed status and trends of seals

Seals are worth considering in detail as while there are only seven seal species listed in Europe, their populations are often better monitored than many other marine species, at least for the coastal breeding sites. They are also widely distributed across all European seas.

Three seal species live in the Baltic Sea: grey seal (*Halichoerus grypus*), harbour seal (*Phoca vitulina*) and ringed seal (*Pusa hispida botnica*). In the NE Atlantic, ringed seal, hooded seal (*Cystophora cristata*), bearded seal (*Erignathus barbatus*) and harp seal (*Pagophilus groenlandicus*) lives in the northern waters and grey seal and harbour seal to the Bay of Biscay in the south. Macaronesia and the Mediterranean Sea host only one species of seal, the Mediterranean monk seal (*Monachus monachus*). The species used to be widespread at least in prehistoric times (González, 2015) in the North Atlantic from northern Spain including the Macaronesian islands of the Azores, Madeira and the Canary islands, across the Mediterranean sea and into the adjacent Black Sea, but became extinct in the latter sea by the 1990s (Kıraç, 2011).

The status of European seal species is generally improving, but many of the population trends are not known (Table 4.4).

Grey seal numbers have increased throughout the areas assessed in the Baltic Sea and the NE Atlantic. Grey seal pup production has increased over both the long term and short term in all assessed areas in the Greater North Sea (except Shetland) and in the parts of the Celtic Seas (OSPAR, 2017). In the Baltic, the pregnancy rate has greatly increased (close to 90 %) since the 1970–90s when contamination effects crashed the reproduction all over the region. Also, the distribution area of the grey seal is widening in the Baltic to the southern sub-basins. The increase may begin to reach the natural carrying capacity which has also likely lowered due to coastal development (i.e. habitat loss) and intensive fishing (i.e. prey availability).

Harbour seal populations are stable or increasing in most of the NE Atlantic and Baltic regions, but some are in decline in parts of the north-east of the United Kingdom. Two of the three sub-populations in the Baltic Sea do not quite reach the abundance thresholds indicating good population status.

Ringed seals are a northern species which found in the Arctic waters of the NE Atlantic and the Baltic Sea. The Baltic population is a relic from the connection to the White Sea and that also resulted in two lake-living sub-species in Finland and Russia. After recovering from the contamination effects in 1970-90s, the success of the ringed seal is tightly linked to ice conditions as the species breeds only on ice. The northerly Gulf of Bothnia sub-population is abundant and increasing (HELCOM, 2018d), but in the Gulf of Finland, Archipelago Sea and Gulf of Riga, the recent years of poor ice conditions have reduced the numbers to only a few hundred individuals. The status of these sub-populations is critical (HELCOM, 2018e).

Hooded seals are a polar species found in the Norwegian Sea from Svalbard westwards, and their populations are in decline, estimated to be around 7 % a year (Øigård and Skaug, 2015) This stock is less than 10 % of its abundance observed some 60 years ago (ICES, 2013). The causes appear to be through over-hunting but also climate change affecting sea ice developing near their whelping sites north of Jan Mayen (Norwegian Ministry of the Environment, 2009).

The Mediterranean monk seal has experienced severe population depletion due to its exploitation since classical antiquity and into the recent centuries. As a result, the population distribution is fragmented with respect to the species historical range and the population is estimated at less than 700 individuals. There are signs of population recovery in the eastern Mediterranean subpopulation located in Greece, Cyprus and Turkey and in the two Atlantic subpopulations located in the Cabo Blanco peninsula (Western Sahara) and in the Madeiran archipelago (www.iucnredlist.org; UNEP-MAP, 2017) and as such the

species' IUCN threat status was recently raised from Critically Endangered to Endangered. A small number of seals may be present in areas marginal to the eastern Mediterranean subpopulation (i.e. Syria, Lebanon, Libya) and in areas of the western Mediterranean (north African Mediterranean coasts and Italy) but the status of the species in these areas is unknown and difficult to ascertain given the species' cryptic nature and low numbers. The main threats are direct killing, coastal development and fishery bycatch.

Table 4.4 Population trends of seven seal species and walrus globally, in Europe and in three regional seas

	World	Europe	Baltic Sea	NE Atlantic	Mediterranean
Ringed seal	?	↑ LC	↑↓		
Grey seal	↑ LC	↑ LC	↑ LC	↑	
Harbour seal	?	? LC	↑↓	↑↓	
Hooded seal	? VU	?		↓	
Bearded seal	? LC	?		?	
Harp seal	↑ LC	?		↑↓	
Monk seal	↑ EN	↑ EN		↑	↑ EN
Walrus	? VU	? NT		↑	

Sources: Sander et al., 2006; OSPAR Commission, 2017g; HELCOM, 2018d; Temple and Terry, 2007a; UNEP-MAP, 2017b

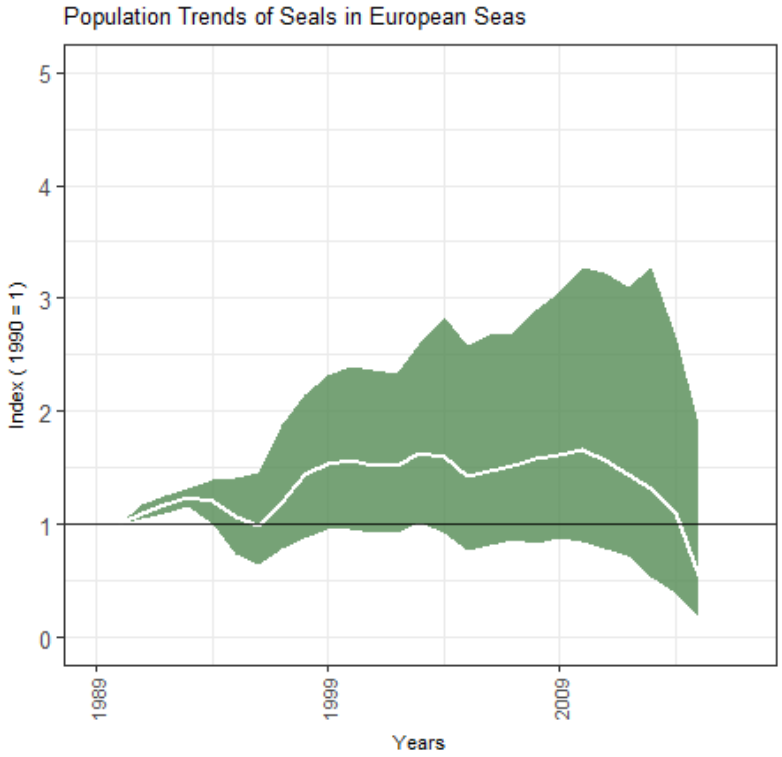
Key to Trend symbols & Red List Status Codes:

Trends	↓	Downward trend	↑	Upward trend	**?** Trend unknown
Status Codes:	**EN**	Endangered	**VU**	Vulnerable	
	NT	Not threatened	**LC**	Least concern	

For seals, the reasons of degraded status include hunting, other forms of human disturbance (e.g. in breeding areas), contamination effects by PBT substances and loss of ice habitat due to climate change. In the Baltic Sea, hunting of seals was re-opened some years ago due to rapid increase of the population abundances and harm for coastal fisheries. Effects of hunting on population growth were shown for the grey seal (Kauhala et al., 2016). As contamination is largely a historical threat for the Baltic seals, the hunting and severely unreported fishery bycatch are currently the main threats.

Figure 4.10 shows the averaged trend in seal populations combined across all European seas based on LPI calculations. The index shows a 50 % fall since the initial year chosen (1990), though the majority of this fall is associated with the last reported trend data. Prior to that seal abundance trends were above the threshold, so increasing. The index is strongly linked to changes in key populations of grey and harbour seals in the NE Atlantic and the Baltic Sea.

Figure 4.10: Seal population trends, based on the Living Planet Index



Status & trends of cetaceans

The population status of most of the European cetacean species is not known (Table 4.5). Most of the species are too occasional to get reliable abundance estimates. Out of the 33 cetacean species, only one is showing an improving status in the European scale (Table 4.5). When looking at more specific assessment areas within the marine regions, more improving trends are seen, but these are only a bit more frequent than the declining trends.

Table 4.5 Population trends of 41 cetacean species globally, in Europe and in four Regional Seas

	Baltic Sea	Black Sea	Mediterranean	NE Atlantic
Improving	1 pop.			6 sp in 16 areas
Stable				3 sp in 6 areas
Declining	1 pop.	3 sp.	5 sp.	3 sp in 8 areas
Unknown			6 sp.	13 sp in 38 areas

The sole cetacean found in the Baltic Sea – the harbour porpoise – has two distinct populations in the region. Both the populations are in Unfavourable-Bad status (EU Habitats Directive) and their trend either stable or declining according to the HELCOM and ASCOBANS assessments (HELCOM, 2018e; ASCOBANS, 2018).

The populations of the three dolphin species in the Black Sea have all severely declined since the mid-20th Century due to industrial exploitation. Although this was banned in 1983, their decline seems to be continuing due to heavy bycatch mortality (see below). Under the EU Habitats Directive, all three species are considered to be in Unfavourable conservation status (Nicolae et al., 2017).

In the Mediterranean, five species of cetaceans have been classified as threatened due to declining trends (Table 4.5).

The trends of the NE Atlantic small-toothed cetaceans were further assessed in the assessment areas in the region and the analysis showed increasing population abundance in 25 % of the monitored trends, 9 % with stable population and only 8 % of the trends were declining (Table 4.5). However, most trends were unknown.

The primary reason for the historical declined state of the larger marine cetaceans is by hunting (Worldwatch Institute, 2019). The North Atlantic Grey whale was extirpated by whaling and whaling still takes place in Europe in Norway, Iceland and Faroe Islands. Annual kills are about 432–660 minke whales (2015-2017) in Norway, 130-160 endangered fin whales and some tens of minke whales in Iceland (since 2006) and about 800 long-finned pilot whales and some Atlantic white-sided dolphins in Faroe Islands. Faroese legislation also allows for hunting of bottlenose dolphin, white-beaked dolphin and harbour porpoise. Dolphin exploitation was also allowed in the Black Sea until 1983, after which the severely depleted dolphins were protected from the activity. Other more recent pressures are potentially significant such as ship strikes (Peltier et al., 2019) and other pressures such as impulsive noise are also being assessed for potential impacts e.g. (OSPAR Commission, 2017h).

Smaller cetaceans are more threatened by fishery bycatch (OSPAR Commission, 2017g). Under-reporting of the bycatch mortality is common and therefore estimates of this pressure are uncertain. In Romanian coastal waters, recent studies have found that 95 % of the fisheries bycatch are harbour porpoises and this may constitute thousands of individuals; 1–2 dolphins in every 30-40 gillnets (Radu & Anton, 2014). In 2012 in Romania, 80 stranded individuals were found in one season after drowned in illegal turbot fishery gillnets (Anton et al. 2012). It has been claimed that illegal or unreported fishing is widespread in the Black and Azov Seas and a significant proportion of the by-catch may occur in such operations (Nicolae et al., 2017).

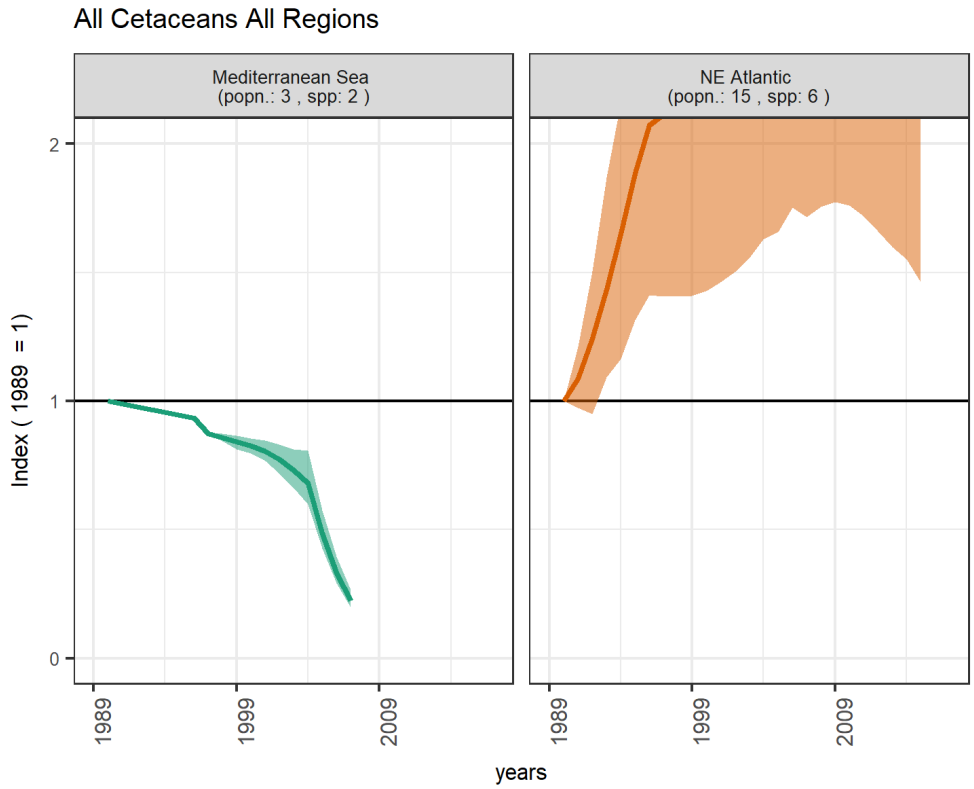
Fisheries are not the only current threat for the cetacean species. All beaked whales seem to be particularly vulnerable to loud man-made noise leading to higher number of strandings than other species. Ship and boat collisions can also have a high impact; it is suggested that 16 % of stranded fin whales in the Mediterranean have died because collision with ships, ferries and fast ferries (Panigada et al., 2006).

Recent scientific studies of populations of killer whales show adverse effects of PCB on their reproduction, threatening >50 % of the global population. This may cause the disappearance of killer whales from the most contaminated areas within 50 years despite PCB having been banned for 30 years. These waters include areas in the North East Atlantic Ocean, around the UK, and in the Mediterranean Sea, around the Strait of Gibraltar (Aarhus University, 2018a)

Measuring cetacean trends across Europe

Trends of set of trends as produced from the LPI are shown in Figure 4.11.

Figure 4.11: Trends in cetaceans in European seas, using the Living Planet Index

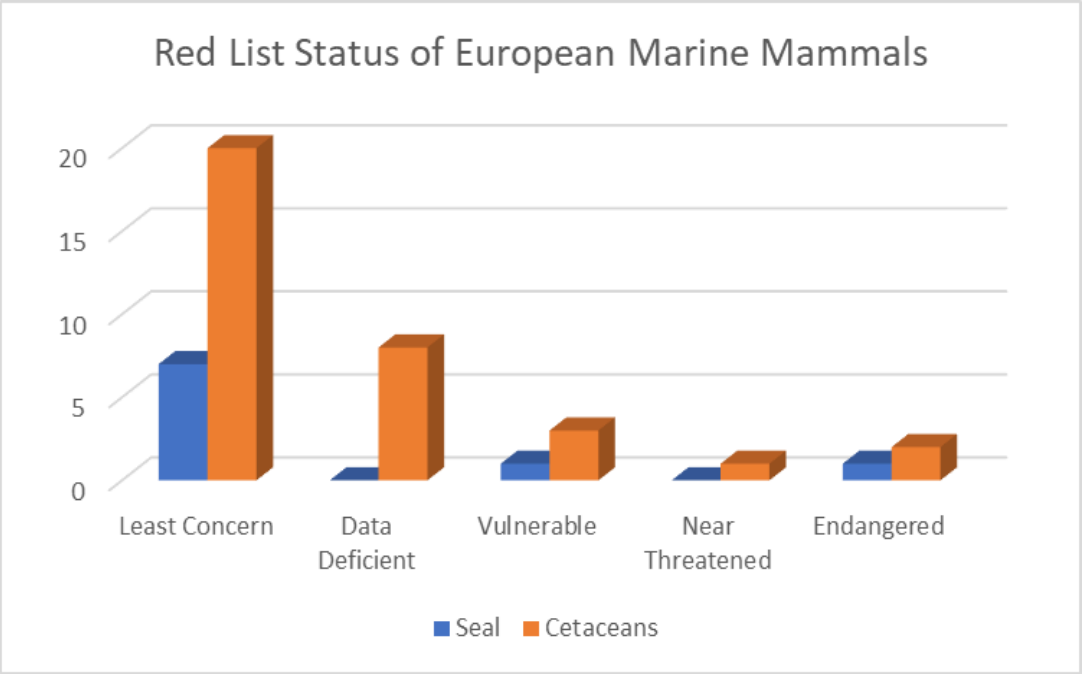


This shows high variability based around the limited set of trend data available, being based solely based on 2 inshore species (harbour porpoises in the Baltic and Bottle-nosed dolphins) in the NE Atlantic and limited monitoring data of fin whales in the Mediterranean (WWF and ZSL, 2019). Monitoring of most mobile species requires high levels of effort and it is therefore difficult to assess either status changes or trends except for the discrete localised populations (OSPAR Commission, 2017a).

Rare & Threatened Marine Mammals

In the European level, one whale species was lost as regionally extinct (grey whale *Eschrichtius robustus*), the North Atlantic right whale *Eubalaena glacialis* is critically endangered, the Mediterranean monk seal (*Monachus monachus*) is endangered and five other species are either endangered, vulnerable or near threatened (Figure 4.12). In all, eight out of 43 species were considered Threatened or Near Threatened, though nearly 20 % of species are data deficient, so the overall picture may be worse. All cetacean species are species of EU community interest according to the Habitats Directive, so there is a clear need for continued efforts to improve monitoring to gain a better European picture.

Figure 4.12: Red list status of marine mammals in European seas



Source: IUCN, 2019

The Black Sea hosts three dolphin species (bottlenose dolphin, short-beaked common dolphin and harbour porpoise). The Black Sea harbour porpoise is a sub-species separated from the NE Atlantic harbour porpoises by a wide Mediterranean area lacking the species. It is classified as Endangered.

The Black Sea short-beaked common dolphins are recognized as a discrete population possessing clear genetic differences from the eastern and western Mediterranean population; it is classified as Vulnerable. The Black Sea bottlenose dolphin is recognized as a subspecies based on morphological differences from Atlantic conspecifics and it is classified as Endangered.

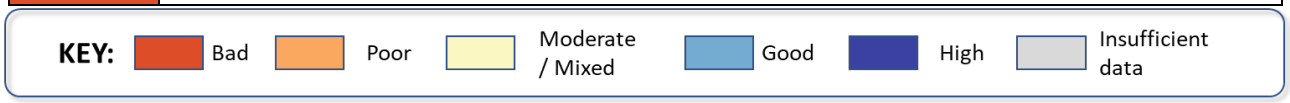
The Mediterranean classification shows that at least seven cetacean species and the monk seal are threatened (Simon Northridge et al., 2010; IUCN, 2019). Orca (*Orcinus orca*) is in critical danger of extinction, sperm whale, short-beaked common dolphin and harbour porpoise are considered threatened, and fin whale, common bottlenose dolphin and striped dolphin vulnerable.

In NE Atlantic, 9 out of the 22 small-toothed cetaceans were classified as 'least concern' while all the others were too sparse in data to allow any classification (ASCOBANS, 2018).

4.3 Marine birds

Summary of regional & European assessments

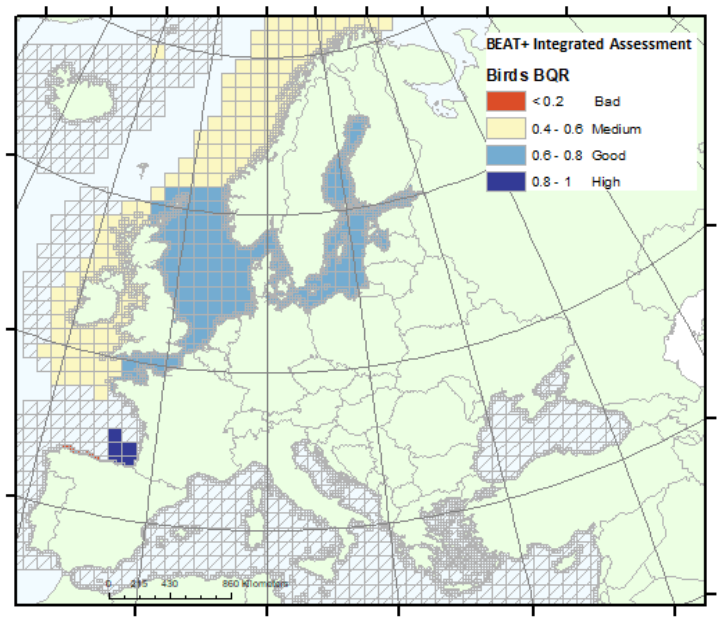
There are around 150–200 species of birds in Europe that, at some point in their annual life cycle, are reliant on coastal and/or offshore marine areas (see IUCN and BirdLife International, 2014). These include waders and waterbirds, such as ducks, geese, swans, divers and grebes; as well as birds that are usually referred to as seabirds: petrels, shearwaters, gannets, cormorants, skuas, gulls, terns and auks. The assessments below were based on monitoring data from breeding populations and/or non-breeding populations during migration or over the winter, depending on the species, primarily for the OSPAR and HELCOM areas. Similar long-term trend data within the Mediterranean and Black Sea regions is rare.	
IUCN	Birds associated with marine habitats in Europe have a relatively high proportion of threatened species (20 %), which reflect the prevalence of human pressures such as disturbance, bycatch and pollution but also predation at colony sites often by invasive species.(IUCN and BirdLife International, 2014) This is the case for the Critically Endangered Balearic Shearwater.
OSPAR	Since the mid-2000s, the abundance of over 20 % of the marine bird species which breed in the OSPAR Maritime Area has been below the 1992 baseline, indicating that the populations are not healthy. A similar pattern was found in the abundance of non-breeding species except in the North Sea where populations of inshore feeding birds remain healthy. Within the breeding birds, populations of water column feeders (e.g. gannets) were healthier than those in feeding at the surface, indicating changes in availability of small surface-dwelling fish. This was also reflected in widespread breeding failure in surface-feeding species (OSPAR Commission, 2017f).
HELCOM	A similar pattern of decline is suggested in the Baltic Sea where open sea species are considered to have strongly declining trends, though the formal assessment covered primarily coastal-dwelling species. Here 31 % of waterbirds in the breeding season have declined, compared to 18 % of over-wintering species. The pattern of status for feeding groups differs in the HELCOM assessment from the OSPAR region, as in the Baltic Sea, surface and pelagic feeders have a good status (HELCOM, 2018e).
UNEP-MAP	Status of birds from the Mediterranean Sea is unclear with most of the data coming from north-western areas. Here however trends in the critically endangered Balearic Shearwater (IUCN, 2019) suggest marked declines, primarily from predation by introduced land carnivores and fisheries by-catch. Of the 16 bird species regarded as Endangered or Vulnerable in the IUCN Red List Assessment, all are marine species (IUCN and BirdLife International, 2014; UNEP-MAP, 2017b).



