06. Marine environment

Key messages

- Marine life is still under pressure across Europe's seas. Multiple pressures affect species and habitats, leading to cumulative impacts that reduce the overall resilience of marine ecosystems.

- Through joint efforts, European countries have managed to reduce selected pressures, and positive effects are starting to become visible. These cover the recovery of some marine species, including commercially exploited fish and shellfish stocks; where an increasing number of these stocks are now being fished at maximum sustainable yield. The target for designation of marine protected areas has been met.

- At the same time, the target of achieving good environmental status of European marine waters by 2020 is unlikely to be achieved in relation to key pressures such as contaminants, eutrophication, invasive alien species and marine litter.

- Changes observed across Europe's seas show that not all pressures are addressed adequately or fast enough and that knowledge of the cumulative effects of pressures remains limited.

- Looking ahead, the marine environment is under pressure from the development of the blue economy and climate change. In the face of this unprecedented amount of human activities competing to use the marine environment, the outlook for achieving the policy vision of healthy, clean and productive European seas is challenging. Transitions in the management of the marine environment to improve policy implementation, integration and cooperation are required.

Thematic summary assessment

Theme	Past trends and outlook		Prospects of meeting policy objectives/targets
	Past trends (10-15 years)	Outlook to 2030	2020
State of marine ecosystems and biodiversity	Trends show a mixed picture	Deteriorating developments dominate	☒ Largely not on track
Pressures and impacts on marine ecosystems	Trends show a mixed picture	Deteriorating developments dominate	☒ Largely not on track
Sustainable use of the seas	Trends show a mixed picture	Developments show a mixed picture	☐ Partly on track
Marine protected areas	Improving trends dominate	Developments show a mixed picture	☑ Largely on track

Note: For the methodology of the summary assessment table, see the introduction to Part 2. The justification for the colour coding is explained in Section 6.3, Key trends and outlooks (Tables 6.2, 6.3, 6.4 and 6.5).

06.

Marine environment

6.1 Scope of the theme

Throughout history, the use of Europe's seas — spanning from the Baltic Sea and North-east Atlantic Ocean to the Mediterranean and Black Seas — has played a crucial role in people's lives. This comprises the use of marine natural capital, including marine ecosystems and their biological diversity, which makes ecosystems function and underpins their capacity to supply ecosystem services, as well as the use of natural resources such as seawater, oil, sand or gravel.

People depend on the seas for transport, energy, food and income as well as for less obvious life-support functions, such as the oxygen in the air we breathe and climate regulation. How this core resource is managed is not only essential for the sea but also to meet people's basic needs and contribute to their well-being and livelihoods. As the seas are exploited, multiple pressures arise leading to cumulative impacts on marine ecosystems, which undermines their self-renewal and resilience, jeopardising the ecosystem services they can supply and upon which we depend.

Marine ecosystems and species remain under threat as Europe's seas continue to be exploited unsustainably.

This chapter explores the state of Europe's seas, the pressures and their effects and sustainable use in the context of 'living well, within the limits' of the sea.

6.2 Policy landscape

Earth is a blue planet. The health of the oceans is vital not only for the planet itself but also for humanity. Past and current human activities, and the cumulative pressures they exert, have reached a level where they not only impact marine species and habitats but are likely to jeopardise the essential structures and functions of marine ecosystems pushing against the limits for a safe operating space for humankind (Rockström et al., 2009; Steffen, et al., 2015) (Chapter 1).

Such progressive realisation has led to developing a comprehensive EU policy framework covering individual activities, whole sectors, pressures, species/habitats and ecosystems. The ecosystem-based approach to the management of human activities in the marine environment (i.e. ecosystem-based management) is at the centre of this framework (EC 2007; EU 2013; Table 6.1).

One of the main drivers for healthy, clean and productive European seas is the 2008 Marine Strategy Framework Directive (MSFD) (EU, 2008a). The MSFD aims to protect the marine ecosystems underpinning the supply of marine ecosystem services, upon which people and several maritime activities depend. It does so by enshrining ecosystem-based management into EU marine policy and requiring that EU marine waters achieve good environmental status by 2020. On the use of the sea, the EU integrated maritime policy seeks to provide a more coherent approach to maritime activities and issues, such as increased coordination between various policy areas, e.g. fisheries and maritime transport, in order to promote a sustainable blue economy. The work is further supported through the long-term efforts of the four Regional Sea Conventions (Helcom, the Baltic Marine Environment Commission; OSPAR, the Convention for the Protection of the Marine Environment of the North-East Atlantic; UNEP-MAP, the United Nations Environment Programme Mediterranean action plan; and the Bucharest Convention, known in full as the Bucharest Convention on the Protection of the Black Sea against Pollution).

UN Sustainable Development Goal (SDG) 14 is a global policy initiative raising awareness of the need to protect ocean health. It focuses on the conservation of, the reduction of pressures and their impacts upon, and the sustainable use of seas and oceans. The EU has adopted and embraced these goals, which are to be delivered through a series of EU policies and legislation pre-dating the adoption of SDG 14. Key among them are not only the MSFD and the integrated maritime policy but also the Seventh Environment Action Programme (7th EAP) (EU, 2013) and the EU biodiversity strategy to 2020 (EC, 2011). With all these instruments, the EU has committed to protecting, conserving and enhancing marine ecosystems. Finally, sustainability outcomes are influenced by other policies, including climate change, air pollution and industrial pollution (Chapters 7, 8, 12). Table 6.1 presents an overview of selected policy targets and objectives addressed in this chapter.

65 % +

of protected seabed habitats are in unfavourable conservation status.

6.3 Key trends and outlooks

Europe's seas are already influenced by centuries of human use, including the adverse effects from climate change, and may have limited, if any, untapped potential to offer. This is unless current management and protection measures are improved, coordinated and/or enforced. This section provides a snapshot of some of the key trends in the driving forces and the state of Europe's seas.

6.3.1 State of marine ecosystems, including their biodiversity

► *See Table 6.2*

Europe's seas, and their associated marine and coastal ecosystems, are very diverse in their geographical extent, structurally and in terms of their productivity. They range from shallow, semi-enclosed seas to vast areas of the deep ocean, and they include diverse coastal zones with prolific intertidal areas, lagoons and ancient seagrass beds (EEA, 2015c).

The Mediterranean and Baltic Seas illustrate such variation. 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). In comparison, the Bothnian Bay in the Baltic Sea holds only approximately 300 species (Helcom, 2018a).

There is still much to discover about Europe's seas. It is estimated that at least 50 % of their total area (within 200 nautical miles) is more than 2 000 m deep and so in eternal darkness. This is an environment about which little knowledge is available and even less so regarding the impacts of human activities upon it.

Recognising such vulnerability as well as our dependency on marine and other ecosystems, the EU has put a strategic vision in place to halt the loss of biodiversity (EC, 2011). Core elements of this vision for 2020 are to achieve favourable conservation status for vulnerable marine species and habitats as well as good environmental status for marine biodiversity and marine ecosystems in general (EEC, 1992) (Table 6.1 and Chapter 3). Unfortunately, no progress reporting on the implementation of either directive has taken place since *The European environment — state and outlook 2015* (EEA, 2015b), and so other information sources have been used in this assessment.

Given the need to address many complex issues within a holistic perspective, it is challenging to come to a single conclusion on whether the loss of marine biodiversity has been halted and if Europe is on track to achieve healthy, clean and productive seas. It is possible, however, to look at long-term trends in the state of key ecosystem components. The trends in the state of widespread or common species show mixed developments.