Spatial Status of Marine Birds Across Europe

Figure 4.13 shows the analysis using BEAT+ of the status of seabirds for the NE Atlantic region and Baltic Sea—there were insufficient data or thresholds for seabird data in the Mediterranean and Black Seas. The BEAT analysis is primarily based on seabird abundance and breeding success estimates as reported to OSPAR and HELCOM. These data have thresholds assigned from the assessment values generated for the Intermediate Assessments. Additional data has been incorporated from the DEVOTES project for the Barents Sea (Uusitalo et al., 2016) which supports the OSPAR outcomes.

Figure 4.13: BEAT+ Integrated Assessment of Seabirds



The worst areas are in the Norwegian Sea. The Baltic area shows an overall good status overall for waterbirds, which is the same as in the North Sea, though there are spatial differences in indicator outcomes when different trophic groups are considered
(HELCOM, 2018a; OSPAR Commission, 2017f)

Results from BEAT+ Assessment of Seabirds

Regional Sea	Average BQR		Worst BQR	
North-East Atlantic Ocean				
Barents Sea	0.40	Medium	0.40	Poor
Iceland Sea	0.40	Poor	0.40	Poor
Norwegian Sea	0.41	Medium	0.40	Poor
Greater North Sea	0.59	Medium	0.59	Medium
Celtic Seas	0.53	Medium	0.40	Poor
Bay of Biscay and the Iberian	0.44	Medium	-	Bad
Baltic Sea				
Baltic Sea	0.64	Good	0.64	Good
Regional Sea	Average BQR		Worst BQR	

[BQR (Biological Quality Ratio) is the normalised value of an indicator compared to a standard threshold on a scale of 0 to 1 between the 'worst' case and reference values for that indicator]

Trends in Abundance

In the Baltic sea, five species among the assessed 30 breeding seabird species had declined more than 30 % from the 1991–2000 mean abundance (HELCOM, 2018a). The declined species were great black-backed gull, velvet scoter, pied avocet, turnstone and dunlin. Four wintering species had similarly declining trends: common pochard, Steller's eider, Bewick's swan and Eurasian coot. Increased trends were observed for eleven birds which are characterized as fish-feeding species (e.g. great cormorant, auks and terns).

The Black Sea is an important wintering area of the Yelkouan shearwater (*Puffinus yelkouan*), the two pelican species (Dalmatian Pelican *Pelecanus crispus* and Great White Pelican *Pelecanus onocrotalus*), The population of Dalmatian pelican has increased due to conservation measures, but the other is declining.

In the Mediterranean, seabirds tend to be more abundant in the north and west of the Mediterranean basin (UNEP-MAP, 2017a). Of the assessed seven species, none indicated increasing population status and three may be declining (UNEP-MAP, 2017a). The Mediterranean hosts two endemic seabird species: Yelkouan shearwater and the Balearic shearwater (*Puffinus mauretanicus*) which may both be declining. The rare Audouin's gull (*Larus audouinii*) population is predominantly Mediterranean.

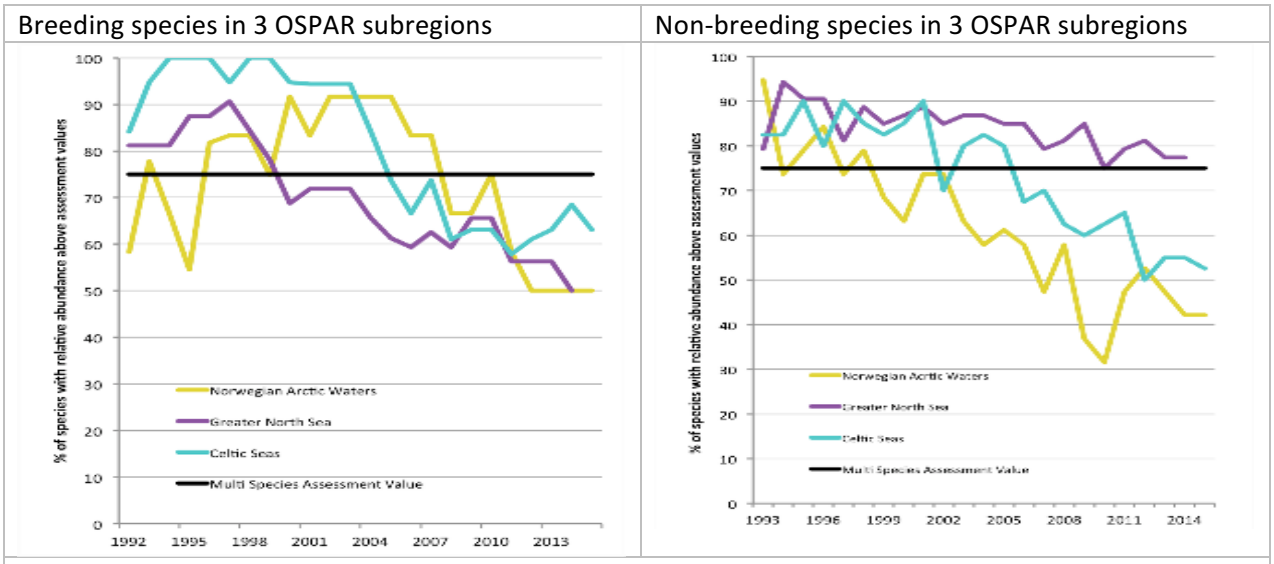
In the NE Atlantic, the OSPAR seabird indicators show that, since the mid-2000s, the breeding abundance of more than a quarter of the marine bird species assessed has been below the baseline set in 1992,

indicating that the populations are not healthy (OSPAR Commission, 2017f) as shown in Figure 4.14. Only in the Greater North Sea was there a majority of species meeting the assessment value.

In the Greater North Sea and Celtic Seas, seabird species that frequently failed to raise young feed on small fish in surface waters. Widespread breeding failure in species feeding in deeper waters or at the seabed was far less frequent.

In the Norwegian parts of the Arctic Waters, an equal proportion of surface feeders and water column feeders exhibited widespread breeding failure. A similar pattern was found in the non-breeding abundance of species that visit the Arctic Waters and Celtic Seas during migration and / or during winter. Prey availability is likely to be driven by ecosystem specific changes, possibly initiated by commercial fisheries (past and present) in combination with climate change.

Figure 4.14: Summary of bird species meeting assessment values in three NE Atlantic regions



Source: OSPAR Commission, 2017f, under Creative Commons License https://creativecommons.org/licenses/by/2.0/

Bird Species under Threat

The two bird species globally extinct are both from the marine environment (Canarian Oystercatcher, *Haematopus meadewaldoi*, and Great Auk, *Pinguinus impennis*). In addition to these two, 23 species (38 %) were assessed as threatened or Near Threatened (IUCN and BirdLife International, 2014). The Balearic shearwater (*Puffinus mauretanicus*) is the only Critically Endangered species and the five endangered species are white-faced storm-petrel (*Pelagodroma marina*), Zino's petrel (*Pterodroma madeira*), northern fulmar (*Fulmarus glacialis*), Atlantic puffin (*Fratercula arctica*) and Ross's gull (*Rhodostethia rosea*). Eleven species are Vulnerable and six species Near Threatened. Seabirds are adversely affected by non-indigenous predators and disturbance at colonies, fisheries bycatch and marine pollution (BirdLife International, 2015).

The RSC assessments of threatened species add to the European assessment. About 15 seabird species of regional threat status were either not evaluated or classified as Least Concern in the European assessment (EEA, 2015a; HELCOM, 2018a; UNEP-MAP, 2017a; OSPAR Commission, 2017f; IUCN, 2019; BSC, 2019). These included shearwaters, terns, gulls, auks and ducks.

In the Baltic Sea, the specific HELCOM assessment of seabirds classified 23 out of 58 breeding bird species and 16 out of 47 wintering seabirds as threatened (HELCOM, 2013a). Among the breeding birds, the gull-billed tern (*Gelochelidon nilotica*) was classified as Regionally Extinct and Kentish plover

(*Charadrius alexandrinus*) as Critically Endangered. Among the wintering birds, the red-throated diver (*Gavia stellata*) and the black-throated diver (*Gavia arctica*) were classified as Critically Endangered.
In the NE Atlantic, OSPAR has listed nine threatened and/or declining seabirds where conservation actions are recommended (OSPAR Commission, 2017f). The species include four gulls and terns, two auks, two shearwaters and a duck species, but no red list status has been assigned.

In the Mediterranean and Black Sea, the endangered or threatened seabird species include nine gulls or terns, four shearwaters or petrels, two cormorants, two pelicans and the flamingo (United Nations Environment Programme, 2018; Korshenko A et al., 2008). No Mediterranean red list classification has been made.

The most threatened seabirds in the NE Atlantic are the Monteiro's sea petrel (*Hydrobates monteiroi*), White-faced storm petrel (*Pelagodroma marina*) and Zino's petrel. The first one lives only in Azores with less than 1,000 individuals and a stable population trend, the middle one has declining trend in its breeding area in the Macaronesian islands and the last is increasing in its only breeding sites on Madeira (IUCN, 2019).

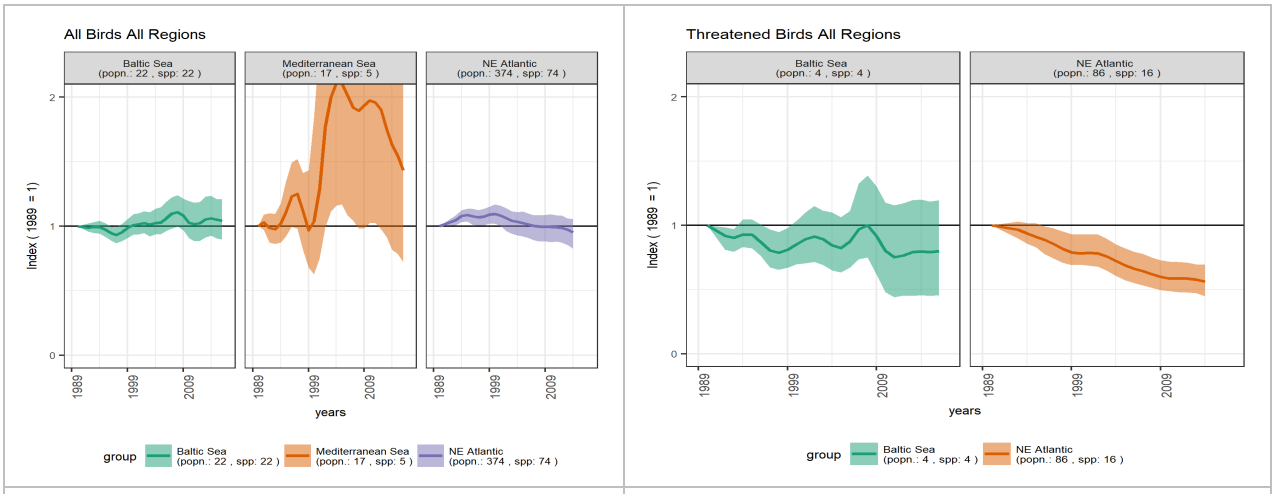
Trends calculated from the LPI

The LPI has been applied to waterbird populations primarily from the Baltic and North East Atlantic areas, with a smaller data set focused on the Mediterranean Sea and Black Sea (see Figure 4.15).

In this aggregated form, the LPI Index across all regions shows a small overall decline for seabirds and waterbirds though the confidence limits suggest this is not significant. However, the index for the rarer, threatened species (based on species classed as endangered or threatened in the IUCN Red List assessment (IUCN and BirdLife International, 2014) is showing a pronounced decline of between 15 and 40 % from the index threshold since 1989. This supports the regionally based analyses from OSPAR and HELCOM.

The numbers in the legends refer to number of populations and the number of species abundance trends used for the analyses.

Figure 4.15: Living Planet Index analysis of birds in European seas



In the Baltic Sea, the overall trend for birds is slightly increasing (up by 1 % from a baseline of 1989) whereas in the NE Atlantic, the overall index is down by 1 % in 2016 from 1989 suggesting declining trends though had been rising in earlier years.	For endangered or threatened birds, the trend suggests a 40 % reduction in the Index from the NE Atlantic (10 species) and 15 % from the Baltic (4 species) though here the variability means the trend is less clear. There is not enough data available for populations in the Mediterranean and Black Seas to allow this trend analysis for those regions.

4.4 Fish

Summary of regional & European assessments

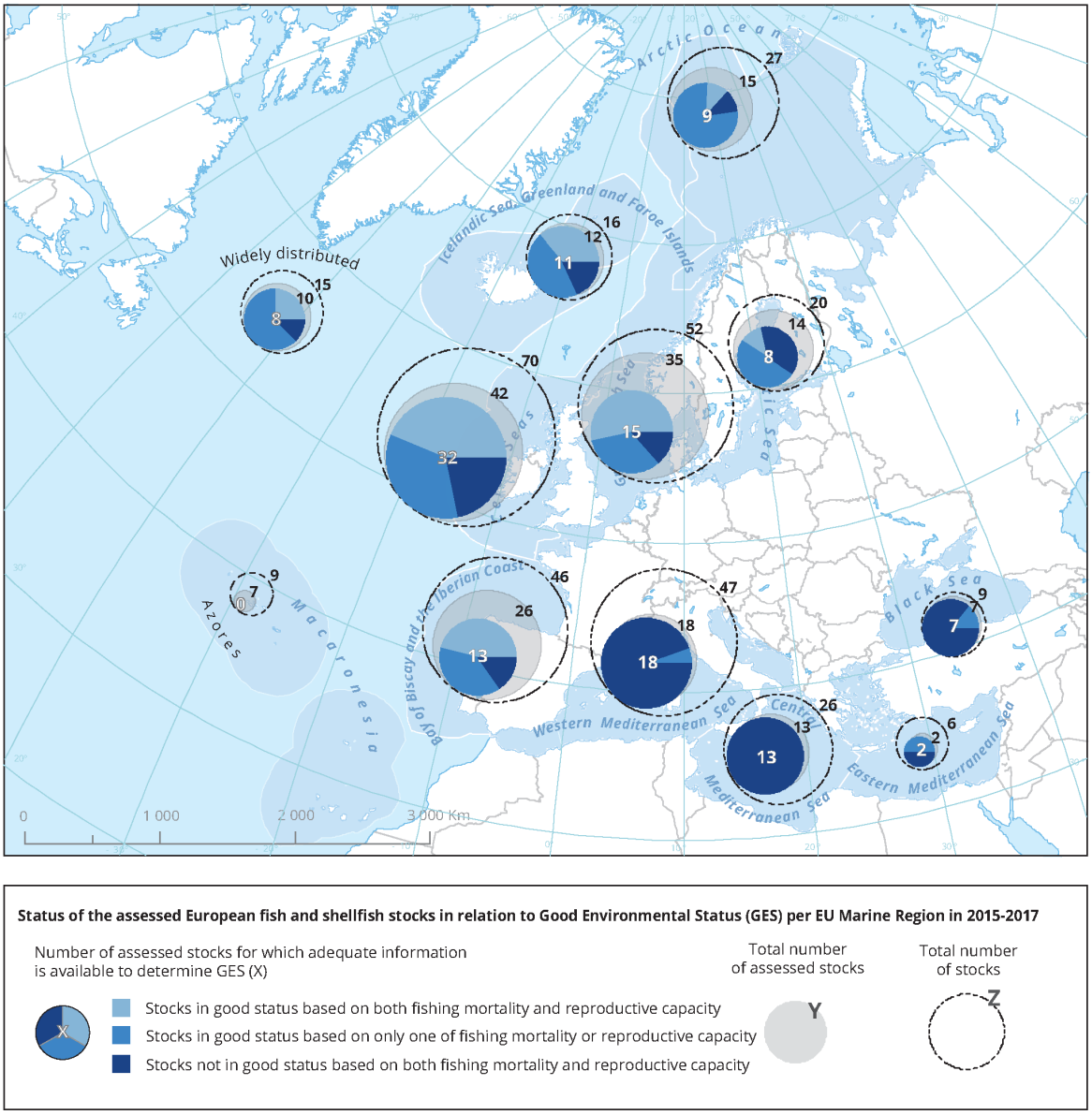
Teleost Fish (bony fish)	**IUCN**	85 fish species (7 % of the total of European marine fish species) and 11 of the endemic species are either threatened or Near Threatened under the IUCN Red List Classification. Among the bony fish, only < 3 % of the species are classified threatened, but with the uncertainties related to the smaller species this share may theoretically extend up to 23 % if all data deficient species were threatened
	OSPAR	The OSPAR assessment showed that there has been an improvement in the proportion of large demersal fish at least in the Greater North Sea, leading to recovery by 2022 but only if current trends continue (OSPAR Commission, 2017d). More sensitive demersal species have shown a recovery in the Celtic Seas at least and typical lengths are increasing, suggesting higher proportion of mature individuals since 2010 in the Greater North Sea and Celtic Seas. The pelagic fish assemblage shows no long-term change in much of the OSPAR Maritime Area (OSPAR Commission, 2017d)
	HELCOM	The Baltic Sea contains 230 fish species and the HELCOM assessment suggests a mixed situation. Pelagic stocks of herring are in good status in Bothnian Bay but demersal stock such as cod are widely deteriorated. Herring and sprats as representative of pelagic stocks are in poor status elsewhere in the Baltic. Coastal fish are in good status in about half of the assessed areas. Though data is sparse, there are indications that the population of the common eel in the Baltic Sea is about 25 % of the European total, but is still regarded as Critically Endangered in the Baltic (HELCOM, 2018e).
	UNEP-MAP / GFCM	Sharks, skates and rays are particularly threatened with almost 40 % of species facing a declining population trend (see next section). In contrast, strong regulation to reduce fishing mortality has brought another Mediterranean top predator, Bluefin tuna, back from the brink of collapse (in 2005-07) towards reaching sustainable levels for reproductive capacity in 2014 (see review in Fishsource, 2018 based on ICCAT, 2017b and ICCAT, 2017a).
Chondrichthyans (sharks, skates & rays)	**IUCN**	Sharks, rays and skates cover two thirds (56 species) of all the threatened species. Many of these chondrichthyans are poorly known and of the 204 Data Deficient species many were benthic sharks. The increased extinction risk of many of these species is linked by high levels of unregulated overfishing in the Mediterranean Sea, where their status has worsened during this century (Nieto et al., 2015; Cavanagh and Gibson, 2007) in the past decade.
	OSPAR	OSPAR has included 11 chondrichthyan species on the OSPAR list of Threatened and Declining species, covering species at most risk (OSPAR Commission, 2019). Long-term trend assessment indicated population decline particularly in larger species (spurdog and common skate) where commercial fisheries existed (Sguotti et al., 2016). Catches has been highly variable and declining until 2010. Other assessments of status of Mediterranean chondrichthyans suggest this has worsened in the past decade.
	HELCOM	HELCOM's Red List assessment also included two shark species (porbeagle and spurdog) where there had been dramatic reduction in populations.
	UNEP-MAP / GFCM	Sharks, skates and rays are particularly threatened with almost 40 % of species facing a declining population trend (GFCM (FAO), 2019; Nieto et al., 2015). The increased extinction risk of many of these species is linked by high levels of unregulated overfishing in the Mediterranean Sea, where their status has worsened during this century (Cavanagh and Gibson, 2007) in the past decade

Note that the Chondrichthyans are separated out as although there is less commercial fishing of these in Europe than in previous times, bycatch of these fish is still a significant problem, both for demersal and pelagic species (EC, 2016).

Status of European fish

Most fish trend and status data come from commercial fishing of pelagic and demersal fish sources. Figure 4.16 shows the overview of these stocks for all regional seas and it supports the general statements above that stocks in the NE Atlantic and Baltic Seas are in mixed status (some good, some not) whereas those in the Mediterranean and Black Seas are not in good status. Taken together, around 28 % of the assessed fish and shellfish stocks in Europe's seas are not in a good environmental status, though only 33 % of stocks show good status in both fishing mortality and reproductive capacity (EEA, 2019d).

Figure 4.16: Status of assessed European fish and shellfish stocks in relation to GES



Source: (EEA, 2019d)

These percentages vary considerably between MSFD (sub)regions – 15–33 % of those in the North-East Atlantic and Baltic Seas fail to meet good environmental status (GES) but in the Black Sea and Mediterranean Seas, this rises to 88–100 % (EEA, 2019d).

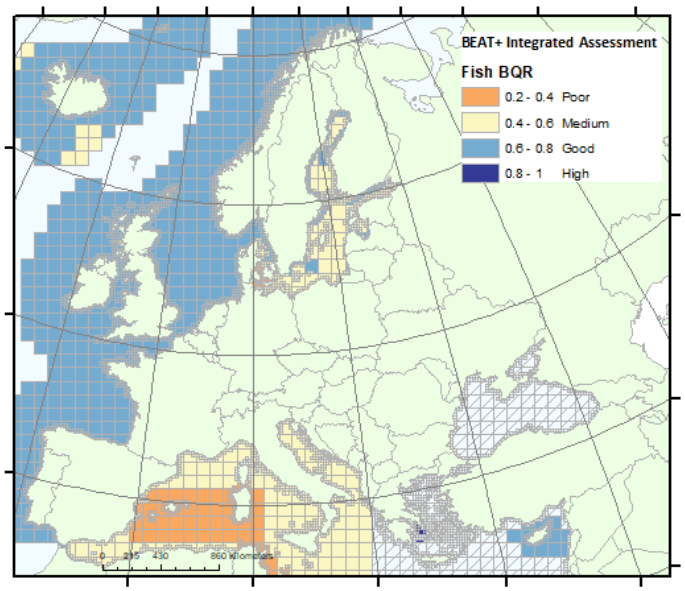
However, the stock assessments cover only part of all the fished stocks. In the NE Atlantic about 40–90 % of the fished stocks (near 70 % in average) have been assessed, whereas scores are in the Baltic about 80 %, in the Black Sea about 65 % and in the Mediterranean Sea about 10 %. This brings additional uncertainty into the assessment (EEA, 2019d).

The Scombridae family of the mackerels, tunas, and bonitos includes many of the most important and familiar food fishes. Tuna, especially bluefin tuna (*Thunnus thynnus*), were heavily overfished some decades ago. According to the 2014 assessment, bluefin tuna, the yellowfin tuna and both the Atlantic and Mediterranean albacore stocks are probably not fished over the targets now, the stocks have started to recover, but most of the stocks are still below target biomass due to overfishing in the past (ICCAT, 2018; Nieto et al., 2015). The skipjack tuna, the bigeye tuna, two out of three European horse mackerel stocks (*Trachurus trachurus*) and the Atlantic mackerel stock (*Scomber scombrus*) are however still fished over the F_{MSY} targets (ICCAT, 2014; ICES, 2017). Stock status of many of the smaller tunas are not assed, but except for the plain bonito (*Orcynopsis unicolor*; Vulnerable), IUCN has classified them as 'least concern' (IUCN, 2019).

Integrated status assessment of fish

The BEAT+ tool combines indicators from all four European marine regions, where available, by normalising all indicators to a standard scale. The outcome for fish indicators is shown in Figure 4.17.

Figure 4.17: BEAT+ integrated assessment of fish



The analysis is primarily based on commercial fish as these have agreed targets defined on biomass and fishing mortality. These broadly reflect the Regional Sea Convention assessments of relatively good status in NE Atlantic (97 %), but not offshore in the Baltic and low status in the Western Mediterranean.

This study used a total of 230 stocks obtained from ICES and GFCM, plus 57 fish indicators from other sources. A recent paper (Froese et al., 2018) has used 341 fish stocks from ICES stock data which was analysed using the NEAT tool to generate a status value for fisheries for Descriptor D3 (Borja et al., 2019) which assessed most fisheries as in Moderate condition with those in the Central and Eastern Mediterranean (especially the Aegean Sea), and the Black Sea, as being poor condition. In this study, only the Barents Sea fisheries were considered in good condition.

Results from BEAT+ assessment of fish

Regional Sea	Average BQR		Worst BQR	
North-East Atlantic Ocean				
Barents Sea	0.66	Good	0.65	Good
Iceland Sea	0.61	Good	0.57	Medium
Norwegian Sea	0.66	Good	0.61	Good
Greater North Sea	0.64	Good	0.46	Medium
Celtic Seas	0.63	Good	0.60	Good
Bay of Biscay and the Iberian	0.69	Good	0.61	Good
Macaronesia	0.64	Good	0.64	Good
Baltic Sea				
Baltic Sea	0.58	Medium	0.35	Poor
Mediterranean Sea				
Western Mediterranean	0.46	Medium	0.30	Poor
Ionian Sea and the Central	0.45	Medium	0.39	Poor
Adriatic Sea	0.57	Medium	0.45	Medium
Aegean-Levantine Sea	0.71	Good	0.65	Good
Black Sea				
Black Sea	0.46	Medium	0.46	Medium

[BQR (Biological Quality Ratio) is the normalised value of an indicator compared to a standard threshold on a scale of 0 to 1 between the 'worst' case and reference values for that indicator]

Status from regional seas assessments

The recent OSPAR assessments indicated that overall fisheries management is beginning to have a positive impact on some fish communities with deterioration being halted and, in some areas, that fish communities are showing signs of recovery.

In terms of future improvements, in the OSPAR area, the trend for large demersal fish to recover should continue provided current pressures do not increase. This was particularly true in the Greater North Sea though recovery assessment values in the Celtic Seas were only met in the northern part. Elsewhere evidence of recovery is lacking.

For more sensitive species, the evidence on whether significant recovery had been achieved was unclear. Another measure, long-term decreases in typical length, suggested that fish communities are now more dominated by small-bodied individuals.

The pelagic fish assemblage shows no long-term change in much of the OSPAR Maritime Area (OSPAR Commission, 2017e).

In HELCOM's Intermediate Assessment, fish status achieved good status in about half of the assessed coastal areas but not in the open sea, good status is not achieved in any assessment area (60 % of pelagic stocks and 75 % of benthic stocks did not meet the target) (HELCOM, 2018e).

In the Mediterranean, 42 % of a set of 60 representative stocks assessed 2012 and 2015 showed low biomass against the threshold while only 22 % showed high biomass. This was based on 60 representative stocks from 15 geographical stock areas and for 14 species (UNEP-MAP, 2017a). Mediterranean states have recognized low biomass of key stocks in the Mediterranean as a key challenge in the context of sustainable blue growth and food security for coastal communities (UNEP-MAP, 2017b).

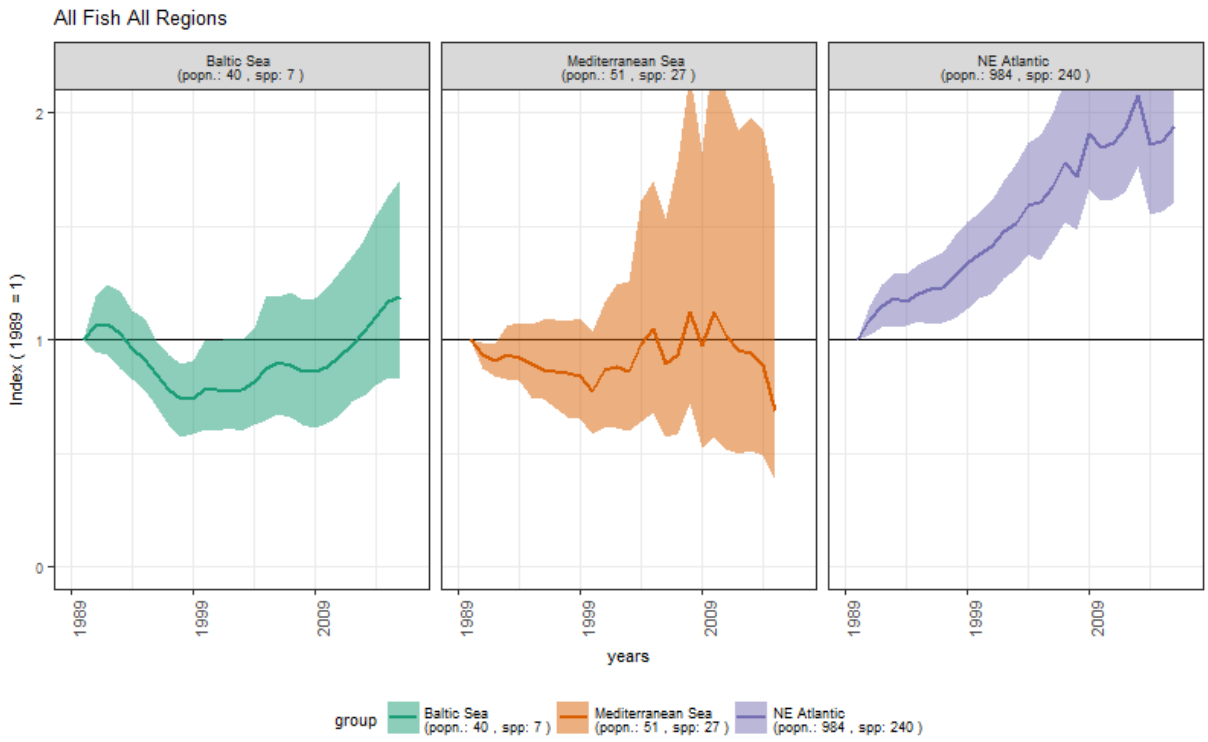
In OSPAR, the view of the assessment was that relaxation of management would be premature. In the Mediterranean as well, stocks may require some time to rebuild after management measures are taken.

Trends in marine fish abundance

Assessment of trends of European marine fish species by IUCN (Nieto et al., 2015) show that 8 % (83 species) have declining populations, 22 % (212 species) are stable and < 2 % (17 species) are increasing. The population trends for 676 species (68 %) remain unknown (Nieto et al., 2015)

In the Mediterranean, the total fish population has faced 34 % reduction over the last 50 years, and this has especially touched the larger fish (Piroddi et al., 2017). The declines were most dramatic in the Western Mediterranean Sea and the Adriatic Sea (- 50 %). Important signs of improvement are being observed in the NE Atlantic Ocean and Baltic Sea. Since the early 2000s, better management of fish and shellfish stocks has contributed to a clear decrease in fishing pressure in these two regional seas. Signs of recovery in the reproductive capacity of several fish and shellfish stocks have started to appear. If these efforts continue, meeting the MSFD 2020 objective for healthy fish and shellfish stocks in the NE Atlantic Ocean and Baltic Sea could be possible based on two of the three criteria (i.e. fishing mortality and reproductive capacity). In contrast, there is little likelihood that the 2020 policy objective will be met in the Mediterranean and Black Seas. Understanding trends is made more difficult when the relative absence of solid data is shown. Fish trend data has also been assessed using the LPI method (see Figure 4.18).

Figure 4.18: Trend analysis of fish populations in European seas, using the Living Planet Index (LPI)



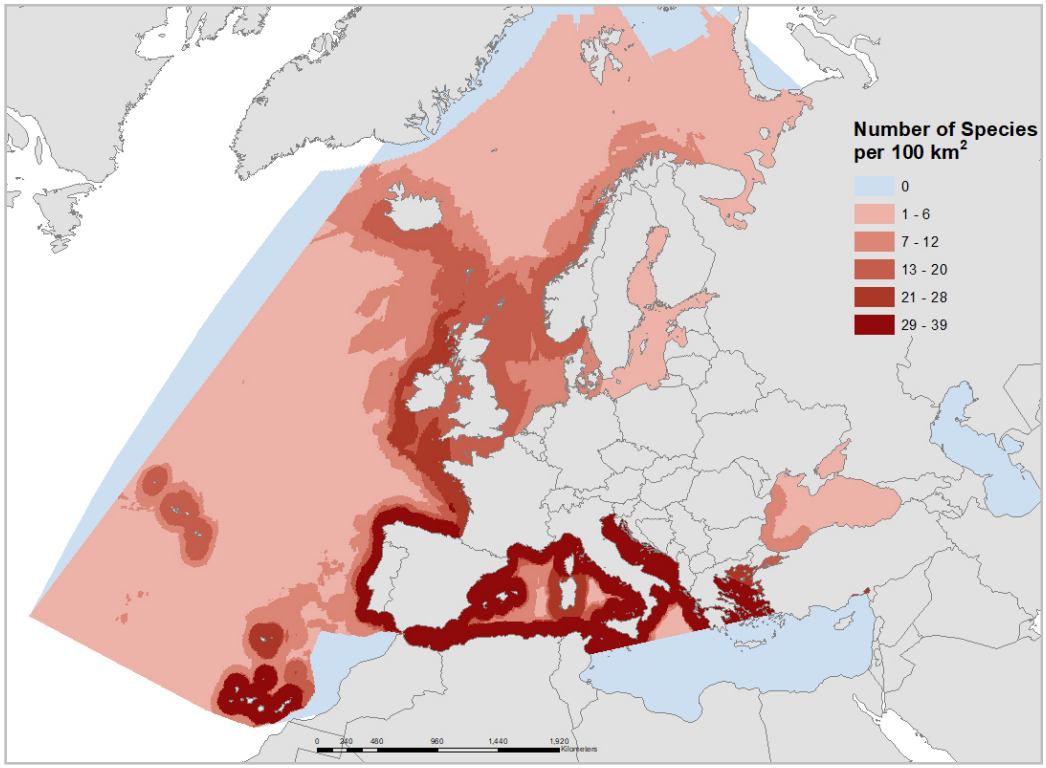
These trends are calculated using the LPI method from data assembled for this report from reported fish stocks and bottom trawl surveys for non-commercial fish. The results confirm the message that for the NE Atlantic fish species abundance is generally improving whereas for the Baltic and the Mediterranean Seas, the trends are less clear (wide uncertainty around the stable index value of unity. However, the Mediterranean the average trend is declining, whilst those in the Baltic Sea it is improving.

Status of rare and threatened fish species

As stated above, 85 fish species (7 % of the total) and 11 of the endemic species are either threatened or Near Threatened under the IUCN Red List Classification. This may be worse when the difficulties of monitoring non-commercial fish are considered.

Among the bony fish, only < 3 % of the species are classified threatened, but with the uncertainties related to the smaller species this share may theoretically extend up to 23 % if all data deficient species were threatened. The greatest hot spots of threatened species appear off the Iberian Peninsula, the Mediterranean Sea and the Canary Islands (Figure 4.19) which are also the areas where the highest number of Data Deficient species are present.

Figure 4.19: Threatened European marine fish species



Source: Based on data provided by IUCN and the European Red List of Fishes (Nieto, 2015)

Sharks, rays and skates (chondrichthyans) cover two thirds (56 species) of all the threatened species. Many of the chondrichthyans are poorly known and of the 204 Data Deficient species many were benthic sharks. Therefore, it is safer to express that 7–27 % of fish are threatened (or Near Threatened).

This lack of data means that distributions of threatened species carry a double message, either indicating the remnants of a wider distribution area or areas with the most severe threats for local fish species. Unfortunately, only species-specific assessments can separate these reasons.

In the Baltic Sea, of the 113 fish and lamprey species assessed; two were classified as regionally extinct (American Atlantic sturgeon (*Acipenser oxyrinchus*) and the common skate (*Dipturus batis*), four Critically Endangered (grayling *Thymallus thymallus*, eel *Anguilla anguilla*, porbeagle *Lamna nasus*, and spurdog *Squalus acanthias,* and 19 as Endangered, Vulnerable or Near Threatened (HELCOM, 2013a).

The fish of Black Sea importance include 38 species (BSC, 2002). In contrast to the other marine regions, the Black Sea species focus to sturgeons (six species), seahorses /needle fishes (five species) and several benthic species.

In the Mediterranean, 36 species of endangered or threatened fish species have been identified under the Barcelona Convention (UNEP-MAP, 2017b). These include, inter alia, 16 sharks, seven skates, two rays and two seahorse species.

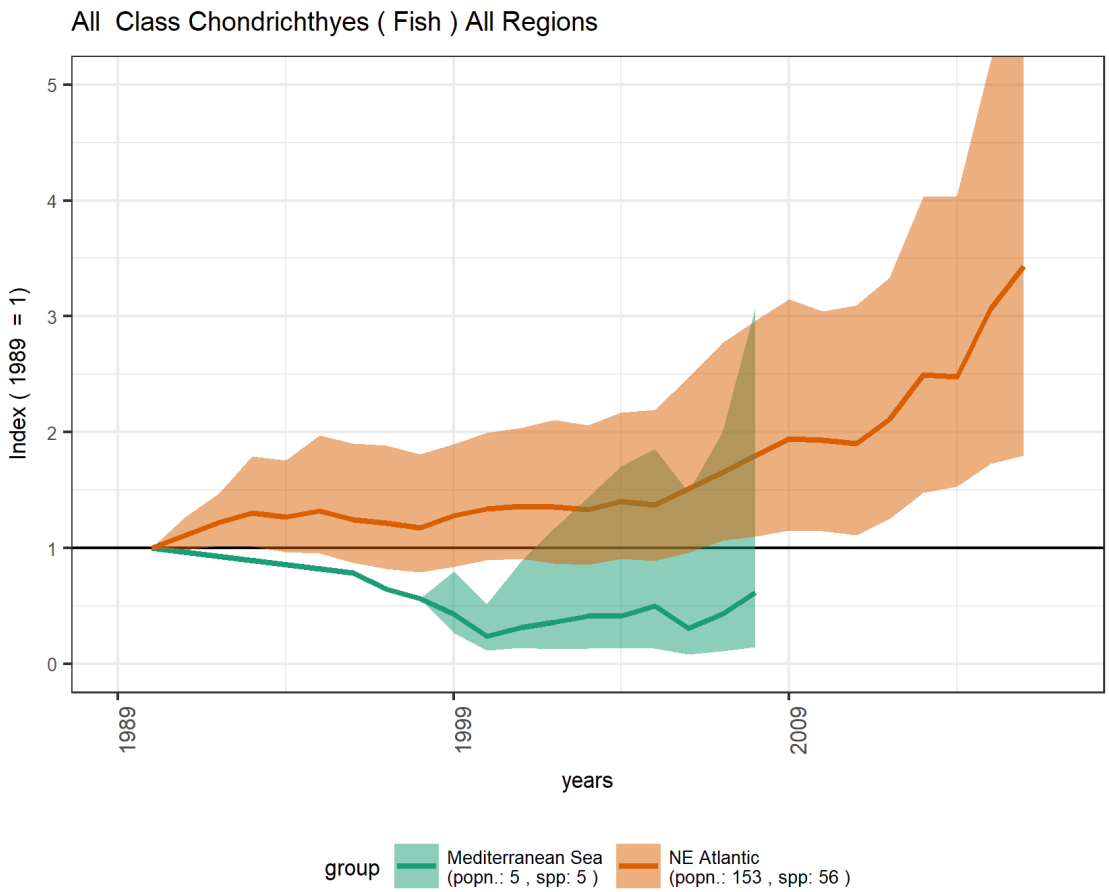
The threat status is lower in the NE Atlantic compared to the Mediterranean where about 57 % of species are under threat. Even so, an Atlantic stock assessment of three species of sharks, showed that while the stocks of the blue shark (*Prionace glauca*) and shortfin mako shark (*Isurus oxyrinchus*) are not overfished, their stock biomass are low due to past overfishing leading to IUCN classifications of Near Threatened in Europe for blue shark and globally Vulnerable for shortfin mako sharks (IUCN, 2019). Fishing of the third species, the porbeagle (*Lamna nasus*), is over F_{MSY} and the species is categorised as critically endangered by IUCN and it may take 15-34 years to recover (ICCAT, 2014). In general, there are

few commercial fisheries left for these species but chondrichthyans suffer predominantly from loss to by-catch and trophy angling. The increased extinction risk of sharks and rays (chondrichthyans) is driven primarily by high levels of unregulated overfishing in the Mediterranean Sea.

Other assessments of status of Mediterranean chondrichthyans suggest this has worsened in the past decade (Cavanagh and Gibson, 2007; Nieto et al., 2015). There is a decline shark numbers in the Mediterranean and Black Seas based on trends in catch data (Saidi et al., 2012).

Figure 4.20 shows the analysis from the Living Planet Index method of trend data for sharks and rays from the NE Atlantic and Mediterranean areas. There are only a small number of such trends available, which may explain the wide uncertainty bands but the overall index in the Mediterranean is typically below the steady-state level suggesting declining populations in line with the discussions above.

Figure 4.20: Shark & ray abundance trends using Living Planet Index (LPI)



Source: LPI Data collected by ETC

Deep sea fish species

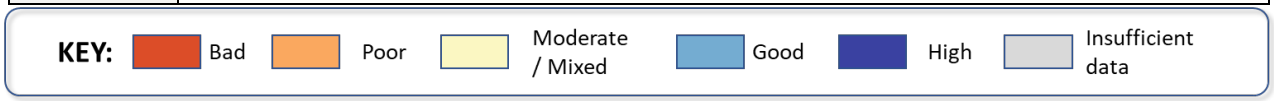
Deep-sea fish species are often characterized by longevity, delayed maturity, low fecundity and slow growth making them vulnerable to overfishing. As a result, most deep-sea stocks have undergone rapid and substantial declines, but a few stocks are fished sustainably, and recoveries have been observed (e.g. Victorero et al., 2018).

For fishery purposes FAO and NEAFC have defined 34 species as deep-sea fish and some species have been defined as groups such as 'deep-sea sharks' or 'small redfish'. Of these species, 35 % are red-listed in the recent European red list of marine fish (Nieto et al., 2015).