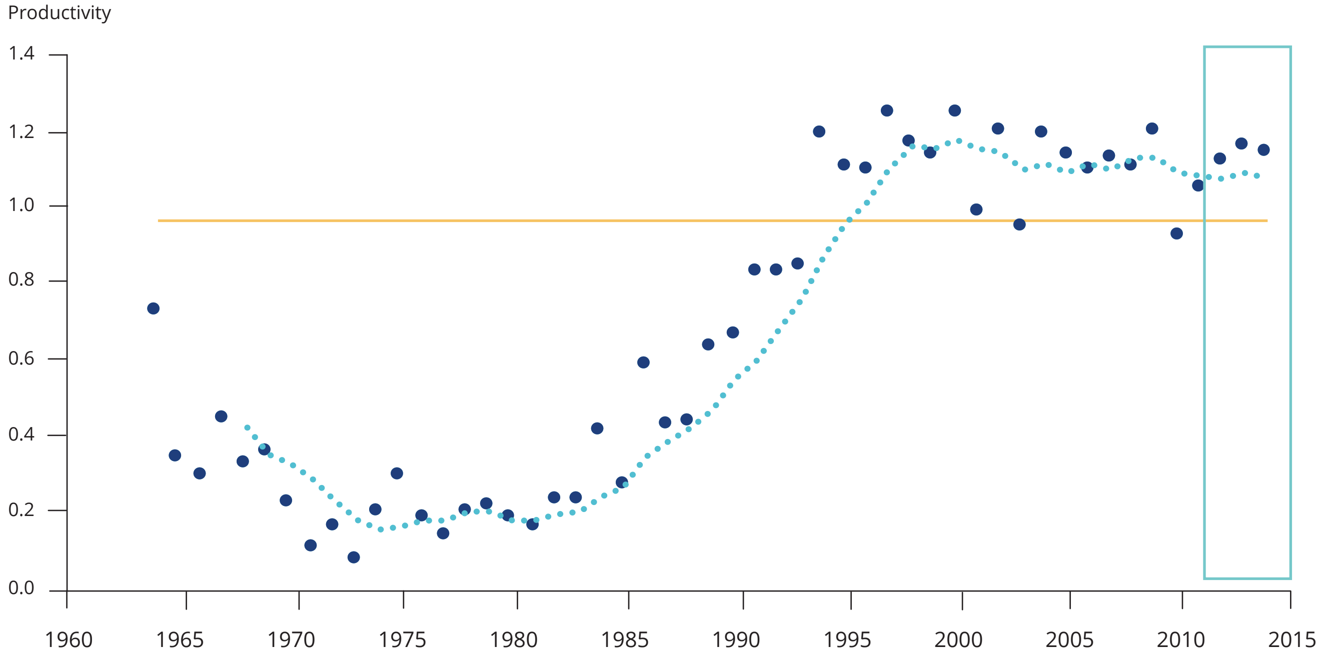
Most of the assessed commercially exploited fish and shellfish stocks in the North-East Atlantic Ocean (62.5 %) and the Baltic Sea (87.5%) were on track for meeting at least one of the GES criteria

TABLE 6.1 Overview of selected policy objectives and targets

Policy objectives and targets	Sources	Target year	Agreement
State of marine ecosystems and including their biodiversity			
Better protection and restoration of ecosystems and the services they provide	EU biodiversity strategy to 2020	2020	Non-binding commitment
Ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora	Council Directive 92/43/EEC; Directive 2009/147/EC	N/A	Legally binding
The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographical, geographical and climatic conditions	Directive 2008/56/EC as amended by 2017/845 and Decision 2017/848	2020	Legally binding
Minimise and address the impacts of ocean acidification	SDG 14.3	2030	Non-binding commitment
Pressures and their impacts			
Continuously reducing discharges, emissions and losses of hazardous substances and moving towards the target of their cessation within one generation	Fourth North Sea Ministerial Declaration 1995	2020	Non-binding commitment
Achieving concentrations in the marine environment near background values for naturally occurring hazardous substances and close to zero for man-made synthetic substances	Directive 2000/60/EC; SDG 14.1	2028	Legally binding
Keep concentrations of contaminants at levels not giving rise to pollution effects	Directive 2008/56/EC; Commission Decision 2017/848; SDG 14.1;	2020	Legally binding
Human-induced eutrophication is minimised, especially its adverse effects	2008/56/EC as amended by 2017/845 and Decision 2017/848; Directive 2000/60/EC	2020	Legally binding
Non-indigenous introduced species are at levels that do not adversely affect the ecosystems	Directive 2008/56/EC; Commission Decision 2017/848; EU biodiversity strategy to 2020	2020	Legally binding
Quantitative reduction of marine litter to a level that does not cause harm to the marine environment	Directive 2008/56/EC; Commission Decision 2017/848; 7th EAP; SDG 14.1	2020	Legally binding
Sustainable use of the seas			
Populations of all commercially exploited fish and shellfish are within safe biological limits	Directive 2008/56/EC; SDG 14.4	2020	Legally binding
Achieve maximum sustainable yields for European commercially exploited fish and shellfish stocks	EU common fisheries policy 2013; 7th EAP	2015-2020	Legally binding
Increase marine renewable energy production and exploration	EU integrated maritime policy — the Limassol Declaration	2020	Non-binding commitment
Support the development of a highly diversified and sustainable coastal and maritime tourism in Europe	EU integrated maritime policy — the Limassol Declaration	2020	Non-binding commitment
10 % of coastal and marine areas are conserved through systems of protected areas	CBD Aichi biodiversity target 11; SDG 14.5	2020	Non-binding commitment
Establish necessary measures to achieve or maintain good environmental status in the marine environment	Directive 2008/56/EC as amended by 2017/845 and Decision 2017/848; Directive 2000/60/EC	2020	Legally binding
Apply an ecosystem-based approach to the management of human activities	Directive 2008/56/EC; Directive 2014/89/EU	2020	Legally binding

Note: 7th EAP, Seventh Environment Action Programme; CBD, Convention on Biological Diversity; SDG, Sustainable Development Goal; N/A non-applicable.

FIGURE 6.1 **Mean annual productivity of the white-tailed eagle in the Baltic Proper, Swedish coastal**



Note: The productivity is estimated as the number of nestlings in the Baltic Proper from 1964 to 2014. Productivity is defined as the number of nestlings per checked territorial pair. The yellow line illustrates the threshold value of the Helcom core indicator.

Source: Helcom (2018a).

in the regions in 2017 due to better fisheries management (EEA, 2019c). In contrast, most of the assessed stocks in the Mediterranean Sea (94%) and Black Sea (85.7%) were subject to overfishing in 2016 (EEA, 2019c). Overall, 40 % of shark and ray species in Europe's seas show declining populations (Bradai et al., 2012; Nieto et al., 2015). In contrast, strong regulation to reduce fishing mortality has brought another top Mediterranean predator, bluefin tuna, back from the brink of collapse (in 2005-2007) to achieve sustainable levels of reproductive capacity in 2014 (Fishsource, 2018; based on ICCAT, 2017a, 2017b).

Average European seabird population 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 one 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. the banning of DDT (dichlorodiphenyltrichloroethane) and PCB. This includes the white-tailed eagle in parts of the Baltic Sea (Helcom, 2018b) (Figure 6.1).

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 the International Union for Conservation of Nature (IUCN) assessments being data deficient (Temple and Terry, 2007). Some seal populations are relatively healthy and increasing in numbers or reaching carrying capacity (OSPAR, 2017c; Helcom, 2018a). Despite the increase in the population of grey seals in the Baltic Sea, their nutritional condition and reproductive status is not good (Helcom, 2018a). In the Mediterranean Sea, the number of monk seals appears to be stabilising, although this species is still at risk because of its small population size (Notarbartolo di Sciara and Kotomatas, 2016).

Recent studies of populations of killer whales show adverse effects of PCB on their reproduction, threatening > 50 % of the global population. This may result in the disappearance of killer whales from the most contaminated areas within 50 years, despite PCB having been banned for 30 years. This includes areas in the North-East Atlantic Ocean and around the Strait of Gibraltar (Desforges et al., 2018; Aarhus University, 2018).

Seabed habitats are under significant pressure across EU marine regions,

TABLE 6.2 Summary assessment — state of marine ecosystems and biodiversity

Past trends and outlook		
Past trends (10-15 years)		A high proportion of marine species and habitats continue to be in unfavourable conservation status or declining condition, although management efforts targeting individual species and habitats, or specific pressures, have led to improvements in their condition. However, this success is only partial, as recovery is not common to all biodiversity features or to all of Europe's seas.
Outlook to 2030		Many marine species or species groups still have declining populations or have failed to reach favourable conservation status. Nevertheless, several have achieved good condition, showing that some management efforts are working. However, the underlying climatic drivers of marine ecosystem degradation appear not to be improving, as related pressures are worsening. Legacy hazardous substances and heavy metals, non-indigenous species and marine litter will continue to impact marine ecosystems. The use of marine resources and space is expected to increase. Reaching agreed policy goals for the marine environment across all policies and mitigating climate change are essential to prevent further damage and/or achieve full recovery of marine ecosystems, thereby preserving their long-term resilience, if the outlook is to change.
Prospects of meeting policy objectives/targets		
2020	☒	EU marine regions are at risk of achieving neither the Marine Strategy Framework Directive's good environmental status for marine biodiversity nor the Habitats Directive's favourable conservation status for protected marine species and habitats by 2020.
Robustness		There is large variation in the availability of information on the state of marine species and habitats across marine regions and gaps in data remain. Formal reporting of progress on the implementation of EU marine environmental legislation is often delayed and/or inadequate. The available outlook information is limited, so the assessment of outlook relies primarily on expert judgement.