4.5 Marine Reptiles

Summary of regional & European assessments

Reptiles	
IUCN	In the NE Atlantic and the Mediterranean sea, both OSPAR and the Barcelona Convention list the loggerhead and leatherback turtles as threatened and/or declining species (OSPAR Commission, 2019; UNEP-MAP, 2017a)). In the Black Sea marine turtles are very rare visitors and, in the Baltic Sea, they have not been observed. A global analysis calculated that the Mediterranean has the highest average threats score out of all global ocean basins (Wallace et al., 2011).
HABITATS DIR ART.17 (2007-12)	Overall, the Favourable Conservation Status of marine reptiles was unknown in 67 % of the reports, with 33 % in unfavourable status. However, for one region, the marine Mediterranean, 60 % of the reports were unfavourable, compared to 40 % unknown (EEA, 2013a).
UNEP-MAP	At present knowledge on sea turtle abundance and demography is patchy at best for each component and that effort needs to be placed on filling existing gaps in order to predict with any certainty the future viability of sea turtle populations in the Mediterranean (UNEP-MAP, 2017b)



Geographic status – Reptiles

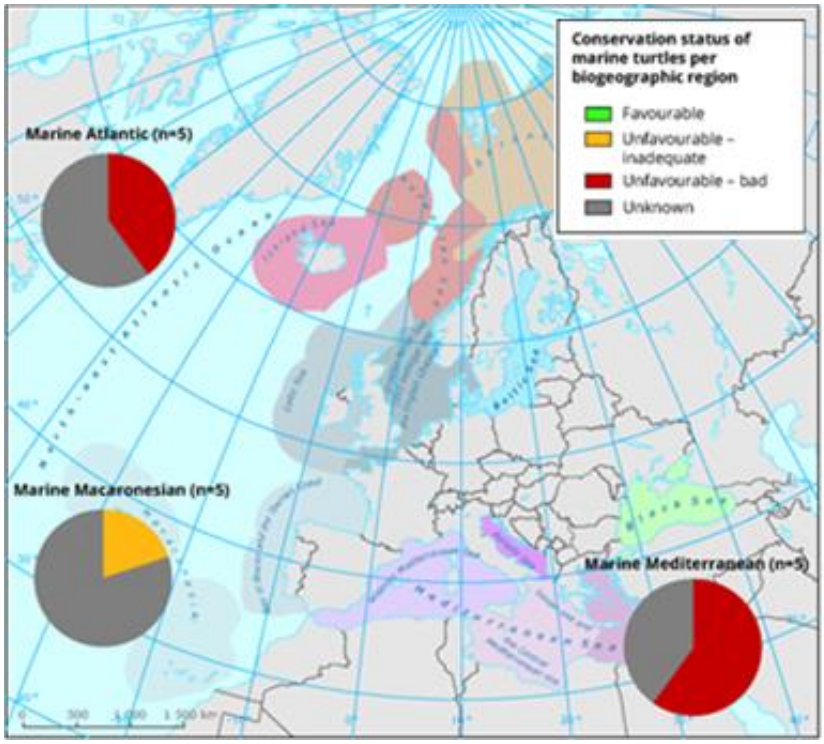
There are five species of turtles in European Seas of which only two are known to breed in European waters. These are the green turtle (*Chelonia mydas*) which breeds in the south-eastern portion of the Mediterranean Sea and the loggerhead turtle (*Caretta caretta*) which breeds in the southern part of the same basin. The leatherback turtle *(Dermochelys coriacea)* disperses from its Atlantic tropical breeding grounds into the north-eastern Atlantic and western Mediterranean Sea which it uses as foraging grounds. In addition, two rare species, the Hawksbill turtle (*Eretmochelys imbricata*) and the Atlantic ridley (*Lepidochelys kempii*.) are occasional visitors. All five species are threatened.

Despite the high conservation concern, assessment data is hard to acquire. Systematic and repeatable assessments of turtle distribution and abundance at sea have only begun in recent years and, at present, the data originating from aerial surveys is still not sufficient to define baseline population estimates. Although total nesting distribution and abundance in the Mediterranean is unavailable, the mean annual number of nests in the Mediterranean is estimated at 7,200 with a total mature adult population estimate of 21,414 individuals (IUCN, 2015). Since European seas host a subpart of the Northwest Atlantic loggerhead turtle subpopulation and the Mediterranean one, it is not possible to provide a geographic species status assessment at European scale.

Figure 4.21 shows that, based upon the previous reporting round of the Habitats Directive 2007-2012, none of the five turtle species normally occurring in European waters were in 'favourable conservation status'. Of these two species breed in European waters. These are the green turtle (*Chelonia mydas*) which breeds in the south-eastern portion of the Mediterranean sea and the loggerhead turtle (*Caretta caretta*) which breeds in the southern part of the same basin (EEA, 2015b).

Loggerhead turtles (Caretta caretta) are the most abundant sea turtle in the Mediterranean Sea (Broderick et al., 2002). The main nesting beaches of the loggerhead turtles are in the eastern Mediterranean in Greece, Turkey, Cyprus and Libya. Smaller populations nest in Israel, Lebanon and Tunisia, with occasional nesting in Italy, Spain, France and Albania (Margaritoulis, 2001). The leatherback turtle (*Dermochelys coriacea*) is an Atlantic species which uses Mediterranean Sea as its feeding area. The green turtle (*Chelonia mydas*) has a very endangered population in the Mediterranean by less than 400 individuals. Nesting is concentrated on a few beaches in Turkey, Syria and Cyprus and some animals also nest in Lebanon, Israel and Egypt (Kasparek et al., 2001; Rees et al., 2008).

Figure 4.21: Conservation status of marine turtles in European seas



Source: EEA, 2015d

Population trends across Europe

The global loggerhead population is decreasing, but the very recent IUCN (2015) assessment shows that its Mediterranean subpopulation, as inferred from the overall past and present nesting trends at specific index sites, is increasing and not threatened (Casale & Tucker, 2017). The viability of the population is, however, dependent on conservation actions conducted on the index sites which are object of protection measures. The NE Atlantic subpopulation has an unknown population trend (Casale & Marco, 2015).

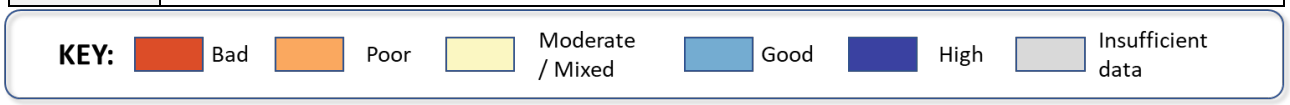
The global leatherback population is decreasing, and no European assessment is available.

Reliable trend data is difficult to acquire systematically. As a result, though the available trend data shows an increasing trend (WWF, 2015; IPBES, 2018b), this is only for a limited time span and for one species (loggerhead turtles) (UNEP-MAP, 2017b).

4.6 Pelagic habitats

Summary of regional & European assessments

Pelagic habitats	
HELCOM	Using indicators for phytoplankton and zooplankton, HELCOM reported good status for pelagic habitats is achieved in the Kattegat, but not in any other open sea sub-basin during 2011–2016 and 20 % of the coastal areas achieve good integrated status
OSPAR	In the OSPAR region, local and large-scale changes in phytoplankton biomass and zooplankton abundance (were observed from 1958 to 2002 and since 2004 plankton communities experienced significant changes in relative abundance, indicating alterations to key aspects of ecosystem functioning. The inference is that those changes are linked to prevailing environmental conditions such as climate change, nutrient enrichment or other factors (OSPAR Commission, 2017i).



Status and trends of pelagic habitats

Pelagic habitats are particularly difficult to assess given the range of human pressures and the dynamic nature of the physical oceanography of each region. Nevertheless, there have been attempts to develop robust indicators of pelagic habitats, at least for the planktonic forms, which are not free-swimming. The assessment of primary production of phytoplankton provides a valuable approach from the base of the food web, to identify trends in production which would have impacts on higher trophic levels.

The state of pelagic habitats is characterised primarily by their phyto- and zooplankton assemblages. Our assessment is, however, limited to more coastal areas where indicator data is available and which are also more likely eutrophicated or contaminated (EEA, 2019d).

The only areas in the BEAT+ assessments indicating good status in Europe were found from the Greater North Sea and Celtic Seas. However, these areas have also faced changes as shown by indicators starting in 1950s. The OSPAR assessment showed that plankton communities have experienced significant changes in relative abundance, indicating alterations to key aspects of ecosystem functioning. In the Greater North Sea and the Celtic Seas, plankton communities have recently shifted to high biomass of phytoplankton and low biomass of zooplankton. More specifically, planktonic dominance patterns have biased from diatoms to dinoflagellates, from large to small phytoplankton and from fish larvae to gelatinous zooplankton (OSPAR Commission, 2017d).

In the Baltic Sea, the integrated BEAT+ assessment indicated deteriorated status. Similar results were found by the HELCOM assessment by phytoplankton and zooplankton indicators. Phytoplankton community has changed towards dinoflagellate dominance and increased blooms of cyanobacteria and the zooplankton community is in most areas dominated by small-sized species (HELCOM, 2018i). Due to the high concentrations of chlorophyll the status was assessed as good only in Kattegat, whereas individual indicators of phytoplankton or zooplankton indicated good status also in the Gulf of Bothnia or Gdansk Basin.

Development of cyanobacterial blooms (both spatial extent and share of cyanobacteria in phytoplankton) increased strongly in the Baltic Sea in the 1990s but stabilized and even decreased in the 2000s (HELCOM, 2018b). Similarly, in the 2000s the phytoplankton community indicated an increase in diatoms in the Baltic Proper, which is indicative of an improved environmental status (HELCOM, 2018c). Zooplankton time series indicate that the large-bodied species were more abundant in large parts of the sea region in the 1980s but decreased thereafter in the central parts of the region (HELCOM, 2018i). In coastal waters, about one fifth of the pelagic habitat area is estimated to be in good status. Only one open sea area showed a good condition.

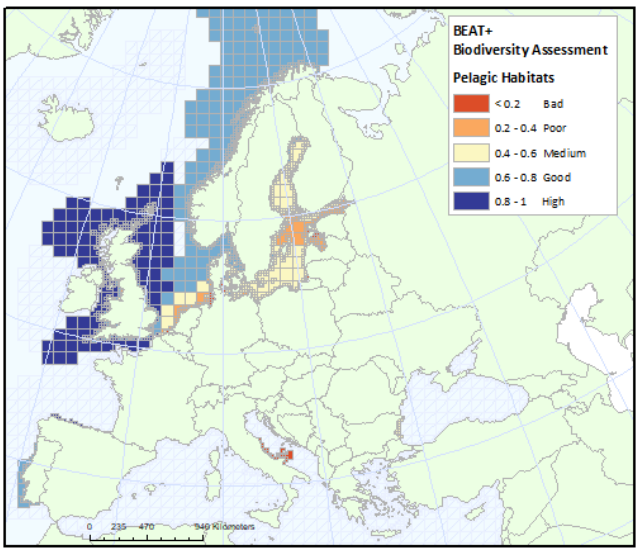
In the Mediterranean, high chlorophyll and productivity levels have been found near large urban areas as well as in the Adriatic Sea (e.g. EEA, 2019a), though there is evidence the latter is improving following satellite data analysis (Mozetič et al., 2010). The phytoplankton community is believed to be changing along the changes in nutrient levels (UNEP-MAP, 2017b). Harmful algal blooms are observed in the region caused by 57 species of algae, e.g. the *Alexandrium tamarensis* a dinoflagellate producing paralytic shellfish poisoning (PSP) toxins in the northern Adriatic.

In the Black Sea, planktonic communities have experienced changes due to eutrophication and subsequent introductions of planktivorous predators. The gelatinous zooplankton (mainly *Mnemiopsis leidyi* and *Aurelia aurita*) contributed up to 99 % of total wet weight in 1995 in the Black Sea (BSC, 2008). Some zooplankton species decreased 50-fold in abundance since the end of the1990s'. In the 2000s', this reversed due to a decrease in *M. leidyi* abundance and improvement of the meso-zooplankton (Arashkevich et al., 2014; BSC, 2019).

Integrated assessment of pelagic habitats

Figure 4.22 shows the outcome of the BEAT+ analysis of pelagic habitats. This is dependent on a relatively small number of indicators which have been developed to understand phytoplankton communities though in some areas, such as the Baltic Sea, the North Sea and the Celtic Seas, this also includes assessments of chlorophyll-a, based on data from HELCOM (HELCOM, 2018e) and the EEA eutrophication report (EEA, 2019b) as a proxy for phytoplankton production. Ideally, the focus here would be to use indicators which described community changes or production changes against thresholds but in general most of these indicators are still in development and not widely operational (see the report on a trial indicator on phytoplankton biomass to assess the state of primary productivity using the NEAT assessment tool (Haraldsson et al., 2017).

Figure 4.22 BEAT+ analysis of marine pelagic indicators



The map shows that where eutrophication is a problem (especially Baltic Sea, North Sea and Adriatic Sea), the state of pelagic habitats is either poor or at best medium. Other areas generally show good or even high state. This is mainly based on direct effects indicators for eutrophication with a few localised plankton diversity indicators. Other phytoplankton indices are in development by OSPAR e.g. life-form pairs (abundance and distribution of key trophic planktonic groups) but thresholds have yet to be agreed. HELCOM is also trialling similar indicators with a diatom/dinoflagellate index. More of these are needed however for wider seas coverage.

Results from BEAT+ assessment of pelagic habitats

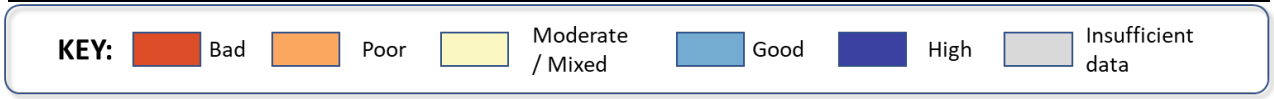
Regional Sea	Average BQR		Worst BQR	
North-East Atlantic Ocean				
Barents Sea	0.66	Good	0.66	Good
Norwegian Sea	0.66	Good	0.66	Good
Greater North Sea	0.62	Good	0.02	Bad
Celtic Seas	0.82	High	0.82	High
Bay of Biscay and the Iberian	0.72	Good	0.43	Medium
Baltic Sea		Good	1	Medium
Baltic Sea	0.48	Medium	0.01	Bad
Mediterranean Sea				
Adriatic Sea	0.16	Bad	0.16	Bad
Black Sea				
Black Sea	0.45	Medium	0.43	Medium

[BQR (Biological Quality Ratio) is the normalised value of an indicator compared to a standard threshold on a scale of 0 to 1 between the 'worst' case and reference values for that indicator]

4.7 Seabed habitats

Summary of regional & European assessments

Seabed habitats are under significant pressures across European seas. Bottom fishing pressure is one of several pressures that need to be taken into consideration in assessing the cumulative effects of human activity on benthic habitats, although other pressures such as coastal development also creates impacts on marine environments. Over 65 % of protected seabed habitats were reported as being in unfavourable condition in the last Habitats Directive Article 17 reporting round 2006–2012.	
IUCN	European seabed habitats have undergone a red list assessment where 257 benthic marine habitat types (EUNIS 4) were included: 61in the Baltic Sea, 86 in the NE Atlantic, 47 in the Mediterranean, and 63 in the Black Sea. About one fifth of the habitats were classified as threatened and an additional 11 % were Near Threatened (Gubbay et al., 2016). More than half of the habitat types were data deficient, and no classification was possible to make. The highest proportion of threatened habitats was found in the Mediterranean Sea (32 %), followed by the North East Atlantic (23 %), the Black Sea (13 %) and then the Baltic Sea (8 %). Majority of the assessed seagrass habitats, estuarine habitat types and infralittoral mussel beds were classified at least as Near Threatened but even Critically Endangered. Across all the threatened habitat types, the two main reasons for the status were either reduction in extent over 50 years or reduction in quality over the past 50 years (Gubbay et al., 2016).
HABITATS DIR. ART.17 (2007-12)	In the 2013 Article 17 Habitats Directive reporting, the overall summary of the 8 marine habitat types was that 66 % of the habitats were assessed as being in Unfavourable Favourable Conservation Status. There were regional differences such that most unfavourable-bad habitats were found in the Marine Atlantic, Marine Baltic and Marine Mediterranean regions. Reported assessments for the Black Sea where mainly unfavourable-inadequate whereas in the Macaronesian region, the largest status class was unknown (EEA, 2013b).
OSPAR	A first OSPAR assessment shows that 86 % of the assessed areas in the Greater North Sea and the Celtic Seas are physically disturbed, of which 58 % had higher disturbance. Consistent fishing pressure occurs in 74 % of all assessed areas, which is very likely to affect the ability of habitats to recover (OSPAR Commission, 2018).
HELCOM	For benthic habitats in the Baltic Sea, there is indication of good status in 29 % of the open sea areas assessed (restricted to soft bottom habitats). Coastal areas show good status in 44 % of the assessed Baltic Sea region (HELCOM, 2018e).
UNEP-MAP	Assessment of Mediterranean seabed habitats is mainly qualitative due to the lack of ground-truth data and standardized monitoring for most of offshore habitats. This includes the lack of baseline data at the regional scale for many habitats exposed to abrasion by bottom-trawling fisheries. This has so far restricted the ability to identify a sustainable condition for habitats under continuously high-pressure levels. However, extents of special habitats are under threat and in decline (UNEP-MAP, 2017b).



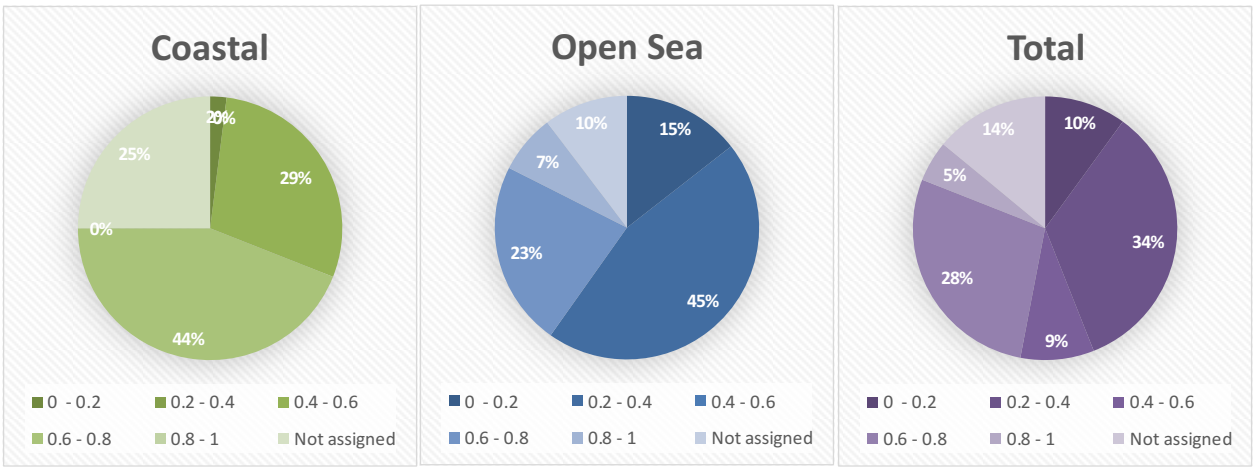
Sea floor habitats are typically group into broad-scale habitats (those which cover large areas of contiguous seabed) and special habitats defined often by rare or unusual biological or geological features. Broad-scale habitats are covered particularly in the MSFD assessments whereas special habitats are identified at European, regional or national scales.

Status of benthic habitats

Inshore habitats have been more widely monitored especially due to the requirements of reporting under the WFD. However even here the national indicators are not directly comparable across coastal areas as different parameters are used and the indicators are not always intercalibrated (Haraldsson et al., 2017). The IPBES report (IPBES, 2018b) stated that 53 % of the benthic shallow habitats in Western and Central Europe are data deficient. The corresponding figure is 87 % in the Black Sea, 60 % in the North East Atlantic, 59 % in the Mediterranean Sea and 5 % in the Baltic Sea (IPBES, 2018b)

Generating an assessment of benthic habitats for all types of seabed and in all water areas, including offshore, requires a mix of methods. For the HOLAS II Integrated Assessment (HELCOM, 2018e), HELCOM combined two core indicators: the 'State of the soft-bottom macrofauna community' indicator for coastal areas the one for 'Oxygen debt' as a surrogate indicator for open sea areas (Figure 4.23).

Figure 4.23: Integrated assessment of benthic habitats in the Baltic Sea

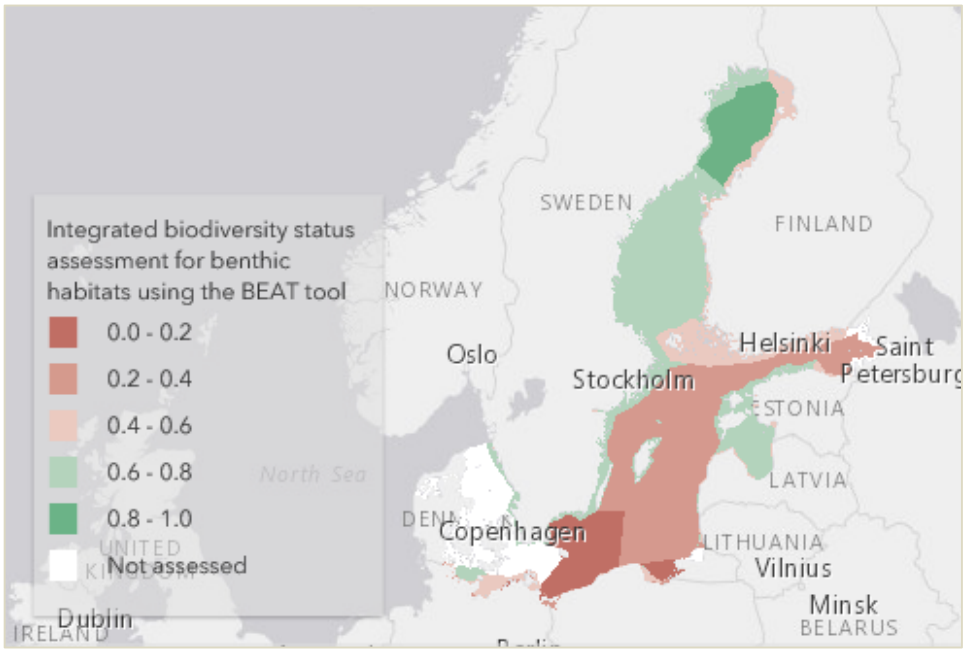


Source: Data from HELCOM, 2018e

Status is shown in five categories based on integrated BQRs. Values of at least 0.6 correspond to good status. Coastal areas were assessed by national indicators. White sectors represent unassessed areas, including areas not assessed due to the lack of indicators or data and all Danish coastal areas (see Figure 4.24 (HELCOM, 2018e)).

In the Baltic Sea, there is a clear deteriorating gradient in state of seabed from north to south. The Gulf of Bothnia has well oxygenated near-bottom waters and disturbing human activities are limited to coastal dredging. The SW sub-basins are heavily bottom-trawled, which is also visible in the state of the benthic habitats (HELCOM, 2018g). Although less than 1 % of the benthic habitat area was estimated as lost, 40 % of benthic habitats were disturbed and this percentage was much higher in the sub-basins where bottom-trawling is practiced, and sand and gravel extraction is more intensive (HELCOM, 2018e).

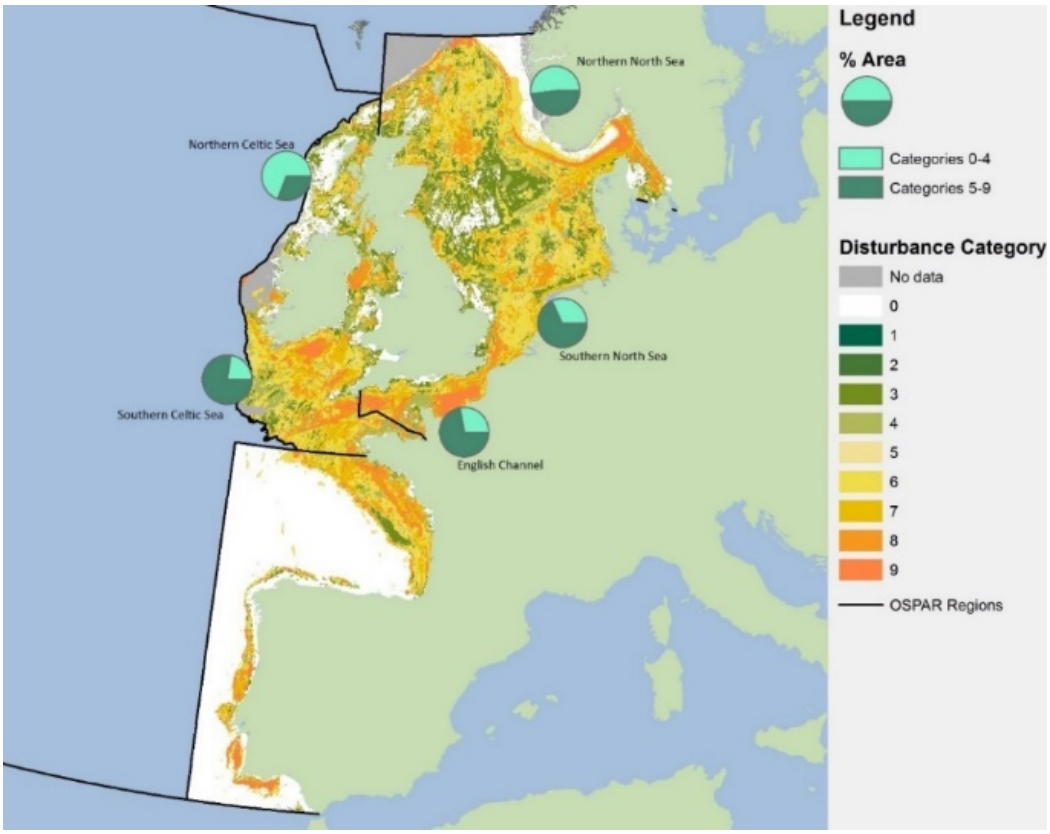
Figure 4.24: Baltic Integrated Benthic Assessment



Source: HELCOM, 2018e

For wide spatial coverage, OSPAR used indicators of Physical Damage to seabeds based on a proxy measure based on fishing intensity. Figure 4.25 shows this spatial distribution of aggregated disturbance (using 2010–2015 data series) across OSPAR sub-regions.

Figure 4.25: OSPAR assessment of the extent of physical damage to predominant and special habitats



Source: OSPAR Commission, 2018, under Creative Commons License https://creativecommons.org/licenses/by/2.0/

Disturbance categories 0–9, with 0 = no disturbance and 9 = highest disturbance. Plots show percentage area of OSPAR sub-regions in disturbance categories 0–4 (none or low disturbance) and 5–9 (high disturbance) across reporting cycle (2010–2015). The percentage was not included for the Bay of Biscay and Iberian Coast due to the lack of complete data.

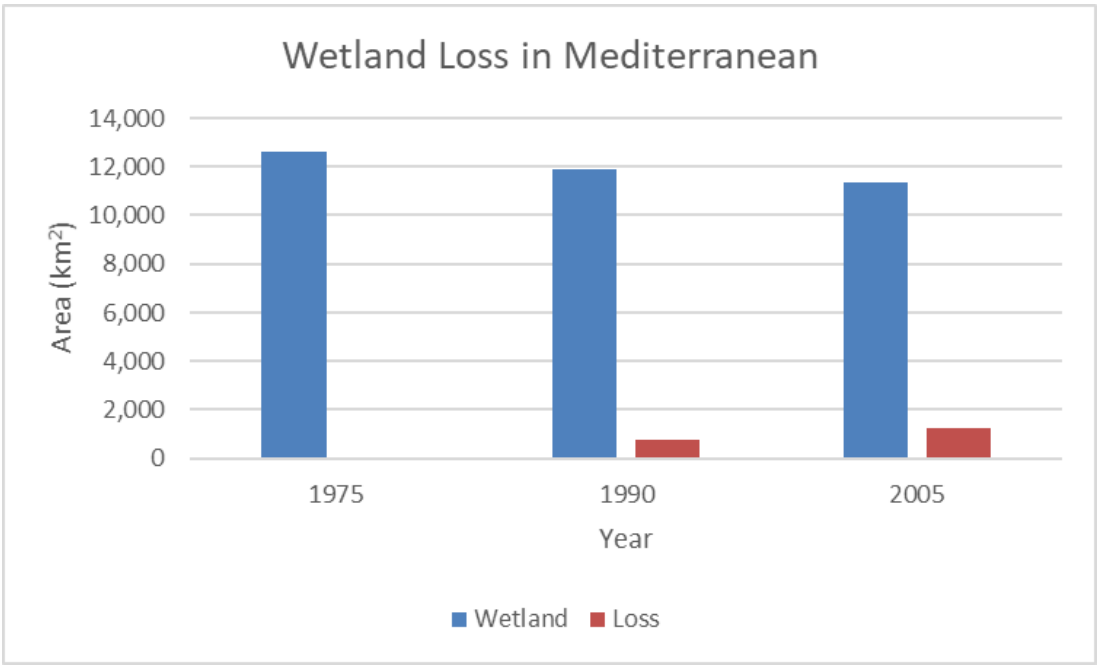
The results indicate that up to 86 % of the grid cells assessed in the Greater North Sea and Celtic Seas show evidence of some physical disturbance of the seafloor from fishing gears which contacted the seabed (e.g. beam trawling). Within that area, 58 % of areas show higher levels of disturbance, especially in the Celtic Seas and the English Channel. Fishing pressure is not constant with a quarter of the assessed grid cells showing high variability in pressure, especially in the Greater North Sea. Overall there are no clear trends across habitats or regions.

Lack of ground-truthed data and monitoring limiting assessment of condition of Mediterranean habitats. Coastal zone pressures in the Mediterranean are affecting sensitive inshore and wetland habitats (Geijzendorffer et al., 2018). A study by the Mediterranean Wetlands Observatory in 2014 showed there had been a 10 % loss in over 200 natural wetland sites since 1975 to 2005, including those on the sea margins (Figure 4.26).

Integrated spatial assessment of benthic habitats

The EEA assessment of pressures and their effects in Europe's seas estimated that at least 14 % of European seabed is under physical disturbance and the share of disturbed seabed rises to 32 % in the coastal waters (0–12 nm) (EEA, 2019). The same analysis estimated that ~3 % of habitats is considered lost during 2011–2016. More detailed analysis was made for the known extents of seagrass meadows, saltmarshes, seamounts, cold-water corals and coralligeneous algae. Only a minimal fraction of these habitats was estimated to be free of human disturbance (EEA, 2019). These analyses are, however, made in the scale of 10 km × 10 km squares which may overestimate the impacts for small habitat areas.

Figure 4.26: Loss of natural habitat area from 1975 to 2005 in sample of 214 wetland sites around the Mediterranean



Source: Data from Gardner et al., 2015

In the Black Sea, the benthic habitats are primarily disturbed by eutrophication and especially oxygen deficiency (Capet et al., 2016; EEA, 2015a). No status assessment was available for this region.

In the Mediterranean the habitat distributional range and condition of the habitat's typical species and communities indicate that a large proportion of habitats are to some degree threatened (UNEP-MAP, 2017a). The results of the BEAT+ and the Mediterranean cumulative effects assessment seem to agree in areas under poorer status. These are around the Balearic Islands, African coast in the Western Mediterranean, the sea between the Tunisian coast and Sicily, the Adriatic and the coast of Egypt (UNEP-MAP, 2017b).

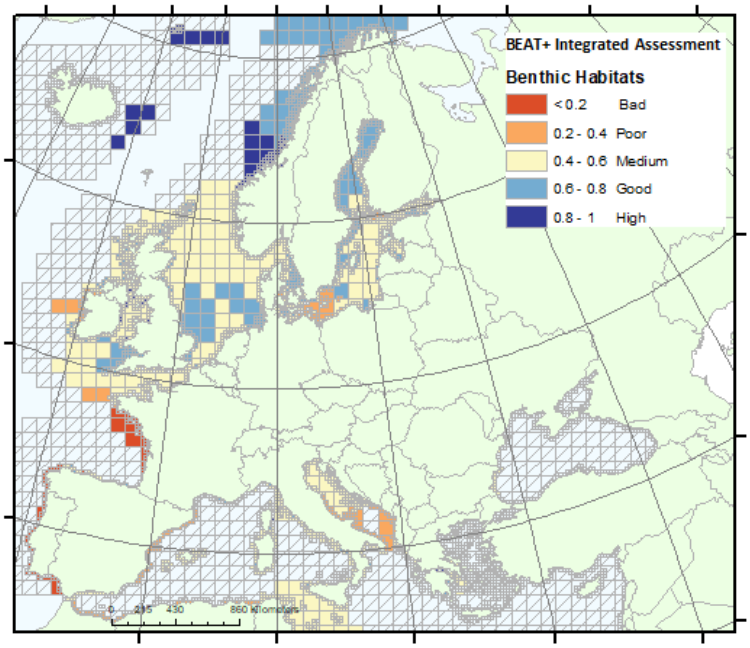
In the NE Atlantic, almost the entire shelf area is disturbed according to the benthic indicators (OSPAR Commission, 2018). The worst status is found from the Greater North Sea and the Celtic Seas where 86 % of the assessed area are physically disturbed and even 58 % is highly disturbed (OSPAR, 2017). Consistent fishing pressure occurs in 74 % of all assessed areas, which is very likely to affect the ability of habitats to recover. The OSPAR indicator was able to show that the benthic diversity depended on fishing pressures (OSPAR Commission, 2019). In the coastal waters, however, the benthic macrofauna indicates good status in 74 % of the coastal water bodies and even 89 % of them are in good status when assessed based on macroalgae (OSPAR Commission, 2017b)

Spatial assessment of the state of benthic habitats

The integrated BEAT+ assessment of Europe's benthic habitats (Figure 4.27) suggest that 58 % of the total shallow water seabed area is not in good status. The respective score varied among the sea regions: 63 %, 100 %, 98 % and 44 % of the areas assessed in the Baltic, the Black Sea, the Mediterranean and the NE Atlantic which reflects the situation from the RSC Key messages.

The assessed area excludes areas where the seabed is more than 2 km below the surface as data for these areas, such as from commercial fishing, are sparse.

Figure 4.27: BEAT+ analysis of marine benthic indicators



The BEAT+ analyses for benthic habitats is based on a diverse set of indicators. Some are primarily designed for coastal use especially those used to meet WFD monitoring. There are a number of WFD indices measuring coastal invertebrate or macrophyte communities, for example. One advantage of the BEAT+ tool is that WFD data, being largely point sample based, matches automatically to an assessment grid square; there is no need to depend on the complex intercalibration exercises needed for water body assessments. However, there are fewer biotic samples available for most countries than for chemical status data, in part because they have more complex monitoring requirements and also because they are only required for a narrower strip of coastal waters. This means that on the overall assessment maps (HELCOM, 2018g), the overall spatial coverage is very low. Away from the coasts, it is necessary to use more pressure-based indicators such as OSPAR's BH3 (a measure of physical damage by matching fishing and other pressures to benthic habitat sensitivity) and the community-based ones being developed for soft-sediment habitats in HELCOM and the BH2 indicator for OSPAR which is evaluating the use of multi-metric indices for benthic habitats in offshore waters. The map also includes data from commercial invertebrate fisheries (e.g. *Nephrops*) where the catch mortality gives an indicator of conditions.

Results from BEAT+ assessment of benthic habitats

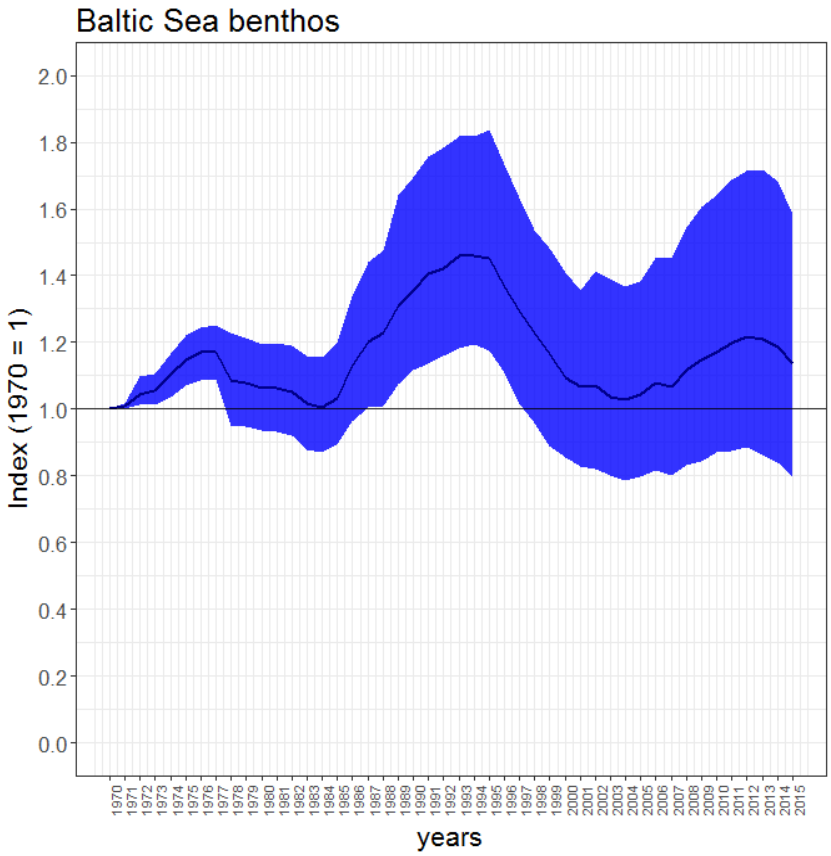
EEA_SubRegion	Average BQR		Worst BQR	
North-East Atlantic Ocean				
Barents Sea	0.67	Good	0.49	Medium
Iceland Sea	0.86	High	0.86	High
Norwegian Sea	0.74	Good	0.49	Medium
Greater North Sea	0.55	Medium	0.33	Poor
Celtic Seas	0.52	Medium	0.33	Poor
Bay of Biscay and the Iberian	0.20	Bad	0.15	Bad
Baltic Sea				
Baltic Sea	0.55	Medium	0.21	Poor
Mediterranean Sea				
Western Mediterranean	0.44	Medium	0.20	Poor
Ionian Sea and the Central	0.52	Medium	0.35	Poor
Adriatic Sea	0.39	Poor	0.14	Bad
Aegean-Levantine Sea	0.52	Medium	0.36	Poor
Black Sea				
Black Sea	0.52	Medium	0.49	Medium

[BQR (Biological Quality Ratio) is the normalised value of an indicator compared to a standard threshold on a scale of 0 to 1 between the 'worst' case and reference values for that indicator]

Trends in benthic biodiversity

In the Baltic, long-term changes in the benthic status are primarily caused by oxygen conditions and saline water inflows. In the Gulf of Bothnia, where oxygen is not a limiting factor for benthic macrofauna, the benthic quality index indicates relatively stable development and the only temporary decrease was caused by the introduction of the non-indigenous polychaete worm *Marenzelleria viridis* (HELCOM, 2018g). In contrast, the seafloor of the Gulf of Finland faces repeated fluxes of hypoxic waters from the deeper Baltic Proper which cause repeated changes to the benthic macrofauna. In the southern sub-basins, the benthic species composition depends on saline water inflows while temporary oxygen deficiencies cause biomass falls (Wasmund et al., 2015). These trends are shown in Figure 4.28 using data from the recent HOLAS II assessment and applying an LPI trend analysis. This suggest that broadly the trends are positive but there are downward fluctuations (potentially linked to the changes itemised above); there is a high level of uncertainty around the analysis shown by the spread of values in 2018.

Figure 4.28: Living Planet Index of Baltic benthos from HELCOM data



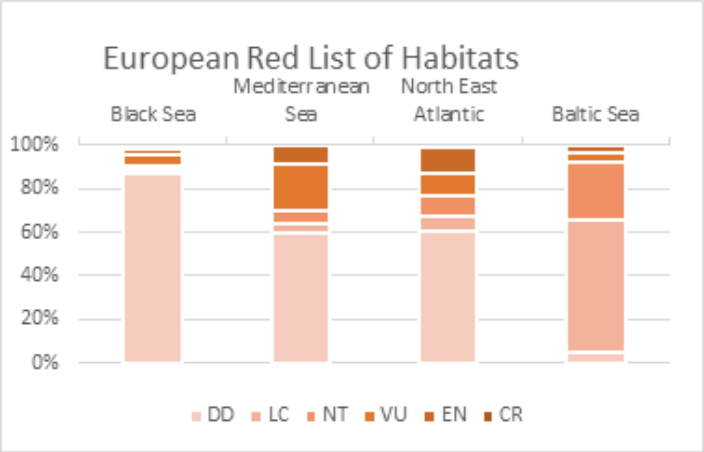
Source: SYKE 2019

The Mediterranean benthic habitats have been seriously affected by warming surface waters which have caused a shift to thermophilic species – often non-indigenous – and by anomalies in the depth of the thermocline which caused a series of mass mortalities in the littoral zone (e.g. Garrabou et al., 2003; Parravicini et al., 2015; Betti et al., 2017). Also, the coverage of larger macroalgae has significantly decreased (Bertolino et al., 2016).

Rare & endangered habitats

Seabed habitats have been assessed using IUCN Red List criteria for a wide range of broadscale benthic habitats (Gubbay et al., 2016) and the spatial distribution of Red List status and of trends is shown in Figure 4.29.

Figure 4.29: Red List status of European seabed habitats by region



Key: DD= Data Deficient; LC= Least Concern; NT= Nearly Threatened; VU= Vulnerable; EN= Endangered; CR= Critically Endangered

Source: Data from Gubbay et al., 2016

European seabed habitats have undergone a red list assessment where 257 benthic marine habitat types (EUNIS 4) were included: 61 in the Baltic Sea, 86 in the NE Atlantic, 47 in the Mediterranean, and 63 in the Black Sea. About one fifth of the habitats were classified as threatened and an additional 11 % were Near Threatened (Gubbay et al., 2016). More than half of the habitat types were Data Deficient, and no classification was possible to make. The highest proportion of threatened habitats was found in the Mediterranean Sea (32 %), followed by the North-East Atlantic (23 %), the Black Sea (13 %) and then the Baltic Sea (8 %).

Majority of the assessed seagrass habitats, estuarine habitat types and infralittoral mussel beds were classified at least as Near Threatened but even Critically Endangered. Across all the threatened habitat types, the two main reasons for the status were either reduction in extent over 50 years or reduction in quality over the past 50 years.

In the Baltic Sea, the greatest threat for the threatened habitats is eutrophication and the associated oxygen depletion, but also demersal fisheries and coastal development (e.g. constructions, dredging) are typical threats (HELCOM, 2013b). One third of the Baltic habitats were assessed as threatened or Near Threatened (Gubbay et al., 2016). The more detailed HELCOM assessment identified 328 Baltic biotopes of which 209 were included in the assessment and 59 were red listed (HELCOM, 2013b). Only one biotope was assessed as Critically Endangered: the aphotic muddy bottoms dominated by the ocean quahog (*Arctica islandica*).

In the Mediterranean, coastal zone pressures are acting to reduce resilience of wetland habitats (Gardner et al., 2015). In the Black Sea, majority of the marine habitats had too few data to make a threat classification; 85 % of habitats were Data Deficient (Gubbay et al., 2016). Seven out of nine classified habitats were assessed as threatened or near threatened. The main reasons for the decline are pollution by nutrients and hazardous substances but also coastal development and beam trawling of the seabed is of great concern (Gubbay et al., 2016). The Black Sea Commission has also defined 'Species of the Black Sea Importance' which include rare and threatened species and many of them are also habitat-

forming species such as three species of brown algae, three species of red algae and two seagrass species (BSC, 2002).

In the Mediterranean, most habitats in estuarine, infralittoral and mediolittoral environments were either Vulnerable or Endangered. Coastal development, pollution and demersal fishing are the main threats causing the habitat declines(Gubbay et al., 2016). While nearly 35 % of the Mediterranean marine habitats were classified as threatened or Near Threatened, but 60 % of the habitats had too little data to make a classification. Under the Barcelona Convention, Mediterranean countries have identified five so-called dark habitats in need of protection and included them in an action plan: assemblages of underwater caves, assemblages of underwater canyons, deep water engineering benthic invertebrate assemblages, deep-sea chemo-synthetic assemblages and assemblages associated with seamounts (UNEP-MAP, 2017b).