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 (EEA, 2015d). In another example, 86 % of the seabed assessed in the Greater North Sea and Celtic Seas shows evidence of physical disturbance by bottom-trawling gear (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 were in good status, respectively (Helcom, 2018a). However, the common dog whelk is recovering on the Norwegian coast as a direct response to banning TBT (tributylin) (see Schøyen et al., 2019, and Chapter 10).

To summarise, when considering the halting of marine biodiversity loss, there are several examples of recovery for some species and groups of species. These include the common dog whelk (Schøyen et al., 2019), assessed commercially exploited fish and shellfish stocks in the North-East Atlantic Ocean and Baltic Sea (EEA, 2019c), harbour seals in the Kattegat (OSPAR, 2017c; Helcom, 2018a), white-tailed eagle in the Baltic Sea (Helcom, 2018b) and the Mediterranean bluefin tuna (ICCAT, 2017a, 2017b).

Despite these examples, halting marine biodiversity loss remains a great challenge. Some marine populations and groups of species are still under threat, including copepods (UKMMAS, 2010; Edwards et al., 2016), pteropods (NOAA, 2013), Atlantic cod (Stiasny et al., 2019), seabirds (BirdLife International, 2015), assessed commercially exploited fish and shellfish stocks in the Mediterranean and Black Seas (EEA, 2019c), sharks and rays (Bradai, et al., 2012) and killer whales (Desforges et al., 2018). The same applies to seabed habitats (ETC/BD, 2012; OSPAR, 2017a; Helcom, 2018a). In addition, ocean warming (EEA 2016a), acidification (Fabry et al., 2008; NOAA, 2013) and deoxygenation (Carstensen et al., 2014; Breitburg et al., 2018; Schmidtko et al., 2017) continue to worsen.

These last examples indicate that various trophic levels could be impacted, which implies that the resilience of Europe's seas could be degrading and so significant systemic changes may be under way. Given the sometimes long response time for species to recover, e.g. 25-30 years for white-tailed eagle (Figure 6.1), or the even longer time taken for some trends in pressures on the ecosystem to reverse, e.g. eutrophication (Murray et al., 2019), the outlook for 2020 remains bleak. Therefore, marine ecosystems continue to be at risk, which could undermine the sea's capacity to supply the ecosystem services upon which humanity depends.

6.3.2
Pressures and their impacts
► *See Table 6.3*

Europe's seas and their ecosystems are perceived as the last wilderness with a large potential for increased exploitation. In reality, they are under various pressures from multiple human activities even in remote marine areas. Each human activity causes several pressures that often overlap (Jackson et al., 2001), and these overlapping pressures can cause cumulative adverse effects on marine ecosystems (Halpern et al., 2008; Micheli et al., 2013). But how to deal with these cumulative impacts has not yet been fully captured in management or planning processes.

Contaminants

Hazardous substances above agreed threshold levels are found across all of Europe's seas. While concentrations of specific substances and/or groups of substances have declined, some heavy metals and persistent substances are still found at elevated levels, at which — in the case of persistent substances, such as PCBs, or heavy metals, such as mercury — achieving politically agreed targets is jeopardised (Table 6.1). Furthermore, new substances are being developed and marketed faster than before. These may or may not pose a future threat (EEA, 2019b).

Contaminants in the marine environment can cause adverse effects on marine species but also potentially have an impact on human health (Chapter 10). For example, phthalates can cause reduced fertility in humans and they have been found in high concentrations in Europe's seas: from Bergen, Norway, to the German Bight, North Sea (AMAP, 2017). One phthalate (DEHP, or diethylhexyl phthalate) is listed as a priority substance under the EU Water Framework Directive (WFD), illustrating some of the existing

The impacts of eutrophication on the marine environment and its ecosystems remain a problem in some European marine regions.

efforts to reduce people's exposure to such substances (EU, 2000). Other substances, such as dioxins, have been recorded in oily fish, such as herring or salmon, in the Baltic Sea (Vuorinen et al., 2012). This has caused health authorities to advise restricting consumption of fish from the affected areas, especially by pregnant women. Dioxin can disrupt growth, cause cancer or adversely affect the immune system (Livsmedelsverket, 2018).

Eutrophication

Eutrophication, linked to nutrient pollution, remains a problem in some European marine regions. The forthcoming EEA assessment of eutrophication indicates that nutrient levels exceed threshold values in 40 % of the assessed sites.

Nutrient inputs have been reduced, but the Baltic Sea and the Black Sea remain eutrophic (Andersen, et al., 2017; Yunev et al., 2017). Thus, despite significant decreased inputs of nitrogen and phosphorus, more than 97 % of the Baltic Sea is still eutrophic (Helcom, 2018a) (Figure 6.2). Model results show that one Baltic basin may be non-eutrophic by 2030 or 2040 and more areas will have joined it by 2090. The Baltic Proper and Bothnian Sea may reach good eutrophication status only around 2200, and two areas may not be affected by eutrophication at all (Murray et al., 2019).

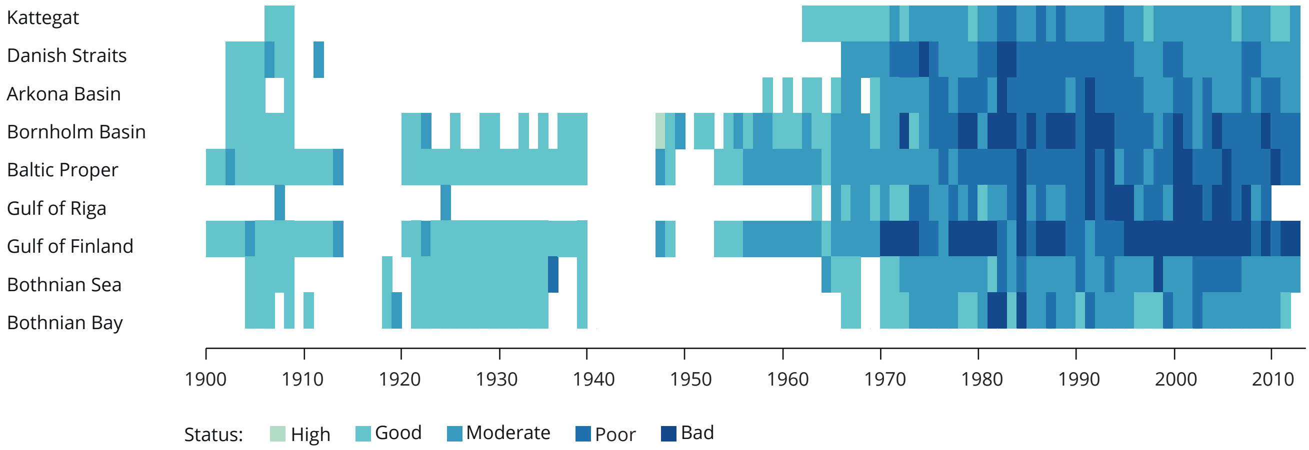
In the Black Sea, reduced nutrient inputs have translated into a 15-20 % reduction in primary production compared with 1992 levels. However, it remains mesotrophic compared with the pre-1960s oligotrophic levels, i.e. still eutrophic (Yunev et al., 2017).

Coastal water assessments under the WFD (EEA, 2018a) indicate that 55 % of the coastal waters assessed achieve its good ecological status objective regarding phytoplankton conditions (reflecting eutrophication status) as they are in either high or good status, although outcomes vary among EU marine regions. Good or high status is observed in the coastal waters of the Celtic Seas and the Bay of Biscay, the Macaronesian and most of the Mediterranean Sea. In contrast, 85 % and 76 % of the coastal waters assessed under the WFD in the Black and Baltic Seas were in less than good status, respectively. Nutrient inputs from point sources have significantly decreased, but inputs from diffuse sources have not, and the use of agricultural mineral fertilisers has even increased in some areas (EEA (forthcoming), 2019). Agriculture is the major driver of diffuse pollution with the highest inputs of nutrients and organic matter into aquatic environments (Chapter 13). The main driver of point source pollution is still urban waste water treatment and storm overflow (EEA, 2018c).