In NE Atlantic, threatened habitats are almost exclusively sediment habitats from estuarine, littoral, infralittoral and circalittoral zones (Gubbay et al., 2016). The Macaronesian communities on sheltered rocky shores have declined in both quality and extent, primarily because of coastal developments. Mobile demersal fishing is the main reason for habitat declines and in closer to the shore also pollution is a major threat. One third of the NE Atlantic habitats were assessed as threatened or Near Threatened, but the share of Data Deficient habitats was 60 % and therefore the share of threatened habitats may be higher (Gubbay et al., 2016). The OSPAR assessment of threatened and declining marine habitats has also listed the carbonate mounds, the coral gardens, the *Cymodocea* seagrass meadows, deep-sea sponge aggregations, intertidal *Mytilus edulis* beds on mixed & sandy sediments, intertidal mudflats, littoral chalk communities, *Lophelia pertusa* reefs, maerl beds, *Modiolus* beds, oceanic ridges with hydrothermal vents, *Ostrea edulis* beds, *Sabellaria spinulosa* reefs, seamounts, sea-pen and burrowing megafauna communities, and *Zostera* meadows (OSPAR Commission, 2019)

Threatened invertebrate species. There is no European wide red list assessment of marine invertebrates, but regional sea conventions have either red-listed or assessed several species. Of 1211 Baltic macrozoobenthic species evaluated, 96 % were classified as Least Concern and none was regionally extinct or critically endangered (HELCOM, 2013a).

The NE Atlantic list of threatened and/or declining species include the ocean quahog (*Arctica islandica*) and dog whelk (*Nucella lapillus*) due to climate change, Azorean barnacle (*Megabalanus azoricus*) due to fishing, flat oyster (*Ostrea edulis*) through diseases and introduction of other species by aquaculture and Azorean limpet (*Patella ulyssiponensis aspera*). The Mediterranean endangered or threatened invertebrate species include 7 species of sponges and two genera, a bryozoan (i.e. a moss animal), 18 cnidarians (e.g. corals and a hydroid), 17 molluscs, two crustaceans and three echinoderms (Langhar and Ouerghi, 2019). The Black Sea Commission has listed two sponges, five polychaetes (two endangered), 28 crustaceans (14 endangered), four endangered arthropods (BSC, 2019).

Threatened marine macrophytes. Regional sea conventions have also assessed the state of macrophytes – vascular plants or macroalgae. In the Baltic Sea, many of the species are of fresh-water origin and living in the brackish-water environment. Of the 317-evaluated species, 95 % were classified as Least Concern. Seven species were classified as Endangered or Vulnerable and four more as Near Threatened (HELCOM, 2013a). The majority were charophytes and seagrasses which are adversely affected by coastal construction and development activities. In the Mediterranean, the endangered or threatened species include four seagrass species, a green alga (*Caulerpa ollivieri*), six large brown algae species plus the genus *Cystoseira* and nine red algal (Langhar and Ouerghi, 2019). The Black Sea list has two endangered vascular plants and two rare seagrass species (BSC, 2002). There are no macrophytes in the NE Atlantic list of threatened and /or declining species. However, research by Casado-Amezúa et al., (2019) showed that cold-water fucoids were declining in range by 21–45 %, compared to smaller range contractions in warmer water kelps (10–13 %) on the North Iberian Coast.

5 The ecosystem approach: integrated biodiversity assessments

KEY MESSAGES ON INTEGRATED ASSESSMENTS

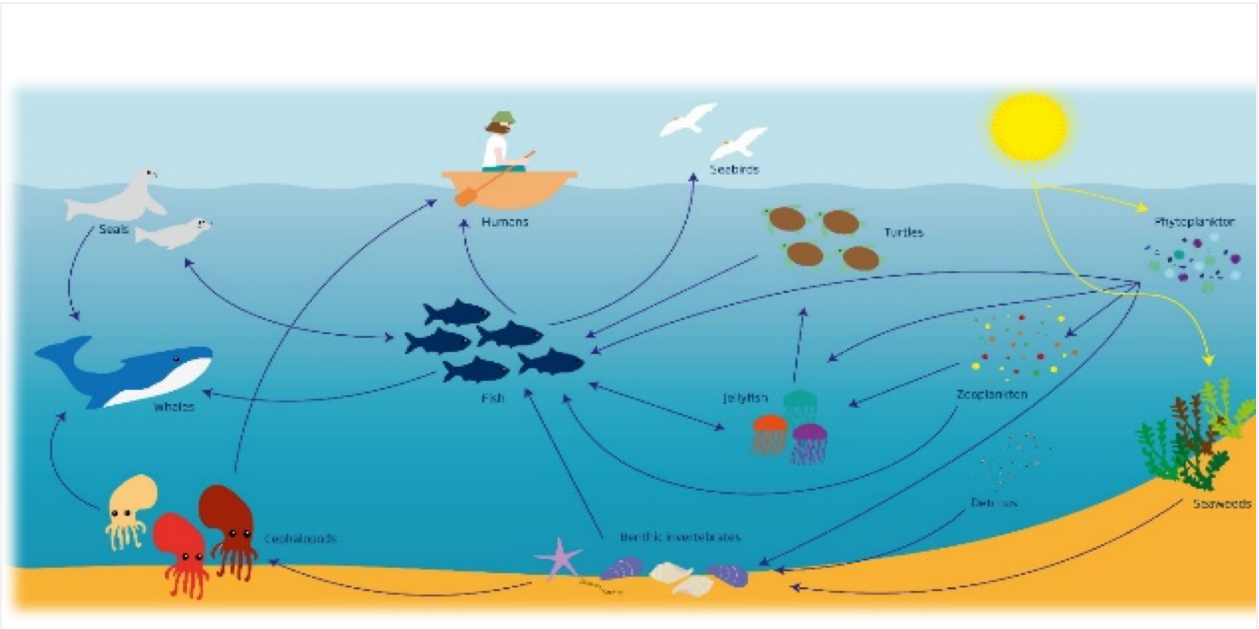
- Integrated assessment tools provide the means to utilise existing component-based indicators into a common assessment framework in the absence of full ecological models.
- Food web assessments need to be fully developed to understand how pressures affect the ecosystem as a whole but while there are new approaches in development, these are not yet operational.
- The productivity of some trophic guilds is impacted though the exact reasons remain elusive.
- There are examples of recovery for some key species (indicative of a trophic level) in some regional seas, which is a direct response to long-term historic and on-going management measures.
- There are still many cases where assessments are incomplete, have high uncertainty or are simply not possible due to lack of suitable data.

5.1 Achieving ecosystem assessments

To fully understand the state of biodiversity, the trends and state assessments for individual ecosystem components need to be brought together into a holistic assessment covering the state, pressures, impacts and responses across the marine environment. This is already enshrined as the goal for the MSFD which is seeking to ensure Europe's seas are achieving a GES and will be addressed in MSFD reporting by Member States and in the assessments from the RSCs (EC, 2008).

This in turn implies a much stronger emphasis on the successful functioning of food webs as being a core part of these assessments as well as understanding the status of individual species and habitats (Figure 5.1).

Figure 5.1: Generalised European marine food web



Source: EEA, 2018d

Within the MSFD, Descriptor 4 is designed to deliver assessments of ecosystem by considering food webs and hence provide a better understanding of how marine ecosystems function. The Guidance to the MSFD states this should cover:

"…Ecosystems in this context should be considered as broad-scale parts of a region or subregion, each encompassing a set of species groups and broad habitat types. It might be appropriate to consider coastal, shelf and open ocean/deep sea zones separately" (EC, 2017).

GES then implies that "All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity" (EC, 2017).

However, the MSFD guidance also recognises that there is more work to be done to be able to effectively assess ecosystem functions. The primary focus is on understanding trophic relationships and functions which implies assessing the state of food webs, but this is challenging. Work to improve assessment of food webs has progressed under the RSCs and research programmes in different ways.

5.2 Food web assessment in the RSCs

A suite of indicators was produced or trialled for the OSPAR assessment which were targeted at ecological functions related to pressures. The indicators were:

1. Assessment of Phytoplankton Production
2. The Large Fish Index (LFI)
3. Change in Mean Trophic Level of Marine Predators

The Phytoplankton indicators have already been discussed in Section 4.6. The second two were designed to show changes in fish populations to understand changes in food web composition. Linked to this is the concept of "Fishing down the Food Chain" which describes how intensive unregulated fishing removes the larger fish and top predators in the food chain (either directly or via by-catch) which leads to potential shift in ecosystem composition or increased proportion of smaller species of invertebrates and fish (Pauly et al., 1998).

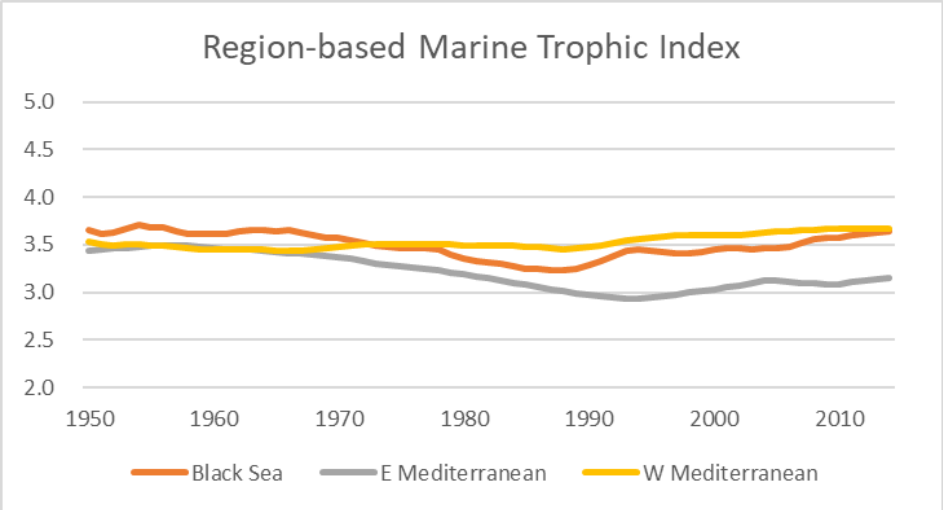
The LFI showed that larger fish were more prevalent in the Greater North Sea region, which might indicate success of fishery protection measures and quotas. The implication was that if the trends continued, recovery of large fish would achieve target values by 2022.

The mean trophic level indicator was a pilot designed to test a similar idea in that top predators would be the most likely species to suffer from pressures, causing a change to more omnivorous or herbivorous species and fundamental shift in the ecosystem structure. The study highlighted the complexity here in that the same fish species may have different diets in different regions, so the mean trophic level is not a constant. This is shown in the EcApRHA research project which applied the integrative assessment model Nested Environmental status Assessment Tool (NEAT) (Borja et al., 2016) to trial a food web assessment in the Bay of Biscay (Haraldsson et al., 2017).

As the graph shows, there was no apparent change in overall food web structure for Spain when considering the Mean Trophic Level in this area. However, the index in the Bay of Biscay showed a positive trend, so the overall result was ambiguous. The authors noted the spike in 2008 which was around unusual absence of a key species (blue whiting), which the authors used to emphasise the need for understanding of underlying causes.

In the Mediterranean, the food web indicators were not developed at Regional level but there are examples of global indicators applied to the region, such as the 'Sea Around Us' Regional Fish Mean Trophic Index. Data from this source has been combined together to produce average trends in Figure 5.2, from (Pauly and Zeller, 2015).

Figure 5.2: Combined regional fish Mean Trophic Index for the Mediterranean & Black Seas



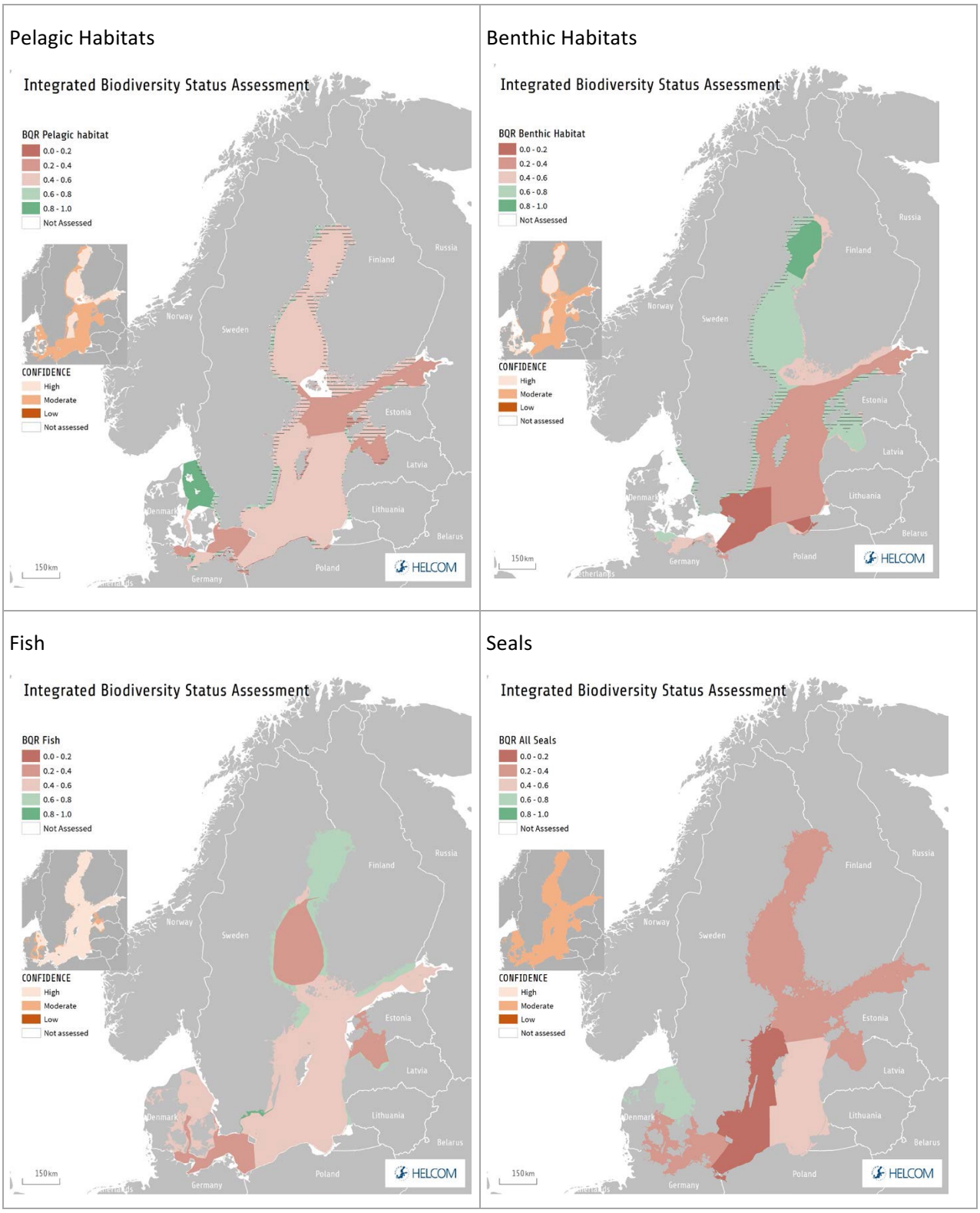
Data Source: Pauly and Zeller (Editors), 2015. Sea Around Us Concepts, Design and Data (seaaroundus.org)

This shows a similar pattern to the Spanish data above in that the index is remarkably stable over time for the Black Sea and Western Mediterranean but there has been a shift in the Eastern Mediterranean.

For the HOLAS II integrated assessment of the Baltic, the BEAT+ tool was used to aggregate indicators of around different ecosystem components to derive a BQR (Figure 5.3).

The overall impression is of generally poor status especially in the southern areas of the Baltic, with the exception of Benthic habitats in the Gulf of Bothnia which is less impacted by pressures (see Section 4.7). The source indicators were a combination of HELCOM Core indicators from the biodiversity and eutrophication assessments, plus national indicators for near-shore coastal areas with fisheries-specific data from ICES. The focus was here on aggregating indicator outcomes across these components rather than targeting specific responses of food webs to pressures.

Figure 5.3: Integrated assessment of Baltic Sea



Source: HELCOM, 2018e

5.3 Trends in European biodiversity

Section 3.5 introduced the LPI approach to evaluating trends. In Section 4, the LPI was used to consider overall trends within the main species groups as well as specific trends within those groups. Here, the LPI is used to aggregate over all the Regional Seas to find the overall European trends. The main taxa involved are the vertebrate species, and predominantly birds, fish and mammals. The data for turtles are not included as the data were too limited. Cetacean data is similarly restricted but coastal populations of cetaceans and seals are represented for all regional seas.

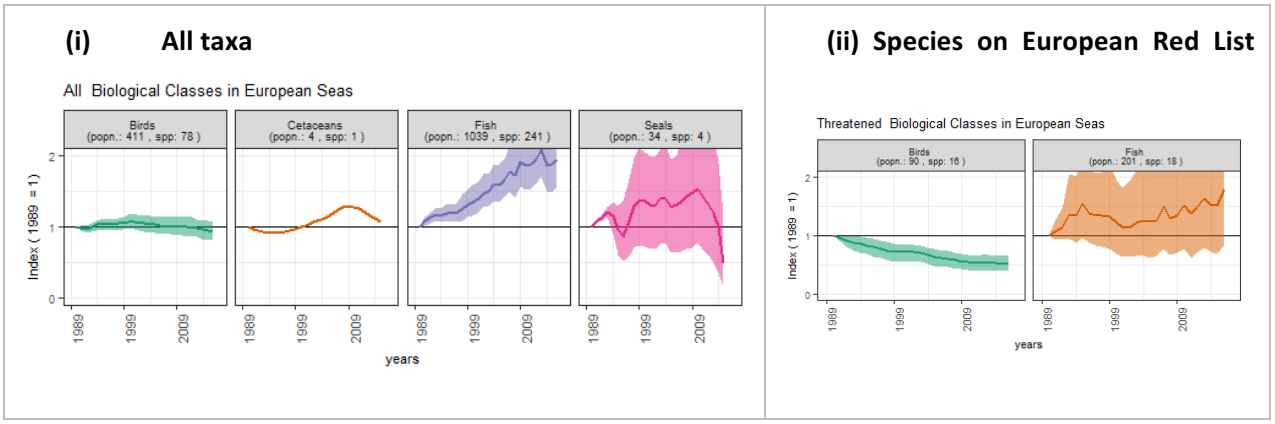
For this report, invertebrates, plants or habitats were not included for all regional seas, though transitional and coastal data from WFD monitoring could be used (see Baltic example in Section 4.7).

However, there are some underlying messages within these trends. In this century, the overall trend is starting to decline which reflects some of the messages from the Regional Seas Assessments. Commercial fish populations are improving in the Celtic and North Seas, which again reflects the increase in management measures during the time of this LPI assessment. Mammal populations are similar to birds with a sharp decline towards recent years. These are driven strongly by overall seal abundance.
Figure 5.4 shows the LPI trend analysis for marine vertebrates aggregated across all populations and species and marine regions where abundance data were available. As above, the lighter colour around the trend line shows the variability as measured by bootstrap sampling (Loh et al., 2005). All trends are measured from a cut-off year of 1990 (where the index equals 1).

The trends suggest that for birds, there is an overall decline since 2007, with the index now 10 % lower than at the start. Seals also show a declining index of 50 % in the most recent year though the index shows strong fluctuations (and is mainly positive) in earlier years. The confidence intervals around both trends spans the index value, suggesting high level of uncertainty in the trends. Cetacean data is based on a small number of inshore species so uncertainty is less. Here again the trend fluctuates which a recent decline since 2009. Fish trends on the other hand are increasing strongly across Europe, using the LPI as an aggregate value. This is broadly in line with other trends calculated for the LFI in the North and Celtic Seas (see Section 5.1).

When the LPI is calculated for threatened species only (as listed in the IUCN European Red Lists (IUCN, 2019)), there are only sufficient data at this stage for fish and seabirds. The trend for threatened seabirds is strongly declining with a 40 % decrease by the end year of 2017, which tallies with concerns raised over seabird populations in Section 4.3. Threatened fish species are generally improving in abundance which the average LPI is above the threshold which suggests that populations are generally maintaining themselves. This is in keeping with other LPI analyses based on fewer datasets for Europe (CBS, 2019; WWF and ZSL, 2015), which suggest that overall trends in abundance are broadly stable for Europe when averaged across all species (as compared to developing countries where trends are markedly downwards. However, threatened species when analysed separately show more negative trends which is a concern where species are potentially at risk of local or wider extinctions.

Figure 5.4: Combined biodiversity trends from Living Planet Index



5.4 Spatial Integrated Assessment of biodiversity using the BEAT+ tool

Thresholds and spatial assessment units for integrated assessments

In bringing together indicators, there need to be common scales both spatially and in terms of distance to targets between indicators. The latter is covered by normalising the indicator metrics to a scale of 0 to 1 (or percentages) with a set threshold for determining if the indicated status is good or not.

The approach in this assessment has been to be pragmatic in finding and using thresholds. Thresholds ideally are derived from the underlying ecological basis behind the indicator, but often the lack of knowledge of how ecology responds to impacts, the threshold necessarily involves either a level of expert judgement or is derived from, in effect, the value of that component in terms of ecosystem services. An example here is to use Maximum Sustainable Yield values as thresholds for fisheries.

Thresholds were developed for all of the indicators used within the HOLAS II assessment, drawing many for coastal indices from those developed under the WFD. However, many offshore indicators have less readily agreed thresholds, given the high uncertainty around data and trends, so it has been necessary to use thresholds from research literature. OSPAR does not use thresholds formally in its assessments, but there are some indicators such as those used for seabirds which have adopted 'assessment values' which are used here as surrogates for thresholds. More thresholds will need to be defined for MSFD reporting so this part of integrated assessment will develop markedly in forthcoming years. The current revision of the Commission Decision (EC, 2017) indicates that all indicators will need assessment thresholds by 2024. This implies the need to define reference values in the upcoming six years (i.e. 2016-2022) in order to meet the requirements of the Commission Decision for the third MSFD assessment in 2024. Locally derived thresholds are used as placeholders, but the aim is to improve confidence by increasing the number of regionally accepted thresholds.

In the meantime, indicators can still be used in absence of reference/threshold values in trend analyses (EcApRHA, 2016).

SAUs are also critical in terms of definition. Where data are grid points, these are associated with the grid cell which covers the location. This is typical of data from point sources such as those used for WFD monitoring. For broader habitats and for larger, more mobile species, the SAUs need to be more complex.

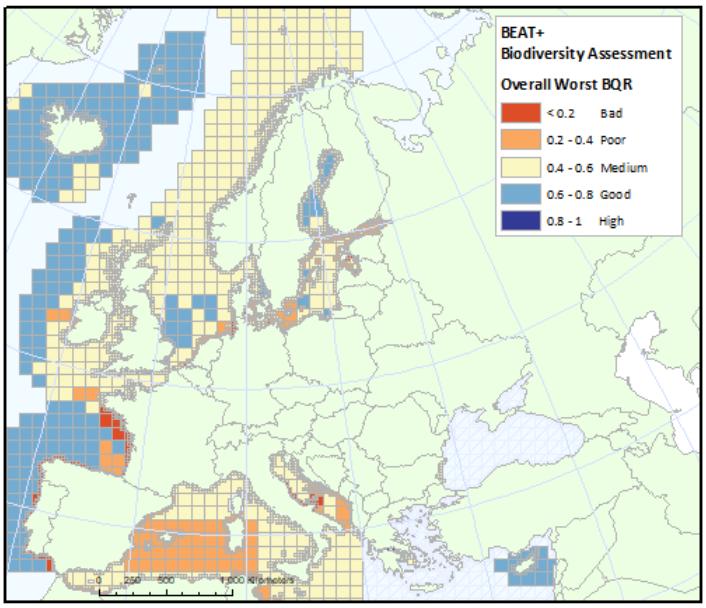
For seabirds and wading birds, the wide-ranging nature means that SAUs are typically at sub-regional scale, as this reflects the range of their populations. Fish data is typically collated for large fishing areas which represent larger grids used to collate fisheries information. Mammals and turtles also have different but large distribution ranges. So, SAUs also need to be interpolated to a common spatial

reference in order to compare data. Essentially all biological SAUs need to be conformed to the standard assessment grid shown in Figure: 5.5, based on 400 km^2 squares near the coastline, and 10,000 km^2 squares in offshore waters.

Where biological assessment areas are larger than these grid cells (which is the case, for example, for NE Atlantic mobile species), the indicator value is apportioned equally to each assessment grid square. This is important as it ensures that where distributions are highly variable, e.g. with marine mammals, or fish species which move with oceanographic changes, that they are included into assessments at a sub-regional level.

For these reasons, all data need to be cross-referenced spatially with the Assessment Grid before analysis can proceed.

Figure: 5.5: BEAT+ integrated assessment (i) worst case BQR



No. of BEAT+ indicators per group

Regional Sea	Max No. Grid Cells	No. of Indicators: Benthic Habitats	Birds	Fish	Mammals	Pelagic Habitats
Baltic Sea	1,496	18	9	16	19	6
Black Sea	97	8		9		6
Mediter-ranean Sea	1,402	95		30	10	2
NE Atlantic	4,330	53	69	78	21	13

This map brings together the BEAT+ aggregations to provide an overall synthesis of the Biological Quality Ratios (BQR) values. The map shows which are the worst (lowest) BQR values in each assessment grid cell. The 'worst' value is used here to identify the biological group most at risk, rather than averaging over all groups to avoid over-emphasis on groups with more intensive monitoring.

BEAT+ integrated assessment

As suggested by the analysis in earlier chapters, there are biodiversity components Bad or Poor state along the Bay of Biscay coast and in the in the Southern North Sea. This is primarily due to specific indicators of fish (Biscay) and phytoplankton or benthic data (Southern North Sea). The Celtic Seas, Norwegian Sea Northern North Sea and northern Baltic all have a worst case of Medium, although it should be emphasised that the thresholds for use in offshore waters in these regions are still under development.

The Western Mediterranean, southern Ionian Sea and Central Adriatic are also showing Poor BQRs (mainly from commercial fish status measures).

Other areas generally have indicators which show good or high BQR values, notably parts of the Celtic Seas, the Bay of Biscay and Iberian Coast plus areas in the Eastern Mediterranean. The Black Sea data is showing a Medium response though the assessment area is limited to Bulgarian coast.

There are not sufficient indicators to assess the worst case across open waters Macaronesia sub-regions, most of the Eastern Mediterranean or the Black Sea.

In this assessment report, two approaches are described which provide complementary insights:

1. To identify the worst performing indicator (and component) of biodiversity within a spatial unit using the BEAT+ to compare performance of a basket of biodiversity indicators
2. To identify general trends in condition of biodiversity features through averaging population or seabed condition trends with the LPI.

These generalised methods can provide a complementary approach to the indicator assessments already undertaken and in fact take the outputs further to address wider policy questions at European or international levels.

Aggregating outcomes to inform European policy

There can be at least three different forms of aggregation in a biodiversity assessment:

1. Aggregation of trends over time;
2. Aggregation over species or habitat groups;
3. Spatial aggregation of biodiversity indicators, within a specific assessment unit.

Combining all state measures into a single ”indicator” for biodiversity is contentious and indeed was specifically ruled out in the Explanatory Notes for MSFD, where the highest level of aggregation was the species group. In part, this is because of concerns that this would be comparing contradicting states from, for example, different species, which has already been discussed in food webs.

The indicators developed in the RSCs are targeted precisely at not only measuring a component’s state but in most cases also link to specific pressures and hence to management options. The concern had been raised that further aggregation will dilute the link between management options and the indicator (DPSIR approach) (ICES, 2018c) unless there is a transparent way of drilling down into which indicators are showing adverse conditions (see Borja et al., 2019).

In this assessment however, the purpose is to assess biodiversity state at the European level which implies regional aggregation, across all European Seas. The integrating tools provide this synoptic view, even where indicators or assessments are not fully aligned (see Borja et al., 2019). Combination of indicators needs to be done with care, as those developed for different regions (or assessment outcomes) may show different status values, but in principle, aggregating and normalizing of indicators provides the opportunity for combination.

Aggregation also presents a risk of masking underlying trends or failing states by focusing on the common species or indicators. This has been recognised for the MSFD context where two workshops (WKD_AGGDIV and WKD_EXTINCT) (ICES, 2018a, 2018b) were held to identify optimum aggregation approaches for the future and ensure rarer species can still be recognised within an assessment. They concluded that the One-Out-All-Out approach (or ”worst case”) was acceptable for situations with small numbers of indicator groups. This could for example apply to the BEAT+ overall assessment comparing outcomes from species groups and habitats. The LPI tool then provides a means of showing loss or otherwise of rare species over time.

Other aggregation methods suggested were *probabilistic methods* (useful where targets could be derived statistically) and *averaging* (as used in BEAT+). The latter was considered to be best for giving false alarms after integration but had the highest risk of missing true alarms (e.g. where one indicator had a status of ’poor’ within a set of 20 ’good’ status indicators).

As there are pros and cons with all methods, the approach adopted in this assessment is to combine outcomes from different assessment processes together, which will be summarised in the next Section.

In this report, however, the aim is a broader one of answering policy questions, not identifying local or even regional management actions. This means that the risk of comparing 'like with unlike' as with cross-criteria indicators is reduced because with tools like LPI and BEAT+, the aggregation is across indicator or trend *outcomes*, rather than identifying the underlying causal relationships. The BEAT+ tool provides a means of aggregating both across species groups and also spatially within assessment units based on a standard grid. This provides a platform for further work on integrating state assessments with pressures and impacts.

Borja et al. (2014) reviewed aggregation options for 56 indicators of status in Europe at different assessment scales and concluded that whichever method is used for aggregation, it should be ecologically-relevant, transparent and well-documented. Both the LPI and BEAT+ tools meet these criteria.

5.5 Integrated assessments for ecosystem based management

While the ecosystem approach requires an understanding of how pressures impact on food webs as ecological systems, the functioning of food webs is not usually a simple combination of indicators from the underlying components. However, at present the development of indicators for food webs is insufficient to achieve an understanding of ecosystem functions so the use of integrative tools such as BEAT+ and aggregated trends from LPI analyses provide a proxy of the state of European marine biodiversity. These are picking up signals of change within taxonomic groups or specific habitat which if replicated across other biological groups within the same spatial assessment units may signify changes in food supply or quality within food webs (Haraldsson et al., 2017). Much of the urgency in understanding food webs in relation to biodiversity is to understand the connection between species diversity and population complexity with ecosystem resilience to human pressure. Resilience may not be only, or the most important, factor: there is theoretical support for resistance of food webs to withstanding pressure and hence underpinning ecosystem stability as being more important (Vallina and Le Quéré, 2011).

The other benefit of using integrative tools is that they can show dynamic changes over time and space and so give a degree of advance warning of impending declines or deterioration in state. For example, the status of one species may be stable over the European range, but because the populations have moved away from an area, they cause their predators to decline (e.g. nesting seabirds in the North Sea where food fish populations have changed their range) (OSPAR Commission, 2017f). The movement of more trophic-general boreal fish species into the Barents Sea as a result of climate change is forecast to bring changes to the less generalised Arctic food webs (Kortsch et al., 2015).

The step towards better understanding is to recognise when these changes happen, even if the wider implications to the functions are not known. This means that for EBM to be effective, there is a need to utilise the information to hand while accepting more understanding is needed over time. Borja et al. 2019 identified six potential barriers to action and showed that four at least could be overcome by better utilisation of existing tools and data. While accepting that there is still a need for more and better biodiversity indicators, and for more robust thresholds for indicators especially at regional level, the authors presented assessment outcomes showing that around 40 indicators (across all descriptors) would be sufficient to obtain robust assessments of environment state and to be able to come up with management solutions (Borja et al., 2019).

6 Synthesis & outlook for marine biodiversity

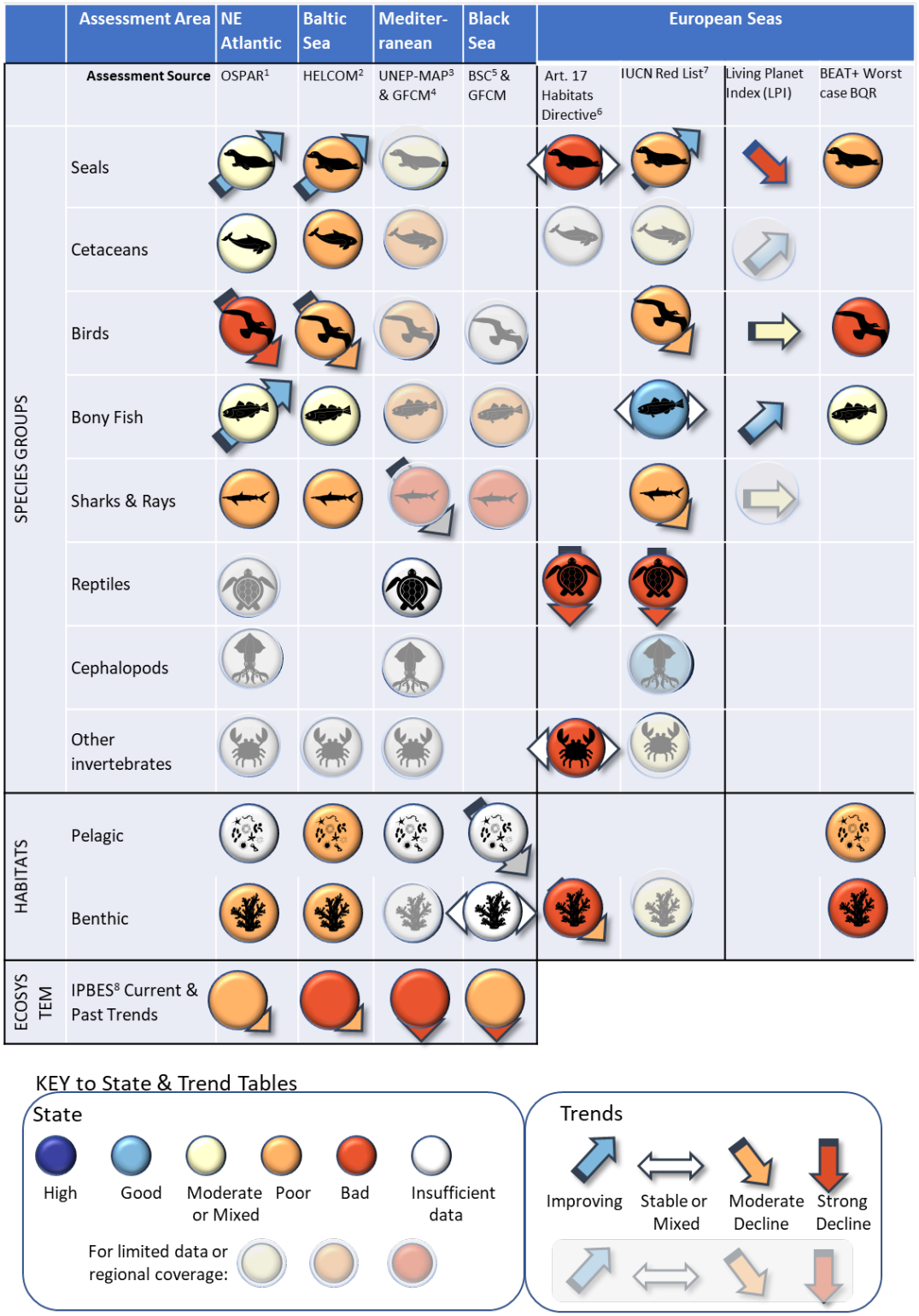
KEY MESSAGES REGARDING THE CONDITION OF MARINE ECOSYSTEMS, INCLUDING THEIR BIODIVERSITY		
Past trends (10–15 years)		A high proportion of marine species and habitats continues to be in unfavourable status. Management efforts targeting individual marine species and habitats have led to improving their condition in some EU marine regions, but this fragmented success does not offset the combined impact of human activities across Europe's seas.
Outlooks 2030		EU Member States need to ensure full implementation of existing political commitments if EU are to halt the loss of marine biodiversity by 2030. The underlying drivers of degradation of marine ecosystems are not changing favourably and pressures and effects of climate change are set to continue. Reaching agreed goals for mitigating climate change are essential for preserving the resilience of marine ecosystems. While there have been very few extinctions of European marine species to date, there are risks that increasing declines in biodiversity will lead to more extinctions in future
Prospects to meet policy objectives 2020	2020 ☒	Europe is not on track to achieve 'good' condition for marine species, habitats and ecosystems and 'favourable conservations status' for protected species and habitats in all EU marine regions by 2020. Measurement of progress is also impeded by large number of data gaps both in terms of synoptic monitoring and in availability of operational indicators of status for all European Seas
Potential Responses to trends	2020	Fisheries management show what can be achieved for biodiversity components with a direct economic relation – the challenge now is to present the value of other components through methods and approaches like natural capital accounts
Robustness	There is large variation in data availability across species and marine regions regarding conservation status and data gaps remain. Available outlook information is limited so the assessment of outlooks relies primarily on expert judgment.	

6.1 Summarising the state of marine biodiversity across Europe

Combining all outcomes

There are several examples of recovery for some species and groups of species where conservation management or removal of pressures has been applied. These include commercially exploited fish in the North East Atlantic Ocean and Baltic Sea (EEA, 2018b), Grey seals in general and Harbour seals in the Kattegat (HELCOM, 2018a; OSPAR, 2017c), White-tailed Eagle in Baltic Sea (HELCOM, 2018b), Dalmatian Pelicans in the Black Sea and the Mediterranean Bluefin tuna (ICCAT, 2017a, 2017b). Despite these examples, halting marine biodiversity loss remains the Great Challenge. Table 6.1 combines all the outcomes of the assessments introduced in this report and seeks to identify the common threads. While this combines assessments from different scales and objectives, the overall messages are that there are relatively few cases where there are unambiguous improvements in trends of species across all populations. This focuses on work undertaken for RSCs, for European Directives, from data used for the BEAT+ and LPI tools and the results from the regional IPBES report. From all these inputs, *we can conclude that overall, biodiversity loss is not being halted*.

Table 6.1 Overall summary of the state and trends in European marine biodiversity trends & status assessed by Regional Seas Conventions (RSCs) and European assessments



Note: Where assessments based on limited data or restricted regions, pale colours used

Key BSC = Black Sea Commission; GFCM = General Fisheries Council of the Mediterranean; BQR = Biological Quality Ratio of BEAT+ tool;

Sources: 1 (OSPAR Commission, 2017e), 2: (HELCOM, 2018e), 3: (UNEP-MAP, 2017a), 4: (GFCM (FAO), 2019); 5: (BSC, 2019) 6: (EEA, 2015b, 2013a, 2018c, 2019d); 7: (Nieto et al., 2015; IUCN and BirdLife International, 2014; IUCN, 2019; Temple and Terry, 2007a), 8: (IPBES, 2018b). Data for the BEAT+ tool and Living Planet Index are covered in Section 4.1 of this report.

6.2 Has biodiversity loss been halted?

Looking at Table 6.1, it is striking that there are so few assessments where biodiversity can be said to be in good condition with only one status assessment providing a 'good' rating (Red List index for bony fish) and four overall trends (three regional seal assessments and bony fish in the NE Atlantic). The trend for cetaceans in the NE Atlantic using the LPI data was also positive but this is based on some coastal dolphin populations which constitute a small percentage of total European species.

However, there are many more downward trends and adverse status assessments, notably for seabirds in the NE Atlantic, turtles, sharks & rays in the Mediterranean. The assessment tool BEAT+ and the LPI show that the overall picture may not be completely negative, with outcomes for aggregated status generally moderate (Section 5.3) and overall biodiversity trends generally stable (Section 5.2) where there are sufficient data. There are exceptions (such as seabirds and seals) where overall signals are negative. It is worth noting that the IPBES assessments show overall negative trends both historically and at present for all species and habitats for each of the European Seas (IPBES, 2018b) especially for the Mediterranean and Black Seas.

Details behind these overall pictures are given in Sections 4 and 5, but the main reasons are summarised here:

The condition of the populations of commercially exploited fish and shellfish species that could be assessed across Europe's seas presented a contrasting picture. Trends for more widespread or common species are mixed. Fish populations subject to commercial fishing are showing improvements in the North-East Atlantic Ocean and Baltic Sea, but overfishing remains a challenge in the Mediterranean Sea (UNEP-MAP, 2017b). Greater North Sea and Eastern Baltic cod stocks had reached a very critical stage by 2018, which means that exploitation of the former should be reduced by 70 % (ICES, 2019a, 2019b) and may need to be stopped in the case of the latter (Coalition Clean Baltic et al, 2019).

The condition of assessed fish stocks in Mediterranean Sea and Black Sea populations remained critical (FAO, 2018b; Jardim et al., 2018; UNEP-MAP, 2017b), with only 6.1 % and 14.3 % of these stocks, respectively, being fished sustainable in 2016. Cartilaginous fish (sharks, skates and rays) are particularly at risk, especially in the Mediterranean.

Average European seabird population state trends are either stable or declining. Approximately 33 % are slightly declining and another 22 % are regarded as 'Threatened' (BirdLife International, 2015). In the Norwegian Arctic, the Greater North Sea and the Celtic Seas, there has been an overall drop of 20 % in seabird populations over the last 25 years for more than a quarter of the species assessed (OSPAR, 2017b). On a positive note, there are examples of recovery of individual species as a result of targeted management efforts, e.g. Marine mammals are all protected by EU legislation or global policy, but their status is not fully understood due to complexities in monitoring. This has resulted in 72 % of Member States' reports on their status (ETC/BD, 2012) and 44 % of IUCN assessments being 'data deficient' (Temple and Terry, 2007b). Some seal populations are increasing in numbers or reaching carrying capacity, e.g. harbour seals in the Kattegat, though it is decreasing in other areas (HELCOM, 2018a; OSPAR, 2017c). However, despite the increase of the population of Grey seals in the Baltic Sea, their nutritional condition and reproductive status is not good (HELCOM, 2018e). In the Mediterranean Sea, the number of Monk seal appears to be stabilising, although this species is still at risk due to its small population size (Notarbartolo di Sciara and Kotomatas, 2016).

Seabed habitats are under significant pressure across EU marine regions, with over 65 % of protected seabed habitats reported as being in 'unfavourable' conservation status 20 years after the entry into force of the Habitats Directive (ETC/BD, 2012; ETC/BD, 2015). In another example, 86 % of the assessed seabed in the Greater North Sea and Celtic Seas shows evidence of physical disturbance by bottom-touching fishing gears (OSPAR, 2017a). In the Baltic Sea, only 44 % and 29 % of the soft-bottom seabed habitat area in coastal waters and in the open sea and were in 'good' status respectively (HELCOM, 2018e).

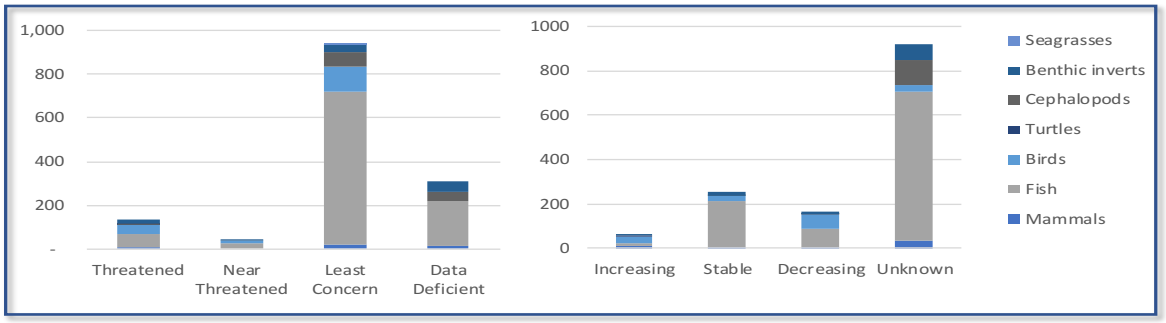
Vulnerable species – visible indicators of resilience loss

When populations are in decline, and the causes for those declines are not diminishing, then the greatest risk is that the species may go extinct or loose ecological relevance. To avoid losing sight of these species when aggregating data for all species, specific assessments and indicators are needed to assess rare and threatened species (ICES, 2018b). The IUCN Red List assessments were developed to identify state and future trends of populations or species at risk (IUCN, 2019) (Figure 6.1). Of particular concern are those of Europe's seas with hotspots of biodiversity, places where endemism is high and/or rare species are present in significant numbers (see (Nieto et al., 2015)). These include as the Mediterranean Sea already under significant human pressure and potentially or Macaronesia or the Black Sea where monitoring and assessments are relatively sparse. In one study, the Mediterranean has the highest average threats score out of all global ocean basins (Wallace et al., 2011).