Reduced oxygen in seawater

Hypoxia is the extreme symptom of eutrophication, and deoxygenation is an increasing global challenge in coastal and open waters (Carstensen et al., 2014; Breitburg et al., 2018). It is a severe threat not only to the living conditions of biota but also for

FIGURE 6.2 **Long-term trends in eutrophication in the Baltic Sea**



Note: Long-term spatial and temporal trends are assessed for nine sub-basins of the Baltic Sea for the period 1901-2012 based on the HEAT multi-metric indicator-based tool and a broad range of *in situ* measured indicators.

Source: Andersen et al. (2017).

attempts to reverse the eutrophication process. Hypoxia in near-bottom water releases sediment-bound phosphorus in a readily utilisable form and enhances eutrophication, which may lead to a feedback loop (EEA (forthcoming), 2019). Deoxygenation may be exacerbated by increases in sea temperature (Carstensen et al., 2014; Breitburg et al., 2018).

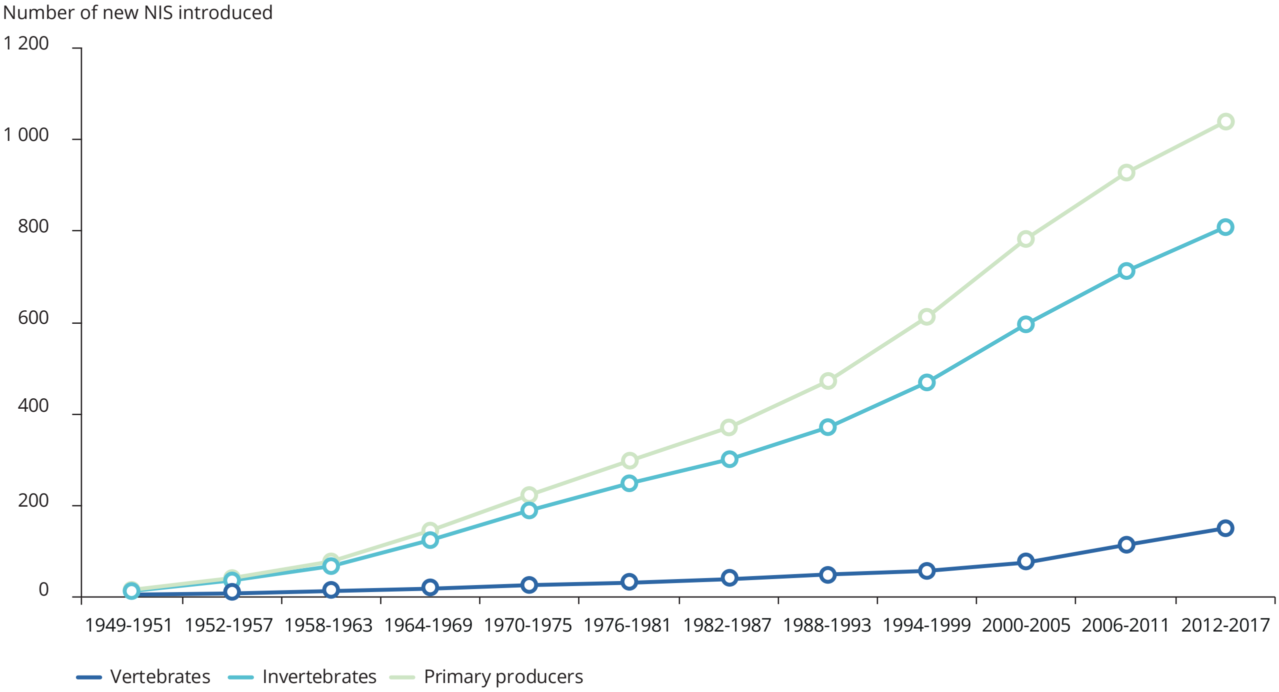
Widespread oxygen depletion occurs in the Baltic and Black Seas, although it is partly due to natural conditions (stratification) (EEA (forthcoming), 2019). The lower water layers of the Black Sea are naturally permanently anoxic, but the depth of the surface oxygenated layer has decreased from 140 m in 1955 to less than 80 m in 2016 (von Schuckmann, et al., 2016; Capet, et al., 2016). In the Baltic Sea, there was a 10-fold increase in the perennially hypoxic area during the 20th century, i.e. from 5 000 km^2 to > 60 000km^2 (Carstensen et al., 2014). In the Baltic Sea coastal zone, hypoxia has been steadily increasing since the 1950s (Conley et al., 2011). However, significant reductions in nutrient loads into the Baltic Sea in the last couple of decades have slowed the expansion of hypoxia, but the trend has not yet been reversed (Carstensen, 2019).

In the Greater North Sea, reduced oxygen concentrations are observed mainly at some stations in fjords in Denmark and along the Swedish and Norwegian coasts. Concentrations decreased at 9 % of the stations during the period 1990-2017, mainly in Danish fjords and at some points in the German Bight (EEA (forthcoming), 2019).

Fisheries

Commercial fisheries cover large areas of Europe's seas and are considered one of the human activities with the highest impact on the marine environment (Micheli et al., 2013; FAO, 2016; OSPAR, 2017b). Historically, many commercial fish and shellfish stocks have been overexploited, sometimes to the point that it may affect their reproductive capacity and, thus, their potential to recover from exploitation. Decreased fishing pressure in the North-East Atlantic Ocean and the Baltic Sea in recent years has led to signs of recovery of many stocks, meeting policy targets for fishing mortality or reproductive capacity or both in 2017 (EEA, 2019c). In contrast, most of the assessed stocks in the Mediterranean Sea (93.9 %) and Black Sea (85.7 %) were subject to overfishing in 2016 (EEA, 2019c; Section 13.3 in Chapter 13). A similar pattern is observed by Froese et al. (2018)) when looking across 397 stocks found in the Black Sea, Mediterranean Sea, Baltic Sea and the North-East Atlantic Ocean over the period 2013-2015. The abundance of sensitive species (sharks, rays, and skates) decreased by 69 % in heavily trawled areas (Dureuil et al., 2018). Bycatch of marine mammals, seabirds and non-commercial fish is still a major threat (OSPAR, 2017b).

FIGURE 6.3 Cumulative number of non-indigenous species in Europe's seas



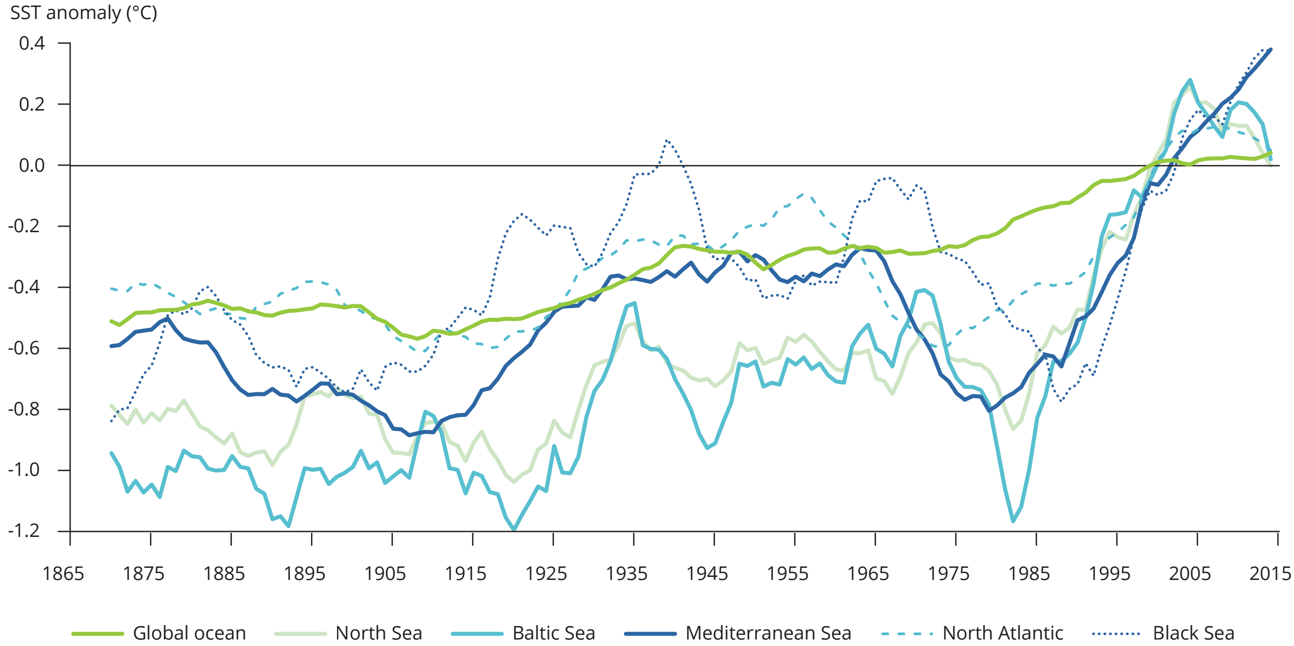
Note: Data file: MAR002_Trends in MAS_DATA-METADATA_v2.15.12.18.

Source: EEA (2015e).

Hydromorphological and other physical pressures

About 28 % of Europe's coastline is affected by pressures causing changes in hydrographic conditions, e.g. in seawater movement, temperature and salinity, according to the hydromorphological pressure assessments made in coastal waters under the WFD. Coastal developments modify natural hydrological conditions and impact habitats where hydrographical pressure is highest in the coastline of the Mediterranean and Black Seas. Reporting under the WFD also determined that about 19 % of the EU coastline is affected by permanent physical alterations in seabed habitats consistent with pressure from physical loss and due to, for example, urbanisation, port facilities, boating, flood protection infrastructures and land reclamation (EEA, 2019a) . In addition, about 25 % of the area of the coastal strip (up to 12 nautical miles from shore) is subject to seabed habitat loss due to construction of, for example, wind farms, oil and gas installations and ports, as well as exploitation of, for example, fish, shellfish and minerals. In offshore waters (from 12 to 200 nautical miles from shore), less than 3 % of seabed habitats are considered lost, although the extent of seabed habitat loss is region specific and highest in the Baltic Sea, where it affects 14 % of the seabed (ETC/ICM, unpublished data). In addition, about 16 % of Europe's seabed is under pressure from physical disturbance, which is mainly caused by bottom trawling and by shipping in shallow waters. Overall, 14 % of Europe's seabed was trawled at least once during the period 2011-2016, although this figure increases to 32 % when focusing on the coastal area (up to 12 nautical miles from shore). Up to 86 % of the Greater North Sea and Celtic Seas' seabeds have been physically disturbed by bottom trawling, of which 58 % is highly disturbed. Up to 40 % of seabed habitats in the Baltic Sea are physically disturbed and this is much higher in the sub-basins where bottom trawling is practised (OSPAR, 2017b; Helcom, 2018a). Shipping in shallow waters causes pressure from physical disturbance in 10 % of Europe's seabed overall, although regional extents can be much higher, reaching 57 % in the Baltic Sea (ETC/ICM, unpublished data).

FIGURE 6.4 Average sea surface temperature (SST) anomaly (running average over 11 years)



Note: Time series of annual average sea surface temperature (°C), referenced to the average temperature between 1993 and 2012, in the global ocean and in each of the European seas. Data sources: SST data sets from Copernicus Marine Environment Monitoring Service (Mediterranean Sea) and the Hadley Centre (HADISST1; global and other regional seas).

Source: EEA (2016b).

Non-indigenous species

All Europe's seas suffer from the introduction of non-indigenous species (NISs), with the highest number of introductions in the Mediterranean Sea. Currently, at least 1 223 marine NISs have been recorded. NISs appear to be introduced at a relatively constant rate (Figure 6.3) (EEA, 2019d). The main pathway of introduction is maritime transport, responsible for more than 50 % of NIS transfer via ballast water, tank sediments, hull fouling, corridors and other vectors (Tsiamis et al., 2018; EEA, 2019d) . The European sea with the highest pressure from NISs is the Mediterranean (Tsiamis et al., 2018). NISs are currently established in approximately 8 % of Europe's sea area. Of these, 81 NISs belong to the group most impacting species; these have the highest invasive potential. These invasive alien species are found across all of Europe's seas.

> 8 million
>
> tonnes of plastic waste ends up in the ocean every year putting pressure on the marine environment and its ecosystems.

Marine litter

Marine litter puts pressure on all marine ecosystems. For example, 8 million tonnes of plastic ends up in the ocean every year (EEA, 2018b). Plastic items are the most abundant and damaging components of marine litter because of their persistence, accumulation and toxicity, and they can have physical, chemical and biological impacts on marine biodiversity. Plastics constitute up to 95 % of the waste that accumulates on shorelines, the sea surface and the sea floor. The majority of plastic litter items are packaging, fishing nets and small pieces of unidentifiable plastic or polystyrene (Pham et al., 2014). Litter pollution harms marine animals through entanglement, clogging their digestive systems (following ingestion) and physiological changes, although the effects at population level are still not well investigated. Land-based sources contribute the largest proportion of litter, which is mostly transported by rivers or

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TABLE 6.3 **Summary assessment — pressures and impacts on marine ecosystems**

Past trends and outlook		
Past trends (10-15 years)		Where targeted management measures to address well-known pressures have been implemented consistently, negative trends are beginning to reverse, e.g. in nutrients and some contaminants. However, this success is only partial, as many trends in pressures have not changed. The underlying climatic drivers of marine ecosystem degradation appear not to be improving, as related pressures, such as sea surface temperature and ocean acidification, are worsening. The same is true of deoxygenation.
Outlook to 2030		Legacy hazardous substances and heavy metals, non-indigenous species, and marine litter will continue to impact marine ecosystems. Ocean acidification, deoxygenation and sea surface temperature all have worsening trajectories. The use of marine resources and space is expected to increase. Meeting agreed policy goals for the marine environment across all policies and mitigating climate change are essential to preventing further damage and/or achieving full recovery of marine ecosystems, preserving their long-term resilience and changing the outlook to 2030.
Prospects of meeting policy objectives/targets		
2020	☒	EU marine regions are at risk of not achieving the Marine Strategy Framework Directive's good environmental status for key pressures such as those on commercially exploited fish and shellfish stocks (in the Mediterranean and Black Seas), introductions of non-indigenous species, eutrophication, contaminants and marine litter by 2020.
Robustness		There is large variation in the availability of pressure-related information across marine regions and gaps in the data remain. Monitoring of key pressures should be improved and assessment threshold values established. Formal reporting of progress in the implementation of EU marine environmental legislation is often delayed and/or inadequate. The available outlook information is limited, so the assessment of outlook relies primarily on expert judgement.

directly discharged from coastal activities, e.g. tourism. The main marine sources of litter are fisheries, aquaculture and shipping (ETC/ICM (forthcoming), 2019).

Underwater noise

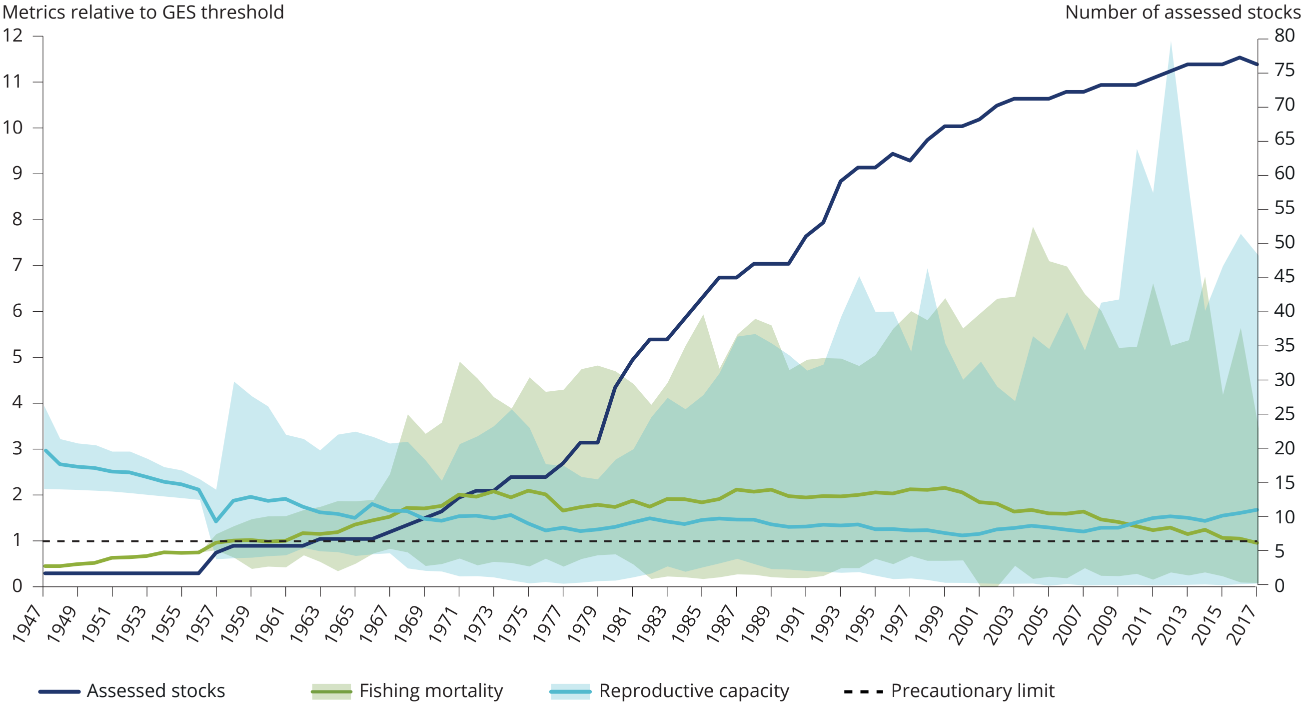
Underwater noise is a geographically widespread pressure. In the absence of a methodology for operational monitoring and of assessment thresholds, the severity of its effects on marine life cannot be determined. Anthropogenic sounds can lead to continuous underwater noise (mainly from marine traffic) and impulsive underwater noise, which is short pulses with high energy levels (arising mainly from impact pile driving, seismic exploration, explosions and sonar systems). The sources and spatial distribution of continuous and impulsive underwater noise are starting to be analysed in order to characterise the potential exposure of marine ecosystems to this pressure. According to the scientific literature, both types of underwater noise can affect marine animals, e.g. marine mammals, in various ways, ranging from changes in behaviour to death (ETC/ICM (forthcoming), 2019).