To better understand the rate of biodiversity loss, and to help report on Aichi Target 12 (CBD, 2018), two aggregated indexes have been proposed: the Red List Index (RLI) to assess extinction risk and the LPI for population trends (IPBES, 2018a; WWF and ZSL, 2015). The RLI is calculated for all birds and mammals but show that birds have a declining index value across all European marine regions. The Red List assessments for Europe show that of the 1,196 marine species assessed, 9 % are threatened while 3 % are "near-threatened". Birds, mammals and turtles are particularly at risk with over 20 % of species threatened (IUCN, 2019).

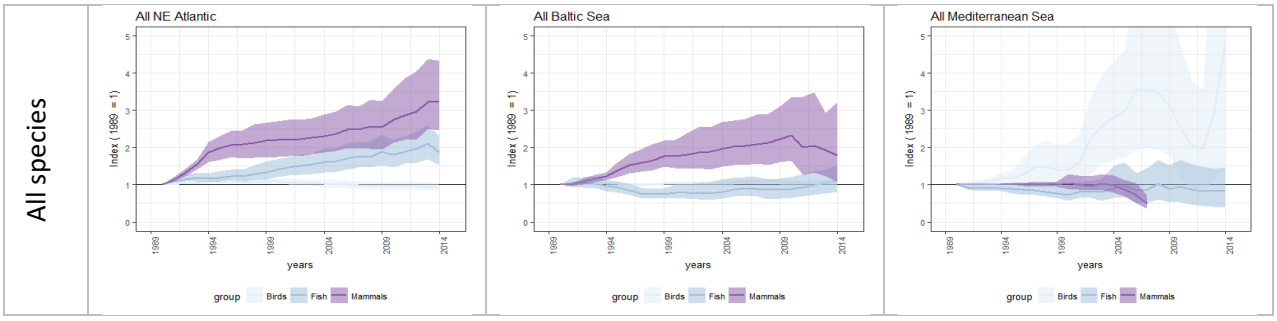
In measuring marine abundance trends, the LPI for European marine fauna is relatively stable (see Figure 6.2) compared to trends in developing countries (WWF and ZSL, 2015) though threatened species are performing less well (WWF, 2015). However, rates of loss for marine fauna globally are greater than those on the land (WWF and ZSL, 2015). If human resource demands of the seas increase to match historical exploitation on land, marine extinctions may increase but opportunities still exist to prevent wholescale defaunation of the seas (McCauley et al., 2015). Ensuring that measures such as marine protected areas deliver conservation benefits remains a cost-effective management option (ICF, 2018).

Figure 6.1: Summary of status & trends of threatened species



Sources: EC and IUCN, 2018; Nieto et al., 2015; BirdLife International, 2015; IUCN, 2019; Bo et al., 2017

Figure 6.2: Living Planet Index (LPI) calculated for main vertebrate groups

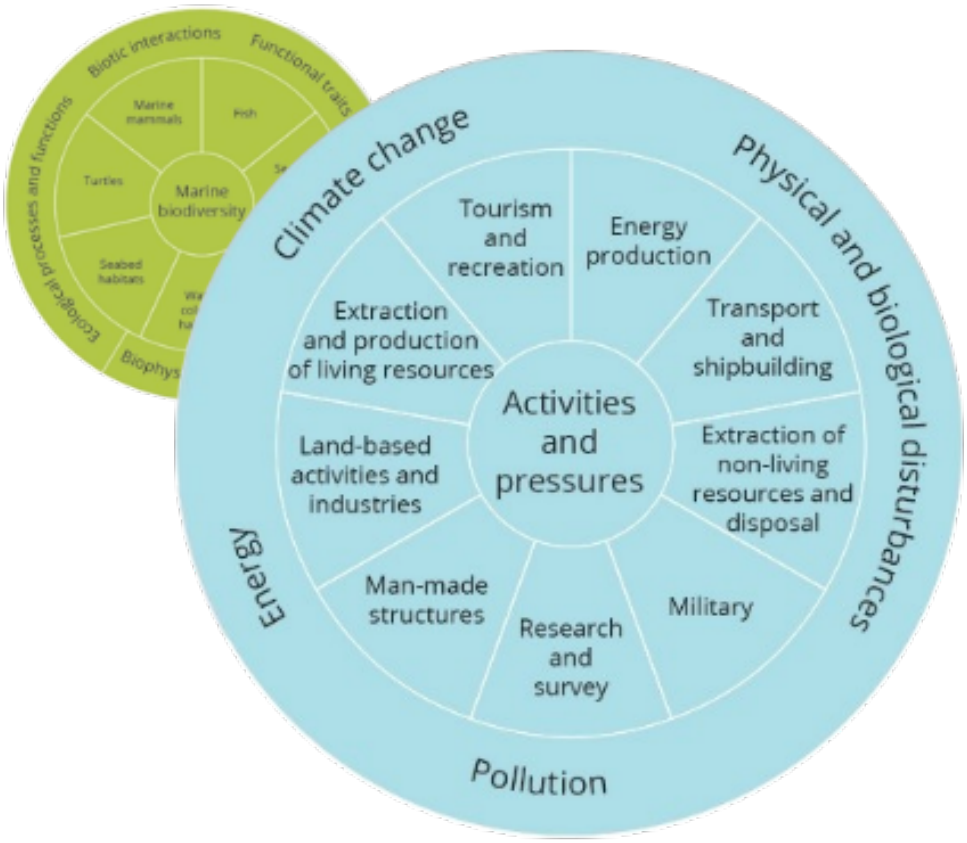


Source: Data collected by EEA (ETC 2019). LPI from Freeman, 2019, WWF and ZSL, 2015; IPBES, 2018a

6.3 Spatially identifying threats to marine biodiversity

Figure 6.3 shows the importance of understanding pressures in order to understand what changes may be observed in biodiversity and hence develop a better understanding through the DPSIR process (EEA 2015). Section 4 highlighted which pressures are most impacting on which components.

Figure 6.3: Threats and pressures on marine biodiversity



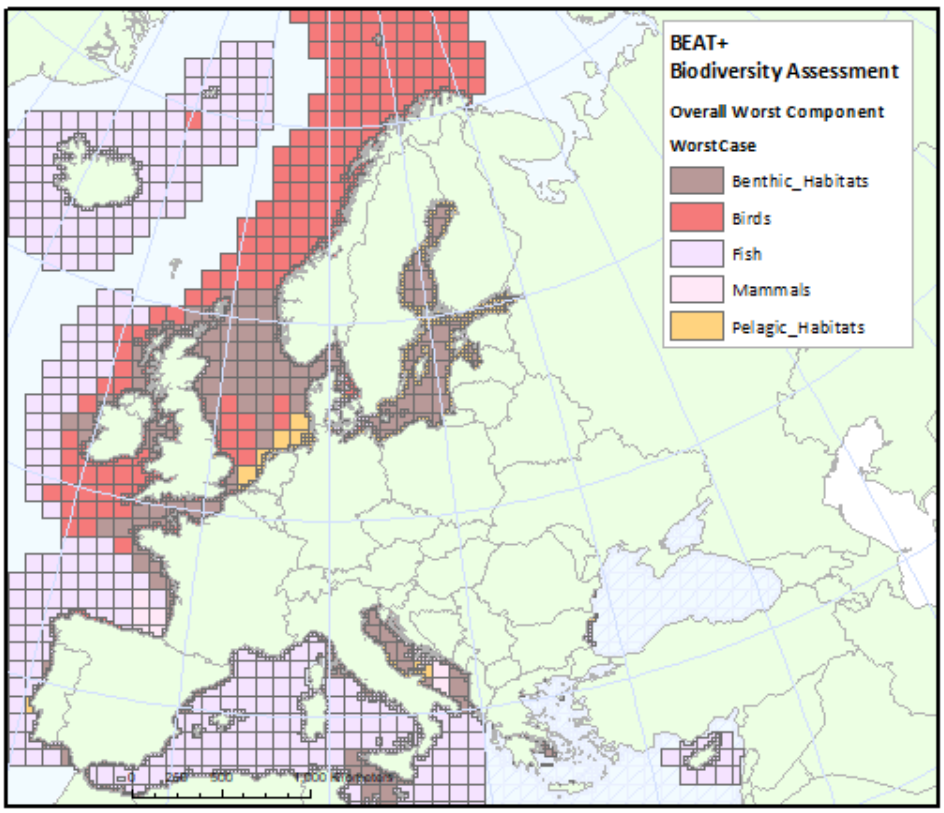
Source: EEA 2015

Pressures on marine organisms are often spatially specific, so condition assessment necessarily must have a spatial component if effective management is to be developed. This means that multi-metric indicator-based tools, such as the BEAT+ are needed to add this spatial variability and to provide a synoptic overview when there are differences in how local or regional assessments have been performed (see ETC, 2019).

The BEAT+ tool itself is anchored in earlier versions developed and tested by HELCOM (2010) and the EU-funded DEVOTES project (Uusitialo et al. 2016; Nygaard et al. 2018 and EEA, 2019). The indicators used for assessing biodiversity conditions across Europe' seas range from planktonic organisms over benthic communities to fish, seabirds, reptiles and marine mammals – and each indicator is represented by two numerical values, a figure representing biodiversity and a figure representing agreed target values (e.g. from HELCOM, OSPAR, MSY, etc.).

Figure 6.4 shows the overall outcomes based on data collated for this assessment which helps to identify which of the assessed biological groups is performing worst in any particular area, which is potentially valuable as a management tool.

Figure 6.4: Assessment of worst-performing biodiversity groups using BEAT+ analysis



For the map in Figure 6.4, data coverage is in general good in the North-East Atlantic Ocean and the Baltic Sea for some species groups (notably birds and fish) while individual case study, local or national assessments can also be used to augment the regional of HELCOM and OSPAR. However, there is room for improvements in the Black Sea and Mediterranean Sea, both in terms of indicator development and monitoring. Nonetheless it has been possible to identify as a first cut the biodiversity components potentially of most concern in different marine areas (see Figure 6.4).

The map shows that across Europe's seas, the areas most at risk are pelagic habitats in areas nearer the coasts and in the shallower shelf seas, such as the Baltic and North seas. Away from the shallower seas but nearer the coasts, benthic habitats are the worst performing whereas offshore the worst performing tend to be fish or seabird indicators.

This shows a logical progression in terms of which components may inform best for which areas of sea. However, data availability on trends and condition of most biodiversity components is limited in offshore waters. This highlights the need for more and continued monitoring and development of reliable indicator thresholds.

This work has highlighted again the need for agreed thresholds and reference values for quantitative indicators provides a focus for new work. If this is done, BEAT+ offers a platform for combining new research with existing indicators. This parallels the need for more operational food web indicators to understand functional dependencies and responses to cumulative impacts (Borja et al., 2016).

These ecosystem-level approaches also need a better understanding of natural variability to be able to account better for the large fluctuations seen in some population abundance estimates. It also has to be recognised that biodiversity data and knowledge is expensive compared to other questions, so there is a need to balance monitoring between what is desired with what is possible. This is recognised in MSFD with more recent focus on risk-based approach (EU, 2017), by understanding the level of key impacts

from key pressures on individual components, such as fishing on fish community structure and benthic habitats (EC, 2010).

The assessments shown in Section 4 show the imbalance between data availability for open waters with the knowledge of coastal areas in all Regional Seas. Much has been made of needing to understand the land-sea interface but there is a more practical one at the inshore-offshore interface. Offshore monitoring is both expensive and needs to cover a much wider area – 80 % of Europe's seas are open water and over 50 % are over seas more than 2,000 m deep.

6.4 Breaking the trends

Identifying threats – acting on reducing pressures

Marine biodiversity co-exists with humans and human activity in an intricate web of resources and activities used to exploit those resources. With the advent of technologically advanced industries such as deep-sea mining and identification of marine litter across the seas, the number of unimpacted marine systems is becoming smaller. Even without the direct impacts, indirect sources such as carbon emissions have a long latency of effect from impacts of climate change and ocean acidification.

Different biota are subject to different pressures depending on their location, and the level of impact is related to their sensitivity to that pressure, making the assessment of impacts a complex matter (Korpinen et al., 2019; EEA, 2018a).

Understanding threats is needed to identifying priorities for management and monitoring. Given the discussion on difficulties of data gathering, knowing priority threats directly helps to identify the highest information needs, which is enshrined in the risk-based approach formulated in the recent revised MSFD guidance (EC, 2017):

1. Map the distribution and intensity of human uses and activities;
2. Assess the spatial (& temporal) distribution and intensity of each (predominant) pressure;
3. Assess the extent of environmental impacts from these pressures in relation to the elements to be used for the state-based assessments;
4. Assess the state, bringing together the relevant assessments of impacts from (c) to lead to an overall assessment of status per ecosystem element.

One corollary from this is the benefits of using pressure indicators as proxies for biological assessments. Where there is a demonstrable link between the state of the ecosystem component and the pressure applied, then data from the activities causing the pressure is potentially cheaper and quicker to obtain in a lot of cases. This is shown in the development of indicators such as the Benthic Damage Indicator (BH3) for OSPAR (OSPAR Commission, 2018) and the use of Chlorophyll-A as a surrogate for pelagic system health in the Baltic Sea (HELCOM, 2018g).

Currently though, there are a wide range and variety in indicators and even in measures of population abundance and habitat condition – there are 27 indicators of seagrasses used to measure state in the Mediterranean. This thematic assessment is intended in part to show how it is still possible to use this wealth of information from these disparate indicators into aggregated models like BEAT+ and LPI. In-built into these models are concepts of distance to a target of the indicator metric and providing ways of comparing these across different ecological elements, even when the specific objective of the indicators may be to meet different management objectives.

Reducing pressures on biodiversity is key but recovery may take time

While reduction or removal of pressures is important, there may be a delay in response by the species. Sei whale populations remain small in the North-east Atlantic (IWC, 2019) despite the cessation of whaling (IWC, 2019). Ringed seals in the Baltic Sea have recovered from hunting but are now at risk from reduction of sea ice (HELCOM, 2018e). Fish trends in the same region may be improving but the seabed integrity is still highly disturbed (OSPAR Commission, 2018, 2017c).

Recovery may take place at different rates within an ecosystem. While fish stock management in the NE Atlantic is showing progress (OSPAR Commission, 2017c), the associated damage to the seabed has yet to be reversed (OSPAR, 2017a). PCBs are still present in orcas, despite the ban (Desforges et al., 2018). This is another reason why biodiversity needs to be considered as a whole, not just in components.

Policy measures should therefore factor in the need to allow for recovery.

Conservation management measures can turn the tide

Management measures are improving the health of fish populations. Most commercially exploited fish and shellfish stocks in the North-East Atlantic Ocean and the Baltic Sea showed improvements in 2017 due to better fisheries management (EEA, 2019d). In contrast, about 78 % of the stocks assessed across the Mediterranean and Black seas were subject to overfishing in 2017 (FAO, 2018; UNEP-MAP, 2017a).

Direct conservation efforts have made an impact. The numbers of the Dalmatian Pelican (Pelecanus crispus) (Catsadorakis et al., 2015) have increased in Greece and the Black Sea (BirdLife, 2019) thanks in part to better protection policies, and by provision of artificial nest sites. The loggerhead turtle (Caretta caretta) population in the Mediterranean is increasing, linked to protection of nesting sites (Mazaris et al., 2017), even though the global status of these turtles is declining (IUCN, 2015). The banning of DDT and PCB has helped the White-tailed Eagle recover in parts of the Baltic Sea (HELCOM, 2018b), though Killer whales (Orcinus orca) reproduction is still adversely affected by PCBs which undermines the viability of key North-east Atlantic populations (Desforges et al., 2018; Aarhus University, 2018a).

Signs of resilience and recovery

Biodiversity loss is usually attributed to impacts of human pressures. It has been suggested many times that population losses are reduced when ecosystem resilience is high, and this has been linked to well-functioning food webs (see Chapter 5). Recovery rate is then important in determining how long it might take for ecosystems to recover.

While the ideal is to invoke ecosystem-based management (see Chapter 5), at present our knowledge of biodiversity status is primarily based on species- or habitat-based assessments. Management is then targeted primarily at these individual components.

Recovery is possible with management intervention and/or policy initiatives. Strong regulation to reduce fishing mortality has brought Bluefin tuna, a Mediterranean top predator, from the brink of collapse (in 2005) to possibly reaching sustainable levels for fishing mortality and reproductive capacity in 2022 (Fishsource, 2018 based on ICCAT, 2017b and ICCAT, 2017a). the banning of DDT and PCBs. This includes the White-tailed Eagle in parts of the Baltic Sea (HELCOM, 2018b). Some of the bottom living molluscs on the Norwegian coast are recovering as a response to banning TBT, i.e. the Common dog whelk (Schøyen et al., 2019).

Understanding trends through more coordinated cross-border monitoring

In the previous discussions, there have been many instances referring to lack of data or limited time series. In a detailed review of European monitoring, the authors highlighted the disparity in monitoring

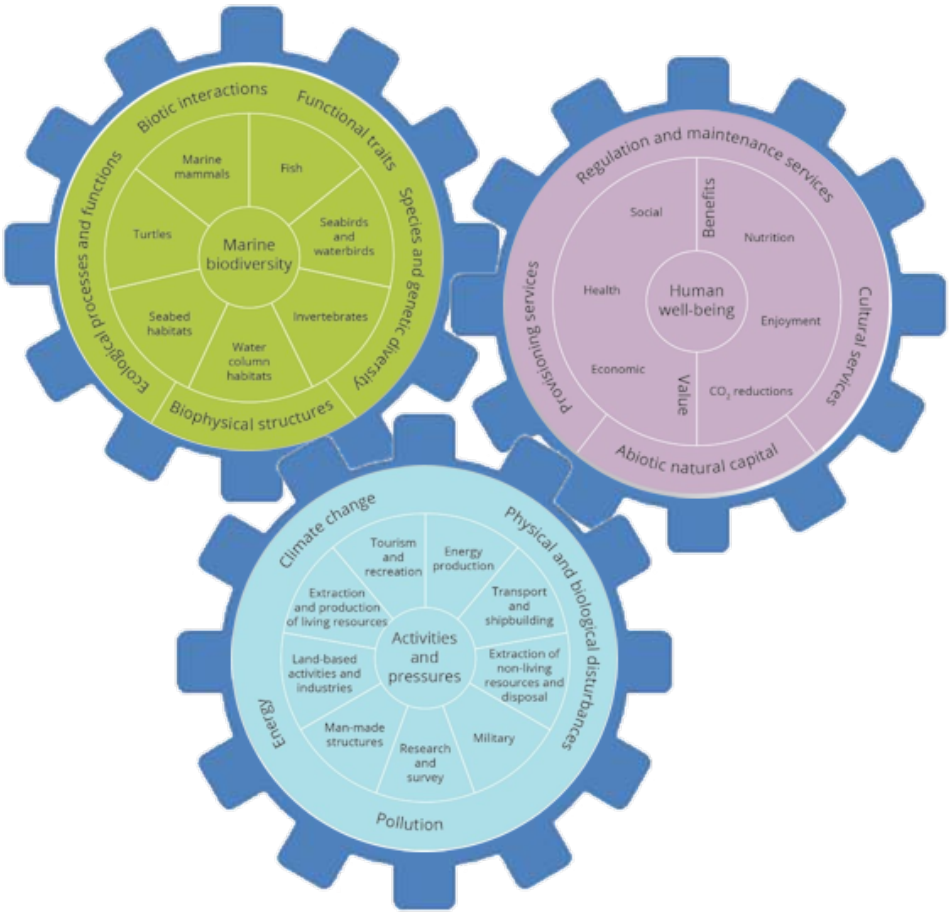
between regions and between biological groups (Patrício et al., 2016). They highlighted the costs associated with marine monitoring, especially offshore, so one approach would be for more inter-country coordination of monitoring to establish repeatable time series for future biodiversity assessments at the European or Regional Seas scales. OSPAR for example are producing guidelines for monitoring in support of its common indicators (OSPAR Commission, 2016). New technologies provide new opportunities for cost-effective monitoring, allied to seaborne surveys, for example in assessing the use of Copernicus programme for remote sensing and a new survey for large cetaceans in the Mediterranean using drones (von Schuckmann et al., 2016; ACCOBAMS, 2019).

Promoting success beyond local boundaries

To break the cycle of increasing pressure to reduce biodiversity health, more is needed than just assessing the chains of events. Management actions at appropriate levels are key to ensuring that damaging trends can be broken. While this thematic assessment is not directed towards specific management actions, it is intended that by helping the understanding the wider European context of any component of biodiversity, policy frameworks can be attuned to supporting management.

Regional cooperation has been part of the MSFD assessment cycle, and this brings considerable benefits in terms of sharing resources and knowledge to improve consistency and repeatability of assessments going into the future. This level of cross-sectoral collaboration is in the end the key to ensuring a more effective long-term approach to ecosystem-based management as shown in Figure 6.5.

Figure 6.5: Towards ecosystem based management



After: EEA 2015

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