> Achieving the Marine Strategy Framework Directive's good environmental status across all EU marine regions remains unlikely by 2020.

Climate change

Anthropogenic climate change is a pressure causing changes to, for example, the temperature and acidity (pH) of Europe's seas. These have all warmed considerably since 1870, and this warming, which has been particularly rapid since the late 1970s, continues (Figure 6.4). Ocean surface pH has declined from 8.2 to below 8.1 over the industrial era and continues to do so (EEA, 2016a). Global mean sea level rose by 19.5 cm from 1901 to 2015, at an average rate of 1.7 mm/year, but with significant decadal variation. The rise in sea level relative to land along most European coasts is projected to be similar to the global average, with the exception of the northern Baltic Sea and the northern Atlantic coast (EEA, 2017). Whole marine ecosystem responses to these changes are largely unknown, although effects on individual species or species groups have been observed or projected (Fabry et al., 2008; NOAA, 2013; EEA, 2017). For example, in more acidic and food-limited conditions, cod larvae may experience reduced functionality or impairment of their organs as they expend more energy on growth and ossification of their skeletal elements (Stiasny et al., 2019). Impacts from seawater warming include the replacement of cold water species with warm water species, as observed in

FIGURE 6.5 **Trends in the number of assessed commercially exploited fish and shellfish stocks in the North-East Atlantic Ocean and Baltic Sea since 1945 and in the progress of these stocks towards achieving the MSFD's 'good environmental status' for descriptor 3, 'Commercial fish and shellfish', on the basis of their mortality and/or reproductive capacity**



Notes: This figure shows trends in the status of commercially exploited fish and shellfish stocks assessed between 1946 and 2016 expressed as two metrics: fishing mortality (F) and reproductive capacity (i.e. spawning stock biomass, SSB) relative to the MSFD thresholds for good environmental status (GES). These thresholds relate to the stocks' maximum sustainable yield (MSY), i.e. F_{MSY} and MSY $B_{trigger}$ (the biomass at the lowest level of the range around SSB_{MSY} able to produce MSY), respectively. For fishing mortality, 1 is the value ($F = F_{MSY}$) above which exploitation is unsustainable, while for reproductive capacity a value of 1 is a precautionary limit (SSB ≥ MSY $B_{trigger}$) below which there is a high risk that reproductive capacity will be impaired. The figure is based on 83 fish stocks in the North-East Atlantic Ocean and Baltic Sea for which F and/or SSB could be calculated against reference points in the period 1946-2016, i.e. stocks for which adequate information exists at the regional level to calculate one or the other metric or both. Both F/F_{MSY} and SSB/MSY $B_{trigger}$ could be calculated only for a maximum of 74 stocks. Note that the value of the metrics is determined by an increasing number of stocks and, therefore, part of the trend may be explained by new stocks being introduced into the analysis over the years. However, from 2013 onwards, the suite of stocks assessed remained stable.

Source: EEA (2019c).

copepods and fish in the North-East Atlantic Ocean (EEA, 2017). Sea level rise and the increased frequency of storm events add to the coastal squeeze and may have potentially severe effects (Gynther et al., 2016).

Marine ecosystems affected by climate change may also become more vulnerable to other anthropogenic pressures (ETC/ICM (forthcoming), 2019); Breitburg et al., 2018).

These assessments indicate that targeted management measures can serve to reduce pressures when the pressure-impact causality is clear and strong. They also indicate that, overall, management measures have either not yet taken effect or are insufficient to prevent, reduce or reverse marine ecosystem impacts or that they are not effective in the context of multiple pressures and cumulative impacts upon them. This implies that the resilience of Europe's seas could be degrading and so significant systemic changes may be under way.

6.3.3
From the past to the future — Europe depends on the seas

▶ *See Table 6.4*

Oceans and seas have been the foundation for the development of European societies

TABLE 6.4 Summary assessment — sustainable use of the seas

Past trends and outlook		
Past trends (10-15 years)		The use of Europe's seas continues to increase, with some established sectors declining or stagnating while new sectors are emerging. This puts marine ecosystems at risk and could undermine the sea's capacity to supply ecosystem services.
Outlook to 2030		It is envisaged that the use of Europe's seas will continue to increase in the light of the blue economy objectives. There is a mixed pattern of development for individual sectors. For example, oil and gas extraction has peaked in the North Sea, but offshore wind is growing. As competition for marine resources and space increases, coordination among stakeholders and policy integration will be needed to ensure that activities are sustainable.
Prospects of meeting policy objectives/targets		
2020	☐	Significant progress has been made in reaching maximum sustainable yields for commercially exploited fish and shellfish stocks in the North-East Atlantic Ocean and Baltic Sea. However, most assessed stocks in the Mediterranean and Black Seas are still overfished. Although commercial fisheries are very widespread and have a high impact, they represent just one of the uses of the sea. This means that other policy targets could be at risk from other uses and the cumulative impacts of multiple pressures.
Robustness		There is large variation in the availability of sector-related information across sectors and marine regions and gaps in the data remain. The available outlook information is limited, so the assessment of outlook relies primarily on expert judgement.

throughout history, and the mutually supportive relationship between oceans and humans has never been more widely recognised than it is today.

The maritime economy, often referred to as the 'blue economy', is a powerful driver of socio-economic growth in the EU. It is estimated that global maritime-related activities have an output of EUR 1.3 trillion — a figure set to double by 2030 (EC, 2017). Maritime activities include both traditional sectors, such as fishing, shipping, tourism and extracting resources, and emerging sectors, such as offshore wind, aquaculture and deep-sea mining (EU, 2017, 2014), as well as new ocean infrastructures, e.g. floating nuclear plants. All of these activities compete with each other for the use of marine resources and space. One of the solutions for realising the untapped potential of the seas will be ensuring that maritime spatial planning fully supports the achievement of good environmental status.

Of the more traditional uses of the seas, fisheries have faced significant challenges over the last couple of decades and have had significant impacts on the marine environment and coastal communities. In recent years, more assessed commercially exploited fish and shellfish stocks have been fished sustainably, i.e. at maximum sustainable yield, in the North-East Atlantic Ocean and Baltic Sea. Signs of recovery of the reproductive capacity of some of these stocks are also being seen (Figure 6.5; Chapter 13). Very few assessed stocks in the Mediterranean Sea (6.1 %) and Black Sea (14.3 %) are currently on track to being exploited at maximum sustainable yield (FAO, 2018; Froese et al., 2018; EEA, 2019c). In fact, in these seas there is 'no trend, to indicate any improvement in the exploitation since the implementation of the 2003 reform of the [common fisheries policy]' (Jardim et al., 2018, p. 48).

> **93.9 %**
>
> of assessed commercial fish and shellfish stocks in the Mediterranean Sea and 85.7 % in the Black Sea are still overfished.

Shipping, including maritime transport, has also been an important maritime activity for centuries. With the rise of globalisation and access to new markets, shipping traffic soared from the 1950s until the economic crisis in 2008 (WOR, 2010). In 2016, roughly 3 860 million tonnes of goods and commodities were handled in EU Member State (EU-28) ports, while passenger visits amounted to over 383 million people (EEA, 2016c; Eurostat, 2017). The sector contributes an estimated EUR 70 734 million in gross value added to Europe's economy, employing roughly 1.74 million people (COGEA et al., 2017).

Some industries, such as oil and gas extraction, are stagnating and declining in some regions, while other industries are emerging. An example of the latter

TABLE 6.5 Summary assessment — marine protected areas

Past trends and outlook		
Past trends (10-15 years)		In the period 2012-2016, the extent of marine protected areas (MPAs) almost doubled within EU marine waters to an area equal to that designated in the period 1995-2011.
Outlook to 2030		The challenge to ensure that EU MPA networks are coherent, representative and well-managed remains to deliver tangible benefits for biodiversity by 2030.
Prospects of meeting policy objectives/targets		
2020	☑	In 2018, the EU had met part of Aichi biodiversity target 11 and Sustainable Development Goal 14.5 relating to designating 10 % of its seas within networks of MPAs. Whether the MPA network will deliver measurable benefits for biodiversity remains to be documented.
Robustness		There is good information available on the spatial coverage of MPAs. There is little information available on how effective management measures are inside MPAs and, thus, whether they are as effective in protecting marine biodiversity as they could/should be.

is the offshore wind industry's continued expansion into marine territory. Europe's installed offshore capacity reached 15 780 MW (= 4 149 grid-connected wind turbines) in 2017, the year by which 11 European countries had established 92 wind farms (including those under construction). Most of these are found in Denmark, Germany, Sweden and the United Kingdom (4C Offshore, 2018). Turkey has announced its intention to build first offshore windfarm projects as candidate renewable energy resource zones in the Aegean Sea, the Sea of Marmara and the Black sea.

Similarly, tourism is on the rise. Between 2006 and 2016, EU-28 (foreign) tourist arrivals increased by approximately 60 % (Eurostat, 2018). In 2014, Europe's coastal tourism accounted for 24.5 % of the EU's maritime economy, generating over EUR 86 436 million in gross value added (direct and indirect) and employing over 3.1 million people (COGEA et al., 2017). Such increases in tourism are dependent upon healthy coastal and marine ecosystems and simultaneously put pressure upon them.

Overall, the seas provide resources and space for a wide variety of human activities generating economic value as well as social and cultural benefits. As competing activities continue to increase, so will the cumulative impact on ecosystems already affected by centuries of use. Such expected growth, combined with the potentially degrading resilience of the ecosystems of Europe's seas, highlights the need for ecosystem-based management more than ever if Europe's seas and their limited resources are to be used in a sustainable manner.

The EU seas covered by the network of marine protected areas almost doubled from 2012 to 2016.

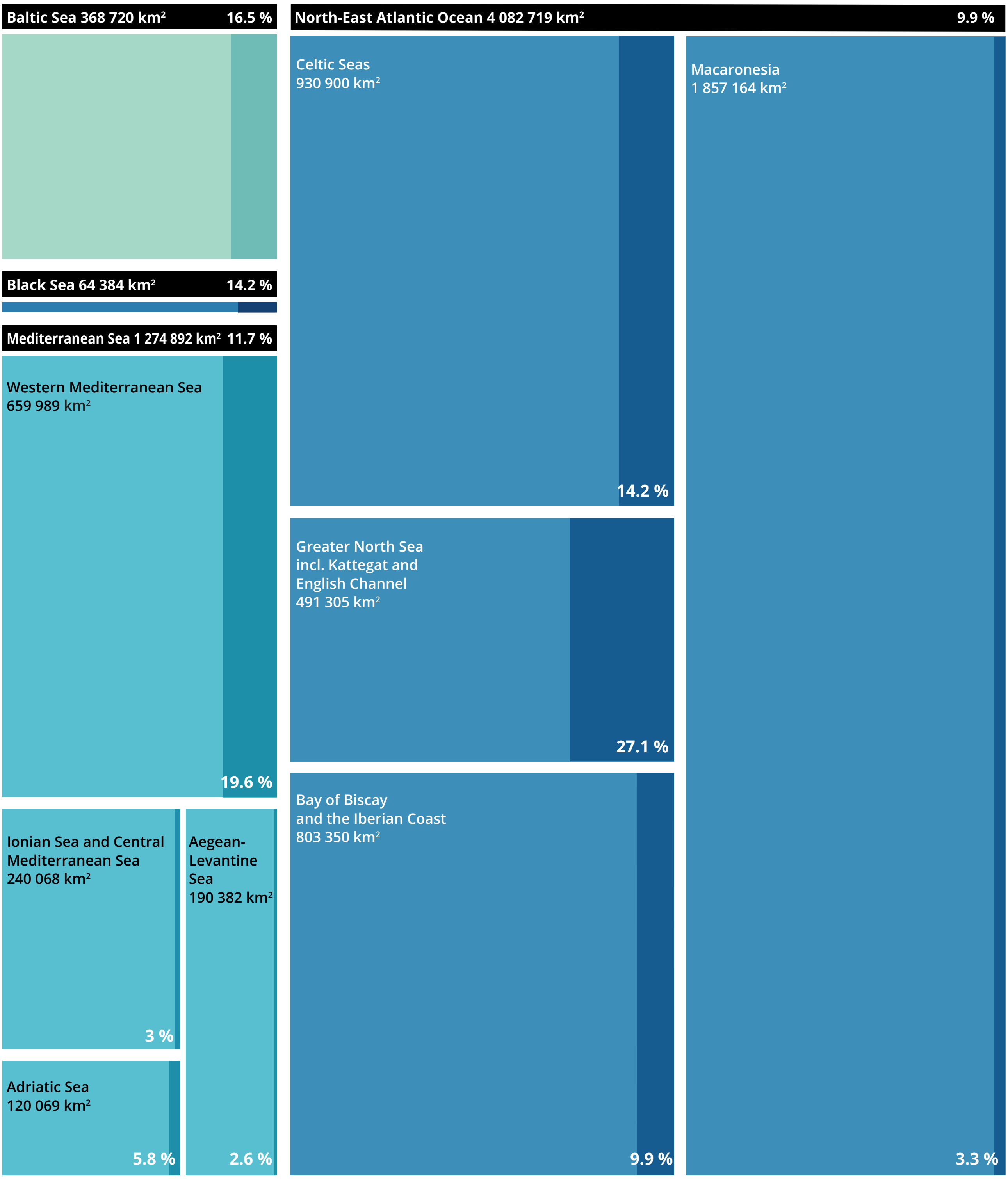
6.3.4
Marine protected areas — significant progress has been made

►See Table 6.5

Marine protected areas (MPAs) and networks of MPAs are a key measure for protecting the marine biodiversity of Europe's seas (EU, 2008a). MPAs are geographically distinct zones for which protection objectives are set. They constitute a connected system for safeguarding biodiversity and maintaining marine ecosystem health and the supply of ecosystem services. Networks of MPAs operate together at various scales and cover a range of protection levels, which work towards objectives that individual MPAs cannot achieve (EEA, 2015a, 2018c).

Approximately 75 % of EU MPAs are sites designated under the EU Habitats Directive (EEC 1992; Chapter 3) and the EU Birds Directive (EEC, 1979). These are an important element of the Natura 2000 network of protected sites — the largest coordinated network of protected areas in the world (EEA, 2018c). The remaining MPAs are sites designated only under national legislation (Agnesi et al., 2017). The next step is to make the Natura 2000 network coherent and representative ensuring adequate coverage of the diversity of the constituent ecosystems, in line with Article 13 of the MSFD.

FIGURE 6.6 **The EU part of the regional sea surface area (km²) and the area covered by MPAs in 2016**



Note: The quadrants illustrate the relative size of the EU part of each regional sea as well as the proportion of MPAs within them. The dark shading indicates the area covered by MPAs and the percentages are given in figures.

Sources: Agnesi et al. (2017) and EEA (2018c).

From 2012 to 2016, the EU almost doubled its network of MPAs. By 2018 it had reached Aichi biodiversity target 11 — protecting at least 10 % of its sea area within MPAs (United Nations, 2015) — albeit with some variation between the marine regions. Five out of 10 regional seas are still short of reaching the target of 10 % coverage of MPAs (EEA, 2018c; Figure 6.6).

With an entire MPA network designated across the marine territories of 23 EU countries, the next step is to ensure that they deliver the best possible benefits for marine biodiversity. This includes actions such as accurately measuring the degree to which MPAs and the network as a whole are achieving their intended purpose, including general protection of marine biodiversity (see also EEA (2018c)). It has been demonstrated that European MPA networks are being affected by commercial fisheries more than unprotected areas, which raises questions about the true benefit of the MPA network (Dureuil et al., 2018).

However, the establishment of MPA networks in EU waters remains a success story, showing the types of achievements that are possible when countries work towards a common goal, such as halting the loss of biodiversity. However, management efforts need to be improved.

6.4 Responses and prospects of meeting agreed targets and objectives

Overall, EU policy is set for both the long-term recovery and the sustainable use of Europe's seas. However, while the policy framework is among the most ambitious and comprehensive in the world, some of its objectives and goals, or variants thereof, have been in place for decades. These include the ambitions to cease emissions of hazardous substances, to achieve sustainable fisheries, and to establish a representative, coherent network of well-managed MPAs.

> Knowledge gaps remain in relation to the availability of quality information to evaluate progress.

Some targeted management measures, or other legal obligations, resulting from EU policy have been fully implemented and have been successful in reducing, or even removing, some well-known marine pressures. Other measures/obligations have not been implemented or implemented only in part and/or slowly and with limited success. The latter could also be because there is a time lag between implementing a strong pressure-impact causality measure and its having an effect. Furthermore, it could also be because the measures were not designed to deal with multiple pressures and their cumulative impacts. There are also large differences in progress in achieving policy targets within and between EU marine regions (e.g. Figure 6.6). Challenges remain with regard to the amount and quality of information available to evaluate progress. For example, no Member State had adequately reported the up-to-date state of its marine waters by the October 2018 deadline required by the MSFD. In addition, while Member States have established a few new measures, as well as measures integrating policy needs across several policies when implementing the MSFD, certain pressures are still addressed through fragmented, ineffective approaches.

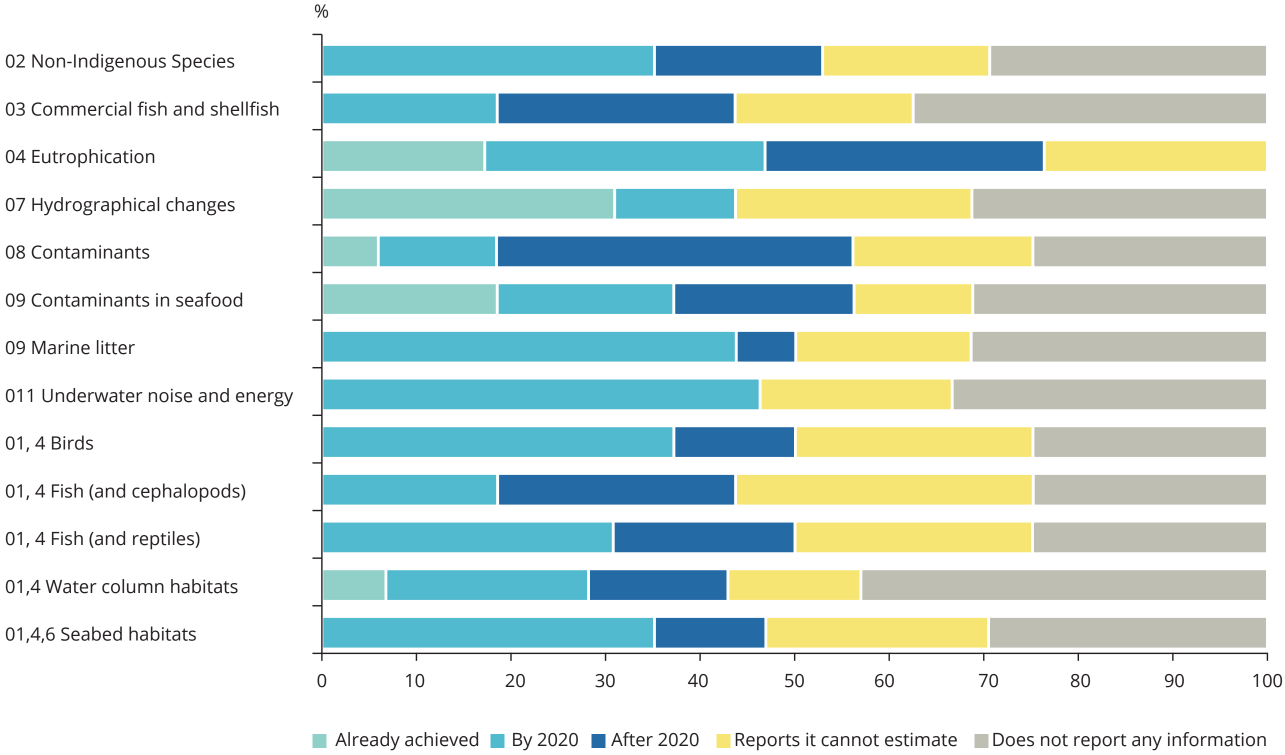
As a result, there seems to be a risk that the measures currently implemented across all policies are not sufficient to achieve the MSFD's good environmental status by 2020. The risk extends to whether they will be able to mitigate the additional adverse effects of the expected increase in maritime activities in forthcoming decades. The risk is compounded by having to achieve both good environmental status and the ambitions of the EU's blue growth strategy in a climate change context.

With many long-term policy commitments coming to fruition in the period 2018-2021, now is the time to make the most of the EU marine policy framework, including reflecting on what should be done differently in the next decade if the EU wants to achieve its long-term vision for clean, healthy, resilient and productive seas.

The implementation of this framework shows, at best, a mixed picture. There are several positive examples of recovery of specific biodiversity features across Europe's seas, reversing increasing pressure trends, and improved sustainability of some uses of the sea. However, these partial successes seem barely to register against the observed continued degradation and the expected increased use of the sea, as well as the observed and forecast worsening of climate change impacts on Europe's seas.

Overall, it seems that the knowledge and political vision to facilitate a change are available, but the question of whether Europe has the necessary resolve to act quickly and effectively enough remains. The root of most problems suffered by Europe's seas is not only the low rate and slow speed of policy implementation but also because there seems to be poor coherence and coordination between all the policies aiming to protect them. Thus, policymakers should all work towards ensuring that the limits to the sustainable use of Europe's seas, represented by achieving good

FIGURE 6.7 **Timelines for achieving good environmental status as reported by Member States**



Note: Member States integrated national, EU and international policies during their implementation of the MSFD to identify existing management measures and gaps in current management. New or additional measures were assigned to fill the gaps identified to address all relevant pressures on the marine environment. Assessment showed that many pressures had not been addressed in existing legislation and that additional efforts will be needed to achieve good environmental status. The timelines for achieving good environmental status therefore vary among topics.

Source: EC (2018a).

environmental status under the MSFD, are respected. Currently, some policies are giving an impetus for growth that does not seem to fulfil this premise.

When assessing the programmes of measures established under the MSFD, the European Commission concluded that, while EU Member States have made considerable efforts, it appears unlikely that good environmental status will be achieved by 2020 (Figure 6.7), as concluded in the present assessment. One of the reasons is that 'certain pressures of transboundary nature, the lack of regional or EU coordination potentially leads to a fragmented and ineffective approach to tackling the pressure' (EC, 2018a).

In conclusion, there may be less of a need to come up with specific new policies, or legislative initiatives, or to reiterate existing deadlines to meet legislation/policy, but rather a need to focus efforts on implementing and integrating existing policies and on fulfilling the intentions behind several thematic policy visions. In this respect, it seems that Europe is still learning: (1) about the limits to the sustainable use of its seas; and (2) how to address challenges of a transboundary or ecosystem-based nature.

A lot has been achieved since Europe first became aware of the effects of pollution on the marine environment, on marine biodiversity and on human health. However, ensuring that Europe's seas keep on supplying the ecosystem services upon which people's basic needs and well-being, and the economy, depend requires managing the unprecedented amount of human activities that are competing to use them — and to do so in the context of climate change. This will entail improved policy integration and a firm commitment to implementing already existing policies as well as increasing cooperation within Europe and with its neighbours.